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The Impact of County Level Characteristics on Type 2 Diabetes Related ED Utilization

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THE IMPACT OF COUNTY LEVEL CHARACTERISTICS ON TYPE 2 DIABETES RELATED ED UTILIZATION

BY

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A doctoral project submitted to the faculty of the Medical University of South Carolina
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THE IMPACT OF RURALITY ON DIABETES RELATED ED USAGE

BY

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Chair, Project Committee	Mary Dooley, PhD	Date
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Abstract of Dissertation Presented to the
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Approximately 90-95% of the more than 37 million American adults who are living with diabetes have type 2 diabetes. Additionally, those living in rural areas face poor health outcomes related to chronic diseases such as diabetes. The impact of factors related to social determinants of health such as the role of rurality and social vulnerability were described by examining county diabetes related Emergency Department (ED) visit rates for adults aged 18-25 living in North Carolina. No difference in county level diabetes related ED visits were observed between rural counties vs. nonrural counties in the state. However, patterns did emerge in county level diabetes related ED visit rates. Higher ED visit rates were observed in counties having a social vulnerability index (SVI) of 90% or greater, indicating high social vulnerability. Therefore, future research should focus on factors contributing to higher ED visit rates for this study population living high SVI counties which could lead to policy development and targeted health programming.

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CHAPTER I INTRODUCTION

1.1 Background and Need

In the United States, there are over 37 million adults living with diabetes and nearly 7 million individuals are unaware that they have the condition (Centers for Disease Control and Prevention, 2022). Approximately 90-95% of those living with diabetes have type 2 diabetes (T2DM) (Centers for Disease Control and Prevention, 2022). The prevalence of diabetes continues to rise, increasing from 9.5% in the period from 1999-2002 to 12% in the period from 2013-2016 (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). For Americans living with diabetes, the costs associated with the disease can be quite burdensome. In 2017, the estimated direct and indirect costs associated with diabetic care was $327 billion (National Institute of Diabetes and Digestive and Kidney Diseases, 2018).

Though only 15% of the U.S. population live in rural areas, these populations experience diabetes prevalence rates that are 17% higher than those living in more metropolitan areas (Tran, Tran, & Tran, 2019). Rural communities face poorer health outcomes due to higher rates of smoking, physical inactivity, obesity, unemployment, lower levels of educational attainment, uninsurance, and healthcare professional shortages (Tran, Tran, & Tran, 2019). Additionally, due to factors such as higher rates of uninsurance, lack of access to reliable transportation, long travel distances to specialty care and the remote geography of rural areas, lack of access to adequate healthcare services continues to be an issue (Rural Health Information Hub, 2021). In areas where healthcare access is limited, increases in ED usage are observed (Uppal, et al., 2022). According to a study examining sociodemographic differences in diabetes related ED usage by Uppal et al., rural ED usage for diabetes related causes was 34% higher than that of urban populations. (Uppal, et al., 2022).

1.2 Problem Statement

Individuals living in rural areas face poorer health outcomes with regard to chronic diseases, such as diabetes. Contributing to these poor health outcomes are factors such as barriers to access of healthcare due to a lack of health insurance coverage. Rural populations experience higher levels of uninsurance compared to their urban counterparts. Children younger than 18 years old and adults 65 and older are eligible for government coverage, however, young adults are vulnerable and experience more barriers to accessing adequate health services, making them more likely to be seen in the Emergency Department (Rural Health Information Hub, 2021). Along with rurality, the social vulnerability index (SVI), which measures the resiliency of communities when faced with natural disasters, serves as an indicator for health outcomes (Khan, et al., 2021). Using the social vulnerability index as an indicator for health outcomes has shown communities ranking higher on the SVI experiencing worse health outcomes (Khan, et al., 2021).

T2DM, which has historically been more likely to develop in adults over 45, is now on the rise in younger adults (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). Much of the existing research examining diabetes related ED usage in rural areas compared with urban areas does not compare differences between age groups. Studies such as that of Uppal et al., examine diabetes related ED usage in rural areas comparing differences between sociodemographic groups (Uppal, et al., 2022). Research has also examined the role that rurality plays on diabetes screening rates (Tran, Tran, & Tran, 2019). While these studies are important to help understand the impact that rurality plays on diabetes management and ED usage related to the disease, there is a need to examine this in the context of young adults aged 18-25 and with regard to SVI.

1.3 Research Questions

This study seeks to investigate the following research question:

1. What are the differences between county-level variations in T2DM related ED utilization among adults aged 18-25, living in counties in North Carolina?

1.4 Population

The population of study includes adult individuals aged 18-25 living in the state of North Carolina. Rurality and social vulnerability will be determined based on the patient's county of residence. This study utilized data from the Agency for Healthcare Research and Quality's Healthcare Cost Utilization Project (HCUP) database. The data accessed was NC specific Emergency Department data. The data represents all ED discharges that did not result in hospital admission and has been compiled from hospital affiliated EDs within the state.

2 CHAPTER II SCOPING LITERATURE REVIEW

2.1 Background

Diabetes is one of the most common chronic conditions in the United States, affecting over 37 million adults (Centers for Disease Control and Prevention, 2022). It is estimated that 90-95% of adults who have diabetes are living with Type 2 diabetes (T2DM) (Centers for Disease Control and Prevention, 2022). Diabetes is the seventh leading cause of death in the U.S. and is also the number one cause of blindness, kidney failure and amputations (Centers for Disease Control and Prevention, 2022). According to a 2017 report from the National Institute of Diabetes and Digestive and Kidney Disease, the condition is associated with higher levels of disability, medical office visits, hospitalizations, and premature death (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). It is estimated that each year diabetes costs the U.S. $327 million in expenses associated with healthcare and lost productivity (Tran, Tran, & Tran, 2019).

2.2 Diabetes

Diabetes occurs when an individual's blood glucose (blood sugar) levels are too high. The body breaks down food into glucose, causing blood sugar levels to rise. As a result, the pancreas releases the hormone insulin, which allows glucose to enter cells to be used for energy (Centers for Disease Control and Prevention, 2022). In T2DM, the body either does not make enough insulin or does not use insulin efficiently (insulin resistance) leaving excess amounts of sugar in the bloodstream (National Institute of Diabetes and Digestive and Kidney Disease, 2016). Currently, there is no cure for the condition but with lifestyle modifications such as increasing physical activity, following a healthy diet, losing weight, sticking to the recommended treatment plan, it is manageable.

