2021

Social Determinants of Health and Type 2 Diabetes Among Enrollees of California Children's Services Program in Fresno County, California

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Abstract

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by

Daniela Aghadjanian

MPH, Benedictine University, 2011

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Doctoral Study Submitted in Partial Fulfillment

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Doctor of Public Health

Walden University

August 2021

Abstract

Despite extensive study in adults, Type 2 diabetes (T2D) has been the subject of little research concerning young adults or children. Doctors believed T2D to develop only in a person's later years until health care providers found younger individuals developing this disease. The purpose of this cross-sectional quantitative analysis was to determine correlations between T2D and social determinants of health in Fresno County, California, based on children and adolescents. The 2017-19 data came from the Fresno County Department of Public Health. The theoretical foundation for the study was the socio-ecological framework focusing on individuals' traits having a bidirectional impact on health. Binominal logistic regression showed associations between age, gender, ethnicity, and place of residence in correlation to the occurrence of T2D. Specific to environment, the greatest disparity was among those residing in suburban communities (*OR* = 0.593, 95% CI [0.421, 0.835], $p < .003$) compared to rural or urban neighborhoods. Age and gender were also significant factors among the population of 372 patients with T2D; when age increased, so did the likelihood of T2D (*OR* = 1.258, 95% CI [1.224, 1.293], $p < 0.005$), while females were more likely to have a diagnosis than males (*OR* = 1.499, 95%CI [1.218, 1.844], $p < 0.005$). Individuals who identified their race/ethnicity as mixed/other had a far greater likelihood of T2D diagnoses (*OR* = 1.96, 95% CI [1.174, 3.273], $p < 0.01$) compared to their neighbors. Participants from households with incomes above $40,000 did not show statistically significant results (*OR* = 0.339, 95% CI [0.084, 1.365], $p = 0.128$). With further research conducted into T2D in youth and adolescents, understanding of preventative and disease management efforts can aim to improve the quality of life for the overall population leading to positive social change.

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Section 1: Foundation of the Study and Literature Review

Type 2 diabetes (T2D) is one of the top preventable diseases for young adults in the diverse Central California county of Fresno. Increasing T2D reoccurrence rates in the United States have led to funding and efforts to educate and prevent T2D in individuals over 18 years of age (Centers for Disease Control and Prevention, 2020). Additional funding goes to informing residents on how to manage their diabetes when they receive formal diagnoses. Preventing T2D in children and adolescents has positive health outcomes and economic benefits, with fewer expenditures of state-funded organizations' resources on an often-avoidable but lifelong disease.

In the remainder of this section, I summarize the problem and the purpose of this study as well as provide an analysis of the relevant literature. The section also includes the problem statement, research questions, and justification for the research design and theoretical framework. I also present the research questions, assumptions, and delimitations.

Problem Statement

Despite initiatives for improving children's health across the United States, the Centers for Disease Control and Prevention (CDC, 2016) indicated that approximately 12.7 million children and adolescents still suffered from obesity. Data from 2015 to 2016 showed that nearly 1 in 5 school-aged children (defined as 6 through 19 years of age) in the United States had obesity (CDC, 2018). Additionally, there was a 14.5% prevalence of childhood obesity among young, low-income women, infants, and children from 2 to 4 years of age (Pan et al., 2016). Pulgaron and Delamater (2014) found that one third of U.S. children were overweight or obese, with Black and Hispanic children at increased risk. Obesity significantly increases the risk of adverse medical and psychological outcomes, such as high blood pressure and cholesterol; sleep apnea; dental problems; low self-esteem; social isolation; discrimination; and insulin resistance, which includes T2D.

According to Fonseca et al. (2012), approximately 26 million U.S. residents have T2D. The CDC (2018) indicated that overweight or obese children tend to be obese as adults and face increased risks of T2D and other ailments. Moreover, additional reports have shown increasing T2D diagnoses in children and adolescents of all ethnicities despite seemingly stable rates of obesity (Reinehr, 2013).

The U.S. Centers for Medicare & Medicaid Services (2015) showed average national health expenditures of approximately $3.3 trillion in 2016, or about $10,000 per person. In 2016, California's personal health expenditures were over $367 billion, with public funds used to pay for 71% of that amount (Sorensen et al., 2016). Annual diabetic costs in the state are approximately $24.5 billion, including $254 million in hospital costs through Medi-Cal, the California Medicaid program (University of California, Los Angeles [UCLA] Center for Health Policy Research, 2016). Diabetic health care costs comprise direct costs, such as physicians, laboratory tests, prescription drugs, nursing care, and indirect expenses, such as loss of productivity due to morbidity and mortality (Chukwueke & Cordero-MacIntyre, 2010).

In 2016, a UCLA study, one of the most recent large-scale studies within the state, showed that 13 million residents might have had prediabetes or undiagnosed diabetes and more than 2.5 million adults lived with diagnosed diabetes (UCLA Center for Health Policy Research, 2016). Additionally, the UCLA Center for Health Policy Research (2016) found that approximately 33% of young adults from 18 to 39 years of age had prediabetes, despite the predominant belief that diabetes was more common among older adults. The researchers did not investigate minors or determinants beyond racial or ethnic variations contributing to prediabetic or diabetic rates.

The identified gap in the literature was the exclusion of Fresno County residents between the ages of 10 and 20 years from T2D research. The county public health department and hospitals do not have dedicated resources for targeting this younger audience; therefore, by the time doctors have diagnosed children with the disease, it is too late for prevention and education courses. The social determinants of health (SDOH) impact the way a person lives, learns, works, and plays. Thus, understanding how and specifically why Fresno County residents under 21 years of age develop T2D could lead to the reduction of overall diagnoses and the need for medical care. Life expectancy is a drastically different variable in different zip codes due to variations in education, employment, housing, safety, community development, and access to quality health care (Lavizzo-Mourey, 2014). The identified gap in practice was the failure to use the social determinants of health with diabetes diagnoses in young people who live in Fresno County.

In 2015, a UCLA Center for Health Policy (2016) study showed a significant increase of prediabetes, a precursor of T2D, in California adults. The study indicated significant county-to-county disparities. In rural counties, 40% of residents had prediabetes, with higher rates among underrepresented groups residents as well (UCLA Center for Health Policy Research, 2016).

Fresno County, located in Central California, has a geographically diverse landscape, agricultural communities to the south and west, cities in the center, and suburbs in the north and east. An influx of residents into Fresno County has resulted in increased age diversification and a population of over 1 million residents (State of California, 2020). Fresno County's health statistics, including rates of diabetes, are not publicly available; however, community health needs assessments show diabetes is a significant health concern.

Diabetes affects residents of all ethnicities in Fresno County, including Latino, Black, and Hmong residents who are the most impacted (CDC, 2018; Central Valley Health Policy Institute, 2017). According to the Central Valley Health Policy Institute (2017), the root causes of diabetic management concerns are limited resources and education among citizens and the absence of adequate treatment in some communities. Preventive education for children is fundamental to curbing the rates of diabetes diagnoses (Central Valley Health Policy Institute, 2017). However, exclusive of diabetic outreach within the community, the study concluded by the Central Valley Health Policy Institute (2017) did not include diabetes rates for individuals under 18 years of age and did not target this group for diabetes prevention or management.

Purpose of the Study

The purpose of this study was to determine correlations between T2D and social determinants of health in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. The Fresno County Health Department director and Fresno County's health officer have prioritized research within the county, particularly on children and adolescents under 18 years of age who are often exempt from traditional studies. Understanding the potential association between the social determinants of health (i.e., age, household income, and race) and diabetes could show trends for public health officials to consider when designing diabetes prevention programs for youth in Fresno County.

Research Questions and Hypotheses

Despite initiatives to educate the greater community on diabetes prevention and management, individuals under the age of 18 years are an overlooked population. There are also inconsistent rates of diabetes across zip codes in Fresno County (Fresno State Central Valley Health Policy Institute et al., 2020). Therefore, the first research question (RQ) was a means to examine if a relationship exists between where California Children's Services (CCS) clients reside and T2D development. The second RQ was specific to additional independent variables while controlling for the variables of age, race, and gender and the relationship to T2D. Finally, the third RQ was the means used to examine household income data to determine if a relationship exists between the independent variable and T2D diagnoses. Table 1 shows the hypotheses and methodological components. The research questions were as follows:

RQ1: Is there an association between residential zip code and T2D occurrence among Fresno CCS clients under 21 years old?

$H_0$1: There is no association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

H_a1: There is an association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

RQ2: Are there associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for educational level?

$H_0$2: There are no associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

H_a2: There is an association between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

RQ3: Is there an association between the households that fall under the federal poverty guidelines with T2D occurrence for Fresno CCS clients under 21 years old?

$H_0$3: There is no association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

H_a3: There is an association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

Table 1

Hypotheses and Corresponding Methodological Components

Hypothesis	Independent variable	Dependent variable	Statistical analysis
*H*1: Residents who reside in areas outside of the urban zip codes of Fresno County, such as 93720, 93721, and 93612, will have a higher risk of developing T2D	Zip code	T2D diagnosis	Logistic regression
*H*2A: Of the enrolled patients, those who are older will have higher risk of developing T2D.	Age	T2D diagnosis	Logistic regression
*H*2B: Females will have greater odds of T2D than males.	Gender	T2D diagnosis	Logistic regression
*H*2C: Historically, ethnic minorities will have a higher likelihood of T2D than nonminority patients.	Race	T2D diagnosis	Logistic regression
*H*3: Households with a lower overall income will have a greater occurrence of T2D than households with higher incomes.	Poverty threshold	T2D diagnosis	Logistic regression

Theoretical Foundation for the Study

The CCS program has provided medical assistance to residents under the age of 21 years since 1928 (State of California, 2020). CCS, in collaboration with local hospitals and health care providers, maintains a state database known internally as CMS-Net, or more recently, E-47. The database contains CCS enrollees' data that scholars or program leaders can extract and report for insight into community needs. A conceptual framework that includes several factors beyond nutrition and physical activity would be a suitable approach for determining if a positive association exists between social inequalities and the risk of developing T2D in Fresno County.

I used the socio-ecological framework in this study. Scholars established the socio-ecological framework in the 1970s, and it has been the approach used for public health initiatives, including the World Health Organization (Blas & Kurup, 2010) and Healthy People 2020 (Office of Disease Prevention and Health Promotion, 2019). The concept behind the socio-ecological framework is that all an individual's traits have a bidirectional impact on health. The model consists of five factors: individual, interpersonal, organizational, community, and public policy (Kilanowski, 2017).

Nature of the Study

I conducted a quantitative, cross-sectional study to determine whether an association exists between age, gender, race and ethnicity, place of residence, household income, and T2D. Household poverty guidelines was a potential effect modifier on the independent and dependent variables. This study had several independent variables (see Table 1). I used a logistic regression model for the statistical analysis to determine if any association exists. Secondary, de-identified data was supplied by the California Children's Services program which is a part of the Fresno County Department of Public Health in order to determine if their population had any correlations between SDOH and occurrence of T2D.

Literature Search Strategy

The purpose of this literature review is to present a synthesis of research on the SDOH that affect diabetes and youth. I conducted this review by accessing a variety of peer-reviewed, scholarly journals; professional organizations; and databases through the Walden University Library and Google Scholar. Medical and nursing databases used included PubMed, CINAHL, and MEDLINE as well as ProQuest Dissertations and

Theses Global. I selected articles predominantly published between 2014 and 2019, including older material when needed to explain historical references to the disease, methodology, and other related variables. The keywords searched were *type 2 diabetes* and *social determinants*, which had 927 results; *social cognitive theory*, which had over 286,598 results; and *diabetes*, which had 208,460 results. To narrow the yielded results, I input the following additional keywords: *social determinants of health* and *California*, *Fresno County*, *social determinants*, *health*, *race*, *socioeconomic*, *ethnicity*, *health behavior*, *disparities*, *psychosocial*, *social*, *epidemiology*, *income*, *occupation*, and *education*. The inclusion criteria for the literature reviewed were that they were published in peer-reviewed, scholarly journals written in the English language. Moreover, I sourced references with the information provided by the CDC, National Kidney Foundation, American Diabetes Association (ADA), and Fresno County government.

