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Type 2 Diabetes and Pesticide Exposure Among U.S. Hispanic Migrant Farmworkers

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Walden University
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Abstract

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MSN, Kaplan University, 2014

BSN, Kaplan University, 2011

Doctoral Study Submitted in Partial Fulfillment

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Abstract

Hispanic migrant farmworkers provide indispensable services to the United States, yet they are low-paid, uninsured employees working in extremely hazardous conditions. Public health and other healthcare professionals have worked to address the impact of pesticide exposure in the Hispanic migrant population. Although pesticides have been associated with various chronic diseases, limited evidence and studies have established an association between pesticide exposure and Diabetes Type 2 (DT2) among Hispanic migrant farmworkers. Guided by fundamental causes theory, this study addressed whether there is a relationship between agricultural pesticide exposure and DT2 among Hispanic migrant farmworkers in the United States who participated in the 2014 National Agricultural Workers Survey (NAWS). Fundamental causes theory was used for this study because it is a practical theory focused on socioeconomic factors such as education level, income, and access to healthcare resources and how they are associated with certain outcomes, in this study, the prevalence of DT2 among a certain population. Correlational study design was used to analyze quantitative secondary data from almost 70,000 farmworkers who took part in the NAWS. Descriptive statistics and binomial and multiple logistic regression tests were used to analyze the data. The multivariate logistic regression results indicated that DT2 in Hispanic farmworkers was associated with number of years doing farm work, education level, and access to healthcare services. Results indicated the need to improve working conditions and health outcomes for this vulnerable population. Addressing these risk factors could decrease the incidence of DT2 within the Hispanic migrant farmworker population in the United States and globally, thereby promoting positive social change.

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Section 1: Foundation of the Study and Literature Review

Introduction

According to the Center for Disease Control and Prevention (CDC, 2020) 26.9 million people in the United States have been diagnosed with Diabetes Type 2 (DT2), and an additional 7.3 million remain undiagnosed while living with the disease. Ferrer (2017) reported that, of the estimated 26.9 million diagnosed with DT2, around 27% are Hispanics. The Centers for Disease Control and Prevention (CDC, 2017) stated that Hispanics have a 70 percent greater risk of dying from diabetes compared to non-Hispanics. According to the National Agricultural Workers Survey (NAWS; U.S. Department of Labor [DOL], n.d.), of Hispanic farmworkers in the United States, about 75% were born in Mexico, 23% were born in the United States, 2% were born in Central America, and 1% were born in other countries.

Some data suggest that diabetes rates are higher in Hispanic population (Quandt et al., 2018), which was the initial prompt for this research. Despite an exhaustive search, no prior research or report was found on the prevalence of DT2 in migrant farmworkers. However, this population is continuously exposed to pesticides that are reported to cause many metabolic disorders (Arrebola et al., 2015; Juntarawijit & Juntarawijit, 2018). In this study, I investigated whether there is any relationship between DT2 and pesticide exposure among Hispanic migrant farmworkers in the United States.

Migrant farmworkers have served U.S. agriculture for over 100 years, yet they have remained the most medically underserved population in the United States (Connolly & Crosby, 2014). Public healthcare providers and stakeholders can tailor educational programs on diabetes to target migrant farmworkers. Quandt et al. (2018) state that

Hispanic migrant farmworkers' diets consist mainly of simple carbohydrates and foods high in fats, but the fact that members of this population are very physically active could alter the findings of many studies, because diet is not the only cause of DT2. It is of crucial importance to investigate diabetes and pesticide exposure among this population, as well as any relationship between these factors. Stakeholders in public health can use their influence and their expertise to promote diabetes awareness and prevention in communities with significant health disparities, including this underserved population (CDC, 2015).

Problem Statement

It is estimated that nearly 5 million Hispanic migrant seasonal farmworkers serve as the backbone of the U.S. agricultural industry (National Center for Farmworker Health [NCFH], 2013). It is well known that Hispanic migrant farmworkers are continuously exposed to pesticides. Arcury et al. (2016) examined levels of dialkylphosphate urinary pesticide metabolites in farmworkers and found that they had a disproportionately higher level of exposure than nonfarmworkers to pesticides that are known to cause immediate and long-term health consequences. Montgomery et al. (2008) examined how exposure to certain environmental toxins may be associated with increased risk of developing diabetes, including lifetime exposure to agricultural pesticides and the incidence rates of DT2 among pesticide applicators. The study included 33,457 White American licensed applicators over 5 years from 1999–2003. Exposure to agricultural pesticides was found to significantly increase the likelihood of developing DT2 by as much as 94% (Montgomery et al., 2008).

Although a preventable disease, DT2 is currently one of the leading causes of premature death globally (Asif, 2014). It is a chronic disease that requires constant monitoring of hemoglobin (A1C) values, a pharmacological regimen, podiatry and ophthalmology visits, and weight management (Stark Casagrande & Cowie, 2012). The complications from DT2 are varied and often result in renal failure, limb amputation, cardiovascular and pulmonary diseases, and death (Davidson et al., 2015). DT2 is the sixth leading cause of death in the United States (Clark & Utz, 2014). Proper management and prevention of this chronic disease remain the best ways to deter complications. According to the *National Diabetes Statistics Report 2017* (CDC, 2020), smoking, physical inactivity, obesity, high blood pressure, high blood cholesterol (hyperlipidemia), and high blood sugar (hyperglycemia); all increase the risk of developing DT2.

Several studies have identified and reported education, language, and income as potential risks for diabetes among Hispanics (Hu et al., 2013). Other studies have focused on the causes of common injury issues in the migrant seasonal farmworker community (Cuevas & Brown, 2018). For the past 10 years, multiple studies have reported correlations between exposure to pesticides and development of multiple pathologies (Damalas & Eleftherohorinos, 2011; Gangemi et al., 2016) in the United States and other developed countries, although none of these studies has investigated DT2.

The number of agricultural workers who report loading, mixing, or applying pesticides has been increasing steadily in recent years. In 2015, an estimated one in five (19%) agricultural workers reported working with pesticides. High exposure to pesticides compounded by low socioeconomic status poses a significant risk for developing chronic

illnesses such as DT2 (DOL, 2018a). Detailed health data on undocumented and foreign-born seasonal farmworkers are extremely limited because this marginalized population remains largely invisible (Bail et al., 2012).

Understanding the relationship between high pesticide exposure and the development of chronic conditions such as diabetes among this historically disenfranchised population is of public health importance (Bail et al., 2012). While considerable research has been conducted on the relationship between pesticide exposure and chronic illness, large-scale studies examining this relationship have been conducted only on U.S. citizens (Teixeira & Zuberi, 2016). Remarkably, there has been no conclusive research on the effect of pesticide exposure, utilization of healthcare services, and diagnosis of diabetes among this underserved population (O'Connor et al., 2018; Velasco-Mondragon et al., 2016). This study used an extensive national database on Hispanic migrant farmworkers to address this specific gap in the research literature.

Purpose of the Study

The purpose of this correlational study was to analyze the 2014 NAWS Public Access Data (NAWSPAD) secondary quantitative datasets to determine whether a relationship between pesticide exposure and DT2 among Hispanic migrant farmworkers in the United States has been the catalyst for other health issues, including death (Tancredi et al., 2015). Correlational analysis has become an increasingly popular method of data analysis by governments, funding agencies, and health-related registry systems (Cheng & Phillips, 2014). The independent variables of the present study were length of exposure to pesticide status using time as a migrant farmworker, poverty status, education level, and access to healthcare. The dependent variable was the DT2 incidence rate.

Research Questions and Hypotheses

To assess the association of the independent variables of pesticide exposure, poverty status, education level, and access to healthcare on the dependent variable of DT2, the following research questions and hypotheses were developed.

RQ1 (Inferential): Is there a relationship between the length of time of pesticide exposure (based on time working as a migrant farmworker) and diagnosis of DT2 among Hispanic migrant farmworkers?

Ho2: There is no relationship between DT2 and the length of time of pesticide exposure (based on time working as a migrant farmworker).

H2: There is a relationship between DT2 and the length of time of pesticide exposure (based on time working as a migrant farmworker).

Significance level: Reject Ho2 if $p < 0.0$.

RQ2: Is there a relationship between poverty status, level of education, and the diagnosis of DT2 among Hispanic migrant farmworkers?

Ho1: There is no relationship between poverty status, level of education, and DT2 among Hispanic migrant farmworkers.

Ha1: There is a relationship between poverty status, level of education, and DT2 among Hispanic migrant farmworkers.

Significance level: Reject Ho1 if $p < 0.05$.

RQ3: Is there a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers?

Ho3: There is no relationship between diagnosis of DT2 and the use of healthcare services among Hispanic migrant farmworkers.

H3: There is a relationship between diagnosis of DT2 and the use of healthcare services among Hispanic migrant farmworkers.

Significance level: Reject Ho3 if $p < 0.05$.

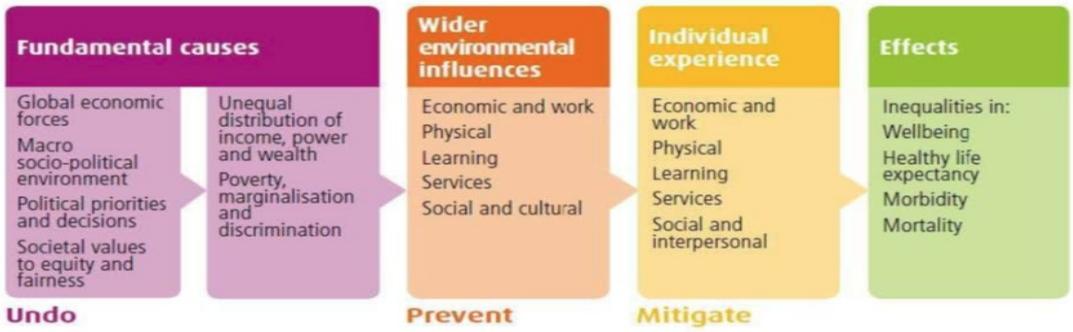
Theoretical Foundation of the Study

Fundamental causes theory (FCT; Link & Phelan, 1995) was used to frame the study. This theory posits that variables related to socioeconomic status can have both negative and positive effects on the health of an individual or a population (Williams, 1990). In the present study, vulnerability, and exposure to hazardous elements such as pesticides were consequences of the low social and economic status of the study population.

The Fundamental causes theory plays a crucial role in public health planning strategies. This theory addresses health disparities through analysis of the causes and effects of diseases and the resources available to reduce related causes. The components of this theoretical framework focus on a multidirectional cause–effect dynamic and involve determinant systems and orientations that have a reciprocal effect (Phelan & Link, 2013; see Figure 1). The FCT framework identifies the possible factors influencing the development of negative chronic health outcomes such as DT2. This framework can be extensive and detailed in its analysis of the components that affect the decision to access treatment and the quality of care that the patient receives.

Figure 1

Fundamental Causes Theory



Note. From "Income, Wealth and Health Inequalities—A Scottish Social Justice Perspective," by E. Molony and C. Duncan, 2016, *AIMS Public Health*, *3*(2), p. 258 (https://doi.org/10.3934/publichealth.2016.2.255). Copyright 2016 by: Available via license: CC BY 4.0.

Nature of the Study

This correlational analysis was based on quantitative secondary data. The data were used to examine the relationship between pesticide exposure and DT2 diagnoses among Hispanic migrant seasonal farmworkers. One of the primary reasons for using secondary data sources is to test for the relationship between multiple variables. Secondary data are data that have already been collected, usually from a trusted source that has followed strict ethical and sampling protocols. Secondary data provide a foundation for correlation of the data amassed by the investigator who also tested the data for validity and reliability (Cheng & Phillips, 2014; Wang & Alexander, 2016). Another strong rationale for using secondary data is that its use significantly increases the cost efficiency and time efficiency of large-scale studies (Cheng & Phillips, 2014).