Though diabetes is a common condition, there are certain individuals who are at increased risk. Individuals who are overweight, physically active less than three days a week, have prediabetes, or who have had gestational diabetes are at increased risk of developing T2DM (Centers for Disease Control and Prevention, 2022). Also among those at increased risk are adults 45 and older. However, in recent years it has been observed that more teens and young adults are being diagnosed (National Institute of Diabetes and Digestive and Kidney Disease, 2016). Genetic risk factors for developing T2DM include having a parent or sibling with diabetes or being African American, Hispanic/Latino, American Indian, or Alaska Native (Centers for Disease Control and Prevention, 2022).

Over time, prolonged exposure to high blood sugar levels causes damage to blood vessels and nerves, leading to complications (National Institute of Diabetes and Digestive and Kidney Disease, 2016). Individuals who have diabetes can develop heart disease and stroke. These individuals are two times more likely than individuals who do not have diabetes to have a stroke or heart disease (CVD) (National Institute of Diabetes and Digestive and Kidney Disease, 2016). Kidney Disease also referred to as Chronic Kidney Disease (CKD) is a common complication for individuals with diabetes and can lead to kidney failure which often requires a kidney transplant or regular dialysis treatments (National Institute of Diabetes and Digestive and Kidney Disease, 2016).

Other complications include nerve damage, eye disease and blindness, as well as gum and dental diseases. Prolonged high blood sugar levels can cause nerve conditions such diabetic neuropathy and issues with blood flow to the legs and feet (peripheral artery disease) (National Institute of Diabetes and Digestive and Kidney Diseases, 2018). These conditions can lead to the development of infections that result in the amputation of toes, portions of the feet, or legs

(National Institute of Diabetes and Digestive and Kidney Disease, 2016). The numerous complications associated with diabetes make the condition one of the leading causes of disability (National Institute of Diabetes and Digestive and Kidney Diseases, 2018).

2.3 Health Impacts of Living in Rural Areas

Compared to their urban counterparts, residents of rural areas face stark differences in their health outcomes (National Center for Chronic Disease Prevention and Health Promotion, 2019). Residents of rural areas have higher rates of cigarette smoking, physical inactivity, obesity, and high blood pressure (Rural Health Information Hub, 2022). These populations tend to be older as well (Rural Health Information Hub, 2022). Due to the prevalence of high-risk health behaviors observed in rural areas, these areas experience increased levels of multiple comorbidities and increased mortality related to these comorbidities, compared to those living in urban areas (Rural Health Information Hub, 2022).

In rural areas, the prevalence of T2DM is 17% higher than in urban areas (Tran, Tran, & Tran, 2019). According to Tran, Tran, and Tran, rural areas outpace urban areas in all variables that increase an individual's risk for developing T2DM. For example, 39.6% of rural Americans are overweight/obese compared to 33.4% of urban Americans and 42.4% of rural Americans are physically inactive as compared to 38.8% of urban Americans (Tran, Tran, & Tran, 2019).

With regard to the undeniable gap in health outcomes observed between rural and urban areas, several contributing factors have been identified. Sociodemographic factors such as age, race, income level, and educational attainment contribute to poorer health outcomes. Rural areas tend to have older populations with lower income and lower levels of education (National Center for Chronic Disease Prevention and Health Promotion, 2019). Individuals living in rural areas also tend to have limited access to healthy food options and supermarkets which directly impacts

the development as well as the management of several chronic illnesses (National Center for Chronic Disease Prevention and Health Promotion, 2019). Therefore, the lifestyle habits observed largely in rural areas are expected to contribute to an increase in the number of rural residents living with T2DM due to a variety of social, environmental, and clinical barriers (Tran, Tran, & Tran, 2019).

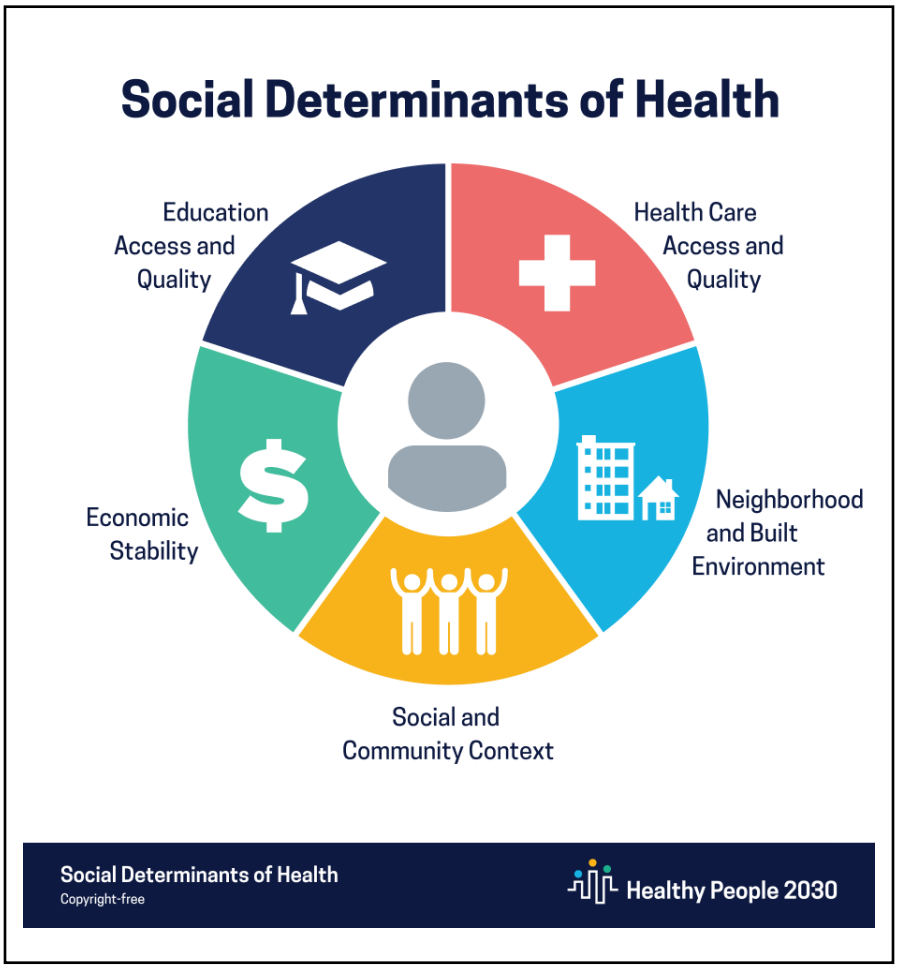
For example, residents of rural areas also face barriers when it comes to accessing adequate healthcare services. Residents of rural areas often have to travel long distances to access specialty care which can be costly, time consuming, and require time taken off work. Traveling long distances can also be burdensome to rural residents if they lack access to reliable transportation as well (Rural Health Information Hub, 2021). In rural communities, healthcare access is also impacted by healthcare workforce shortages, low health literacy and high levels of uninsurance (Rural Health Information Hub, 2021).