Literature Review Related to Key Variables and/or Concepts

Background

Humans absorb three nutrients when they consume food: proteins, fats, and carbohydrates (National Institute of Health, 2019). The body uses each nutrient for various processes. With carbohydrates, humans can process starch, fiber, and glucose (i.e., sugar) (National Institute of Health, 2019). The metabolism of glucose provides energy throughout the body; however, a disruption in the ability to process glucose could result in diabetes.

Diabetes Mellitus

Diabetes is not a single disease, but a group of metabolic diseases categorized by elevated blood glucose levels (i.e., hyperglycemia) and low insulin levels (ADA, 2010).

Hyperglycemia indicates insufficient production or utilization of insulin (Asmat et al., 2016). Insulin is a protein (i.e., hormone) synthesized in the beta (ß) cells of the pancreas that enables the body to transform glucose from foods into energy or to store for future use (ADA, 2010; Asmat et al., 2016). Prolonged, severe hyperglycemia often correlates with long-term damage, dysfunction, and failure of the eyes, kidneys, nerves, heart, and blood vessels (ADA, 2010). In addition to hyperglycemia, other contributing factors include hyperlipidemia (i.e., high cholesterol) and oxidative stress (i.e., an imbalance of free radicals and antioxidants), both of which could also present complications (Asmat et al., 2016).

Diabetes can affect individuals of any ethnicity, race, gender, and age. In the 2017 National Diabetes Statistics Report, the rate of diagnosed cases varied across multiple racial and ethnic backgrounds (CDC, 2017). Persons of American Indian or Alaskan Native descent had the highest prevalence at 15.1% of 30.3 million individuals; percentages for other races were 12.7% of non-Hispanic Blacks, 12.1% of Hispanics, 8% of Asian Americans, and 7.4% of non-Hispanic Whites (CDC, 2017). Although diabetes by itself is not a terminal disease, it can cause complications with an impact on quality of life and overall longevity. Among the many long-term complications of diabetes are visual impairment, such as retinopathy, which could cause blindness; kidney disease; renal failure; damage to the spinal cords and brain; foot ulcers and amputations; and nerve damage throughout the body, known as autonomic neuropathy, which could damage the gastrointestinal or cardiovascular systems (ADA, 2010).

Classification of Diabetes Mellitus

The term *diabetes* also includes several categories or types of genetic markers and insulin levels. The vast majority of diabetes cases fall into two broad etiopathogenetic categories: Type 1 and Type 2 (ADA, 2010). Medical professionals diagnose diabetes mellitus Type 1, known as diabetes Type 1 or Type 1 diabetes (T1D), when there is no insulin secretion. T1D occurs in individuals with antibody evidence of an autoimmune pathologic process that occurs in the pancreatic islets where glucose metabolism occurs as well as by genetic markers (ADA, 2010). Scientists have shown that genetic and environmental factors, including viruses, can cause T1D by triggering the immune system to attack and kill the insulin production in the ß cells of the pancreas (National Institute of Diabetes and Digestive and Kidney Diseases, 2016).

The second type of diabetes is a more prevalent diagnosis (ADA, 2010). Insulin secretory defects and insulin resistance indicate T2D. An individual with T2D might go undiagnosed for an extended period due to external factors with an impact on varying degrees of hyperglycemia that may cause pathologic and functional changes (ADA, 2010). Additionally, lifestyle factors and genetic factors, such as T1D, can also contribute to the disposition of developing insulin abnormalities or being overweight or obese (National Institute of Diabetes and Digestive and Kidney Diseases, 2016). In addition to T1D and T2D, there are two main diabetes classifications: idiopathic diabetes, categorized as T1D with no known origin, and gestational diabetes, which occurs in pregnant women who have developed glucose intolerance (Asmat et al., 2016).

Accounting for approximately 5% to 10% of the population diagnosed with diabetes, T1D is the less frequently diagnosed of the two diseases (CDC, 2018).

Professionals have historically referred to T1D as juvenile-onset diabetes (ADA, 2010). Type 1 diabetes mellitus (T1DM) occurs when there is complete insulin deficiency due to the destruction of pancreatic ß-cells (Ergun-Longmire & Maclaren, 2000). Fluctuations in the rate of β-cell destruction are common in T1DM, with children and adolescents having a more rapid destruction rate than adults (ADA, 2010). This destruction, especially in children, can result in ketoacidosis, which occurs when the body produces an excess of blood acids (i.e., ketones). Excessive ketones could cause an array of complications that ultimately result in a loss of conscientiousness or fatality (Mayo Clinic, 2018). T1D requires regular insulin injections, monitoring of food consumption and blood sugar levels, and proper diet and exercise (Mayo Clinic, 2018).

T2D occurs with insulin deficiency and prominent peripheral insulin resistance instead of total insulin deficiency (Cantley & Ashcroft, 2015). T2D comprises most diabetes diagnoses and is a condition historically referred to by professionals as non-insulin-dependent or adult-onset diabetes (ADA, 2010). T2D includes pancreatic β-cell function failure that does not significantly improve despite medical intervention (ADA, 2010; Stopford, 2018). Moreover, insulin resistance is a leading factor in T2D. Insulin resistance occurs without proper insulin usage in the muscles, liver, and fat cells, as the body requires more insulin to absorb glucose; however, the pancreas cannot support the increased demand (National Institute of Diabetes and Digestive and Kidney Diseases, 2016).

In T2D, autoimmune destruction of β-cells does not occur (Cantley & Ashcroft, 2015). Researchers, scientists, and medical providers have not found a specific cause of this disease, despite identifying some correlating factors (ADA, 2010; Ergun-Longmire &

Maclaren, 2000). The most common correlating factors are body weight (i.e., individuals categorized as overweight or obese), physical inactivity, increased visceral fat, and genetic disposition. Although insulin treatment is not a required intervention for T2D patients' survival, medical professionals often recommend insulin to maintain optimal glycemic levels and reduce complications (Stopford, 2018).

T2D Risk Factors

T2D is a chronic condition occurring with resistance to the effects of insulin or insufficient insulin production. Despite having no definitive cause, T2D is more likely to develop in the presence of several risk factors. Although a person cannot change some of the factors associated with the disease, such as genetics, age, or ethnicity, there are some ways to minimize risk, including diet, physical activity, and decreased body mass index or overall weight (National Institute of Diabetes and Digestive and Kidney Diseases, 2016). Additional factors contributing to a higher risk of developing T2D include place of residence; socioeconomic status (SES); high blood pressure; a history of heart disease, stroke, or depression; a history of gestational diabetes; polycystic ovarian syndrome; or acanthosis nigricans, which is darkened skin by the armpits and neck that could indicate insulin resistance (Gebreab et al., 2017; Mayo Clinic, 2019; National Institute of Diabetes and Digestive and Kidney Diseases, 2017). Table 2 presents a summary of the risk factors.

Table 2

An Overview of Risk Factors for the Development of Type 2 Diabetes

Type	Description
Nonmodifiable	
Genetic	Family history
Demographic	Ethnicity
	Age
Medical	Preexisting medical condition: polycystic ovarian syndrome, heart disease, stroke, or depression
Modifiable	
Behavioral/lifestyle	Geographical place of residence
	Obesity (elevated body mass index)
	Level of physical activity
	Socioeconomic status

Beyond the quantifiable measures, there are additional risk factors associated with the increased likelihood of developing T2D. Environmental features, such as accessibility to healthy foods, social cohesion, neighborhood violence, and neighborhood composition, can affect the occurrence of T2D (Diez Roux & Mair, 2010; Gebreab et al., 2017). Diez Roux and Mair (2010) found that the social complexities of neighborhood makeup could cause the contributing factors of T2D development: elevated stress levels, increased transmission of negative health behaviors, and a lack of social support. The figure in Appendix C shows how neighborhood environments can contribute to the health inequalities stated by Diez Roux and Mair. Additionally, prediabetes is a precursor of T2D (UCLA Center for Health Policy Research, 2016). Prediabetes is a reversible health condition in which physician-prescribed blood sugar tests indicate elevated blood sugar levels over an extended period (CDC, 2019).

Prevalence of T2D in California

Researchers within California treat diabetes as a significant health concern by focusing predominantly on adult subsets of the state's population. A 2016 UCLA study, the most significant large-scale study within the state to date, showed that 13 million California residents may have had prediabetes or undiagnosed diabetes and that more than 2.5 million adults lived with diagnosed diabetes (UCLA Center for Health Policy Research, 2016). Additionally, the UCLA Center for Health Policy Research (2016) found that about 33% of young adults between 18 and 39 years of age had prediabetes and since prediabetes is a listed risk factor for the development of T2D, this creates an elevated concern for the long-term danger of developing diabetes. In the UCLA Center for Health Policy Research (2016) study looking at California residents aged 18 to 39 years to determine the prevalence and concern of diabetes, the researchers did not include residents younger than 18 or older than 39 years due to privacy concerns and other health conditions. Additional studies within the Central Valley of California were specific to adult residents over the age of 20, showing the need to care for children in focus groups (Central Valley Health Policy Institute, 2017).

T2D and Impact on Youth

In the mid-1990s, medical professionals referred to T2D as late-onset or adult-onset diabetes; however, studies such as the SEARCH for Diabetes in Youth led to the reclassification of the condition to include impacted youth (Butler, 2017; Cherney, 2014; Imperatore et al., 2012; Mayer-Davis et al., 2017). Clinicians outside the United States, including Canada, Japan, and several European counties, have also noted increased diabetes diagnoses (Reinehr, 2013). Approximately 3% of diagnosed T2D cases were in adolescents 15 years ago, whereas more recent studies have indicated 45% of T2D diagnoses occur in adolescents newly diagnosed with diabetes (Butler, 2017). Given the more recent connection of T2D with youth, there is little extant literature on this population compared to research on adults (Butler, 2017). Imperatore et al. (2012) predicted that the rate of T2D diagnoses for people under the age of 20 would increase by nearly 50% by 2050, which could quadruple the number of youth cases. Bloomgarden (2004) found that the diabetogenic process does not only occur in adulthood; instead, the development begins in childhood, often due to low birth weight or poor nutrition.

Risk factors that have an impact on youth and adolescents often mirror what affects adults. Despite initiatives to improve children's health across the United States, the CDC (2016) found approximately 12.7 million children and adolescents with obesity, a risk factor for additional health complications such as T2D. Additionally, the CDC (2018) noted that children with obesity or overweight tended to be obese as adults, which resulted in increased risks of T2D and other ailments. This is a continued trend from the early 2000s. Bloomgarden (2004) determined that the rate of obesity in children aged 6 to 11 and 12 to 19 years increased by 11.1% and 10.9%, respectively, from 1963–1970 to 1999–2000. Children and young people who develop T2D are often obese, have a family history of T2D, and are members of racial or ethnic minorities (Butler, 2017). Another risk factor is puberty, a developmental time when there is an increased likelihood of insulin resistance (Reinehr, 2013). Due in part to puberty, adolescent girls are more likely to develop T2D than adolescent boys (Mayo Clinic, 2017). Additionally, if a mother with gestational diabetes births a child with either low birth weight or weight of over 9 pounds, the child is at an increased risk of T2D (Mayo Clinic, 2017).