Confounding variables with the potential to have a strong influence on the results included access to medical care, length of time of pesticide exposure (based on time working as a migrant farmworker), education level, and poverty status. These four variables were considered as predictor variables in a multiple regression analysis. The control variables were not of primary interest, although they could have affected the relationship between the independent and dependent variables, which were of primary interest to me as the researcher.

The relationship between the independent and dependent variables was measured by odds ratio (*OR*). *OR* is a measure of association between an exposure and an outcome. *OR* represents the odds that an outcome will occur given an exposure, compared to the odds of the outcome occurring in the absence of that exposure. *OR*s are most commonly used in case-control studies, although they can also be used in cross-sectional and cohort study designs or with some modifications and/or assumptions (Szumilas, 2010). Data for a total of five specific variables (independent and dependent) were downloaded in Microsoft Excel or CSV format and transferred into SPSS for analysis (DOL, 2018a).

Literature Search Strategy

Multiple databases were searched, including the Thoreau Multi-Database Search at Walden University Library, Google Scholar, and National Library of Medicine, for peer-reviewed published articles in order to conduct a comprehensive search of the literature. Authoritative government and scientific websites were also searched, such as those of the CDC, American Diabetes Association, and National Institutes of Health, to identify published sources that addressed the relationship between pesticide exposure, chronic illness, and diabetes among farmworkers. Keywords and search phrases used

included “pesticide exposure among seasonal agriculture workers,” “pesticides and chronic illness,” “pesticides and diabetes,” “diabetes among seasonal farmworkers,” “education level of Hispanic migrant farmworkers,” “barriers to healthcare,” and “diabetes management among farmworkers.” The publication dates of articles examining the history of migrant farmworkers in the United States and their conditions at large ranged from 1955–2018. A total of 1,083 publications were initially identified using the search terms. After applying inclusion criteria of “non repeated,” “peer-reviewed,” “English language,” published within the past 5 years, and relevant to the topic and using the Walden University literature review matrix to assess relevant articles, I used 54 articles in this review.

Literature Review Related to Key Variables

The Target Population: Migrant Farmworkers

The U.S. agriculture industry depends on migrant workers. Between 2.5 and 3 million migrant farmworkers make up the U.S. agriculture industry’s labor force (NCFH, 2017). Of the farmworkers employed in the United States, approximately 68% were born in Mexico, 27% were born in the United States, 4% were born in Central American countries, and 1% were born elsewhere. According to recent estimates by the NAWS, six out of every 10 U.S. farmworkers are undocumented, and as many as eight out of 10 are foreign born and crossed the U.S. border to acquire work as farmworkers. By definition, a migrant farmworker is one who seeks work in agriculture on a seasonal basis, establishes a temporary home, and may migrate from farm to farm, state to state, or within states (Arcury & Quandt, 2007). Approximately 80% of Hispanic immigrants to the United States are farmworkers (NCFH, 2009). Hispanic migrant farmworkers consist

predominantly of Mexican-born men who have experienced considerable financial hardship and political unrest, and who entered the United States to support their families monetarily (Gonzalez-Barrera, 2015). According to Therrien and Ramirez (2000), migrant Hispanics tend to be relatively young, to have relatively low levels of education, to have low income, and to work in high-risk and stressful environments.

Many Hispanic migrant farmworkers lack authorization to reside and work in the United States, which has been noted as a cause of intense fear of deportation and other stresses (Hernandez et al., 2016). Despite the advocacy work of multiple organizations and agencies, such as United Farm Workers of America, NCFH, and Farmworker Justice, lack of legal status predisposes Hispanic migrant farmworkers to social inequities, contributing to poor healthcare access (Hernandez et al., 2016).

Factors Influencing Diabetes Diagnosis

Minority groups (e.g., African Americans, Hispanics/Latinos, and American Indians) are at high risk of developing DT2 and its complications (Attridge et al., 2014). The prevalence of DT2 in Hispanic Americans (aged 20 years or older) is approximately twice that of non-Hispanic White Americans (11.8% vs. 7.1%, respectively; Cusi & Ocampo, 2011). Hispanic American adults are 1.7 times more likely than non-Hispanic White American adults to have been diagnosed with DT2 by a medical professional (Office of Minority Health, 2014). This minority group has higher rates of diabetes-related complications and is 1.5 times more likely to die from diabetes compared to non-Hispanic White Americans (Office of Minority Health, 2014). When it comes to minority groups and DT2, Hispanic migrant farmworker populations are understudied. They remain in the United States for either a single harvest season or multiple harvest seasons

(Hernandez et al., 2016). Migrant workers and their families who enter the United States for protracted periods of time are often subjected to substandard living conditions, long periods of exposure to allergens and pesticides, poor diet, social isolation, and limited access to primary healthcare (Thompson et al., 2015), all of which are significant determinants of health. According to Castañeda et al. (2015), the prevalence of diabetes among Latino/Hispanic communities is 17% higher than the U.S. national average (Castañeda et al., 2015).

It has been scientifically proven that DT2 is directly linked to obesity, inactivity, and high cholesterol, and farmworkers are usually physically fit due to the nature of their work and follow diets that traditionally have less cholesterol than American fast food diets (Quandt et al., 2018). However, migrant farmworkers experience "high stress levels" because of substandard living conditions, food insecurity, abuses by employers, and a host of other social and policy challenges (Morales et al., 2002; NCFH, 2014; Ramos et al., 2015), which also constitute a contributory factor to the development of DT2. Stoecklin-Marois et al. (2015) confirmed the contribution of exposure to pesticides, poverty, poor-quality housing, and lack of nutritious foods to poor health and chronic disease such as diabetes among migrant farmworkers. Although researchers have reported that Hispanics in the United States experience a disproportionate occurrence of DT2 (Nam et al., 2011), the environmental and socioeconomic factors associated with this have not been studied.

Diabetes and Comorbidity

The risk of comorbidities such as cardiovascular diseases varies by ethnicity and race. Latinos/Hispanics are at a disproportionately high risk of diabetes, cardiovascular

disease, and other chronic conditions (Minkoff-Zern, 2018). Aguayo-Mazzucato et al. (2018) found that the prevalence and incidence of DT2 among the Hispanic population in the United States are higher than the national average, which is partly due to sociocultural factors such as lower income, decreased access to education, less access to healthcare, genetic susceptibility to obesity, and higher insulin resistance. However, they also argued that this population had not been well examined from a multidisciplinary perspective, and that the intersection of risks is even less well understood in the community of Hispanic migrant agricultural workers.

Variables

DT2 is defined by the World Health Organization (WHO, 1999) as a metabolic disorder of multiple etiology characterized by chronic hyperglycemia with disturbances of carbohydrate, fat, and protein metabolism resulting from disorders in insulin secretion, action, or both. The risk factors for these insulin defects are primarily inactivity; obesity; smoking; heredity; and being African American, Hispanic/Latino American, American Indian, or Alaska Native (CDC, 2017). Although diabetes affects 30.3 million Americans (9.4% of the U.S. population), 7.2 million (23.8%) remain undiagnosed (CDC, 2018a). The growing pandemic of diabetes constitutes a public health challenge for every country.

Length of Exposure to Pesticide Status

Migrant farmworkers are exposed to pesticides during their application, through access to equipment, and by being close to crops being sprayed, resulting in deleterious consequences to their and their families' health (Kim et al., 2017). Arrebola et al. (2015) and Eslami et al. (2016) examined exposure through pesticide application equipment,

serum concentrations of persistent organic pollutants, and increased incidence of gestational diabetes among pregnant women. Their findings supported the argument that pesticides have the potential to cause chronic diseases such as diabetes (Stoecklin-Marois et al., 2015).

Long-term exposure to pesticides may increase the risk of developing DT2 (Kim et al., 2017). Even though most farm chemicals are toxic to humans and the environment, the pesticide market is enormous and growing. According to the Environmental Protection Agency (2017), the U.S. demand for agricultural pesticide active ingredients is estimated to be approximately US$12.5 billion annually. Diabetes may be associated with pesticides such as fungicides, carbonate, organophosphate, and organochlorine (Sanchez-Santed et al., 2016).

In a case-control study by Velmurugan et al. (2017), mice were made to drink water mixed with monocrotophos pesticides for 180 days. The dose was equivalent to approximately 12–15 years of exposure to human beings. After 60 days, the presence of glucose plasma was detected, and glucose intolerance was identified after 180 days of exposure, suggesting adverse effects as a consequence of chronic exposure to pesticides (Velmurugan et al., 2017). However, Kim et al. (2017) suggested that while some studies had attempted to link pesticide exposure to illnesses, the findings were not substantive or conclusive.

Grandjean and Bellanger (2017) calculated the disease burden associated with environmental chemical exposures and applied the toxicological information to the financial burden of healthcare. Using a disability-adjusted life year metric, the authors found that the cost of care significantly increased as the length of exposure to

environmental chemicals increased. Adverse health effects were also linked to a dose response to environmental exposure. They concluded that research efforts examining the impact of dose response to environmental chemicals primarily focus on mortality, and few examine the impact and duration of exposure to environmental toxins on clinical morbidity or chronic illnesses such as diabetes (Grandjean & Bellanger, 2017).

In a medical record review, Liu et al. (2014) investigated the mortality rates of 118 patients with and without diabetes mellitus after acute large-dose exposure to organophosphate insecticides between 2000 and 2011. Most patients were middle aged (53.45 ± 16.20 years), were male (65.3%), and had been referred to a hospital shortly after being poisoned by this particular pesticide. Approximately 15% of the 118 patients died, including 15 of the 109 patients without diabetes mellitus and three of nine (33.3%) with diabetes mellitus. An analysis estimated no significant difference in mortality between these groups ($p = 0.117$); although the onset of diabetes mellitus was found to be associated with postexposure to the pesticide ($p = .002$), random blood glucose measurements gave no evidence of new-onset diabetes in patients without pre-existing diabetes. The researchers concluded that while mortality related to diabetes mellitus following acute large-dose exposure to organophosphates may be minimal in the short term, larger prospective studies with formal testing for diabetes at later times postexposure are required (Liu et al., 2014).

Arcury et al. (2014) reported the lifetime and current pesticide exposure of Hispanic migrant farmworkers compared to Hispanic immigrant nonfarmworkers. They reported that farmworkers experienced higher levels of occupational and residential pesticide exposure than nonfarmworkers. Exposure to pesticides was significantly

associated with three social determinants: living condition, education level, and worker status (Arcury et al., 2014). This study was one of the first to compare the lifetime and current pesticide exposure between these two groups. However, the study was limited to self-reported information from nonrandomized North Carolina male farmworkers only.

Education Attainment

According to a recent report by the National Center for Health Statistics (2018), in 2018, the average farmworker has completed eighth grade, with only 10% having finished high school. The report also found that 80% of adult migrant farmworkers function at or below a fifth-grade level. Many farmworkers also have limited English proficiency, and 70% speak little or no English (Prado et al., 2017). The majority of foreign-born seasonal agricultural workers are unable to speak English, or the dominant language spoken in the area in which they live and work (Kingma, 2018). Being less informed on the risks of exposure to pesticides and ways to better prevent and manage health risks is related to language barriers (Jallow et al., 2017).

According to Prado et al. (2017), poor education and lack of awareness of the harm that chemicals such as pesticides pose have significant consequences for health. A lack of adequate awareness decreases personal use of protective equipment, frequent hand washing, and other safe work practices (Grzywacz et al., 2010). While the role of chemicals cannot be ignored, some studies have examined behavioral factors that contribute to diabetes and other chronic illnesses. Lifestyle has been examined as a significant factor contributing to the development of diabetes, but no study has found conclusive evidence of any relationship between DT2 and level of education (Kim et al., 2017). In a cross-sectional study by Shin et al. (2014), diabetes among migrant and

seasonal workers in Michigan was found to be caused by alcohol consumption, rather than exposure to pesticides. This study also identified a need for nutritional and health risk training. The authors suggested that a longitudinal study examining the long-term effects of behavioral factors such as lack of exercise, diet, and consumption of alcohol and other substances on diabetes is warranted (Shin et al., 2014).