2.4 Social Context Related to Health Outcomes

Social Determinants of Health (SDOH) are defined as the conditions that individuals are born into as well as the environment in which they live, work, play, worship, and age (Office of Disease Prevention and Health Promotion, 2022). According to the Department of Health and Human Services, Office of Disease Prevention and Health Promotion, SDOH can be divided into 5 categories (Figure 1) which includes: neighborhood and built environment, economic stability, social and community context, access to quality health care and access to education and quality (Office of Disease Prevention and Health Promotion, 2022). All of these factors can impact an individual's health outcomes and quality of life. SDOH lead to inequities and disparities in health. These factors can contribute to higher risk of developing chronic conditions like obesity,

diabetes, or heart disease, even leading to decreased life expectancy (Office of Disease Prevention and Health Promotion, 2022).

Figure 1. Social Determinants of Health Graphic

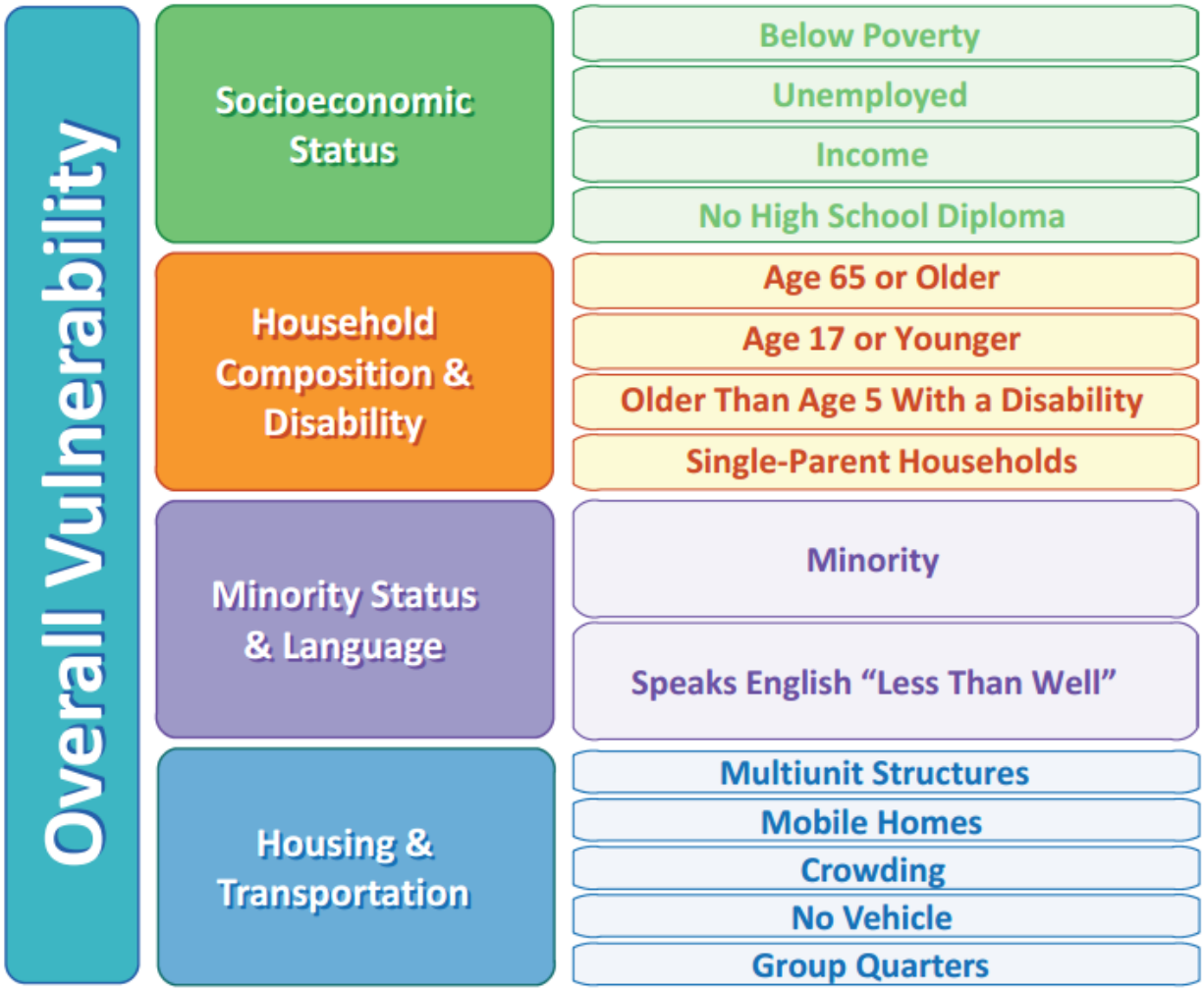


Source: (Office of Disease Prevention and Health Promotion, 2022)

The Geospatial Research Analysis and Services Program at the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry created the Social Vulnerability Index (SVI) which takes into consideration the characteristics of a person or community that impacts the ability to anticipate, confront, repair and recover from the effects of

a disaster (Flanagan & Hallisey, 2018). SVI is made up of 15 census variables which are grouped into four themes as illustrated in Figure 2. SVI are calculated based on census tract and county level data. Each theme receives a percentile ranking, which is then totaled into an overall percentile ranking (Flanagan & Hallisey, 2018). Percentile rankings range from zero to one with those values closer to one indicating high vulnerability (Khan, et al., 2021). According to Khan et al., SVI has been identified as a strong determinant of health outcomes which has been demonstrated in relation to cognition, disability, and mortality (Khan, et al., 2021).