T2D complications in children have many similarities to complications in adults, though often more expeditiously. Reinehr (2013) and Pinhas-Hamiel and Zeitler (2005) found that chronic complications of diabetes, including the increased likelihood of cardiovascular diseases, end-stage renal disease, loss of visual acuity, and limb amputations, occur in children as often as in adults. Moreover, these complications correlate to the excess morbidity and mortality rates of individuals with diabetes. Unlike adults, adolescents with T2D are more likely to present with acute crises, such as diabetic ketoacidosis, rhabdomyolysis, or a hyperglycemic hyperosmolar state (Pinhas-Hamiel & Zeitler, 2005). More severe complications might correlate to a lack of continuous adherence to medical treatments (Pinhas-Hamiel & Zeitler, 2005). A retrospective chart review of 237 patients in Children’s Hospital of Philadelphia diagnosed with T2D indicated that 46, or 19.4%, received diagnoses of neuropsychiatric diseases, such as depression, schizophrenia, and other behavioral disorders, which showed a correlation between T2D and psychiatric disorders (Pinhas-Hamiel & Zeitler, 2005).

As with adults, there are increased costs in managing T2D in children. A CDC (2011) press release indicated that the annual medical expenses for youth with diabetes were approximately $9,061, or $7,593 more than the medical expenses for youth without T2D. Prescription medications and outpatient care comprised much of the additional costs of diabetic care (CDC, 2011).

CCS Program and T2D

In 1927, the government implemented a program that provided for the medical needs of the most at-risk populations in all California counties. The program, later renamed CCS, provides youth and children under the age of 21 years having certain complex medical conditions with proper health care (California Department of Health Care Services, 2020). The complex medical conditions covered by CCS range from genetic ailments to diseases that require specific treatment and intense medical interventions, such as cancer, cerebral palsy, muscular dystrophy, and diabetes. Enrollees must be residents of the county and have a total family income equal to or less than $40,000 annually as well as coverage from state medical care such as Medi-Cal, California's Medicaid program. Additionally, enrollees must incur out-of-pocket medical expenses of 20% of the family's adjusted gross income for CCS eligibility (California Department of Health Care Services, 2020). Medical professionals, including registered and public health nurses, physical and occupational therapists, medical social workers, and licensed physicians, review the medical records of all eligible children while working with the children and their families to ensure proper medical attention and continuity of care. The staff members authorize medical treatments, medication, and supplies beneficial for the child while also working with local medical facilities to coordinate and plan future treatment (California Department of Health Care Services, 2020).

The CCS program does not cost anything for residents within the county and provides care to enrollees at no direct cost. Federal, state, and local county funds, such as health realignment derived from taxes, provide CCS funding. Because source funding is dependent on the number of enrolled children, the financial impact of children with preventable conditions, such as T2D, has a direct economic impact on each respective county and the State of California overall. Though Fresno County continues to provide funding for CCS, the goal of the CCS Manager is to reduce the prevalence of such diseases and funding reallocation to education measures and county community improvement Additionally, the understanding is that once these registered children age out of the CCS program, they will become dependent on additional county, state, and federal resources if they do not receive dedicated case management, proper disease management education, and personal care tools.

As of July 2018, approximately 8,000 children were enrolled in the Fresno County CCS; 72% of the enrollees resided in the City of Fresno, the largest urban area in the county (Aghadjanian, 2018). Fresno County CCS provides services for individuals with T1D and T2D, who comprise approximately a quarter of the program (Aghadjanian, 2018). Public Health Department leaders, such as the Associate Director and Director, in connection with local paneled providers, seek an explanation and a resolution to the prevalence of T2D diagnoses in the community. Medical professionals, such as public health nurses, who work within the CCS program note the prevalence of metabolic syndromes, including T2D, in Central Valley youth (Aghadjanian, 2018). Additionally, in speaking with the Fresno County Health Officer, there is an increasing annual number of children with T2D within the Central Valley region, which includes Fresno County, coupled with early diagnoses.

Assumptions

One assumption was that the information used to conduct the analysis would accurately reflect T2D diagnoses and that the children or adolescents impacted would be between 10 to 18 years of age at their initial diagnoses. Another assumption was that the members of the impacted population resided in Fresno County. There was also the assumption that T2D would be the sole diagnosis, with no other underlying or genetic factors causing health limitations. I also assumed the CCS program would have accurate records and diagnosis coding in electronic medical charts for the impacted subset.

Scope and Delimitations

The purpose of this study was to determine correlations between T2D and social determinants of health in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. This study was not an examination of T1D or factors outside SDOH that could result in a medical condition or T2D. In this study, I only examined a subset of a particularly impoverished population and not the greater population of Fresno County. The investigation of T2D was only within Fresno County and no other counties or regions within California.

Significance, Summary, and Conclusions

The study has implications for social change. Uncovering the essential social inequalities within Fresno County to reduce the personal and financial burdens of T2D provides useful information for strategic partnerships and advocacies with local nonprofit organizations, government agencies, and schools. The partnerships would present quantifiable data that scholars and medical professionals could use to create new educational programs on T2D prevention and care management. Programs introduced directly in educational establishments for enrolled students could be a means of promoting health modification techniques for T2D prevention. Another way to reduce the societal and financial constraints on the local community would be to work with local food vendors, the local health department, and the Board of Supervisors to establish localized farmers' markets in identified food deserts. Reinstating programs dedicated to youth initiatives would be a means of creating and maintaining community programs for the younger residents of Fresno County.

Despite plentiful data on diabetes, specifically T2D, research on the disease in younger populations is limited. There remains a clinical underestimation of the number of T2D diagnoses in children. The underestimation may be due to T2D's asymptomatic nature in children, the possible misclassification of T1D when severe hyperglycemia occurs, or decreased case reporting by pediatric endocrinologists (Bloomgarden, 2004).

The literature review presented the limitations of T2D awareness among younger demographics, despite the debilitating, costly, and chronic nature of the disease. Diabetes awareness and management with medical intervention are effective means of preventing complications and improving outcomes. Research showed how the disease progression in adults could cause further complications and indicated ways to manage diabetes after receiving a diagnosis. However, there is a gap in the literature on the impact of the disease on children and young adults in a predominantly agricultural community with a large transient population subset.

The psychological, ecological, and social determinants found in the literature presented some explanation of the impact of diabetes on children, adolescents, and young adults; however, scholars must further evaluate this population to determine the correlating factors of T2D and how to enhance self-management programs. Researchers need to understand health opportunities and limitations to identify what causes disparate health outcomes and prevention tactics. In Section 2, I describe the data collection and analysis processes used to determine if an association exists between SDOH and T2D Fresno County CCS enrollees under 21 years of age.

Section 2: Research Design and Data Collection

In the previous section, I described the contributing factors to T2D and outlined the impact of diabetes on children and young adults in Fresno County, California. Despite continuous educational efforts on management techniques and prevention methods in adults, the rate of T2D among youth has remained steady (County of Fresno, n.d.). On the topic of diabetes, scholars and medical professionals have repeatedly overlooked the younger residents and the communities in which they reside.

I considered using quantitative, qualitative, and mixed-method approaches to analyze medical health conditions and SDOH in this study. Researchers choose a methodology by considering their research questions, the answers they seek, the researchers themselves, and their studied populations. Scholars conduct quantitative, qualitative, or mixed-methods research to determine if correlations exist between variables that produce varying outcomes (Creswell & Creswell, 2018). Quantitative methodology consists of a numerical or statistical approach, qualitative researchers adopt a personalized and linguistic approach, and mixed methods research is a combination of both quantitative and qualitative methods (Creswell & Creswell, 2018).

A quantitative, cross-sectional approach using secondary data was the most appropriate method for investigating the given population and achieving the study objectives. A scholar who conducts a cross-sectional study uses data derived from an established population at a specific point in time; for this study, the data were from a secondary source (see Sperandei, 2014). A cross-sectional study requires recruiting participants based on inclusion and exclusion criteria, followed by investigating a one-time measurement of exposure to emphasize a potential correlational outcome over a causal outcome (Sperandei, 2014). Analyzing the rate of T2D diagnoses in youth in impacted communities was the first step in determining why there is an increased rate of T2D diagnoses in Fresno County. I also examined resident demographics in the impacted communities to understand why there is such a high likelihood of T2D in those areas.

The purpose of this study was to determine correlations between T2D and SDOH in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. I utilized existing Fresno County CCS program data from 2017 to 2019 years to measure the prevalence of T2D diagnoses within the established population, thus presenting a snapshot of the community (see Levin, 2006). I examined the associations between the dependent and independent variables within the data collected between 2017 to 2019 with a cohort of individuals with T2D diagnoses.

In this section, I explain the quantitative methodology, sampling, and instrumentation used for understanding if a relationship exists between SDOH variables and T2D occurrence in Fresno County CCS enrollees under 21 years old. In addition, I justify the data analysis process and address ethical constraints.

Research Design and Rationale

I conducted a secondary analysis of data from the Fresno County Department of Public Health to examine several variables to determine if there is any link to developing T2D when considering variables such as household income. Table 3 shows the variables investigated and the level of measurement.

Table 3

Independent and Dependent Variables

Variables	Type	Level of measurement
T2D diagnosis	Dependent	Nominal
Zip code*	Independent	Nominal
Age	Independent	Continuous
Race/ethnicity	Independent	Nominal
Gender	Independent	Nominal
Household financial status	Independent	Ordinal

* See Appendix D for a complete list of zip codes by community makeup.

Biases are preconceived opinions against or in favor of a specific item, person, or group that could result in unfair behavior. Bias can occur in any phase of research, from the study design to data collection, and could result in skewed outcomes (Pannucci & Wilkins, 2010). A researcher must stay mindful of and account for potential bias. Every research methodology presents the risk of bias. (Creswell, 2009). Bias can still occur in secondary research due to the predisposition of primary investigators during data collection or to the elements of social desirability, selection, or channeling. Informational bias is possible because there may be inexact or inaccurate primary data of the familial unit or patient (Hammer et al., 2009). For example, the parents or guardians of the enrolled clients could fail to provide or be unaware of their family history with diabetes. Although a family history would be an important factor, a margin of error could skew the results. The primary source of the data could have had selection bias because families and patients could be excluded from CCS by not meeting qualifications or not receiving proper information about the program; therefore, there may be more T2D cases than presented in the data. There was limited investigator bias because I used data collected through nonresearch methods with a direct link from community sources to the CCS systems.

Population

Fresno County CCS program enrollees are varied because admission into the program can occur at any point following a medical diagnosis. The annual average enrollment within recent years has been approximately 7,000 children aged 0 through 21 years of age. Some children with less severe medical conditions are temporarily enrolled within the program, whereas other youth enrolled at birth due to complex health conditions remain in CCS until their 21st birthday. Children with T2D can enter the CCS program at any age after receiving a diagnosis if they meet all the eligibility requirements, such as household income below $40,000 or maximum medical expenses beyond 20% of annual income. The eligible children with T2D remain with the program until they age out, assuming no other factors affect themselves or their guardians, such as relocation or change in employment. The subset of the youth population diagnosed with T2D varies yearly. In 2019, approximately 300 of the 7,000 enrolled in CCS had a diagnosis of T2D; this average included the children enrolled in CCS for primary medical conditions plus T2D and those with only T2D.

Sampling and Sampling Procedures

Quantitative researchers must calculate sample size to ensure they have neither too large nor too small a group to avoid compromising their conclusions. Too few people in a sample might prevent proper generalizability, and too many could result in insignificant statistical differences (Faber & Fonseca, 2014). According to 2019 data, the unique program of CCS, from which I drew my sample of the greater Fresno County population, included a subset of approximately 300 participants with T2D. The subset comprised individuals with the shared characteristics of a T2D diagnosis and Fresno County residence. I used purposive, or deliberate, sampling for this cross-sectional study on the prevalence of T2D in Fresno County youth enrolled in CCS. A researcher uses purposive sampling to select participants based on knowledge of the population (Lavrakas, 2008). The sample for this study is a subset of an overarching population with shared characteristics.