Health literacy affects an individual's ability to use diabetes information and adopt preventive measures. Both health and social literacies have been demonstrated to influence and impact diabetes-related outcomes and costs (Golden et al., 2013). As pointed out by Heisler et al. (2014), Hispanic farmworkers with low health literacy and limited English proficiency make less optimal treatment decisions, which may result in poor medication adherence and outcomes. They also have limited access to services because of language and literacy obstacles (Nam et al., 2011). Diabetes education and awareness can promote an individual's early detection, prevention, or delay of the onset of diabetes (Saleh et al., 2012). Given the disproportionate effect of diabetes on Hispanic populations, more targeted education is clearly required.

The Agency for Healthcare Research and Quality has speculated that low health literacy is associated with higher risk of mortality and more emergency visits and hospitalizations (National Network of Libraries of Medicine, 2013). Health literacy may be associated not only with years of education or reading ability (National Network of Libraries of Medicine, 2013), but also with language barriers. Research conducted by the National Assessment of Adult Literacy in 2003 found that low health literacy was lower among adults who spoke a language other than English before starting school (National Network of Libraries of Medicine, 2013). This research also demonstrated that an

individual who functions appropriately at home or work may have a limited level of health literacy and that populations affected by low health literacy include immigrants, minorities, and those with low income (National Network of Libraries of Medicine, 2013). This socioeconomic factor prevents Hispanics in the United States from effectively controlling their DT2. Several researchers have identified education level and English proficiency as the main barrier for minorities in the United States seeking to utilize health services (Chang et al., 2013; Kim et al., 2011; Nam et al., 2011). Chang et al. (2013) reported that Hispanics were more likely to have diabetes if they had less than a high school education and were less proficient in English.

Poverty Status

Socioeconomic disparities play an essential role in the development and progression of chronic conditions (Boggess & Bogue, 2016). The NCFH (2017) reported that in 2017, the mean family income of agricultural workers in the United States was between US$17,000 and US$20,000 per year, which was below the U.S. federal poverty rate.

Poverty can cause high stress, especially in males, heads of families, or those who have left their families and relatives behind and are held responsible for sending money home for food and other necessities. High levels of stress have been reported by the American Diabetes Association (2013) as a considerable risk factor for diabetes.

Gaskin et al. (2014) used data from the 1999–2004 National Health and Nutrition Examination Survey and 2000 U.S. Census, which calculated the impact of individual race, poverty, neighborhood racial composition, and poverty concentration on DT2. The authors reported a race–poverty–place gradient for diabetes prevalence for African

Americans and poor White Americans. Although the study only included these two populations, it found that DT2 was higher for African Americans than for White Americans (Gaskin et al., 2014). The results of the study suggest that poverty is the main factor linked to DT2, which supports the findings of Tol et al. (2013). Gaskin et al. (2014) further stated that living in a poor neighborhood increased the likelihood of diabetes for both African Americans and White Americans. These findings could apply to the Hispanic migrant farmworker population because of members' socioeconomic status, but as previously noted, there are other causes of diabetes that must be considered (Castañeda et al., 2015). As reported by Arcury and Quandt (2011), Hispanic migrant farmworkers are impoverished, their access to healthy food is very limited, and their housing conditions are substandard. Gaskin et al.'s study lacked representation of the Hispanic population, which, as previously noted, has high diabetes prevalence compared to White Americans and other populations. Another limitation was that the population studied was middle-aged and old-age Americans; the average age among Hispanic migrant farmworkers is 33 years (NCHF, 2017). The prevalence of DT2 in Hispanics in the United States aged 20 years or older is approximately twice that of similarly aged non-Hispanics in the United States (Cusi & Ocampo, 2011). Research in this area needs to include a population of Hispanic migrant farmworkers.

Migrant farmworkers are less likely than other groups of farmworkers to have health insurance. Because most migrant farmworkers travel with their families, including children, the drawbacks of low earnings, lack of health insurance, and frequent changes in location extend to their families (Boggess & Bogue, 2016). It is evident that poverty

status and lack of health insurance prevent a substantial portion of this population from obtaining the healthcare services that they need (Tol et al., 2013).

Access to Quality Healthcare

Access to healthcare refers to the degree to which people are able to obtain appropriate care from the healthcare system in a timely manner (U.S. Department of Health and Human Services, 2016). Foreign-born farmworkers are more vulnerable to developing diabetes and may not be able to manage the severe effects of the diseases. According to Stoecklin-Marois et al. (2015), there are various barriers to accessing medical care for workers indigenous to a country other than the United States, such as socioeconomic disparities, language differences, and cultural practices. This study found that migrant workers do not earn a sufficient income to afford proper healthcare and may only be able to afford unhealthy foods, which limits their immune systems' ability to fight the effects of pesticides.

Velasco-Mondragon et al.'s (2016) literature review on Hispanic health in the United States identified the significant barriers to this population's access to health services as limited cultural sensitivity, health illiteracy, and a shortage of Hispanic healthcare providers. They utilized the methodological framework developed by Arksey and O'Malley (2005). This modified social-ecological framework includes the social determinants of health, health disparities, risk factors, and health services, and their relationship with morbidity and mortality (Arksey & O'Malley, 2005). Although methodology is relevant in interviewing healthcare providers about farmworkers and barriers to access to healthcare, Velasco- Mondragon et al.'s (2016) study was limited because it did not provide a comprehensive description and understanding of these

assessments. However, it may assist in a comprehensive approach to assessing and monitoring Hispanic health in the United States It could also be replicated at the local levels to evaluate current health and social policies because access to healthcare does not only involve healthcare coverage (James et al., 2017).

According to Collins (2016), although workers are multigenerational, many return to their original locations and are unlikely to remain in the area in which they were temporarily employed. This finding is consistent with Farmworker Justice's (2018) report, which found that frequent relocation increases the likelihood of remaining undocumented. According to statistics from this report, 48% of migrant farmworkers in the United States are undocumented and, consequently, remain uninsured (Farmworker Justice, 2018). This report argued that non-documentation increases the challenge for the U.S. Government to reach and help the migrant farmworkers. Government-supported services are often the only services that make it possible for migrant workers to receive timely medical attention and, more often than not, even manageable conditions are only cared for when they have reached chronic stages (Farmworker Justice, 2018).

Migrant workers' ineligibility to access healthcare due to their residency status and lack of finances limit their choice of medical attention services. Insurance coverage applies only in the state where individuals are registered (Garza et al., 2015). Moving to new places increases the distance that one would need to cover to access proper healthcare (Collins, 2016). Moving to new areas means migrant workers may not be familiar with the local social service agencies that can help them locate public health benefit applications. This is a significant barrier to access and utilization of healthcare services. Garza et al. (2015) added that more than a quarter of migrant farmworkers in the

United States had not seen a doctor in over two years. Time is a critical aspect of proper healthcare, including sufficient time away from work to enable individuals to seek medical attention. From the above, it is clear that the barriers to healthcare faced by Hispanic migrant farmworkers are manifold, and it would take several years of research by different organizations in different states to address the most salient ones such as medical coverage, transportation, shortage of Hispanic healthcare providers, and language barriers.

The Hazards of Agricultural Work

Agricultural work is identified as the most dangerous occupation in the United States due to exposure to pesticides and other pollutants that cause disease. Exposure to any pesticide increased the risk of endocrine and other chronic diseases by at least 60% (Juntarawijit & Juntarawijit, 2018). According to Castañeda et al. (2015), occupational hazards have been the focus of many researchers. However, most studies have focused on injury and acute conditions, and less on the prevention and management of chronic diseases. The lack of research on the prevention and management of diabetes among farmworkers is part of this gap in the research. Castañeda et al. (2015) are particularly critical of studies focused on the relationship between diabetes and exposure to pesticides. Researchers have addressed the relationship between lifestyle and genetics and the risk and prevention of diabetes. However, no recent studies have demonstrated the role of environmental factors such as pesticides in the etiology of diabetes (Kim et al., 2017).

Agricultural workers are particularly vulnerable to developing diabetes mellitus due to environmental exposures, compounded by socioeconomic conditions such as

poverty and lack of healthcare access. According to the NCFH (2017), DT2 has become particularly burdensome in the United States, particularly among Hispanics, American Indians, and African Americans. It is hypothesized that this risk may be unusually high among migrant farmworkers due to their direct and frequent exposure to pesticides (Kim et al., 2017).

Definitions

For the purpose of this study, the following definitions are provided:

Diabetes Type 2 is a progressive metabolic disorder characterized by hyperglycemia resulting from the body's inability to use blood glucose for energy due to inulin disturbances (WHO, 1999).

Diabetic complications are damages of small blood vessels, such as eyes, kidneys, and nerves (microvascular), and of larger blood vessels, such as cardiovascular diseases (macrovascular) (WHO, 2019).

Migrant farmworkers are individuals from different countries employed in farm work. In the case of Hispanic migrant farmworkers, they are from Hispanic countries, mainly Mexico (Hernandez & Gabbard, 2019). The seasonal farmworker performs agricultural work during a specific period of time (usually 12 months or less) for which they are enrolled (DOL, 2006). They work in different places as needed where needed (GPO Access, 2010).

Access to healthcare refers to access to quality healthcare, medical insurance, or coverage (with these terms used somewhat interchangeably in this thesis). When used as a variable, the covariate was poverty level or income status. For the variable of medical insurance, a "0" value is used for non-insured and "1" for insured.

Education attainment is defined by (census.gov, 2017) as the highest level of education that an individual has completed. In this study, the values for the variable of education level were "0" for some high school, "1" for completion of high school or general education diploma, "2" for some college, and "3" for completion of undergraduate studies.

Exposure refers to radiation or pollutants that come into contact with the body and present potential health threats. Common routes of exposure include the skin, mouth, or by inhalation (Environmental Protection Agency, 2018).

Pesticide exposure, for humans, is the direct or indirect contact of pesticides on a surface or organism (WHO, 2001).

Length of exposure to pesticides or the duration of exposure which can be measured by number of hours, days, and months (WHO, 2001).

Pesticides are a group of chemicals used to control and repel pests in different crop fields (Mostafalou & Abdollahi, 2017).

Literacy is the ability to read and write regardless of the language of the individual. In the case of the Hispanic migrant farmworkers, the average literacy level is reported to be at a Fifth-Grade level or below (National Center for Health Statistics, 2018).

English proficiency is the ability to use the English language to communicate verbally and in writing (Graham, 1987).

Assumptions

This thesis focused on investigating whether there is any relationship between DT2 and pesticide exposures among Hispanic migrant farmworkers in the United States.

It was assumed that the figures obtained from self-reporting of diabetes by Hispanic migrant farmworkers were not accurate due to this populations' general fear of losing employment, deportation, and/or language barriers. As mentioned by Babbie (2007), inaccuracy in self-reports has been tied to recall bias and social desirability effects. The CDC (2017) reports that many Hispanics with diabetes remain undiagnosed due to lack of reporting and available testing.

Scope and Delimitations

Diabetes is a significant public health problem and the fifth leading cause of death among Hispanics/Latinos in the United States (CDC, 2017). As previously stated, the impact of diabetes may place one at increased risk of developing major health complications. While this disease has become a global pandemic, little to no research has addressed the exposure to pesticides as a risk factor of DT2 within the Hispanic migrant farmworker population. The present study investigated whether there is any relationship between DT2 and pesticide exposure among Hispanic migrant farmworkers in the United States. Because this study focused on Hispanic migrant farmworkers, it provides valuable information on an under-studied population with significant historical and present-day societal impact.