Figure 2. Variables and Themes in Social Vulnerability Index Databases



Source: (Flanagan & Hallisey, 2018)

2.5 Conclusion

T2DM is a common chronic health condition effecting millions of Americans. Lifestyle factors greatly impact an individual's risk for developing the condition as well as the development of complications (Centers for Disease Control and Prevention, 2021). Unfortunately, for individuals living in rural areas as well as those living in socially vulnerable areas, the risk of developing the disease and the financial repercussions associated with the management of the disease can be burdensome. These individuals are more likely to experience poorer health outcomes than their urban counterparts and those living in areas that are lower on the SVI (Khan, et al., 2021).

Future research and programs should focus on methods to address social factors effecting those living in rural and socially vulnerable areas to mitigate the impacts and possible complications of T2DM. Removing barriers associated with obtaining quality healthcare for diabetes management like cost, increasing the number of healthcare professionals and health services in rural and socially vulnerable communities, and increasing health literacy may positively impact the health outcomes observed in these communities (Khan, et al., 2021).

3 CHAPTER III METHODOLOGY

3.1 Research Design

This study used a descriptive design to examine differences in diabetes related ED utilization rates among adults aged 18-25, living in the state of North Carolina. This study used 2017 HCUP ED discharge data to identify patients who visited an ED in North Carolina. ED utilization rates were calculated for visits identified as having a primary diagnosis of T2DM or having a secondary diagnosis of T2DM complication. Variations in ED utilization rates based on county level rurality or social vulnerability, which is determined by the patient's county of residence of record, were described through the construction of "heat maps." For this study the social vulnerability index from the CDC was used to identify counties with indices that ranked 90% or higher, indicating a high social vulnerability.

3.2 Sample Selection

The population of interest includes all adults 18-25 years old, living in North Carolina, who have had an ED visit for any reason not resulting in hospitalization. Visits of interest were those which had taken place at hospital affiliated EDs in NC.

3.3 Data Set Description

For this study, the Healthcare Cost and Utilization Project State Emergency Department Databases (SEDD) developed by the Agency for Healthcare Research and Quality were used. These databases provide information on all ED visits not resulting in hospitalization from hospital affiliated EDs in 30 participating organizations. These databases are state specific allowing comparisons to be made between specific states. North Carolina is one of the states which contributes information to the SEDD on a yearly basis. This study examined ED discharge data from NC including clinical and nonclinical information regardless of payer.

3.4 Independent and Dependent Variables

All ED visits were limited to those of patients identified as being 18-25 years old at the time of the visit. ED visits were identified as a T2DM ED visit if they had a primary diagnosis of T2DM (ICD-10 codes including E11) or a secondary diagnosis of T2DM related complication (Table 1). The rate of T2DM ED visits of all ED visits was then calculated by county. Approximate county level rates of ED utilization were then calculated as the rate of ED visits per 10,000 using county level population rates of 18–25-year-olds. Patient level descriptive variables included age, race, sex, and primary insurance type. County level descriptive variables included rurality (rural vs. non-rural) and social vulnerability (≥ 90% vs < 90% SVI ranking).

Table 1. Type 2 diabetes related complication ICD-10 codes

Type 2 Diabetes Related Complication ICD-10 Codes	
E11.0	**Type 2 diabetes mellitus with hyperosmolarity**
E11.00	Type 2 diabetes mellitus with hyperosmolarity without nonketoic hyperglycemia-hyperosmolar coma
E11.01	Type 2 diabetes mellitus with hyperosmolarity with coma
E11.1	**Type 2 diabetes mellitus with ketoacidosis**
E11.10	Type 2 diabetes mellitus with ketoacidosis without coma
E11.11	Type 2 diabetes mellitus with ketoacidosis with coma
E11.2	**Type 2 diabetes mellitus with kidney complications**
E11.21	Type 2 diabetes mellitus with diabetic nephropathy
E11.22	Type 2 diabetes mellitus with diabetic chronic kidney disease
E11.29	Type 2 diabetes mellitus with other diabetic kidney complications
E11.3	**Type 2 diabetes mellitus with ophthalmic complications**
E11.31	Type 2 diabetes mellitus with diabetic retinopathy
E11.311	Type 2 diabetes mellitus with diabetic retinopathy with macular edema
E11.319	Type 2 diabetes mellitus with diabetic retinopathy without macular edema
E11.32	Type 2 diabetes mellitus with mild nonproliferative diabetic retinopathy
E11.321	Type 2 diabetes mellitus with mild nonproliferative diabetic retinopathy with macular edema
E11.329	Type 2 diabetes mellitus with mild nonproliferative diabetic retinopathy without macular edema
E11.33	Type 2 diabetes mellitus with moderate nonproliferative diabetic retinopathy
E11.331	Type 2 diabetes mellitus with moderate nonproliferative diabetic retinopathy with macular edema