Inclusion and Exclusion Criteria

The inclusion criteria required participants to have recorded T2D diagnoses and be CCS enrollees. The participants had to have complete medical records on file and be receiving ongoing treatment for T2D. Exclusion criteria were any individuals over the age of 21 years, who have T1D, or who do not comply with routine treatment. The participants also have the ability to opt out of CCS services and be excluded from the data set at any time.

Power Analysis

I completed the analysis for this quantitative study using G*Power 3.1.9.6, a free software program for computing statistical power analysis. Created for statistical tests, G*Power 3.1.9.6 has undergone enhancements and improvements for association, correlation, and regression analysis (Faul et al., 2009). Social, behavioral, and biomedical scholars use G*Power to test for correlations, conduct regression analysis (such as one-sample correlation tests or Poisson regression coefficients), and calculate sample size (Faul et al., 2009).

I used a power analysis in G*Power 3.1.9.6 for Mac OS X to identify the minimum sample size suitable for the study. I used a single hypothesis as a principle to set the sample size calculation based on the assumption that 40% of rural residents (Pr(Y=1|X=1) H0) and 15% of urban residents have T2D. The *z* test family and a statistical test of logistic regression that aligned with the overall study were appropriate computations. An a priori power analysis was used to compute the sample size with a medium Cohen's effect size of 0.5. The parameters used for the a priori power analysis were:

- one tail or two tails
- an effect size input as odds ratio
- a statistical power level of 0.80 for conventional standard minimums that indicates a 20% probability of encountering a Type II error
- a probability level (i.e., *p* value) of 0.05 to meet statistical significance
- a normal X distribution

After accounting for the factors, I needed a minimum sample size of 102 participants for a one-tailed test and 128 participants for a two-tailed test. The number of samples provided by the Fresno County CCS fulfilled the sample size criteria. I used all available samples, which exceeded the minimum sample size calculation.

Recruitment, Participation, and Data Collection

Data collection by the Fresno County Department of Public Health's CCS division occurs through direct communication with local health care providers through the E-47 system. Hospital workers and other health care personnel input client information into the E-47 system and alert the corresponding county's CCS program. The program workers then collaborate with the enrolled families and provide additional coverage beyond the clients' preexisting health insurance while collecting additional data. Individuals who do not respond to CCS outreach efforts do not participate in CCS or receive CCS benefits.

Procedure for Accessing the Data

Because members of the public cannot access the data set used for this study, it was necessary to follow the Fresno County Department of Public Health research guidelines. I requested access to the data and provided a proper explanation and the benefits of my study to members of the Fresno County internal research committee. I confirmed that the data were deidentified and securely stored all material I received permission to access.

Permission to Gain Access to the Data

As a prior employee of the Fresno County Department of Public Health, I received permission to obtain the necessary data for the study. I requested approval from the Walden University Institutional Review Board (IRB) and the Fresno County Department of Public Health before obtaining and analyzing the data.

Theoretical Framework

I developed this study using the social-ecological model. The social-ecological model is a framework that enabled me to understand the various factors impacting health, including SDOH. Researchers use the social-ecological model to account for the complexities between individual, relationship, community, and societal factors as well as the impact of those components on well-being and risk (Rural Health Information Hub, 2020). As shown in Appendix D, the Office of Behavioral and Social Science Research (n.d.) presented a model with five components: individual, interpersonal, organizational, community, and public policy, which is an adaptation of Bronfenbrenner's 1977 model. Following the introduction of the ecological model in the 1970s, Bronfenbrenner (1992) advanced the social-ecological framework to model the entire network an individual needs for human development. This social-ecological model indicates that behaviors have a bidirectional impact on the social environment. The first factor consists of the characteristics, such as age, education level, and sexual orientation, that indicate how and why a person behaves a certain way. The second factor, interpersonal, includes relationships and social networks, such as family, religion, and traditions. The third factor is the organizational component, which might include schools where the individual shares or learns information and the greater physical area. The fourth factor is the community level, which includes cultural values. The final factor, public policy, comprises laws on local, national, and global levels that have a widespread impact. I considered the factors from the social-ecological model and their impact on the participants' health.

Additionally, I used the socio-ecological model coupled with the conceptual framework by the Bay Area Regional Health Inequities Initiative for this study. The Bay Area Regional Health Inequities Initiative conceptual framework, which originated in 2015, presents several factors with an effect on health. This framework shows the influences on health in an upstream and downstream configuration. The upstream concept presents the drivers of health, such as social inequalities, institutional power, and living conditions.

The UCLA Center for Health Policy Research (2016) indicated a significant increase in prediabetes diagnoses in California adults (i.e., individuals over 18 years of age), which is a precursor to T2D. The prediabetes rates in rural counties were more than 40% of the total residents, with an even higher incidence among underrepresented groups residents (UCLA Center for Health Policy Research, 2016). Therefore, the purpose of this study was to determine correlations between T2D and SDOH in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support.

Instrumentation and Operationalization of Constructs

Although scholars cannot prove reliability and validity, they must ensure the consistency and accuracy of their studies as much as possible. The Fresno County Department of Public Health provided valid and reliable data, having taken several steps during the data collection process to ensure accuracy, including:

- Members from the Fresno County Department of Public Health and CCS collect the data.
- The data collected are specific to providing health care and funding for families in need.
- Data collection has been continual since CCS's inception in 1927.
- Data collection occurs through direct access to electronic health records with community health providers and enrollment forms from families.

Other scholars using CCS data include Hintz et al. (2015), who investigated high-risk follow ups at neonatal intensive care units across California.

Although I used data specific to Fresno County, scholars could replicate the study in all California counties for the betterment of the residents. All data are impartial to any confounding variables of the residents. The data undergoes review and entry into the

Fresno County systems for disease surveillance and emergency planning throughout the county.

This study was an examination of several variables and their associations to T2D diagnoses. As shown in Table 3, there are nominal and ordinal variables independent of T2D diagnoses. Table 4 presents the variable type and scale options. The confounding variables (those with an influence on dependent and independent variables that produce a spurious relationship) are age, gender, obesity, and household income.

Table 4

Variable Types and Value Options

Variables	Variable type	Value options for correlating variable
Zip code	Categorical, nominal	Urban, suburban, rural
Age	Categorical, continuous	< 10, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, > 21
Race/ethnicity	Categorical, nominal	Alaskan Native, Asian, Black/African American, Hispanic/Latino, Other/Mixed/Unknown, White/Caucasian
Gender	Categorical, nominal	Male, female
Household income*	Nominal, ordinal	Households above $40,000 annual household income, Households above $40,000 with an out-of-pocket expense rate beyond 20% annually

* Reference category: households below $40,000 annual income or above $40,000 with an out-of-pocket expense rate beyond 20% annually.

Data Analysis Plan

To conduct logistic regression, I used IBM Statistical Package for the Social Sciences 27.0 (SPSS 27.0), provided by Walden University to scholar-practitioners. The program enables calculations of statistical tests, effective sample size calculations, and graphing. Logistic regression calculates the statistical analysis of a relationship between a categorical dependent variable and one or more independent variables (Menard, 2010).

Data cleaning, also referred to as data cleansing, is a preparation step in which the researcher prepares the data for analysis. Cleaning the data provides for two data concerns that could occur during research: missing data and errors (Davis, 2010). Cleaning the data before completing the analysis enables researchers to maintain reliability and validity to strengthen research outcomes (Davis, 2010). As this was a secondary study, I ensured there were no missing or partial data provided; the data set was a complete set contained full patient information per the agreement which included ages, residential zip codes, eligibility codes, gender, race/ethnicity. Instead of skimming the collected and deidentified data, I reviewed the respondents' information for any missing values. Maintaining open communication with Fresno CCS enabled me to fill in any missing criteria quickly and effectively. No missing or partial data were found within the dataset provided by Fresno County Department of Health and therefore no data were excluded; the lack of partial or missing data emphasizes that there was no potential bias within the sample, as I was no data replacement replace missing information was needed (see Davis, 2010).

As stated in Section 1, the RQs were:

RQ1: Is there an association between residential zip code and T2D occurrence among Fresno CCS clients under 21 years old?

$H_0$1: There is no association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

H_a1: There is an association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

RQ2: Are there associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for educational level?

H_02*:* There are no associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

H_a2*:* There is an association between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

RQ3: Is there an association between the households that fall under the federal poverty guidelines with T2D occurrence for Fresno CCS clients under 21 years old?

H_03: There is no association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

H_a3: There is an association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

I used the three RQs to examine if an association exists between the independent and dependent variables and this population. Logistic regression enabled me to determine the OR when comparing more than one explanatory variable. Researchers conduct logistic regression to observe each variable while avoiding confounding effects (Sperandei, 2014). I tested RQ1, RQ2, and RQ3 using a binary logistic regression. The dependent variable was T2D, and the independent variables were zip code, age, race, and gender. A binary logistic regression facilitated the determination of the statistical significance of the T2D diagnosis. Testing the hypothesis occurred at the $p < .05$ parameter for statistical significance at a confidence interval of 95%.

There are multiple methods for interpreting results when analyzing data. In this study, I used the *OR* to present any strengths of the association between T2D and the corresponding factors. The *OR* practice allowed me to determine the probability that the outcome (T2D diagnosis) could occur, given the contributing factors. Logistic regression is limiting because the results are not directly interpretable as probabilities or relative risk; therefore, I used the conversion to *OR* to account for this limitation (see Norton et al., 2018).

Threats to Validity

Researchers must identify the internal and external threats within their studies (Creswell, 2009). Threats to external validity can occur when researchers work with large population samples and generalize the outcomes. I conducted this quantitative secondary study with a focus on the specific subset of young Fresno County residents with T2D diagnoses. The specificity of the sample is a means of accounting for selection bias within the study. I used a diverse (heterogeneous) sample to minimize the external threat to validity (Leighton, 2010a). The sample consisted of individuals with varying community characteristics, including rural to urban residence, age, race and ethnicity, and additional socioeconomic factors. Although I did not randomly select the population due to limited resources, I conducted purposeful sampling to prevent generalization so I could conclude if associations existed (see Leighton, 2010a).

Internal threats to validity can emerge in the general conclusions made about the variable relationships in a study. There are also several threats to internal validity, such as history effects, instrumentation, statistical regression, selection bias, and compensation. As this was a secondary and quantitative study, there was no direct interaction with participants beyond the consent forms. As there was no direct interactions with the participants, any potential impact of compensation and other related threats would be nonexistent. Additionally, I used the data collected during snapshots of historical time to reduce the time on changing outcomes. However, any effects that occurred before data collection could have impacted an individual's eventual diagnosis due to limiting factors such as parental job loss or relocation. As I could not randomly assign the participants to test or control groups, I ensured the individuals had similar key variables, such as comparable SES, with equal numbers of male and female and child and young adult participants (see Leighton, 2010b).

Ethical Procedures

For this study, I treated all ethical issues related to the project per Fresno County Department of Public Health IRB and Walden University IRB (Approval No 10-09-20-032239) requirements. This process was based upon the United States Department of Health and Human Services Regulations for the Protection of Human Subjects, identified as 45 Code of Federal Regulations 46. The clause mandates that children, who were the foundation of this study, incur minimal risk and receive direct benefits for participation. As I neither had direct contact with participants nor required additional information, there was minimal risk. I still addressed several ethical concerns, including informed consent, confidentiality, protection of health information, and participant protection. I did not report the participants' names, as this information was not included in the data set or required. All publications and presentations will include only aggregate data, grouping those with low counts. Additionally, I protected the participants' privacy and did not request any identifying data, such as Social Security Numbers, dates of birth, telephone numbers, or home addresses. Individuals within the CCS program automatically receive unique identifiers upon enrollment. This de-identifiable information is a means of ensuring confidentiality; accordingly, I only used Health Insurance Portability and Accountability Act-compliant transmission methods to obtain the data.