Several life stressors, such as language barriers, lack of social structures, and immigration issues, may impact diabetes development. The variables considered in this study were education level, poverty status, length of exposure to pesticides, and access to healthcare, all of which may increase the risk of developing DT2. Other variables such as physiologic measures of cortisol levels and other harmful products would add value to the study, but these measures were prohibitively costly and required different databases.

A random sample may also undermine the ability to determine how well the sample represents the general migrant farmworker population. Since this is a correlational analysis, the survey method could be compromised by fear. Participants may not want to give accurate income information or the number of years they have worked in the United States for fear of being reported to U.S. Citizenship and Immigration Services. This could be resolved by ensuring participants provide answers anonymously via a proficient bilingual interpreter, ideally a public health worker that they know. This study's primary emphasis is on an underserved population; however, the findings are relevant for and can be applied to other populations globally.

Significance

Contribution to Public Health Practice

Economic, social, and cultural factors are vital to healthcare access and control and management of chronic illnesses. Diabetic disparities and complications among Hispanics in states with a high Hispanic population, such as California, are of considerable concern (Peng et al., 2016). DT2 and related morbidity and mortality a far higher among Hispanics (citizens and non-citizens) than non-Hispanics in the United States (Peng et al., 2016). Seasonal or migrant farmworkers are a vulnerable population for which access to healthcare and exposure to a host of health risks are of particular importance (McCullagh et al., 2015; Domínguez et al., 2015). It is estimated that nearly five million Hispanic migrant seasonal farmworkers serve as the backbone of the U.S. agriculture industry (NCFH, 2018). This capstone study aims to contribute to public health practice by providing essential information on the vulnerability of this population to DT2 due to pesticide exposure. It also demonstrates the urgent need for resource

deployment and education to prevent diabetes incidence and its complications in this population, as well as addressing a prominent gap in the literature.

Implications for Social Change

The relationship between pesticide exposure, poverty, education level, and the diagnosis of diabetes among Hispanic migrant seasonal farmworkers is the focal point of this capstone project. The findings could contribute to positive social change, in that a clearer understanding of the relationship between pesticide exposure and DT2 may be useful to support the planning of public health initiatives to increase awareness regarding this relationship.

According to Griffin et al., (2020), the majority of farmworkers across the United States originate in the southern states, Mexico, or Central America, and approximately 80% speak Spanish as their primary language. A better understanding of the health disparities experienced by disenfranchised communities such as non-English speakers and/or undocumented migrant farmworkers is well established (McCullagh et al., 2015) and considered a priority for Healthy People 2020 (U.S. Department of Health and Human Services, 2016). Therefore, this study could also contribute to positive social change by supporting the expansion of screening programs and resources tailored to relieve the burden of DT2 experienced by the farmworker population.

Summary and Conclusions

The CDC (2016) estimated that, in 2015, 30.3 million people of all ages in the United States, or 9.4% of the U.S. population, had diabetes. The steady increase in both the incidence and prevalence of diabetes in the United States and globally is undeniable (Kim et al., 2017). Diabetes has become a pandemic disease and the leading cause of

morbidity and premature mortality in developing and developed countries alike (WHO, 2016). The prevalence and incidence rates of diabetes are unusually high among migrant farmworkers, and evidence suggests that direct pesticide exposure may play a role in increased risk of illnesses such as diabetes (Castañeda et al., 2015; Grandjean & Bellanger, 2017; Juntarawijit & Juntarawijit, 2018; Kim et al., 2017; Liu et al., 2014).

Socioeconomic factors such as poverty, low level of education (including language barriers), and poor access to healthcare impact the risk of migrant workers developing diabetes (Powers et al., 2017). To date, the evidence suggests a disproportionate rate of diabetes among migrant farmworkers. However, few studies have examined the relationship between the length of exposure to pesticides and the likelihood of diagnoses of DT2 (Aguayo-Mazzucato et al., 2018). An examination of the potential relationship between pesticide exposure and DT2 prevalence, particularly among the migrant farmworker population, may be useful in influencing numerous policies ranging from the use of toxic pesticides in growing agricultural products, assurances for promoting safety in working environments, and promoting the availability of basic health services.

Most of the relevant literature suggests that interventions directed toward the migrant farmworker population, such as educational programs and diabetes self-management education, are needed to prevent and alleviate some of the burdens of DT2 and improve patient outcomes. However, those programs need to consider the systemic factors that influence the development and progression of DT2 in this particularly vulnerable and disenfranchised community in the United States (Aguayo-Mazzucato et al., 2018). Further, more research and attention must be directed toward chronic illness

such as diabetes as a direct consequence of pesticide exposure. Liu et al. (2014) concluded that while research on mortality following acute large-dose exposure to agricultural pesticides such as organophosphates has been conducted, more extensive studies examining the development of chronic illness such as diabetes at later times post-exposure to agricultural pesticides are required. Rather than focusing on mortality, the present capstone study uses a national longitudinal database to examine the effect (if any) of length of exposure to pesticides on the epidemiology of DT2 among Hispanic migrant farmworkers, thereby addressing this research gap.

Section 2: Research Design and Data Collection

Introduction

DT2 is a serious public health concern in the United States, especially among Hispanics (Ramal et al., 2012). Although multiple studies on DT2 among Hispanics living in the United States have been conducted, the incidence and increasing prevalence of DT2 among this population are poorly grasped by public health professionals (Migrant Care Network, 2017). The present research fills this gap and thus could improve DT2 prevention measures and management among this underserved population.

The purpose of this quantitative capstone study was to investigate whether access to medical care, length of pesticide exposure (based on time working as a migrant farmworker), level of education, and poverty status are associated with DT2 among migrant farmworkers in the United States. This chapter describes the research design, methodology, population, sampling technique, study setting, and data analysis. The threats to validity and ethical considerations are also presented.

Research Design and Rationale

This study utilized a quantitative data collection method and a correlational study design to determine the association between pesticide exposure and DT2 in the Hispanic migrant farmworker population in the United States. The independent variables for this study were education level, poverty status, access to healthcare, and length of exposure to pesticides. Education level was measured by no school, preschool, each grade level (i.e., kindergarten, first grade, second grade, etc.), and each year of college for 4 years (i.e., 1st year college, 2nd year college, etc.). Poverty status was measured by two variables, below poverty level and above poverty level. Access to healthcare was measured by

whether the farmworker had insurance or not. Length of exposure (expressed as a length of time) was measured by age at which the individual first worked in agriculture—more specifically, “first worked in agriculture before age 14”, “first worked in agriculture at age 14–18”, and so forth. This was then calculated against the age of the respondent, measured by the exact age of the respondent at the time that the survey data were collected. The dependent variable was the prevalence of DT2 among Hispanic migrant farmworkers in the United States. The correlational research design explores the relationship between variables using statistical analyses (Creswell & Creswell, 2017). The quantitative research design is based on a fixed point in time that uses one or more samples acquired from the target population at one time.

The choice of a correlational design was consistent with the research strategy needed to advance knowledge in the discipline, specifically using the correlational design to document the prevalence of a public health issue (Salazar et al., 2015). A correlational design is the most suitable for investigation of casual associations because it allows testing of expected relationships between and among variables and the making of predictions (Salazar et al., 2015). However, the predictor variables cannot be manipulated (Stangor, 2011, p. 177). Correlational research designs allow the researcher to assess these relationships in everyday life events (Stangor, 2011, p. 177). Correlational studies are often used with survey research, and they facilitate the identification and clarifications of hypotheses (Frankfort-Nachmias & Nachmias, 2008). Correlational design was the most appropriate for this study because no control group was used (Creswell & Creswell, 2017), and correlations were made between demographic factors and rates of DT2. Further, the correlational design was used because the related statistical

analysis was useful for predicting the strength and direction of the relationships between variables (Kellar & Kelvin, 2013).

Data Collection

There are time and resource constraints associated with the choice of the correlational design. Salazar et al. (2015) stated that a longitudinal study in which participants are observed over some time is the ideal method for conducting this kind of research. Time and resource constraints prevented the use of that methodology in the present study. The data for this study were collected from a dataset obtained from the 2014 NAWSPAD. Surveys and questionnaires for the NAWSPAD database were disseminated to survey participants in the Spanish language. This is not the most common technique for collecting quantitative data, but it was the most appropriate for the population for this study, Hispanic migrant farmworkers. This population responded to the individuals who disseminated the NAWS instrument, and individuals from the survey sample self-reported their answers. A significant limitation of self-reporting data is bias (a preference that obstructs objectivity), which can pose severe threats to the accuracy of the collected information and distort the data (Salazar et al., 2015).

Methodology

For this study, I used a quantitative secondary research design to gather and analyze relevant data about the study topic. A quantitative design was chosen over a qualitative methodology because the study required me to identify characteristics about the sample population from a larger sample, and quantitative studies typically have larger sample sizes than qualitative studies (Dworkin, 2012). Additionally, the quantitative design is relatively cost effective and enables a researcher to collect relevant data within a

shorter time period (Bryman, 2017). Exploring the potential association between DT2 and pesticide exposure among Hispanic migrant farmworkers in the United States (Villarejo, 2003) rendered the quantitative approach the most appropriate design for this study because it was possible to measure independent variables (length of exposure to pesticide, poverty status, education level, and access to healthcare) and a dependent variable (DT2 incidence rate).

Population and Sample

Target Population

The target population for this study was migrant farmworkers in the United States, with a specific focus on the Hispanic migrant population of over 3 million farmworkers (MHP Salud, 2019; U.S. Department of Agriculture, 2016). As reported by the DOL (2018a), approximately 1,500 workers are randomly selected for an interview each year. For the survey, the inclusion criteria are as follows: farmworkers diagnosed with DT2, farmworkers not diagnosed with DT2, and farmworkers between the ages of 20 and 60 years (with the average age of 36 years because that age bracket is the most active population working on farms in the United States; NCFH, 2016). Participants must also be Hispanic immigrants working on farms in the United States. The target population included Hispanics of male and female sexes. Since 1988, the DOL has been surveying hired migrant farmworkers through the NAWS, the only national-level source of data on employment, demographic, and health characteristics for this population (Oates, 2011).

Sampling

The farmworkers completed the NAWS, and their responses were part of the NAWSPAD secondary dataset from which the present study's sample was drawn. The

NAWS uses site-area sampling to obtain a nationally representative cross-section. First, 73 counties in 25 states from 12 distinct agricultural regions were selected. Sampling is required to decide which participants' data will be obtained from a population that is too large to survey (McKenzie et al., 2016). For this study, bilingual researchers interviewed patients using a probability sampling technique to select the participants for the study from the target population (DOL & Training Administration Office of Policy Development and Research, 2014). The surveyors used stratified sampling technique by categorizing the target population into two principal strata—those diagnosed with DT2 and those not diagnosed with DT2. These two groups were compared in the study. As previously noted, the approximate population of immigrant farmworkers in the United States is between 2.5 and 3 million (NCFH, 2018), hence the need to narrow the sample population to a smaller representative sample size.

Data Collection Procedures

Quantitative researchers mostly use a type of sampling based on theories of probability sampling. For the NAWSPAD, the researchers used multistage samples, which are reported below. First, the NAWSPAD sampled the national population of Hispanic migrant farmworkers. Because this population moves often and follow crops seasonally, the NAWS administrators used seven levels of sampling:

- cycle (strata)
- region (strata)
- single counties or groupings of counties called "farm labor areas" (or FLA), which constitute the primary sampling unit
- county

- ZIP Code region
- employer
- farmworker

For the present study, the sample included stratified samples of farmworkers diagnosed with DT2 and those not diagnosed with DT2. Within each of these stratified samples, I randomly sampled these two populations using the "Random Sample" function in SPSS.