E11.339	Type 2 diabetes mellitus with moderate nonproliferative diabetic retinopathy without macular edema
E11.34	Type 2 diabetes mellitus with severe nonproliferative diabetic retinopathy
E11.341	Type 2 diabetes mellitus with severe nonproliferative diabetic retinopathy with macular edema
E11.349	Type 2 diabetes mellitus with severe nonproliferative diabetic retinopathy without macular edema
E11.35	Type 2 diabetes mellitus with proliferative diabetic retinopathy
E11.351	Type 2 diabetes mellitus with proliferative diabetic retinopathy with macular edema
E11.352	Type 2 diabetes mellitus with proliferative diabetic retinopathy with traction retinal detachment involving the macula
E11.353	Type 2 diabetes mellitus with proliferative diabetic retinopathy with traction retinal detachment not involving the macula
E11.354	Type 2 diabetes mellitus with proliferative diabetic retinopathy with combined traction retinal detachment and rhetgmatogenous retinal detachment
E11.355	Type 2 diabetes mellitus with stable proliferative diabetic retinopathy
E11.359	Type 2 diabetes mellitus with proliferative diabetic retinopathy without macular edema
E11.36	Type 2 diabetes mellitus with diabetic cataract
E11.37	Type 2 diabetes mellitus with diabetic ophthalmic complication
E11.39	Type 2 diabetes mellitus with diabetic ophthalmic complication
E11.4	**Type 2 diabetes mellitus with neurological complications**
E11.40	Type 2 diabetes mellitus with diabetic neuropathy
E11.41	Type 2 diabetes mellitus with diabetic mononeuropathy
E11.42	Type 2 diabetes mellitus with diabetic polyneuropathy
E11.43	Type 2 diabetes mellitus with autonomic polyneuropathy
E11.44	Type 2 diabetes mellitus with diabetic amytrophy
E11.49	Type 2 diabetes mellitus with other diabetic neurological complications
E11.5	**Type 2 diabetes mellitus with circulatory complications**
E11.51	Type 2 diabetes mellitus with diabetic peripheral angiopathy without gangrene
E11.52	Type 2 diabetes mellitus with diabetic peripheral angiopathy with gangrene
E11.59	Type 2 diabetes mellitus with other circulatory complications
E11.6	**Type 2 diabetes with other specified complications**
E11.61	Type 2 diabetes mellitus with diabetic arthropathy
E11.610	Type 2 diabetes mellitus with diabetic neuropathic arthropathy
E11.618	Type 2 diabetes mellitus with other diabetic arthropathy
E11.62	Type 2 diabetes mellitus with skin complications
E11.620	Type 2 diabetes mellitus with diabetic dermatitis
E11.621	Type 2 diabetes mellitus with foot ulcer
E11.622	Type 2 diabetes mellitus with other skin ulcer
E11.628	Type 2 diabetes mellitus with other skin complications
E11.63	Type 2 diabetes mellitus with oral complications
E11.630	Type 2 diabetes mellitus with periodontal disease
E11.638	Type 2 diabetes mellitus with other oral complications

E11.64	Type 2 diabetes mellitus with hypoglycemia
E11.641	Type 2 diabetes mellitus with hypoglycemia with coma
E11.649	Type 2 diabetes mellitus with hypoglycemia without coma
E11.65	Type 2 diabetes mellitus with hyperglycemia
E11.69	Type 2 diabetes mellitus with other specified complications
E11.8	**Type 2 diabetes mellitus with unspecified complications**
E11.9	**Type 2 diabetes mellitus without complications**

Source: (National Center for Health Statistics, 2022)

3.5 Data Analysis

Patient level descriptive statistics were assessed by rural and nonrural counties. Categorical variables were reported as frequency (percent) and continuous variables were reported as mean (standard deviation). Differences in patient level descriptives were assessed via chi-square test for categorical variables and T-test for continuous variables. Approximate county level rates of ED utilization were calculated as the rate of T2DM ED visits per 10,000 using county level population rates of 18–25 year olds. Variations in county level ED utilization rates were described based on county rurality or social vulnerability. Further descriptive variables provided through the construction of "heat maps" and tables examining ED visit rates per 10,000 of each county in the state with rurality and SVI represented for each.

3.6 Protection of Human Subjects

This study is exempt from Institutional Review Board approval due to the use of secondary data.

4 CHAPTER IV RESULTS

4.1 Demographic Characteristics of Adults Aged 18-25 Living in North Carolina

Patient level demographic characteristics for adults aged 18-25, living in North Carolina that had an ED visit in a hospital located in North Carolina in 2017 are represented in Table 3, as well as the county level SVI. In 2017, there were a total of 546,465 ED visits for adults aged 18-25 residing in North Carolina. These visits do not represent unique patients, only the number of ED visits are counted. A total of 61,343 ED visits were attributed to patients living in rural counties in North Carolina, based on their billing zip code, while 485,122 visits were attributed to those living in nonrural counties.

Table 3: Patient level characteristics for adults aged 18-25 and county level social vulnerability by county rurality in North Carolina (N = 546,465)

	Rural n = 61,343	**Nonrural n = 485,122**	**P-values**
Patient Level Characteristics			
Age, years, mean (SD)	21.7 (2.3)	21.7 (2.3)	<.0001
Sex			<.0001
Female	38,666 (63.0)	310,842 (64.1)	
Male	22,674 (37.0)	174,264 (35.9)	
Insurance Type			<.0001
Medicare	570 (0.9)	4,411 (0.9)	
Medicaid	23,849 (38.9)	155,267 (32.1)	
Private	16,582 (27.1)	145,718 (30.2)	
Self-Pay	18,790 (30.7)	157,181 (32.5)	
Other	1,457 (2.4)	20,752 (4.3)	
Race			<.0001
White	33,170 (54.5)	220,667 (45.9)	
Black	21,924 (36.0)	206,310 (42.9)	
Hispanic	3,916 (6.4)	32,460 (6.8)	
Asian	115 (0.2)	2,548 (0.5)	
Native American	1,095 (1.8)	5,868 (1.2)	
Other	678 (1.1)	13,248 (2.8)	
Diabetes Related Visits	119 (0.2)	1,070 (0.2)	0.1833
County Level Characteristics			
n	37	63	
High Social Vulnerability Index	11 (29.7)	9 (14.3)	0.0623

Data represented as n (%) unless otherwise indicated.

A comparison of the demographic characteristics of patients residing in rural counties versus nonrural counties reveals no significant difference in mean age between the two groups, with the mean age for rural counties being 21.7 years old as well as for nonrural counties. Though statistically significant, there was not a meaningful difference in distribution of sex observed between the group of patients residing in rural counties and the group of patients residing in nonrural counties; with 63% of patients in the rural patient population being female compared to 64.1% females in the nonrural patient population. For the rural patient population, there were 37% males while the nonrural patient population was composed of 35.9% males ($p < 0.001$). It is important to note that statistical significance as a result of a very large sample size is common in observational studies, even when differences are not meaningful.