Summary and Transition

The purpose of this quantitative study was to determine correlations between T2D and social determinants of health in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. The retrospective and ecological ideology enabled me to look back over the 2017 to 2019 data from the Fresno County CCS to uncover any patterns that might exist. This study fills a gap in the literature through an analysis of information readily available on members of a vulnerable population, youth under 21 years of age, as shown in Section 1. In Section 3, I present the data and statistics showing whether any associations exist.

Section 3: Results and Findings

The purpose of this study was to determine correlations between T2D and SDOH in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. The CCS division of the Fresno County Department of Public Health supplied de-identified data collected from program enrollees from 2017 to 2019. In Section 2, I explained the data collection process, including the means of deidentifying data to ensure participant privacy and confidentiality. The following three research questions and related hypotheses underwent testing to uncover any potential associations:

RQ1: Is there an association between residential zip code and T2D occurrence among Fresno CCS clients under 21 years old?

$H_0$1: There is no association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

H_a1*:* There is an association between residential zip code and T2D occurrence for Fresno CCS clients under 21 years old.

RQ2: Are there associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for educational level?

$H_0$2: There are no associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

H_a2: There is an association between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old, controlling for education level.

RQ3: Is there an association between the households that fall under the federal poverty guidelines with T2D occurrence for Fresno CCS clients under 21 years old?

$H_0$3: There is no association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

H_a3: There is an association between household poverty guidelines and T2D occurrence for Fresno CCS clients under 21 years old.

In Section 3, I present the data collection, analysis, and results in addition to a summary of the findings. Each subsection includes tables, figures, and discussions to answer the research questions. There is also a discussion of the hypothesis testing used to show any association between the variables.

Data Collection of Secondary Data

The data for this study came from the CCS program of the Fresno County Department of Public Health. CCS program enrollees are under the age of 21 and residents of Fresno County. The shared data set included clients between the ages of 10 and 20 who were diagnosed with T2D, notated by the International Classification of Diseases, 10th Revision (ICD-10) code of E11. The data set included 372 participants: 114 from 2017, 126 from 2018, and 132 from 2019. As computed by G*Power, the minimum sample size for this study was 128; I exceeded this number by including all participants in the data analysis. Further descriptions of the data collection, variables, and overall study design follow in subsequent subsections.

Because these data are not publicly available, I obtained permission from the Fresno County Department of Public Health to access the files. The Walden University

IRB approved this study. The Fresno County Department of Public Health shared the data in an Excel spreadsheet through encrypted and secure email correspondence. Upon receipt, I input the data set into SPSS 27.0 for statistical analysis. It was necessary to recode most variables for SPSS analysis requirements. Table 5 shows the variables, their original formats, and any recoded values.

Table 5

Summary of Analysis and Variables

Description	Variable from CCS	Code from CCS	New Code
Type 2 diabetes diagnosis	E11	E11 No	1 = Yes 2 = No
Age	Age	0–20 years old	1 = 10 years old 2 = 11 years old 3 = 12 years old 4 = 13 years old 5 = 14 years old 6 = 15 years old 7 = 16 years old 8 = 17 years old 9 = 18 years old 10 = 19 years old 11 = 20 to less than 21 years old 99 = Under 10 years old
Gender	Gender	Female Male	1 = Female 2 = Male
Race/ethnicity	Ethnic group	Alaskan Native Amerasian American Indian Asian Asian Indian Black/African American Cambodian	1 = Alaskan Native 2 = Asian 3 = Black/African American 4 = Hispanic/Latino 5 = Other/mixed/unknown 6 = White/Caucasian

Description	Variable from CCS	Code from CCS	New Code
		Chinese Filipino Hawaiian	
Race/ethnicity continued	Ethnic group continued	Hispanic Japanese Korean Laotian Other/Mixed Samoan Unknown Vietnamese White	1 = Alaskan Native 2 = Asian 3 = Black/African American 4 = Hispanic/Latino 5 = Other/mixed/unknown 6 = White/Caucasian
Zip code	PT zip code	93602 through 93668	1 = Suburban 2 = Rural 3 = Urban
Household income status	Eligibility CCS status	9K CCS 9M MTP Only 9N M/C Only 9R CCS Over Fin Elig 9U CCS Elig Not Comp 9V PPCW Participant	1 = More than $40,000/year with out-of-pocket medical expenses exceeding 20% of income 2 = Less than $40,000/year

T2D

The code E11 variable is an isolated independent variable—specifically, the ICD-10 code for patients within the CCS program who have confirmed T2D diagnoses. This group includes any client enrolled into the CCS program either for T2D only (i.e., primary diagnosis) or with T2D as a coupled diagnosis (i.e., secondary diagnosis). Clients who did not have T2D (or an ICD-10 diagnosis code of E11), such as those with T1D (i.e., E10) or other health conditions that did not include a primary diagnosis of T2D, were not classified as T2D and, therefore, excluded from the data sample. Additionally, clients with specified cases of T2D, such as T2D with kidney complications, were not a part of the data set. Clients with missing or incomplete data were also excluded from analysis.

Age

All participants in the original CCS program data had their ages recorded and had to be under the age of 21 to maintain enrollment. The original data set included participants ranging from newborn to 21 years; therefore, any individuals over 21 years were excluded. Age was a continuous variable, with those under 10 years old grouped (see Table 5) to protect the small sample size. There were four cases diagnosed as having T2D grouped and included in the overall data analysis. The reason for keeping this variable continuous was the small sample size, which enabled showing correlation by age. CCS captures all dates of birth; therefore, there were no participants with missing data.

Gender

The original data set included the client's gender, entered by CCS enrollment requirements. This criterion only has two options—male or female—and thus includes only two codes. This variable coded for analysis was 1 = female and 2 = male. This is a required criterion for health care services through the CCS program; thus, there were no data sets excluded from analysis.

Race/Ethnicity

The CCS data set includes an optional client disclosure of race/ethnicity from the following options: Alaskan Native, Amerasian, American Indian, Asian, Black/African

American, Cambodian, Chinese, Filipino, Hawaiian, Hispanic, Japanese, Korean, Laotian, other/mixed race, Samoan, Unknown, Vietnamese, and White; if a client chooses not to self-identify, the CCS program records it as “Unknown.” I recoded this variable for SPSS analysis (see Table 5), grouping participants into six categories to condense the number of variables. Although this demographic information is not required upon enrollment, CCS enrollment advisors must record a variable; thus, the “Unknown” option is available. One 2017 participant was excluded due to incomplete data compiled during enrollment.

Zip Code

The CCS program included all participants residing in Fresno County during 2017, 2018, and/or 2019 who received care for T2D through the program. The original data set presented the participants’ zip codes, which I recoded according to the U.S. Census categories of rural, suburban, or urban. A requirement for the CCS program is proof of residency, specifically confirming residence within the county that will cover medical services; therefore, because no enrollee can have missing residential information, there were no exclusions for analysis.

Household Income

A prerequisite for enrollment into the CCS program is verification of family income. One option is an annual family income of less than $40,000 or out-of-pocket medical expenses related to the CCS diagnosis of more than 20% of the family’s income, recalculated annually. Using this information converted into the client’s eligibility status and aid code, I recoded the data as 0 if the family fell below the confirmed federal level of poverty of $40,000 per year and 1 if they were above the poverty threshold and qualified through other financial impacts (e.g., the out-of-pocket expenses exceed 20% of the family's household income), as shown in Table 5. All families must provide this information, so there were no missing data and no clients excluded from analysis.

Results

The secondary data set for this study came from the CCS division of the Fresno County Department of Public Health specific to T2D patients under the age of 21 from 2017 to 2019. The data included demographic information of the CCS population, including race, age, family annual income, gender, and area of residence. To answer RQs 1, 2, and 3, binary logistic regression was used to determine if there was any association between the SDOH, including age, race, gender, place of residence, and household income over the federal poverty level of $40,000, and the occurrence of T2D.

Descriptive Statistics

Of all 21,512 participants in the CCS program from 2017 to 2019, there were 372 included in this study with a confirmed T2D diagnosis. Table 6 shows CCS program enrollment and the demographics breakdown. It is significant to note that many participants diagnosed with T2D were between the ages of 14 and 19 years in 2017, 2018, and 2019, with four cases of children under the age of 10 years in 2017 and 2019. Descriptive statistics for both the overall CCS population and the target population appear in Table 6.

In the overall CSS participant population, the percentages of male and female children are almost equal (52.4% and 47.6%, respectively); however, the incidence of T2D was noticeably higher in girls (57.4%) than boys (42.6%). The participants were younger, with 44.8% under 10 years and 48.5% between 10 and 19 years, while only

6.6% were in their 20s. Among the T2D target population, the age range distribution was skewed to the older participants, with a combined 98.7% between 10 and 20 and 84.5% between 10 and 19 years; only 1.1% of the participants were under 10.

The ethnicity of the target population and overall CCS population was similar, with 52.3% and 42.5%, respectively, belonging to the Other/Mixed/Unknown category. The second-highest percentage of participants self-identified as Hispanic/Latino, with 35.4% having T2D and 42.2% in the overall population. The lowest percentage for both populations was in the Alaskan Native category. Although the Fresno CCS program is available to all residents under 21 years old residing in Fresno County, in 2017 and 2018, only Alaskan Native, Asian, Black/African American, Hispanic, Mixed/Other/Unknown, and White patients identified as having T2D. In 2019, there were no Alaskan Natives identified as either T2D-diagnosed or non-T2D patients; this could be due to relocation to other California communities or out of the state altogether.

Table 6

Descriptive Statistics for Total CCS and Target T2D Diagnosed Populations (2017–2019)

		Total CCS population 0–20 years		Total	Target CCS population 0–20 years diagnosed with T2D		Total
		n	%	*N*	*n*	%	*N*
Gender	Male	11,263	52%	21,512	158	42%	372
	Female	10,249	48%	21,512	214	57%	372
Age	Under 10 years	9,642	45%	21,512	4	1%	372
	10–15 years	6,094	28%	21,512	111	30%	372
	15–20 years	5,776	27%	21,512	257	69%	372
Race/ ethnicity	Alaskan Native	4	0%	21,512	2	1%	372
	Asian	1,035	5%	21,512	13	3%	372
	Black/African American	789	4%	21,512	14	4%	372
	Hispanic/Latino	9,086	42%	21,512	132	35%	372
	Other/Mixed/ Unknown	9,143	43%	21,512	195	52%	372
	White/Caucasian	1,455	7%	21,512	16	4%	372
Zip code	Rural	3,456	16%	21,512	262	70%	372
	Suburban	3,826	18%	21,512	38	10%	372
	Urban	14,230	66%	21,512	72	19%	372
Household income status	More than $40,000/year with out-of-pocket medical expenses exceed 20% of income	334	2%	21,512	2	1%	372
	Less than $40,000/year	21,178	98%	21,512	370	99%	372

With the Fresno CCS program serving residents under the age of 21, reviewing the age categories for those with T2D is noteworthy. In Table 7, the breakdown of participants by age shows that individuals diagnosed with T2D typically fell within the age range of 10 to 19 years old year over year, rising from 98 cases in 2017 to 110 in 2018 to 107 in 2019. Participants in the < 21 years of age category had an incremental increase from 2017 to 2019 before aging out of the program: 13 to 17 to 23 from 2017 to 2019. Significant to note is the two cases of participants within the less-than-10 age group in 2017 and 2019 both; there were no cases in 2018, suggesting that the participants aged up into the 10 to 19 group.