The next step in the sampling procedure was the evaluation of the secondary dataset. It is imperative to note that some of the dataset might not meet the required criteria and validity for the study. To ensure that the secondary dataset was reliable and valid, the NAWS staff evaluated the data to exclude data considered unsuitable for the study (Creswell & Creswell, 2017). The evaluation process was based on the aim of the original research, and the credibility of the data collection of the original data. When the data were collected, and the measures that the researcher employed in identifying the relevant data for the study. These criteria enabled the data collectors to identify the most credible and relevant data for the present study from the secondary dataset.

Access to Dataset and Permission

The dataset used in this study was accessed from multiple databases, including Thoreau Multi-Database Search at Walden University Library, Google Scholar, and the National Library, which were the primary sources of the data used in this study. The NAWSPAD datasets are contained in public data files available in varied formats for different programs or computer users: "Data for 2003-2014 are available in SAS, Microsoft Excel, and CSV (comma separated values) format for MS-DOS compatible

computers and Macintosh computers" (DOL & Training Administration Office of Policy Development and Research, 2014). Researchers can access and convert those data into other data analysis programs, such as SPSS and Stata (DOL, 2018). Several codebooks, questionnaires, and explanations of the NAWS methodology are also available for researchers (DOL & Training Administration Office of Policy Development and Research, 2014).

Researchers are not required to have an institutional review board (IRB) review the NAWSPAD research project because the NAWSPAD holds documentation indicating that a HIPAA waiver was approved by an IRB for the survey (DOL & Training Administration Office of Policy Development and Research, 2014). Therefore, no specific procedure or permission is required to obtain access to the dataset (Sample & Areas, n.d.). Nevertheless, at Walden University, IRB approval is compulsory, which ensured that the documentation provided by the NAWSPAD complied with the HIPAA Privacy Rules.

Data for this study were obtained from reputable sources to improve validity and reliability. The primary source was the CDC. The CDC is internationally accredited to conduct research and publish information on health issues, and the data retrieved from the CDC database are always reliable, credible, and valid as secondary data (CDC, 2017). The best sources of data were used to obtain the most relevant information, although no historical or legal documents were used as data sources.

Procedures for Recruitment, Participation, and Data Collection

The initial survey, the NAWS, was an employment-based, random-sample survey of U.S. migrant farmworkers that collected demographic, employment, and health data in

face-to-face interviews. According to the DOL (2006), migrant farmworkers participated in the survey questionnaire voluntarily; no supplemental consent was required to conduct this study's analysis because all of the survey questionnaire results were publicly available on the DOL's website. The NAWSPAD ensured the confidentiality and privacy of survey participants (DOL, n.d.). The NAWS staff then analyzed the survey responses using SPSS to achieve better and more accurate outcomes (DOL, n.d.).

Sampling Size and Power

To determine the appropriate sample size for this study, the power analysis, defined by Boslaugh (2013) as the probability of rejecting the hypothesis is used. The sampling frame for this study was based on the relevance and date of the collected survey data. Given that this was quantitative research on health, it was necessary to use the most recent data that represented accurate information (Holloway & Galvin, 2016). Health issues are diverse and in flux, hence the need to apply the most current data. The inclusion criteria for this study were the same as the inclusion criteria for the NAWS participants. The survey participants constituted "a national probability sample of workers employed in crop agriculture" (DOL, 2018b).

The data for the current study were NAWSPAD data collected in 2014, which had a total of 2,823 participants (DOL, 2018). While the G*Power analysis suggests a minimum sample size of 107 participants of each group for multiple regression data analysis, all 2,823 participants were used for this study. The standard alpha level is generally 0.05 or less because a larger alpha value increases power (Boslaugh, 2013). The only factor able to be manipulated by any researcher is the sample size. However,

because secondary data were being used in this study, it was not possible to control this factor.

Instrumentation and Operationalization of Constructs

The NAWS survey is conducted primarily as an in-person interview survey (DOL & Training Administration Office of Policy Development and Research, 2014). Between 1,500 and 4,000 migrant farmworkers are interviewed yearly, depending on the information needs and resources of the various federal agencies that use NAWS data (DOL, 2018a; Oates, 2011). This survey method has been used repeatedly to collect data among farmworker populations (DOL & Training Administration Office of Policy Development and Research, 2014). This survey method is beneficial, as it ensures that the participants comprehend the questions and have the choice to complete the questions in either English or Spanish (DOL & Training Administration Office of Policy Development and Research, 2014). The NAWSPAD data are publicly available, so there is no need to obtain permission from the developer or administering organization in order to use these data. The demographic questionnaire was developed and used to acquire and measure social statistical information on Hispanic migrant farmworkers (DOL & Training Administration Office of Policy Development and Research, 2014).

The variables measured with the demographic questionnaire were age, marital status, education level, number of times migrating to the United States, language spoken, number of children, number of children living in the same household, hours worked each week, and country of birth (DOL & Training Administration Office of Policy Development and Research, 2014). Interviewers determined where the respondents were during every week of the previous year. For the variable of poverty level, the NAWS

collected information on hourly wage, insurance benefits, and availability of water and toilets at the participant's worksite (DOL & Training Administration Office of Policy Development and Research, 2014). In the present study, the measure of poverty level was based on income. According to the NCFH (2017), the mean family income of farmworkers in the United States was between US$17,000 and US$20,000 in 2017, which was below the federal poverty rate. Although there may not be much variance in the poverty rate, it was still considered in this study. The use of healthcare services and access to healthcare were defined by information on medical history, use of health services, safety training, and the location and type of housing. The other data were collected by asking participants questions about their personal and family income and assets, whether inside or outside the United States. The questionnaire also incorporated questions regarding social services and legal status (DOL & Training Administration Office of Policy Development and Research, 2014).

Operationalization

This study investigated the possible relationship between pesticide exposure and DT2 among Hispanic migrant farmworkers, with definitions provided in Section 1. According to the CDC (2017), pesticide exposure is operationally defined as health risks from the toxicity of pesticides, the amount of pesticide a person is exposed to, and the duration and route of exposure, and DT2 is operationally defined as a long-term metabolic disorder characterized by high blood sugar, insulin resistance, and relative lack of insulin (American Diabetes Association, 2016). The study variables are shown in Table 1.

Table 1

Study Variables

Variables	Definition	Measured/Manipulated
Education level	Highest level of education completed (e.g., no education, fifth grade, completed high school, 1st year college, etc.).	Ordinal
Poverty level	Defined as poor or low income, expressed in annual income level.	Ordinal
Pesticide exposure	Length of time (years) working as a migrant farmworker.	Ordinal
Access to healthcare	If the respondent has insurance, "Yes" or "No."	Nominal/Categorical

Data Analysis Plan for Research Question

SPSS Statistics (standard version 21.0) was used to perform statistical analysis on secondary data from the NAWSPAD and test the study hypotheses. Descriptive statistics included the demographic information of age, education level, language spoken, hours worked per week, salary, and country of birth. The plan for data analysis implies establishing and testing the null and alternative hypothesis and determining the alpha level (the statistical significance level). A decision to reject a null hypothesis is based on the *p*-value. If $p < 0.05$, the null hypothesis is rejected. If $p \geq 0.05$, the null hypothesis is not rejected. The 95% confidence intervals were also calculated. The research questions and associated null hypotheses are outlined below.

Statistical Analysis for RQ1

RQ1 (Inferential): Is there a relationship between the length of time of pesticide exposure (based on time working as a migrant farmworker) and diagnosis of DT2 among Hispanic migrant farmworkers?

Ho2: There is no relationship between DT2 and the length of time of pesticide exposure (based on time working as a migrant farmworker).

H2: There is a relationship between DT2 and the length of time of pesticide exposure (based on time working as a migrant farmworker).

Significance Level: Reject Ho2 if $p < 0.0$.

The study tested for possible relationships between the length of time of pesticide exposure (based on time working as a migrant farmworker) and DT2 among Hispanic migrant farmworkers in the United States by using the Chi-squared test. The Chi-squared test of independence can be used to test the significance of a relationship between two categorical variables (L. M. Sullivan, 2017). Multiple logistic regression was also used to model the significance of the relationship between the dependent variable (DT2 [binomial]) and the independent variable (length of time of pesticide exposure based on time working as a migrant farmworker [categorical]) to decide whether to accept or reject the null hypothesis.

Statistical Analysis for RQ2

RQ2: Is there a relationship between poverty status, level of education, and the diagnosis of DT2 among Hispanic migrant farmworkers?

Ho1: There is no relationship between poverty status, level of education, and DT2 among Hispanic migrant farmworkers.

Ha1: There is a relationship between poverty status, level of education, and DT2 among Hispanic migrant farmworkers.

Significance Level: Reject Ho1 if $p < 0.05$.

The study tested for an association between poverty status, level of education, and diagnosis of DT2 among Hispanic migrant farmworkers by using the Chi-squared test. The Chi-squared test of independence can be used to test the significance of a relationship between categorical and nominal variables (L. M. Sullivan, 2017). Multiple logistic regression was also used to model the significance of the relationship between the dependent variable (DT2 [binomial]) and independent variables (length of time of pesticide exposure based on time working as a migrant farmworker [ordinal], poverty status [ordinal], and level of education [ordinal]) to decide whether to accept or reject the null hypothesis.

Statistical Analysis for RQ3

RQ3: Is there a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers?

Ho3: There is no relationship between DT2 and the use of healthcare services among Hispanic migrant farmworkers.

H3: There is a relationship between DT2 and the use of healthcare services among Hispanic migrant farmworkers.

Significance Level: Reject Ho3 if $p < 0.05$.

The study tested for a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers by using the Chi-squared test. The Chi-squared test of independence can be used to test the significance of a relationship between two categorical variables (L. M. Sullivan, 2017). Multiple logistic regression was also used to model the significance of the relationship between the

dependent variable (DT2 [binomial]) and independent variable (use of healthcare services [nominal/categorical]) to decide whether to accept or reject the null hypothesis.

Threats to Validity

The main objective of this quantitative study is to test the potential relationships outlined above. Validity refers to the accuracy of data in the sense that the research instrument is the appropriate measure (Yilmaz, 2013). This study investigated whether there is any relationship between exposure to pesticides and DT2 among Hispanic migrant farmworkers. To ensure validity for data collection, the NAWS researchers obtained consent for all surveys (DOL, 2006). The questionnaires were followed by a structured survey worksheet to assist in consistency between respondents, and Spanish recordings were transcribed to English. The correlational study design might have predisposed respondents to recall bias due to the self-reporting survey data collection method. Depending on their immigration status, and lack of education or understanding the purpose of the survey, participants might be afraid to disclose certain information.

The NAWSPAD data was likely affected by the non-representative research context. This is a situation where the sample fails to represent the larger phenomenon, thus leading to inaccurate data (McKibben & Silvia, 2016). To reduce the threats of the non-representative research context, this researcher ensured that the data used in the present study represent the target population by applying inclusion and exclusion criteria based on the study variables. Threats to external validity will compromise confidence in the generalizability of the study's results. Although the survey questions were in Spanish, they could be intrusive, forcing choices for "Yes" or "No" answers, rather than offering categorical or ordinal choices (Mickalide, 1997). Surveys with such questions may force

respondents to give untrue answers, especially when answering questions about their children (Mickalide, 1997).

Ethical Procedures

This study was based on pre-collected or secondary data from the NAWSPAD, thus there were no actively involved respondents. Therefore, there were no ethical apprehensions connected to recruitment resources and procedures. However, the NAWS is a multi-agency funded effort and designing the questionnaire is a collaborative undertaking, involving several federal agencies that directly use the results (DOL, 2016). Consequently, the trained interviewers obtained written and oral consent to assure confidentiality to the respondents. The DOL's website reports that the participants were interviewed alone to protect their privacy. Additionally, the participants are protected by the ETA's System of Records for the NAWS, which was established under the *Privacy Act of 1974* (5 USC §552a). All records of participants' names and addresses were destroyed at the conclusion of the survey, and the collected data collected are kept confidential in an electronic database. Access to this electronic database was restricted to the researcher to prevent confidential information being leaked.