There was a significant difference in racial distribution between the two groups ($p < 0.0001$). There was a larger portion of the rural patient population that identified their race as white compared to the nonrural patients (54.5% vs 45.9%, respectively). Conversely, a larger portion of the nonrural patient population identified as black (42.9% vs. 36.0% for nonrural and rural patients, respectively). However, no differences in distribution for patients identifying as Hispanic or other races between those residing in rural or nonrural counties.

Examining differences in insurance type between patients residing in rural and nonrural counties, there is a significant difference in distribution between the two patient populations ($p < 0.001$). Both rural and nonrural patient populations were made up of 0.9% of individuals who report being covered by Medicare. For the rural patient population, 38.9% of the patients were covered by Medicaid while 32.1% of patients residing in the nonrural counties were covered by Medicaid. A higher proportion of patients residing in the nonrural counties, 30.2%, were primarily covered by a private payer compared to 27.1% of patients in the rural counties. The portion of patients having self-pay was higher for those residing in the nonrural counties, 32.5%, as compared to the rural counties, 30.7%. Of those patients residing in nonrural counties, 4.3% were covered by other insurance types compared to 2.4% of patients residing in the rural counties. Ultimately, the conducted examination of patient level data revealed no significant difference in

proportion of patients with diabetes related ED visits between rural and nonrural counties.

County level data indicates that 63 of 100 counties are considered nonrural while 37 counties are identified as rural. There was not a statistically significant difference in the number of rural counties identified as having a high Social vulnerability Index (SVI). However, almost a third (29.7%) of rural counties are classified as high SVI compared to 14.3% of nonrural counties (p=0.0623).

4.2 ED Visit Rate per 10,000 for North Carolina Counties

Table 4 illustrates ED visit rates per 10,000 adults aged 18-25 grouped by county, across all 100 counties in North Carolina. The top five counties with the highest ED visit rates are represented in Table 5 and Figure 3. The highest ED visit rate for adults aged 18-25 was observed in Hyde County with a rate of 71 visits per 10,000. Lenoir County had the second highest ED visit rate at 45.1 per 10,000 followed by Bertie with 43.6 per 10,000, Vance County with 38.6 per 10,000 and Wilson County with 38.1 per 10,000.

Table 4: ED visit rates per 10,000 population for adults aged 18-25 by county.

County Name	***ED Visits Per 10,000 people***
Alamance County	**8.9**
Alexander County	**<1**
Alleghany County	**9.2**
Anson County	**26.8**
Ashe County	**<1**
Avery County	**17.4**
Beaufort County	**15.1**
Bertie County	**43.6**
Bladen County	**23.4**
Brunswick County	**15.4**
Buncombe County	**6.5**

Burke County	**5.7**
Cabarrus County	**5.8**
Caldwell County	**13.7**
Camden County	**<1**
Carteret County	**<1**
Caswell County	**17.4**
Catawba County	**15.4**
Chatham County	**3.2**
Cherokee County	**3.8**
Chowan County	**7**
Clay County	**<1**
Cleveland County	**15.8**
Columbus County	**14.2**
Craven County	**13.9**
Cumberland County	**23.2**
Currituck County	**4.4**
Dare County	**<1**
Davidson County	**5.7**
Davie County	**7.5**
Duplin County	**15.9**
Durham County	**7.3**
Edgecombe County	**23.7**
Forsyth County	**10**
Franklin County	**13.6**
Gaston County	**7**
Gates County	**<1**
Graham County	**<1**
Granville County	**31**

Greene County	**4.8**
Guilford County	**14.6**
Halifax County	**17**
Harnett County	**21.6**
Haywood County	**15.7**
Henderson County	**3.9**
Hertford County	**16.7**
Hoke County	**22**
Hyde County	**71**
Iredell County	**15.5**
Jackson County	**7.7**
Johnston County	**12.2**
Jones County	**20.3**
Lee County	**28.5**
Lenoir County	**45.1**
Lincoln County	**11.9**
McDowell County	**9.2**
Macon County	**6.1**
Madison County	**14.9**
Martin County	**21**
Mecklenburg County	**17.6**
Mitchell County	**<1**
Montgomery County	**3.7**
Moore County	**14**
Nash County	**25.8**
New Hanover County	**5.1**
Northampton County	**9.3**
Onslow County	**9.9**

Orange County	**3.9**
Pamlico County	**<1**
Pasquotank County	**25.4**
Pender County	**11.8**
Perquimans County	**<1**
Person County	**10.4**
Pitt County	**23.3**
Polk County	**<1**
Randolph County	**5.1**
Richmond County	**24.3**
Robeson County	**7.7**
Rockingham County	**5.5**
Rowan County	**14.9**
Rutherford County	**30.4**
Sampson County	**22.8**
Scotland County	**20**
Stanly County	**6.8**
Stokes County	**6.5**
Surry County	**14**
Swain County	**7.4**
Transylvania County	**6.2**
Tyrrell County	**23.4**
Union County	**5.1**
Vance County	**38.6**
Wake County	**9.5**
Warren County	**<1**
Washington County	**<1**
Watauga County	**4**

Wayne County	**14.3**
Wilkes County	**7.4**
Wilson County	**38.1**
Yadkin County	**5.4**
Yancey County	**5.8**

Table 5: 5 Counties with the highest ED visit rates per 10,000 people

County Name	**ED Visits Per 10,000 people**	**High SVI**	**Rural**
Hyde County	71	No	Yes
Lenoir County	45.1	Yes	No
Bertie County	43.6	Yes	Yes
Vance County	38.6	Yes	No
Wilson County	38.1	Yes	No

Table 5 also represents the rurality and SVI status of each of the counties. Of the top five counties, four are categorized as counties with high SVI, with Hyde County being the only county that is not a high SVI county (figure 4). Of the five counties, Hyde and Bertie counties are the only two rural counties with the remaining three counties being nonrural (Figure 5). Bertie County is the only county in the top five that is both rural and high SVI. In comparison, the counties with the lowest rate of ED visits per 10,000 people are represented in Table 6. There were 14 counties within the state with ED visit rates less than one. Of the14 counties with rates less than one, Warren County is the only county with a high SVI. Examining rurality for this group reveals that only nine of the 14 counties are classified as rural

including Ashe, Camden, Clay, Graham, Mitchell, Perquimans, Polk, Warren and Washington counties. Warren County is the only county that is classified as both rural and high SVI.