Fresno County, California has a diverse geographical makeup that includes urban, suburban, and rural environments. From 2017 to 2019, most T2D patients (70.2%) resided in rural communities; in comparison, only 19.3% and 10.2% of participants lived in urban and suburban communities, respectively. This breakdown contrasts with the overall CCS population, with over 66.1% of participants residing in an urban environment and only 16.1% in rural communities. The CCS program aims to help any child under the age of 21 who has a serious medical condition and whose family may be unable to pay for treatment, either due to a lack of health insurance or minimal state-provided coverage and an annual household income under $40,000 (Department of Health Care Services, 2020). In rare circumstances, families who have private insurance coverage and surpass the $40,000 threshold but have incurred significant medical expenses exceeding 20% of the family's annual income can also qualify. The data show that the majority of T2D patients from 2017 to 2019 fell below the poverty threshold, with only two patients (0.5%) above that range, one in 2017 and one in 2018. The same percentage breakdown was apparent in the overall population.

Statistical Analysis

Conducting multiple logistic regression necessitates the creation of dummy variables (Laerd Statistics, 2017). Table 7 shows the dummy variables created for this study.

Table 7

Variable Creations for Logistic Regression

	Name of the categorical independent variable	Type of variable	Number of categories	Number of variables
1	Gender	Nominal	2	1 = female Male is the reference category
2	Ethnicity	Nominal	6	1 = Alaskan Native 2 = Asian 3 = Black/African American 4 = Hispanic/Latino 5 = Other/Mixed/Unknown White/Caucasian is the reference category
3	Zip	Nominal	3	1 = Suburban 2 = Urban “Rural” is the reference category
4	Eligibility	Nominal	2	1 = More than $40,000/year with out-of-pocket medical expenses exceeding 20% of income Less than $40,000/year is the reference category

Note. Age is excluded because it is a continuous variable.

Due to the nominal nature of all variables in this study, having at least two and no more than six categories, and the binary nature of the outcome expected, binominal logistic regression was appropriate to measure all dependent variables. Assessing the adequacy of the models and statistical significance was by using the Hosmer–Lemeshow goodness of fit test (Laerd Statistics, 2017). To determine the variance in the dependent variables in the model, I calculated the Negelkerke R^2 values. The categorical prediction, once the model fit and variance were explained, should be greater or equal to 0.5 to classify as the event as occurring; the prediction of the cases is related to correctly classifying the independent variable calculation. Identifying the statistical significance for each variable was by using the Wald test, also known as the Wald Chi-Squared test, with the specific variable Exp(B), or *OR*.

During data analysis, attention to the variables, such as age, gender, and other socioeconomic factors, could have impacted T2D rates. Avoiding this error entailed completing a binominal logistic regression of all the variables, including covariates, which allowed for controlling for confounding effects (Sperandei, 2014). I converted one continuous variable, ages, to nominal with three potential categories as met the assumption of linearity in related to the dependent variable, resulting in a *p* value lower than 0.05.

There are five main assumptions of logistic regression. In a binary regression, as with this study, it is assumed that the dependent variable is binary (Statistics Solutions, 2021). This study operated with the second and third assumptions in that the observations reviewed were independent of each other and should not be highly correlated. The fourth assumption states that there should be a linear relationship between the continuous independent variables and the log odds of the dependent variable. Lastly, this form of regression analysis requires a large sample size. To ensure that I computed the most statistically significant and accurate outcomes, I included all participants with a T2D diagnosis in the analysis.

Research Questions and Hypotheses

Three RQs guided this study to determine correlations to T2D diagnoses. This subsection provides answers to the RQs and their corresponding null and alternative hypotheses. The first RQ examined if an association between residential zip code and T2D occurrence among Fresno CCS clients under 21 years old exists.

At the onset of the logistic regression, the variables underwent review to meet all the necessary assumptions. The results yielded 38 outliers in the data, indicating a standard residual value that exceeded 2.5 standard deviations. Due to the small sample size of T2D diagnoses ($N = 372$), I decided to continue to include the outlying cases. The logistic regression model was statistically significant, $\chi^2(2) = 10.79$, $p < .005$. The model explained 0.3% (Nagelkerke R^2) of the variance of T2D while correctly classifying 98.3% of cases. The area under the receiver operating characteristic (ROC) curve was .531, 95% CI [.503, .559], which is considered poor discrimination (Hosmer et al., 2013) and equates to the likelihood of a coin toss.

The *OR* calculation measures the association between exposure and outcomes expressing the likelihood that an event will occur. Statistically, when an *OR* is less than 1, there is a decreased likelihood of the occurrence of that event; in contrast, if the *OR* is greater than 1, there is an increased occurrence of the event (Szumilas, 2010). As shown in Table 8, the *OR* for participants residing in a suburban neighborhood was less than 1, which means there is a reduced likelihood of a T2D diagnosis for suburban residents compared to rural communities (notated in Table 8 as the reference group). When reviewing the *OR* coupled with the *CI* for suburban residents, as the *CI* at 95% is so small, there is a higher likelihood of the *OR* calculation being statistically significant.

Table 8

Logistic Regression Predicting Likelihood of T2D Based on Residential Environment

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Suburban	-0.523	0.175	8.971	1	0.003	**0.593**	**0.421**	**0.835***
Urban	0.022	0.134	0.027	1	0.868	1.023	0.786	1.33
Constant	-3.976	0.062	4065.956	1	0	0.019		

Note. The reference category is rural.
* Statistically significant association

The second RQ aims to uncover if any associations between age, race, and gender and T2D occurrence for Fresno CCS clients under 21 years old exist. For this RQ, a univariate binomial logistic regression was the computation performed to determine the effects of age, gender, and ethnicity on the likelihood that participants have T2D. For age, as shown in Table 10, the logistic regression model was statistically significant, $\chi^2(2) = 406.82$, $p < 0.0005$. The model explained 11.7% (Nagelkerke R^2) of the variance in T2D and correctly classified 98.3% of cases. Sensitivity was .0%, with specificity at 100% in addition to a positive predictive value of 0% and a negative predictive value of 98.3%. The *OR* showed a significantly high value for both identified categories due, in part, to the small sample size of those under 10 years of age and age categorized due to the possibility of more than 12 variables for those with T2D diagnoses. As the *OR* for both the 10 to less than 20 and the less than 10 categories is particularly high, it is also important to note the high CI indicates a low level of precision of the *OR* calculation. As shown in Table 9, participants under 10 years of age had 92 times higher *OR* to exhibit T2D diagnosis than those between 20 and 21. Additionally, participants categorized as 10 years to less than 20 had almost 75 times higher odds than their older peers. The area under the ROC curve was .783, 95% CI [.766 to .801], which is an acceptable discrimination, according to Hosmer et al. (2013).

Table 9

Logistic Regression Predicting Likelihood of T2D on Age (Categorical)

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
10 <20 years	4.317	0.503	73.542	1	0	74.94	27.941	200.992
<10 years	4.532	0.519	76.155	1	0	92.943	33.587	257.198
Constant	-7.787	0.5	242.46	1	0	0		

Note. The reference category is 20 to less than 21 years.

However, to better analyze the data, the age variable was converted from the original approach of categorical to continuous. Once converted into continuous variables and grouping those under the age of 10 as 99, all other ages remained in their respective categories (as shown in Table 5) and the results varied (see Table 10). The *OR* being higher than 1 suggests an exposure associated with higher odds of the outcome coupled with a small *CI*, indicating a higher precision for the *OR*.

Table 10

Logistic Regression Predicting Likelihood of T2D on Age (Continuous)

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Age	0.23	0.014	273.411	1	0	**1.258***	**1.224***	**1.293***
Constant	-7.232	0.235	944.552	1	0	0.001		

Note. Variable entered on Step 1: Age.
* Statistically significant association

For gender, as shown in Table 11, the logistic regression model was statistically significant, $\chi^2(1) = 14.8$, $p < 0.0005$. The model indicates 4% (Nagelkerke R^2) of the variance in T2D diagnoses and correctly identified 98.3% of cases. As with age, the sensitivity and specificity are 0% and 100%, respectively, with the same positive value analysis. Overall, females had 1.5 times higher *OR* to exhibit T2D than males. The area under the ROC curve was .729, 95% CI [.712 to .747], which is considered acceptable discrimination, according to Hosmer et al. (2013). In reference to race/ethnicity, Table 12 shows that the logistic regression model was significantly significant, $\chi^2(5) = 28.6$, $p < 0.0005$. The model explained 8% (Nagelkerke R^2) of the variance in T2D and correctly classified 98.3% of cases.

Table 11

Logistic Regression Predicting Likelihood of T2D on Gender

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Gender: Female	0.405	0.106	14.634	1	0	**1.499**	**1.218**	**1.844***
Constant	-4.253	0.08	2817.2	1	0	0.014		

Note. Gender is for females compared to males (reference category).
* Statistically significant association

Unlike age and gender, sensitivity was 0.5% with specificity at 100% in addition to a positive predictive value of 50% and a negative predictive value of 98.3%. In this analysis, Alaskan Natives had 89.9 times higher odds to have a T2D than their White/Caucasian peers. In fact, all races/ethnicities had a higher likelihood of having T2D than Whites/Caucasians. The area under the ROC curve was .561, 95% CI [.532 to .590], which is a poor discrimination, according to Hosmer et al. (2013).

The *OR* for the Alaskan Native population presented a very high outcome, including the *CI* values. This is due, in part, to the minimal sample size for that subset of the population, given there were only two cases with documented T2D and four overall in the CCS population. The Asian, Black/African American, and Hispanic categories resulted in high *p* values and confidence intervals that spanned 1, with insignificant results. In contrast, the Other/Mixed/Unknown category was particularly significant. The *OR* value was almost 2, meaning that the exposure was associated with a higher likelihood of the outcome, and the *CI* was relatively small compared to the other ethnicities.

Table 12

Logistic Regression Predicting Likelihood of T2D on Race/Ethnicity

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Alaskan Native	4.499	1.031	19.039	1	0	89.937	11.919	678.619
Asian	0.136	0.376	0.13	1	0.718	1.145	0.548	2.391
Black/ African American	0.485	0.369	1.733	1	0.188	1.625	0.789	3.346
Hispanic/ Latino	0.282	0.266	1.122	1	0.289	1.326	0.787	2.234
Other/ Mixed/ Unknown	0.673	0.262	6.617	1	0.01	**1.96**	**1.174**	**3.273***
Constant	-4.499	0.251	320.311	1	0	0.011		

Note. White/Caucasian is the reference category.
* Statistically significant association

The third RQ seeks to uncover if there an association between the households that fall under the federal poverty guidelines with T2D occurrence for Fresno CCS clients under 21 years old. To assess RQ3, determining the effects of household income on the likelihood the participant had T2D occurred through binomial logistic regression. The analysis of this RQ was significant in that the majority of CCS program participant households (over 98%) are experiencing financial difficulty, with annual household incomes below $40,000. The logistic regression model was statistically insignificant, $\chi^2(1) = 3.39$, $p > .05$. Additionally, the model did not accurately explain Nagelkerke R^2, as the value was negligible (~1%, which is excluded) of the variance in T2D, although it did correctly classify 98.3% of cases. Sensitivity was 0.0%, and specificity was 100%. As shown in Table 14, the households with an annual income exceeding $40,000 had a .339

decreased likelihood of exhibiting T2D than those with annual household incomes below the designated poverty level. Overall, the results in this analysis are not statistically significant due to the small sample size of families above the federal poverty guidelines. The majority of CCS program families are below the poverty level and receive health care access through governmental assistance.