The data in this study were protected by encrypting the dataset file with a unique password that limited access to the electronic database. The evidence was explicitly used for this study and no other purposes. The researcher will ensure that the personal information of all participants is protected by storing this on a password-protected external hard drive, stored in a locked safe in a secured room with a keyless entry passcode. It is essential to protect participants' information to avoid any potential

consequences resulting from their participation, such as stigmatization or other forms of social discrimination.

Summary

This correlational, quantitative study used a secondary data source. The researcher collected and analyzed data from a secondary dataset from the NAWSPAD. The dataset focuses on correlational study design to determine the association between pesticide exposure and DT2 among Hispanic migrant farmworkers. SPSS v. 21.0 was used to test the associations between pesticide exposure, education level, poverty status, access to healthcare resources, and the development of DT2 in Hispanic migrant farmworkers in the United States. The predictors of DT2 in Hispanic migrant farmworkers in the United States aged 14 years and older were examined using information from the dataset. Validity and reliability testing was used to ensure the validity, robustness, and generalizability of results. Ethical procedures and principles for conducting research were followed to ensure the privacy and confidentiality of participant information, including physical and electronic security procedures for obtaining, storing, and retrieving data. The researcher used the collected data solely for this study.

Section 3: Presentation of the Results and Findings

Introduction

The purpose of this quantitative study was to investigate the relationship between exposure to pesticides, poverty level, education level, access to healthcare, and diagnosis of DT2 among Hispanic migrant farmworkers in the United States. This chapter presents the results and findings of the data analyses and describes the characteristics of the sample population and the data collection process. The results of the statistical analyses of data from the NAWSPAD are presented in table and text formats, and the null hypotheses are accepted or rejected.

The Research Questions and Hypotheses

RQ1: Is there a relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes?

Ho1: There is no relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes.

H11: There is a relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes.

RQ2: Is there a relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers?

H02: There is no relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers.

H12: There is a relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers.

RQ3: Is there a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers?

H03: There is no relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers.

H13: There is a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers.

Data Collection From Secondary Dataset

This section details the data collected from the secondary dataset. The NAWS is an employment-based, random-sample survey of U.S. farmworkers that collects demographic, employment, and health data using face-to-face interviews via Hispanic interpreters. The analysis is mainly comprised of data collection, identification of missing values and outliers, calculation of descriptive statistics of the variables used in the current study, and inferential analysis of the data to test the hypotheses.

Data Collection Process

The NAWS is the only national-level survey of farmworker health and has a population-based sample of hired farmworkers (Hernandez & Gabbard, 2019). Between 1,500 and 4,000 workers aged 14 and over are interviewed each year (DOL, 2018a; Oates, 2011). Various federal agencies use the findings for occupational injury and health surveillance. Since 1989, when the survey first commenced, almost 70,000 Hispanic farmworkers have been interviewed *(N* = 66,553). The results are presented in reports, presentations, tables, and public data files. The latest national summary report, based on

2015–2016 data, is available and can be accessed at the ETA's Research and Evaluation Publication Database (DOL, 2018a).

Description of Sample

The NAWS demographic data include characteristics of hired farmworkers aged 14 years and older (median age of 35 years) on U.S. farms, regardless of worker documentation status (CDC, 2018b). The NAWS collects data on the sex and age of hired farmworkers, education level by country of origin, years of farm work, migrant or settled status, and whether hired farmworkers are employed directly by a farm operator or indirectly through a labor contractor (CDC, 2018b). The NAWS has seven levels of sampling. The first two levels are used to create 36 strata determined by three interviewing cycles and 12 agricultural regions.

More participants were foreign born (n = 52,268; 78.6%) than were born in the United States (n = 14,214; 21.4%). Those born in the United States had completed more years of education (M = 10.97, SD = 2.90, median = 12) than those who were foreign born (M = 6.12, SD = 3.54, median = 6).

Variables

All variables used in the analysis came from the combined NAWSPAD datasets, based on data collected from 1989–2016. Participants who had scores on the variables addressed in the research questions posed by the present study were included in those analyses, even if they had missing scores on one of the variables pertaining to a different research question. Presumably, based on the data collection method described by the NAWS, individuals participated only once over the course of the data collection period. Most questions in the survey were posed in both Spanish and English. The questions and

associated descriptive data are described below, including the variable label from the dataset and codebook.

Diabetes (NH2)

The NH2 variable in the dataset was from the question "Have you ever in your whole life been told by a doctor or nurse that you have the following conditions: DIABETES?" "Yes" responses were coded as 1, and "No" responses were coded as 0. There were 44,033 valid values and 22,520 missing values for this variable across the 28 years of the survey. A total of 1,827 individuals reported having been told that they had diabetes (4.1% of valid answers), and 42,206 individuals reported that they had not been told that they had diabetes (95.9% of valid answers).

Number of Years of Farm Work (NUMYRSFW)

The number of years of farm work was an open-ended question that allowed the participant to indicate the number of years based on their own years of experience as a farmworker. The range of reported years in farm work was 0–78 years. It seemed possible that many of those reporting to work for more than 30 years (about 10%) were reporting their age and not the number of years worked. Because the sample was very large, those scores above 30 were removed from the analysis of hypotheses including the number of years of farm work variable. There were 58,640 valid scores, 5,915 invalid scores (removed based on reporting more than 30 years of farm work), and 1,998 missing scores for this variable. The average years worked for participants who responded was 10.2 years (*SD* = 8.35 years), with a range of 0–30, modal score of 0, and a median of 8.00.

Exposure to Pesticide(s) (PESTCONT)

The PESTCONT variable in the dataset was from the question "In the last 5 years, have you loaded, mixed or applied pesticides?" "Yes" responses were coded as 1, and "No" responses were coded as 0. There were 30,331 valid values and 32 missing values for this variable from 2003–2016. Of the 30,331 reporters, 6,100 (21%) reported having loaded, mixed, or applied pesticides in the last 5 years, and 19% reported having loaded, mixed, or applied pesticides in the last 5 years (see Table 2).

Table 2

Loaded, Mixed, or Applied Pesticide in the Last 5 Years

		Frequency	Percent	Valid percent	Cumulative percent
Valid	No	13,714	20.6	80.7	80.7
	Yes	3,278	4.9	19.3	100.0
	Total	16,992	25.5	100.0	
Missing	System	49,561	74.5		
Total		66,553	100.0		

Level of Education (A09)

The A09 variable in the dataset was from the question "What is the highest grade in school YOU/THEY completed?" In the analysis, the data were recoded and binned into categories because the NAWS's original measures were continuous and collected based on numeric values. Therefore, this variable was treated as an ordinal variable, with the numbers 0–16 representing the number of years of education completed. Level of education was categorized as shown in Table 3. There were 66,176 valid values and 282 missing values for this covariate. Of the participants, regardless of where they were born, 5.3% had never attended school, which could mean that they did not know how to write or read. They may have handled bottles of pesticides whose labels had instructions on

how to use them safely. Most farmworkers had an education level up to the Seventh Grade (Mean = 7.15, *SD* = 3.842, Median = 6.00).

Table 3

Level of Education

Description	*N* (for years 1989–2016)
No schooling	3,481
First grade	1,542
Second grade	2,997
Third grade	4,932
Fourth grade	3,362
Fifth grade	3,116
Sixth grade	15,749
Seventh grade	1,896
Eighth grade	2,964
Ninth grade	8,194
10th grade	2,500
11th grade	2,416
12th Grade	9,297
1st year of college	971
2nd year of college	1,315
3rd year of college	405
4th year of college	1,039
Missing values	282

Poverty Status (FAMPOV)

The FAMPOV was a variable in the dataset with the title "FAMILY INCOME BELOW THE POVERTY LEVEL." "Yes" responses were coded as 1, and "No" responses were coded as 0. There were 57,084 valid values and 9,469 missing values for this variable. Of the valid responses, 36,087 farmworkers (63.2%) reported their family income as above the poverty level, and 20,999 (36.8%) reported their family income as below the poverty level (see Table 4).

Table 4

Family Income Below the Poverty Line (FAMPOV)

		Frequency	Percent	Valid percent	Cumulative percent
Valid	No	36,087	54.2	23.2	63.2
	Yes	20,997	31.5	36.8	100.0
	Total	57,084	85.8	100.0	
Missing	System	9,469	14.2		
Total		66,553	100.0		

Healthcare Access (NQ01)

The NQ01 variable in the dataset was from the question "In the last TWO YEARS have you used any type of health care services from doctors, nurses, dentists, clinics or hospitals in the United States?" "Yes" responses were coded as 1, and "No" responses were coded as 0. There were 48,094 valid values and 18,459 missing values for this variable from 2003–2016. Of the valid responses, 25,234 farmworkers (52.5%) reported having used some type of healthcare services in the last 2 years (see Table 5).

Table 5

Healthcare Access in Last 2 Years

		Frequency	Percent	Valid percent	Cumulative percent
Valid	No	22,860	34.3	47.5	47.5
	Yes	25,234	37.9	52.5	100.0
	Total	48,094	72.3	100.0	
Missing	System	18,459	27.7		
Total		66,553	100.0		

Gender (GENDER)

The GENDER variable was treated as a control variable because of the gender difference in the presence or absence of diabetes—women have a higher rate of diabetes than men, yet the percentage of farmworkers who are male is higher. There were 66,553

valid values and four missing values for this variable. “Male” responses were coded as 0, and “Female” responses were coded as 1.

Table 6

Gender

		Frequency	Percent	Valid percent	Cumulative percent
Valid	Male	53,418	80.3	80.3	80.3
	Female	13,131	19.7	19.7	100.0
	Total	66,549	100.0	100.0	
Missing	System	4	0.0		
Total		66,553	100.0		

Hypothesis Testing

About 80% of farmworkers included in this study were male and between the ages of 14 and 55 years, with a median age of 35 years. Over 21% had been working as farmworkers for between 11 and 21 years. Nearly 37% reported their family income as below the poverty level, and 52.5% reported having used some type of healthcare services in the last 2 years. While 21% reported having loaded, mixed, or applied pesticides in the last 5 years (from 2003–2016), only 4.1% of respondents aged over 28 years reported having been told that they had diabetes.

All of the research questions involved farmworkers’ reports of whether they had been told by a doctor or nurse that they had diabetes (NH2) as a dependent or outcome variable. Answers were recorded as “Yes” or “No.” The dichotomous nature of the dependent variable was the basis for choosing binomial logistic regression to test the hypotheses. The research questions are restated below, along with the results of the hypotheses testing and binomial logistic regression analyses.

RQ1: Is there a relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes?

The analysis determined whether diabetes incidence rate was significantly higher among individuals in this sample if they reported having loaded, mixed, and/or applied pesticides within the last 5 years, and whether the number of years of farm work contributed to that risk. The hypotheses were as follows:

H01: There is no relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes.

H11: There is a relationship between exposure to pesticides within the last 5 years, number of years working as a migrant farmworker, and Hispanic migrant farmworkers' reports of having diabetes.

To address the first research question, a binomial logistic regression was performed to ascertain the effects of having been exposed to pesticide within the previous 5 years and the effects of the total number of years of farm work on risk for reported diabetes. A dichotomous variable for having loaded, mixed, and/or applied pesticide during the previous 5 years ("Yes" = 1, "No" = 0) was entered as a predictor, and the number of years of farm work (continuous scale variable) was also entered as a predictor for this logistic regression. The logistic regression model was statistically significant, X2 (2) = 64.57, $p < 0.0005$. This model explained 2% of the variance (Cox-Snell R^2) in diabetes status. The model has good fit based on the Hosmer–Lemeshow Test, X2 = 14.51, $p = 0.070$. Loading, mixing, and/or applying pesticide did not significantly

increase or decrease the risk for diabetes at the $p < .05$ level. Number of years of farm work influenced the likelihood of diabetes, with a greater number of years doing farm work increasing the likelihood of reporting diabetes ($p < .0005$, $OR = 1.065$).