Table 6: Counties with the lowest ED visit rates per 10,000 people

County Name	**ED Visits Per 10,000 people**	**High SVI**	**Rural**
Alexander County	<1	No	No
Ashe County	<1	No	Yes
Camden County	<1	No	Yes
Carteret County	<1	No	No
Clay County	<1	No	Yes
Dare County	<1	No	No
Gates County	<1	No	No
Graham County	<1	No	Yes
Mitchell County	<1	No	Yes
Pamlico County	<1	No	No
Perquimans County	<1	No	Yes
Polk County	<1	No	Yes
Warren County	<1	Yes	Yes
Washington County	<1	No	Yes

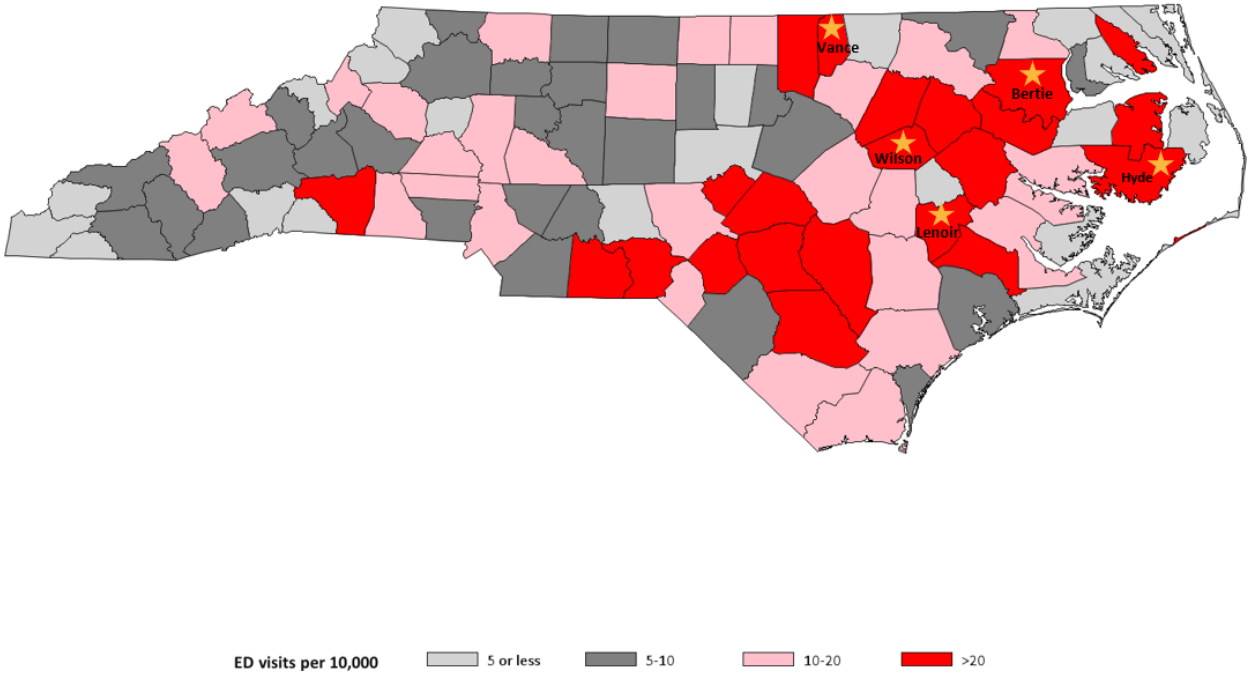
5 CHAPTER V DISCUSSION

5.1 Discussion of Results

The findings of this study highlight differences in Emergency Department (ED) usage among adults aged 18-25 living in North Carolina who experienced an ED visit related to T2DM in 2017. ED usage rates for the rural study population largely mirror those of the nonrural study population with regards to average age and sex. For both the rural and nonrural populations small differences were observed in the distribution of races and insurance types. Based on the results of this study, the majority of patients were white, female and had Medicaid for healthcare coverage. This study revealed that there is no difference in rates of T2DM related ED visits for this population based on county rurality.

North Carolina has 100 counties and of those, 37 are rural. Eleven of the rural counties have a high SVI compared to nine high SVI counties classified as nonrural. By examining each county based on the rate of ED visits per 10,000 population, it is revealed that four of the top five counties with the highest rates of ED visits per population (Table 5) were also high SVI counties, while only two of the top five counties were classified as rural as represented in Figures 2 and 3. The top five high ED visit rate counties have been labeled in Figure 1. Interestingly, four of the top five counties lie within the coastal plain of the state and are close in proximity to one another. The fifth county is not far from the rest of the top five counties but lies more inland in the piedmont region of the state.

Figure 3: Top Five Counties with the Highest ED Visit Rate per 10,000



Conversely, the fourteen counties with ED visit rates less than one were all low SVI counties except for one, Warren county. Of these fourteen counties nine were classified as rural. Unlike the top five counties, most of the low ED visit rate counties are spread across the state. These results reveal that rurality does not play as large of a role in predicting diabetes related ED visits for the population of interest. More focus needs to be put on social vulnerability as this study has indicated a stronger association between living in a high SVI county and having an ED visit for T2DM in this population.