Table 13

Logistic Regression Predicting Likelihood of T2D on Federal Poverty Levels

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Household Incomes with more than $40,000/annually	-1.082	0.711	2.316	1	0.128	0.339	0.084	1.365
Constant	-4.03	0.052	5902.946	1	0	0.018		

Note. Household income less than $40,000 annually is the reference category.

Upon reviewing the unadjusted models per RQ, the next step of the analysis was to calculate an adjusted model inclusive of all statistically significant covariates. As many associations did not prove to be statistically impactful on the outcome variable of a T2D diagnosis, the included covariate variables were age, suburban residential environments, females, and the Other/Mixed/Unknown ethnicity variables (see Table 14). The logistic regression model was statistically significant, $\chi^2(4) = 98.3$, $p < .001$. The model explained 24.0% (Nagelkerke R^2) of the variance and correctly classified 98.3% of cases.

The results of the analysis showed that there was a statistically significant difference between the outlined variables ($p < 0.05$). The results also indicated definitive predictors for a higher occurrence of T2D among the 0 to 20 years of age participants of the CCS program in Fresno County, supporting that females have a higher likelihood of a T2D diagnosis, particularly when residing in suburban areas. Additionally, as age continued to increase among the participant groups, the occurrences for both males and females increased, although females still maintained a higher likelihood.

Table 14

Logistic Regression Results for Checking the Association Between Race, Gender, Residential Environment, and Age on T2D Diagnoses

							95% CI for OR	
	B	SE	Wald	*df*	*p*	OR	Lower	Upper
Age (continuous)	0.238	0.014	287.61	1	0	1.268	**1.234***	**1.304***
Gender: Female	0.376	0.107	12.291	1	0	1.457	**1.18***	**1.798**
Residential environment: Suburban	-0.587	0.174	11.382	1	0.001	0.556	**0.396***	**0.782***
Race/ethnicity: Other/Mixed/ Unknown	0.718	0.107	45.166	1	0	2.05	**1.663***	**2.527***
Constant	-7.801	0.257	924.45	1	0	0		

Note. Variables entered on Step 1: Age, variable for female, variable for suburban, variable for other/mixed/unknown.
* Statistically significant association

Summary

The purpose of this quantitative study was to determine correlations between T2D and social determinants of health in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. This section presented the characteristics of the sample population within the CCS program and the results of the hypothesis testing. Analysis occurred with a sample of 372 participants with recorded T2D diagnoses from 2017 through 2019, using a data set supplied by the CCS

Division of the Fresno County Department of Public Health. I conducted inferential and differential statistics to analyze the data. Based on the findings, the null hypotheses for RQ1 and RQ2 were rejected, and the null hypothesis was supported for RQ3. Therefore, as indicated in the data, there was no association between annual household income and T2D occurrence for Fresno CCS clients under 21 years old. Alternatively, rejecting the null hypothesis for RQ1 and RQ2 indicated a correlation between residential environment (suburban and urban), age, gender, and ethnicity with the likelihood of a T2D diagnosis in Fresno County. I will discuss data interpretation, limitations, recommendations, and implications in Section 4 before providing an overall conclusion of the study and analysis.

Section 4: Discussion, Conclusion, and Recommendations

The purpose of this study was to determine correlations between T2D and SDOH in Fresno County, California, based on children and adolescents enrolled in a state-funded program for medical care support. T2D research for youth and young adults is scarce, despite diagnoses of T2D in younger patients since the mid-1990s in the United States and other countries, such as Canada, Japan, and the United Kingdom (Reinehr, 2013). The goal of the study was to determine if a disparity exists among social determinants and occurrences of T2D to establish prevention and disease management programs for this specific population.

The CCS division of the Fresno County Department of Public Health supplied population data from 2017 to 2019. I analyzed the data to answer three fundamental RQs, with the results and key findings presented in Section 3. Data analysis showed an association between T2D diagnoses and age, race, gender, and rural/suburban residence. Section 4 contains the interpretation of the results, study limitations, recommendations for action and additional research, and implications for social change.

Interpretation of Findings

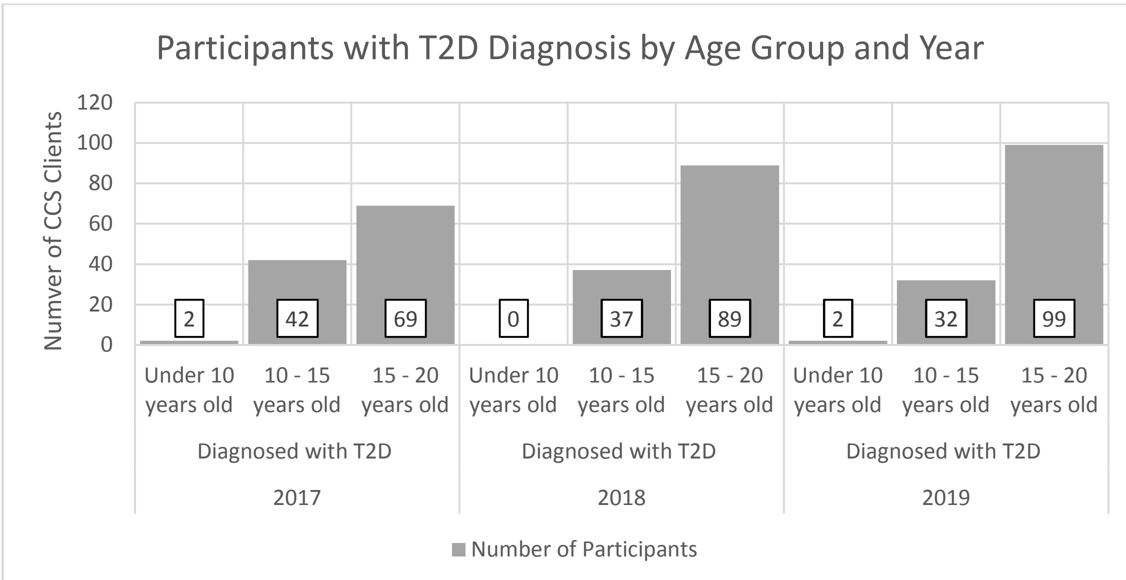
The findings of this study are consistent with other research and current medical knowledge shared with health care providers for T2D in children and adolescents. According to the Mayo Foundation for Medical Education and Research (2021) and Rodbard (2008), although researchers do not currently have enough data to understand why some children are more susceptible to developing T2D than others, certain risk factors might increase the likelihood. One factor is race, in that Hispanic, American Indian, Asian, and Black youth are more likely to develop the disease, which correlates with adult risk factors. Although the population in the Fresno County CCS program is predominantly Hispanic, this study found that the odds of having a T2D diagnosis were statistically significant in Alaskan Natives (due to the number of residents enrolled in the CCS program, where 2 out of 6 participants had T2D diagnoses) and Other/Mixed/Unknown than any other ethnicity in the county. This was an interesting finding despite the volume of Hispanic, Black/African American, and White/Caucasian participants being so high for the program. Many Fresno County residents are migrant or undocumented; therefore, families prefer to disclose as little information as possible, including their ethnicity, which could be why the Other/Mixed/Unknown category is so much larger than others. Another reason for the responses is that this is not a required field to receive services and was often not collected in prior years; as such, the system defaults nonrespondents into an "Unknown" category.

The results of this study corroborated the findings of Reinehr (2013) and Rodbard (2008) in that females were more likely to have T2D as a confirmed diagnosis than males of the same ages and ethnicities. Although why this is the case is unclear, there are possible explanations. Some reasons for females' increased likelihood of T2D could be their increased percentage of body fat throughout adolescence than males, lack of physical activity in organized sports or physical activity, diet with an increase in higher glycemic indexed foods, and hormonal differences. The lack of physical activity is one of the leading reasons girls could have increased T2D occurrences because boys are more likely to participate in sports or physical activities during and after school. Because weight directly correlates to the potential development of T2D, the lack of physical activity also correlates to higher weight, especially in the abdominal area, which leads to insulin resistance and, ultimately, T2D. Although gender and race have an impact on the occurrence of T2D, age also has an effect.

The findings of this study supported preexisting research through an examination of CCS participants from under the age of 10 through 21, when they aged out of the program's services and monitoring. Although it is particularly concerning that CCS clients under the age of 10 received T2D diagnoses, medical professionals have not typically attributed this disease to younger children, particularly because testing begins around the age of puberty or 10 years, whichever comes first (see CDC, 2017). The study results showed that as clients aged through their pubescent/adolescent years (i.e., 10–19), there was an increase in diagnoses. Figure 1, below, shows that the largest number of patients in the program were in the 10 to under-20 age group, and those recorded in the under 21 years old categories would be adolescents who continued to age with their T2D diagnosis.

Figure 1

Number of Newly Diagnosed Clients with T2D in CCS Between 2017–2019



As participants age, the likelihood of increasing T2D occurrences can be attributed to puberty and hormonal changes. According to this study, the odds of having diabetes increased by 27% for every year of age, *OR* = 1.258, with the true value between 23% and 30% CI [1.224, 1.293] as shown in Section 3. One of the main reasons there is a definitive increase in T2D diagnoses in adolescence (typically, 13 years and above) is medical testing. Health care professionals do not typically test for T2D earlier than 10 years of age or more frequently than every 3 years, which indirectly skews the data (CDC, 2017). As girls undergo puberty, they face hormonal changes via increased estrogen and progesterone, which does not stimulate lipolysis the same as testosterone; thus, they are more susceptible to belly fat development and, subsequently, insulin resistance (Mauvais-Jarvis, 2011). This period is also when dietary changes are more likely because children have increased exposure to sugary drinks and high-glycemic foods and snacks. Additionally, young adolescents are more likely to take sedentary breaks, such as playing video games or watching movies or videos. Adolescents also undergo changes in their sleep habits, often receiving fewer than the recommended hours due to external factors, such as schoolwork or sports, with a direct correlation to digestion and weight gain. Additionally, puberty is the time when exposure to unhealthy habits often occurs; as such, it is the age at which adolescents might begin to experiment with nicotine products, alcohol, and other controlled substances, impacting their diet, physical abilities, and insulin production and causing other health complications.

Most researchers who have examined T2D in youth have determined that socioeconomic disparities, such as residential environment, are a factor in disease occurrence. Pulgaron and Delamater (2014) found that living in low-income neighborhoods was linked to higher sedentary behavior; the schools in those communities offer fewer physical education courses as well. In comparison, the findings of this study showed that CCS participants living in suburban communities had higher T2D occurrences than those in urban or rural communities. Within Fresno County, the rural communities are often agricultural with less access to routine medical care. These communities are often active farms, orchards, or other agricultural properties requiring increased physical activity, thus reducing the likelihood of T2D occurrence. The lack of buses or other public transportation also requires more walking.

In comparison, urban communities have a distinct lack of green space, limiting physical education courses in the school systems. In Fresno County, many of the health care facilities are centrally located in the downtown area or accessible by public transportation, increasing access to routine medical care. In a study of adults in several

U.S. neighborhoods, Christine et al. (2015) determined that environments that exposed residents to physical and social activity often had lower incidences of T2D diagnoses. However, as the current study showed, suburban communities were at increased odds for T2D than other communities, which can be attributable to several factors. Individuals who reside in suburban communities are often from middle- to upper-class households with higher household incomes. Despite the increased access to medical care and healthy food options, children from these households are more likely to engage in sedentary activities, such as playing video games.

Additionally, Fresno County often has very poor air quality and extremely hot summers, with weeks-long, 100-degree temperatures not uncommon. The poor climate results in suburban families reverting to indoor activities, physical education course and organized sporting event cancellations, and a dependence on vehicular transport directly from one point to another, reinforcing sedentary behavior. In contrast, rural and urban residents remain physically active with farm work or active commutes wherein residents must walk to designated public transportation stops that are sporadic throughout the county.