Table 7

Research Question 1: Results of Logistic Regression

Variable	B	*SE*	Wald's *F*	*df*	Sig.	Odds ratio - Exp(B)
Exposure to pesticide(s)	.467	.258	3.280	1	.070	.962
Number of years of farm work	.063	.008	61.461	1	.000	1.065

RQ2: Is there a relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers?

The hypotheses were as follows:

H02: There is no relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers.

H12: There is a relationship between poverty status, level of education, and diagnosis of diabetes among Hispanic migrant farmworkers.

The analysis for RQ2 was a logistic regression that explored the relationship between the farmworker's status (as above or below the poverty level) and their level of education in predicting the likelihood of diabetes. The analysis indicated that farmworkers' self-reported diabetes was related to poverty status (below or above the U.S. national poverty level) and level of education (measured from 0–16 years). The omnibus test of model coefficients, which measures how statistically significant the independent variables, as a set, predict the dichotomous outcome variable, was significant, $X2(2) = 10.70$, $p = 0.005$. The results indicated a logistic regression model with $p < .05$. Being above or below the poverty level was not associated with the

likelihood to report diabetes (p = 0.977). Higher levels of education decreased the odds of reporting diabetes, Exp(B) = 0.928. The findings indicated that an increase in education level by one-unit (i.e., year) results in lower odds of reporting DT2 by 0.08 units. However, the Hosmer–Lemeshow test (see Table 8) and Cox-Snell R^2 (see Table 9) indicated that the model fit was not satisfactory, X2(7) = 19.73, p = 0.009. Overall, although the model was significant, the model fit tests suggested that the model was weak in terms of predicting farmworkers' self-reports of diabetes. The statistics of the model's variables are shown in Table 10. The results of the logistic regression are shown in Table 11.

Table 8

Hosmer–Lemeshow Test

Step	Chi-square	*df*	Sig.
1	18.727	7	.009

Table 9

Model Summary

Step	–2 log likelihood	Cox-Snell R^2	Nagelkerke R^2
1	1770.194[a]	.000	.006

[a] Estimation terminated at Iteration 8 because parameter estimates changed by less than .001.

Table 10

Variables in the Equation

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for Exp(B)	B	*SE*
Step 1	FAMPOV (1)	.005	.181	.001	1	.977	1.005	.705	1.433	
	A09	–.075	.023	10.450	1	.001	.928	.886	.971	
	Constant	–5.037	.206	600.198	1	.000	.006			

Note. Variable(s) entered on Step 1: FAMPOV and A09.

Table 11

Research Question 2: Results of Logistic Regression

Variable	B	*SE*	Wald's *F*	*df*	Sig.	Odds ratio - Exp(B)
Poverty status	.005	.181	.001	1	.977	1.005
Education level	–.075	.023	10.45	1	.001	.928

The findings meant that the null hypothesis was rejected for level of education, but not rejected for poverty status.

RQ3: Is there a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers?

Analysis for RQ3 involved logistic regression that explored the relationship between use of healthcare services and DT2 incidence rate among Hispanic migrant farmworkers. The hypotheses were as follows:

H03: There is no relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers.

H13: There is a relationship between the use of healthcare services and diagnosis of DT2 among Hispanic migrant farmworkers.

To address the third research question, a binomial logistic regression was performed to determine the relationship between utilization of healthcare in the previous five years and the likelihood of self-reporting diabetes by Hispanic migrant farmworkers. Healthcare use in the previous two-year period was a dichotomous variable ("Yes"/"No"), as was the outcome variable, diabetes ("Yes"/ "No"). The logistic regression model was statistically significant, $X2(1) = 4.37$, $p = 0.037$. The model was significant (see Table 12) and had satisfactory goodness of fit (see Tables 13 and 14).

Individuals who had accessed healthcare in the last five years were less likely to report a diagnosis of DT2 than those who had not accessed healthcare in this period. However, individuals who had used healthcare within the last two years were more likely than those who had not accessed healthcare to report a diagnosis of diabetes (p = 0.039). There is a low association between the use of healthcare services and diagnosis of DT2 (B = 0.367). The statistics for the analysis are seen in Tables 15 and 16.

Table 12

Omnibus Tests of Model Coefficients

		Chi-square	*df*	Sig.
Step 1	Step	4.369	1	.037
	Block	4.369	1	.037
	Model	4.369	1	.037

Table 13

Model Summary

Step	–2 log likelihood	Cox-Snell R^2	Nagelkerke R^2
1	1702.262[a]	.500	.003

[a] Estimation terminated at Iteration 8 because parameter estimates changed by less than .001.

Table 14

Hosmer–Lemeshow Test

Step	Chi-square	*df*	Sig.
1	.000	0	.0

Table 15

Variables in the Equation

		B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for Exp(B)	
								Lower	Upper
Step 1a	Access to healthcare in last 2 years	.367	.178	4.264	1	.039	1.444	1.019	2.046
	Constant	–5.531	.140	1553.891	1	.000	.004		

Note. Variable(s) entered on Step 1: Access to healthcare in last 2 years.

Table 16

Research Question 3: Results of Logistic Regression

Variable	B	*SE*	Wald's *F*	*df*	Sig.	Odds ratio - Exp(B)
Access to healthcare in last 2 years	.367	.178	4.26	1	.039	1.44

Summary

The purpose of this correlational study was to analyze the 2014 NAWSPAD secondary quantitative data to determine whether a relationship existed between pesticide exposure and diabetes; between level of education, poverty status, and diabetes; and between access to healthcare and diabetes among Hispanic migrant farmworkers. Several significant relationships were identified between these variables. There was also a statistically significant association between gender and diagnosis of DT2, as more women were diagnosed with DT2 than men, regardless of income level, education level, or length of time (expressed in years) working as farmworkers.

Results from the first research question indicated that the number of years doing farm work increased the likelihood of being diagnosed with DT2.

The second research question assessed the relationship between education level, poverty status, and diagnosis of diabetes. The results indicated that poverty level was not a predictor of reporting diabetes diagnosis, but level of education significantly influenced the risk of diagnosis of DT2. The higher the level of education, the lower the odds of reporting DT2 diagnosis.

The third research question assessed the relationship between the use of healthcare services and DT2 diagnosis. The logistic regression model indicated that those

who accessed healthcare services in the last two years had a higher risk of being diagnosed with diabetes.

The findings could be utilized for judicial actions and advanced studies in this field. The next section provides an in-depth discussion and interpretation of the findings in the context of the literature and the theoretical framework. It also discusses the limitations and implications for positive social change, recommendations for future research, and implications for professional practice.

Section 4: Application to Professional Practice and Implications for Social Change

Introduction

DT2 is one of the leading causes of death globally (WHO, 2018). The risk and prevalence of DT2 are higher among Hispanics, and approximately 40% of Hispanics with DT2 have not been officially reported or diagnosed (Avilés-Santa, Colón-Ramos, et al., 2017; Avilés-Santa, Pérez, et al., 2017). Professional practice in the prevention and management of DT2 needs to be evidence based. Understanding of the population most at risk enables public health professionals and other healthcare advocates to direct resources toward addressing the issues that increase the risk of DT2 in this population. The purpose of this capstone study was to investigate whether there is any relationship between pesticide exposure, poverty level, education level, healthcare access, and DT2 diagnosis among Hispanic migrant farmworkers in the United States. The study's findings provide insights into the risk of DT2 among Hispanic migrant farmworkers, which is reported to be 50% higher than for non-Hispanic farmworkers (CDC, 2017). The findings, which include information collected from 66,553 participants across 12 agricultural regions in the United States, provide much-needed comprehensive evidence on the risk of DT2 among migrant farmworkers.

Binomial logistic regression revealed that the number of years doing farm work increased the likelihood of DT2 among Hispanic farmworkers ($X2(2) = 64.57$, $p < 0.0005$). Education level significantly influenced the risks of DT2. The higher the level of education, the lower the odds of DT2 diagnosis, with a lower level of education increasing the odds of DT2 diagnosis. Poverty level was not a significant predictor of diabetes diagnosis. Hispanic migrant farmworkers who accessed healthcare services in

the last 2 years had a significantly higher likelihood of being diagnosed with diabetes (p = .039). When interpreted together, the findings provide a comprehensive evaluation of the factors associated with the risks of diabetes among migrant farmworkers. This section provides a brief interpretation of the study's findings followed by an in-depth discussion of the application to professional practice, recommendations, and implications for positive social change.

Summary of Key Findings

The study established whether the number of years working as a migrant farmworker influences the risk among Hispanics of reporting or being diagnosed with DT2. Based on the assessed 5-year data, the results indicate that the number of years doing farm work increases the likelihood of diabetes diagnosis. However, the results show that loading, mixing, and/or applying pesticides did not significantly increase the risk of diabetes among the farmworkers studied. While these findings may be interpreted to mean that exposure to pesticides (through loading, mixing, and/or applying them) is not related to increased risk of DT2, there is a need to understand that farmworkers are constantly exposed to pesticides in the course of their work (Arcury et al., 2016). Therefore, although exposure to pesticides did not directly increase the risk of diabetes, the possible long-term accumulation of pesticide residues in the body due to continuous exposure could cause various health consequences and increased risk of diabetes as reported by Kim et al. (2017).

The findings of the present study regarding the increased risk of diabetes due to number of years doing farm work corroborate the results of previous studies (Arcury et al., 2016). Previous research indicated that farmworkers had a disproportionately high

level of pesticide exposure compared to the general population (Arcury et al., 2016). Farmworkers who had spent more years in farm work were likely to have a higher concentration of pesticide residues in their bodies due to a longer period of exposure (Kim et al., 2017). According to Arcury et al. (2014), Hispanic migrant farmworkers experience a higher level of occupational exposure to pesticides compared to the general population, which supports the present study's findings. This interpretation is also informed by the fact that pesticides tend to enter the body and are not easily broken down and excreted; instead, residues accumulate in the adipose tissues to a level where they cause health problems (Kim et al., 2014).

Interpretation of the Findings

The interpretation that more years of farm work increase exposure to pesticides, which results in an increased risk of diabetes, is also informed by previous research that has shown that pesticides have the potential to cause diabetes (Arrebola et al., 2015; Eslami et al., 2016; Kim et al., 2017; Stoecklin-Marois et al., 2015). Liu et al. (2014) noted that although there was no significant difference in mortality associated with diabetes between people exposed to pesticides and the general population, exposure to pesticides significantly increased the onset of diabetes.

The present study found that 5.3% of the farmworkers who took part in the study had never attended school, suggesting that they could not read or write. It has been noted that the inability of migrant farmworkers to speak or understand English results in them being less informed about the risk associated with exposure to pesticides, which calls for healthcare professionals to adopt culturally responsive approaches (Jallow et al., 2017). Farmworkers who lack a good understanding of English may not have adequate

awareness of how to use personal protective equipment and how to practice personal protection guidelines such as frequent hand washing (Grzywacz et al., 2010).

The National Network of Libraries of Medicine (2013) highlighted the high risk of mortality and hospitalization among those individuals who have poor health literacy, which is associated with limited education, reading, and language barriers. Chang et al. (2013) reported that lack of English proficiency was the main impediment to the effective utilization of healthcare services by migrants. It should be noted that the findings of the present study focused on farmworkers who were comparatively younger than those examined in prior studies. Previous research assessing diabetes among Hispanic migrant farmworkers focused on individuals aged above 20 years (Cusi & Ocampo, 2011). The present study included participants aged 14 years and above. In conjunction with the other findings, this study's findings indicate that interventions taken to reduce the risk of diabetes among farmworkers should include individuals of lower age groups.