Figure 4: Top Five ED visit rate counties by rurality

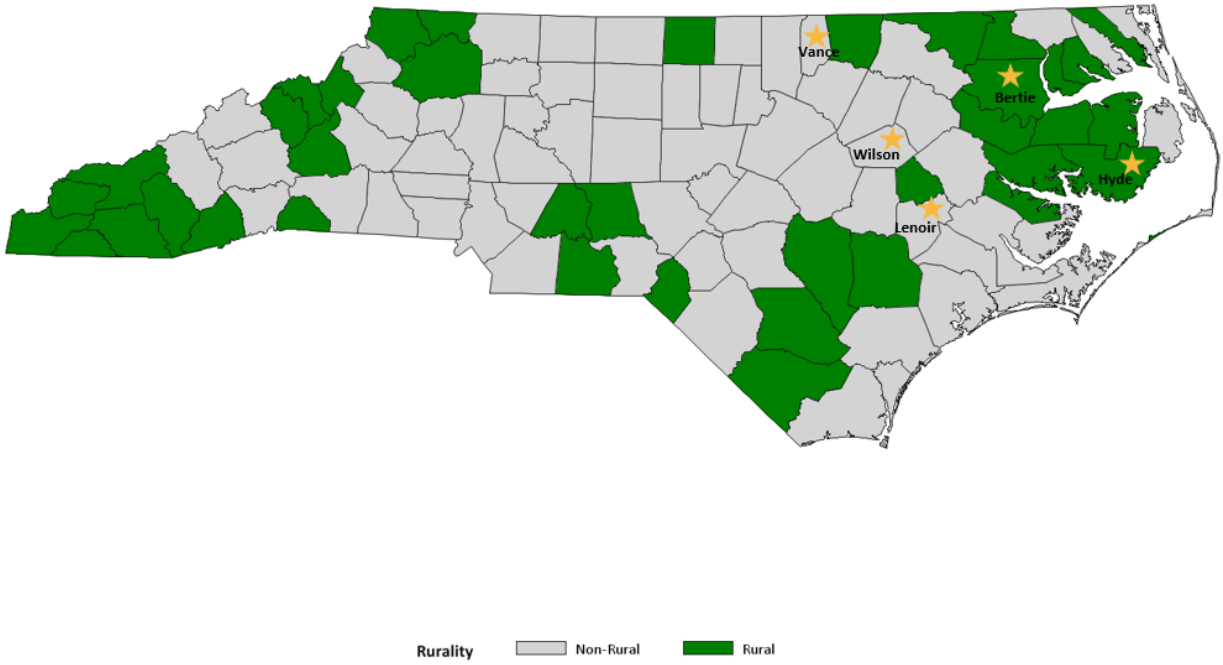
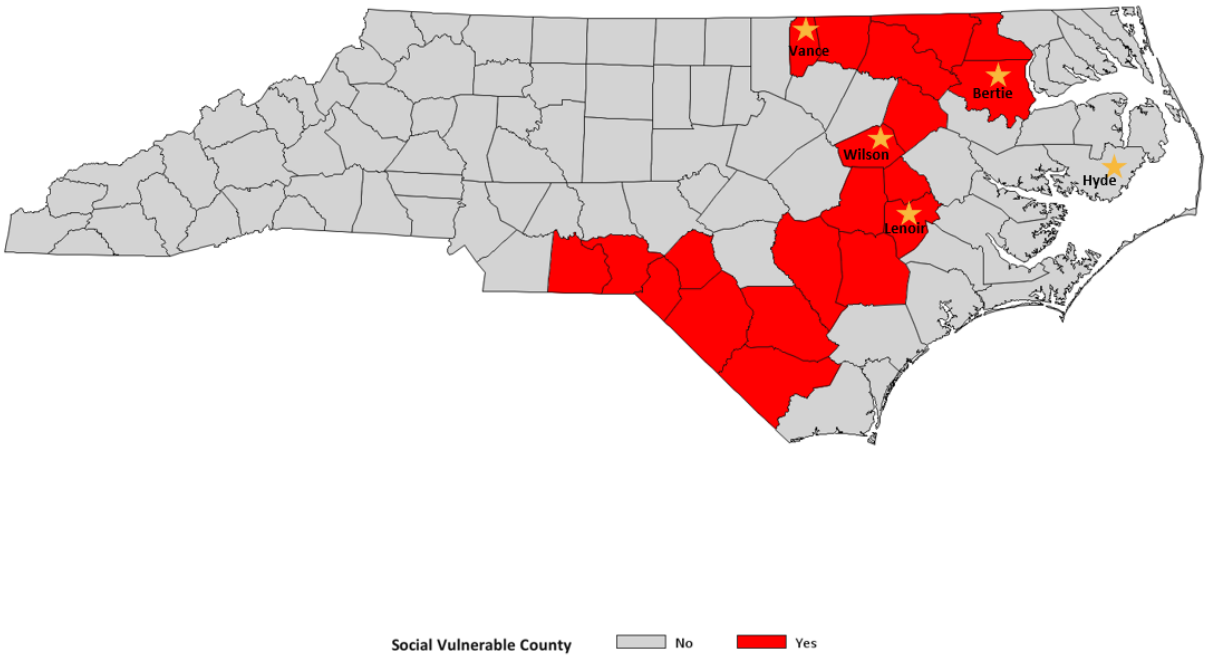


Figure 5: Top five ED visit rate counties by SVI



5.2 Limitations

There are some limitations to this study. Limitations to the study include lack of generalizability. The dataset used in this study only includes information from those who were seen at an ED. Data for individuals who were not seen in an ED but could have visited their local urgent care location for T2DM related reasons were not included in the dataset. Also, the data provided does not allow for conclusions to be drawn regarding those who did not seek care from a healthcare provider. Another limitation of the study was that the data set does not include lab values which prohibited the identification of individuals with uncontrolled diabetes using A1C values.

5.3 Future Research

This study sets the stage for future studies to examine drivers behind T2DM ED visit rates for this population. A qualitative study would allow for the identification of reasons why individuals are visiting EDs for treatment as opposed to being seen in the primary care setting. Other future research may delve deeper into addressing social determinants of health and health equity. As a result, this research could bring about policy changes at the state and local levels to address barriers to health care access.

5.4 Conclusions

This quantitative study was set forth to determine if there were differences in T2DM related ED visits among adults aged 18-25 living in North Carolina based on whether they lived in rural counties or high SVI counties. The results of this study lead to the conclusion that there is no difference in T2DM related ED visits for this study population with regard to whether the patient resides in a rural or nonrural county. However, living in a high SVI county seems to be a better predictor of whether an individual in this patient population will have a T2DM related ED visit. This study further bolsters the benefit of using the SVI in healthcare. Implementing the further use of SVI in healthcare could allow for increased health equity and tailored health care approaches to improve health outcomes for those facing barriers to accessing health care services.

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