Answering RQ3 entailed determining whether household income had a correlation to T2D occurrences in Fresno County. Of the 372 participants who were a part of a statewide program to receive medical care, only two families had an annual household income over the poverty level of $40,000. Although family income is not a required element for CCS program acceptance, all families must submit proof of income and show a need for state coverage. In this study, due to the high percentage of families below the poverty line, there was no significant analysis conducted. The original hypothesis was that lower-income households would have higher incidences of T2D. Dendup et al. (2018) supported that hypothesis by correlating low education and low-income levels with a moderate-to-high risk for developing T2D; furthermore, as SES declined, the likelihood of T2D development rose (Elgart et al., 2021). Tan et al. (2018) determined that individuals in households with higher SES maintained glycemic targets, thus reducing T2D occurrences. Developing additional insights into family income and education levels might show similar correlations within Fresno County.

Limitations of the Study

A primary limitation of this study was the use of secondary data from the Fresno County Department of Public Health, meaning the data could not be substantiated. Secondary data can cause data and computational errors because of missing, incomplete, or modified values. Another limitation was the unavailability of data regarding overweight or obesity diagnoses for the population. Because CCS does not measure obesity, the E-47 system does not collect these data, despite the nurse case managers reviewing medical records for any potential elevated risk factors. Information such as the patient being overweight or obese is available only in written documentation (i.e., note entries) and not reported to the state.

Isolating E11 as the only ICD-10 code for T2D diagnoses is also a limiting agent, reducing the sample size and potentially excluding other participants with ICD-10 codes for T2D, such as E11.1 (i.e., non-insulin-dependent diabetes mellitus with ketoacidosis). The exact number of CCS patients diagnosed with a specific variation of T2D is unknown and dependent on the medical care of health care professionals in the area. The CCS program uses ICD-10 codes to determine eligibility and coverage, which can be broad or specific, depending on the enrollee's medical diagnosis. The provided data used only E11, the main ICD-10 code for T2D, to extract the confirmed diagnosis, excluding any specifications. According to the National Center for Health Statistics (2021), there are 10 components of the E11 ICD-10 code and approximately 99 subcodes specifying insulin resistance or intolerance, ocular complications, oral complications, or other similar complications, thus limiting the ability to review T2D clients entirely.

Finally, the E-47 system used to house the information on CCS clients and medical coverage does not include the family's annual household income. Rather, these data are collected, analyzed, and housed in a separate system, complicating analysis due to more generalized income data converted into the patient's eligibility codes. Therefore, the CCS-provided data specific to the family's financial status were provided through the nondescript/nonidentifying eligibility code, with families coded as "9R" having annual income over $40,000 and the other nine codes denoting financial eligibility and supplemental medical insurance.

Recommendations for Action

Although long classified as late-onset or adult-onset diabetes, T2D has become more common among younger populations, making it a notable problem in pediatric clinical practices (Reinehr, 2013). The findings from this study indicated disparities in some of the most fundamental components of a specific population, including racial disparities. Additionally, the findings showed disparities within age, gender, and T2D occurrence. Notably, the disparities were more common among adolescents between 10 and 19 years of age, Other/Mixed/Unknown ethinicty, and females. The data did not indicate medication usage or access to health care visits for the identified population set.

Although all CCS program participants obtain medical care, the frequency of routine health care visits, availability of disease management, and access to medication are not routinely measured or required. Research has shown that family members must also learn about the effective management of young patients with diabetes (Baig et al., 2015). Health care providers deliver extensive, routine education about risk factors, such as diet and lifestyle. When parents are involved in their children's insulin administration, there is an overall increased likelihood of blood glucose monitoring and improved glycemic control (Rodbard, 2008). Additionally, reports have shown that youth with T2D have a higher likelihood of medical care dropout, indicating that current practices are insufficient (Reinehr, 2013).

Recommendations for Additional Studies

This is the first study of its kind to examine residents under the age of 21 and T2D occurrence within Fresno County. The results indicated correlations among key SDOH and incidences of T2D; however, further studies are recommended to understand more about the county's health disparities related to T2D and younger residents. A qualitative study would be ideal for uncovering additional resources that might be available or possible programs to offer. Data collection would entail speaking to the participants' families to uncover more about the child, such as weight and dietary preferences; the family's SES; family diagnoses of diabetes, gestational diabetes, or other health complications; and the implications for the patient's quality of life. Developing an understanding of the families' health and disease management education needs and then providing that education in the language of their choice would also distribute additional information into the community.

Social Change Implications

This study has broad implications for health care professionals who work with children, including those under the age of 10. Recognizing that young children are receiving diagnoses of a preventable, or at least manageable, disease could reduce the number of missed diagnoses, thus overcoming the disproportionate diagnosis rates in young adults. Health care professionals should begin to test clients at increased risk for T2D development at younger ages. Also, health care providers working with Alaskan Native, Hispanic, Black/African American, and mixed-race populations could learn from conferences, continuing medical education workshops, and public health forums about the higher rates of occurrences for these populations. Early diagnosis and presenting disease management options for families would mean decreases in diabetic complications for patients having a relatively early onset of T2D (Rodbard, 2008). Such knowledge and prevention could also decrease the risks of myocardial infarctions and other cardiovascular diseases.

Additionally, practitioners should focus on family-based interventions versus treating the patient individually. This would entail engaging the family in techniques to increase physical activity, modify diets, and monitor glycemic control techniques, providing a support system for the patients outside the office and promoting better health for the entire family. Moreover, health care professionals can work with Promotores (Hispanic community health workers) in communities to further spread awareness, treatment plans, and resources to aid in the prevention of future incidents (Office of Minority Health & Health Equity, 2019). Promotores are educated, trusted, and welcomed members of the Hispanic community; as such, engaging them in reinforcing healthy practices would be more likely to result in positive outcomes.

Outside of health care providers, individuals could adopt internet-based interventions. Internet use is becoming increasingly prevalent in Fresno County households, not only for social interactions but for education. With the ability to adapt therapeutic interventions through online delivery, health care practitioners could reach more patients, including those typically engaged in internet-based activities while maintaining sedentary behavior. These interventions would allow families to also focus on healthy practices at their own time and pace at decreased or no cost. Telemedicine would allow individuals without immediate access to health care, such as those in the rural communities of Fresno County, to speak with a health care provider and receive ongoing care. Most of Turnbull et al.'s (2021) 21 participants relied on their ability to use technology and social networks to gain insight into prevention, diagnosis, and management.

More specifically, this research has implications for the Fresno County Department of Public Health, particularly when encompassing the Bay Area Regional Health Inequities Initiative (2015). The findings show how upstream impacts of emerging public health practices at a policy and strategic partnership level affect downstream impacts, like chronic disease, risk behaviors, and mortality. Therefore, encouraging the Fresno County Department of Public Health divisions to come together and address this health concern would have a long-term impact on the community.

Currently focused on diabetes in Fresno County, the Office of Health Policy & Wellness works to change policies, systems, and environments to make healthy choices accessible and attractive for all residents. Although the division focuses on several chronic diseases, such as diabetes, targeting youth is not currently within its scope. In tandem with Fresno's CCS program, the two divisions could target communities with notably higher rates of T2D occurrence, providing resources in the appropriate target languages and creating networks for families to receive information for effective disease management and prevention programs.

Additionally, the Public Health Nursing Division could provide information to families when a woman is pregnant and utilizing other public health programs, like Black Infant Health. This division could also identify women with a predisposition for diabetes or gestational diabetes linked to potential diabetes development in their children. Targeting the mothers and their family units before the child's birth could reduce the child's likelihood of developing T2D. Finally, a partnership between the Community Health and CCS divisions could provide additional training and educational resources to the local health care and educational systems, reducing or preventing future T2D incidences.

Conclusion

With the obesity epidemic continuing in the United States, the likelihood of diagnosing adolescents and children with T2D ranges from 1 in 51 to 1 in 1,000, depending on ethnic group (Pulgaron & Delamater, 2014). This study shows that while T2D is not the number 1 disease supported by Fresno County's CCS program, it is a high-risk disease with definitive correlations of increased risk in a vast number of populations. As shown in this study, the population of Fresno County with T2D under 21 years of age is diverse and includes a significant number of Hispanic, Asian, Black, and other ethnicities in patients as young as under 10 years. For a preventable disease, having more than 372 children and young adults experience T2D in 3 years indicates the need for more action to assist Fresno County's youth. The associations found in age and gender were also significant for diagnosis, treatment, and preventative measures, including initiating testing before the current age requirements of 10 years or the onset of puberty, whichever comes first. The need to equip younger audiences with information, test for diseases like T2D before puberty, and drive family engagement is fundamental to overcome these health disparities and the social determinants of health for all of Fresno's residents (The Annie E. Casey Foundation, 2021). T2D has long-term implications on people's quality of life regardless of their ethnicity or where they reside; thus, there needs to be greater alignment between public health officials and health care providers.

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Appendix A1

Figure 2: *Five Key Areas of Social Determinants of Health*

Appendix B1

Table 15: *Table of Social Determinants Identified*

Economic stability	Education	Social and community context	Health and health care	Neighborhood and built environment
Employment	Early childhood education and development	Civic participation	Access to health care	Access to foods that support healthy eating patterns
Food insecurity	Enrollment in higher education	Discrimination	Access to primary care	Crime and violence
Housing instability	High school graduation	Incarceration	Health literacy	Environmental conditions
Poverty	Language and literacy	Social cohesion		Quality of housing

Appendix C1

Table 16: *Fresno County Zip Codes*

93602 (Auberry) – Rural
93605 (Big Creek) – Rural
93606 (Biola)– Rural
93608 (Cantua Creek) – Rural
93609 (Caruthers) – Rural
93611 (Clovis) – Suburban
93612 (Clovis) – Suburban
93619 (Clovis) – Suburban
93210 (Coalinga) – Rural
93616 (Del Rey) – Rural
93621 (Dunlap) – Rural
93622 (Firebaugh) – Rural
93624 (Five Points) – Rural
93625 (Fowler) – Urban
93701 (Fresno) – Urban
93702 (Fresno) – Urban
93703 (Fresno) – Urban
93704 (Fresno) – Urban
93705 (Fresno) – Urban
93706 (Fresno) – Urban
93710 (Fresno) – Urban
93711 (Fresno) – Urban
93720 (Fresno) – Suburban
93721 (Fresno) – Urban
93722 (Fresno) – Urban
93723 (Fresno) – Urban
93725 (Fresno) – Urban
93726 (Fresno) – Urban
93727 (Fresno) – Urban
93728 (Fresno) – Urban
93730 (Fresno) – Suburban
93650 (Fresno) – Urban
93626 (Friant) – Rural
93627 (Helm) – Rural
93628 (Hume) – rural
93234 (Huron) – Urban
93630 (Kerman) – Rural
93631 (Kingsburg) – Urban
93634 (Lakeshore) – Rural
93242 (Laton) – Rural
93640 (Mendota) – Rural
93641 (Miramonte) – Rural
93646 (Orange Cove) – Urban
93648 (Parlier) – Rural
93651 (Prather) – Suburban
93652 (Raisin City) – Rural
93654 (Reedley) – Urban
93656 (Riverdale) – Rural
93660 (San Joaquin) – Suburban
93657 (Sanger) – Suburban
93662 (Selma) – Suburban
93664 (Shaver Lake) – Rural
93675 (Squaw Valley) – Rural
93667 (Tollhouse) – Rural
93668 (Tranquility) – Rural

Appendix D1

Figure 3: *Social Ecological Model*