This study found that the use of healthcare services by Hispanic migrant farmworkers is associated with a low diagnosis of DT2. The use of healthcare services entails access to preventive measures, which reduces the risk of diabetes and leads to low diagnosis rate of DT2. This outcome highlights the importance of increasing access to healthcare services among migrant farmworkers to reduce the risk of DT2. McCullagh et al.'s (2015) extensive study assessed culturally related health practices among migrant farmworkers of Hispanic origin and highlighted the various factors that limit this population's access to healthcare services. According to McCullagh et al. (2015), limited access to health insurance coverage is one of the main reasons for the limited access to health services among migrant farmworkers of Hispanic origin. Other barriers

highlighted relate to the need to locate healthcare services closer to migrant farmworkers. McCullagh et al. also noted that migrant farmworkers face barriers in accessing healthcare services that are associated with the high purchase price for the services, geographical limitations (i.e., healthcare coverage restricted to state in which a farmworker is registered), lack of transport, and limited hours of availability of services.

Poverty impedes access to healthcare services. This is an important consideration that needs to be given adequate attention in planning healthcare interventions for migrant farmworkers to reduce the risk of diabetes. Approximately 37% of families of migrant farmworkers have a family income below the U.S. national poverty level and are unable to afford proper healthcare (Stoecklin-Marois et al., 2015). It should also be noted that without sufficient family income, farmworkers cannot purchase healthy foods that boost the immune system and help them to fight the effects of pesticides (Stoecklin-Marois et al., 2015).

The findings of the study do not support the assumption that diabetes is lower among farmworkers because of the physical nature of their work and limited access to fast foods (Quandt et al., 2018). This study has shown that diagnosis of DT2 among Hispanic migrant farmworkers is associated with the number of years doing farm work, education level, and use of healthcare services. However, caution should be exercised when discussing application of the study findings to professional practice and the associated social implications, in that there could be other factors that increase the risk of DT2 among Hispanic migrant farmworkers. One factor likely to influence the risk of DT2 among migrant farmworkers is diet (Quandt et al., 2018; Shin et al., 2014). Evidence has shown that migrant farmworkers' diet is mainly comprised of food types associated with

increased risk of DT2 such as simple carbohydrates and high fats (Quandt et al., 2018). High consumption of alcohol among farmworkers has also been associated with an increased risk of DT2 (Shin et al., 2014). The reported increased risk of DT2 among farmworkers with the increase in the number of years of farm work could also be linked not only to pesticide exposure, but also to high stress levels among farmworkers. Ramos et al. (2015) reported that farmworkers undergo stressful experiences due to abuse by employers, substandard living conditions, and barriers to accessing social and health services. However, the application to professional practice and the social implications of the present study's findings will be interpreted within the scope of the study, which focused on pesticide exposure.

Application to Professional Practice

The findings showing that those who have worked for a long time in farm work are likely to have an increased risk of reporting DT2 imply that professionals involved in planning and implementation of diabetes prevention and management need to focus on this at-risk group. The reported findings also suggest that public healthcare providers and other relevant stakeholders should tailor education programs on diabetes prevention to target migrant farmworkers. This is important because farmworkers of Hispanic origin remain the most medically underserved population in the United States (Dantu et al., 2019).

The migrant farmworkers examined in this study had limited English proficiency, as indicated by the findings that some had never attended school. Based on these findings, there is a need for healthcare professionals and health educators to devise means of reaching and educating those farmworkers who cannot read educational materials such

as pamphlets and posters. One practical method is the use of local translators for local community health workers.

The study's findings challenge public health providers and other relevant stakeholders to find ways of addressing the factors that limit access to healthcare education and healthcare services among migrant farmworkers. Although the study did not specifically highlight the steps that need to be taken by healthcare professionals to address the issue of increased risk of DT2 among farmworkers, previous studies have provided important insights. To address the highlighted increased risk of DT2 among Hispanic farmworkers who have spent long periods working on farms, there is a need for healthcare providers to find a way of increasing access to health services, especially for those who do not have insurance coverage. This is important because McCullagh et al. (2015) highlighted limited access to health insurance coverage as one of the reasons for limited access to health services among migrant farmworkers of Hispanic origin. Healthcare professionals, in collaboration with other stakeholders, are encouraged to develop interventions that will ensure that farmworkers have the financial capability to access them and that the services are provided at a location and time suitable for farmworkers.

The reported poverty level among Hispanic migrant farmworkers suggests that the relevant authorities and stakeholders need to interrogate potential lack of healthcare insurance coverage as one of the drivers of increased risk of DT2 and possible increased mortality due to limited access to care. Without sufficient income, migrant farmworkers have a limited choice of medical services. Measures that enable migrant farmworkers who have a family income below the poverty level to access some form of health

insurance that will enable them to access healthcare services could help to address the increased risk of DT2 in this population.

The leaders of federal and state agencies should consider implementing policies that will empower community health workers to focus on the risk of DT2 among migrant farmworkers. Community health workers are health professionals whose main role is to educate communities and facilitate health promotion and disease prevention activities at the community level (CDC, 2018b). Community health workers have the crucial role of enabling increased access to healthcare services among migrant farmworkers. Sharing knowledge with community health workers regarding the increased risk of DT2 and the impact of poverty level and education level among Hispanic farmworkers is likely to influence the development of the required prevention activities, programs, and interventions that will effectively address the risk of DT2 among migrant farmworkers. A diabetes educational and awareness approach adopted by community health workers, if tailored to meet the healthcare needs of Hispanic migrant farmworkers, is likely to enhance the adoption of preventive measures or enable farmworkers to detect DT2 early (CDC, 2018b).

Recommendations

There is a need to appreciate the fact that healthcare efforts require a multifaceted approach. Stakeholders involved in the development of guidelines for safe use of pesticides also need to take necessary steps to ensure the reduction of the risk of DT2 among Hispanic farmworkers. Occupation health and safety professionals working for pesticide production companies need to develop ways of communicating safe use of

pesticides. Specific recommendations for addressing the high risk of DT2 among Hispanic migrant farmworkers are summarized as follows:

1. Given that the number of years doing farm work increased the likelihood of DT2, it is recommended that diabetes screening and management target Hispanic migrant farmworkers who have worked on farms for longer periods.
2. It is recommended that diabetes prevention and management programs direct more attention toward female Hispanic migrant farmworkers because they were noted to have higher rates of diagnosis of DT2.
3. Given that some Hispanic migrant farmworkers were reported to have never attended school and could not read or write, there is a need to provide information regarding diabetes and prevention strategies in a language that they understand.
4. There is a need to enhance access to healthcare services among migrant farmworkers by addressing potential barriers such as poverty.

Implications for Social Change

The active involvement of social workers in creating awareness of the availability of DT2 prevention and management programs such as the National Diabetes Prevention Program could be significant in addressing the high risk of DT2 among Hispanic farmworkers. Some steps have been taken by relevant bodies to address access to healthcare among farmworkers. The CDC's Office of Minority Health and Health Equity along with other partners have put in place measures such as involvement of community health centers and community health workers to ensure increased access to health services by farmworkers (CDC, 2018b). The incorporation of community health centers

in addressing the high risk of DT2 among farmworkers who have worked for many years is important in providing targeted intervention. Engaging community health centers in addressing the issue of DT2 is important because they work at the community level and thus have the readiest access to farmworkers (CDC, 2018b).

Given that the outcomes of this study indicated that the risk of DT2 among Hispanic migrant farmworkers who have spent many years in farm work is high, social workers need to focus on those Hispanic migrant farmworkers who, due to language barriers and low levels of education, might not be aware of programs that could help them better manage or delay the onset of DT2. This initiative will likely enable migrant farmworkers to take full advantage of funded community health programs and services such as the CDC's local public health strategies that aim to prevent and manage diabetes. Social workers need to be empowered to undertake awareness programs among migrant farmworkers on the existence of DT2 prevention and management programs and should also be permitted to help farmworkers enroll in such programs.

Hispanic migrant farmworkers themselves have the biggest role in ensuring the reduction in their risk of DT2. Lack of support and information is one of the greatest impediments to social change among minority groups such as migrant farmworkers. They need to be supported and educated to encourage them to adopt positive social change toward reduced risk of DT2. Hispanic migrant farmworkers need to understand the risks posed by long-term exposure to pesticides. This is only possible if all stakeholders, including social workers and public health workers, collaborate in improving the awareness and education of farmworkers. Most Hispanic migrant farmworkers consider farm work as the only avenue through which they will be able to meet their daily needs;

therefore, asking them to limit their number of years in farm work may not be viable. A more practical approach would be to promote attention to self-care and the adoption of protective and safety measures when working on farms.

There are various self-care approaches that Hispanic migrant farmworkers need to adopt to reduce their risk of DT2. One approach is ensuring that they protect themselves from exposure to pesticides while working. Self-protection should not only be the duty of migrant farmworkers; farm owners need to provide protective gear. In addition to improving safety, this is necessary to ensure that farmworkers who may not be able to afford protective gear do not feel disadvantaged and left out. Ensuring the safety of farmworkers should also be a priority for the relevant state personnel. There is a need to develop guidelines, regulations, and policies that ensure that farm owners take responsibility for protecting farmworkers against exposure to harmful pesticide chemicals. Occupational health and safety officers along with other relevant law enforcement entities need to be facilitated and empowered to ensure that farm owners take responsibility for migrant farmworkers' safety.

Farmworkers also need to actively take advantage of DT2 preventive and treatment programs provided by the government. Farm owners, relevant healthcare providers, and social workers need to collaborate to ensure that farmworkers can overcome the challenges that limit their ability to seek healthcare services. Migrant farmworkers should be incentivized to seek healthcare services by ensuring they are given time off from farm duties to seek healthcare services or by availing healthcare services such as DT2 prevention education and screening at their place of work. It is also important to note that the government needs to compel pesticide manufacturers to provide

data on the risk of DT2 associated with pesticides on the market. Labels need to include information on DT2 risk and measures that can be taken to reduce the risk. Pesticide manufacturers also need to be involved in the education efforts through their community social responsibility involvement. The immediate beneficiaries of the highlighted positive social changes are Hispanic farmworkers, who are likely to experience reduced risk of DT2. Reducing the risk of DT2 among Hispanic farmworkers will impact positively on the public healthcare system by reducing the burden associated with DT2.

Summary

It is evident from the assessment of the application of the findings to professional practice and social change implication that healthcare efforts to reduce the risk of DT2 among Hispanic migrant farmworkers require a multifaceted approach. Farmworkers need to be actively involved, alongside other stakeholders such as healthcare professionals, social workers, occupational health and safety and law enforcement personnel, and farm owners, all of whom need to collaboratively work toward addressing the highlighted challenges. Hispanic migrant farmworkers have the biggest role to play in ensuring reduction in their risk of DT2. They need to adopt self-care approaches such as ensuring that they protect themselves from exposure to pesticides and actively take advantage of DT2 preventive and treatment programs provided by the government. It is also noted that for farmworkers to implement the highlighted health and safety behavioral practices, they need to be supported since they face various challenges such as the need to work on farms for their livelihood, low level of education, and limited access to healthcare services. To facilitate access to healthcare services, public healthcare providers and other relevant stakeholders can develop education programs on DT2 prevention that

suit Hispanic farmworkers and are delivered in a language and location that allow the farmworkers to access them.

Community health workers who have a good understanding of Hispanic culture and language need to be actively involved in the development and implementation of the programs. Healthcare professionals, in collaboration with other stakeholders, need to ensure that the developed programs can be afforded by farmworkers. To ensure that farmworkers take advantage of the already available, fully funded community health programs and services, social workers need to actively create awareness and enroll farmworkers in the programs. Farm owners should also ensure that farmworkers have protective gear to prevent exposure to pesticides. Overall, it is evident that to address the challenge of a high risk of DT2 among farmworkers requires multifaceted, collaborative efforts from various professionals and stakeholders.

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