2022

# Adverse Childhood Events and Protective Health Behaviors Among Adults With Diabetes or Diabetes With Comorbid Heart Disease

Ciara Michelle Rukse
*Walden University*

# Walden University

College of Health Professions

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Ciara M. Rukse

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Review Committee
Dr. Vasileios Margaritis, Committee Chairperson, Public Health Faculty
Dr. Twanda Wadlington, Committee Member, Public Health Faculty
Dr. Mary Lou Gutierrez, University Reviewer, Public Health Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
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Abstract

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MPH, West Virginia University, 2018

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Diabetes is a prevalent and costly chronic condition that can lead to other comorbid conditions such as heart disease. Disease management is essential but can be stressful and complicated, especially for individuals who have developed maladaptive behaviors in response to exposure to adverse childhood events (ACEs), which are chronic stressors that impact physiological and psychological development. There is limited research on the potential relationship between childhood adversity and engagement in protective health behaviors among U.S. populations with diabetes or diabetes with comorbid heart disease. The ACEs pyramid was the theoretical framework of this quantitative cross-sectional study concerning morbidity and early mortality. The aim of the study was to investigate the association between the existence of any type of ACEs and the level of engagement in tertiary protective health behaviors when controlling for age, race, and sex. Secondary data from the ACEs module of the Centers for Disease Control and Prevention's 2019 Behavioral Risk Factor Surveillance System survey were analyzed. Logistic regression results indicated a significant relationship between age and protective health behaviors when assessing for counts of ACEs and types of ACEs among those with diabetes (*OR* = .977, 95% CI [.966, .988]; *OR* = .957, 95% CI [.935, .980]). In addition, men were less likely to exhibit high engagement in tertiary protective health behaviors (*OR* = .696, 95% CI [.576, .821]). The positive social change implications of this study include informing the development of public health interventions to promote disease and health self-management among individuals with diabetes or diabetes with comorbid heart disease.

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# Dedication

I dedicate this work to my wonderful husband and family. Without your support and encouragement, none of this would have been possible.

## Acknowledgments

First and foremost, I would like to thank my committee chair, Dr. Vasileios Margaritis, for his guidance and knowledge throughout this process; it has been invaluable. I especially appreciate all the positive encouragement during the end of my capstone process and for always quickly and reliably answering questions. I would also like to thank the other member of my committee, Dr. Twanda Demetrias Wadlington, and my university research reviewer, Mary Lou Gutierrez, for their additional insight and advice during this process.

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Section 1: Foundation of the Study and Literature Review

## Introduction

Diabetes is a prevalent and chronic condition that can worsen over time, causing complications throughout the entire body. Diabetes can lead to the development of other comorbid diseases, such as high blood pressure and kidney disease, that can place the individual at an increased risk for early mortality (Centers for Disease Control and Preventon [CDC], 2019c). In 2017, diabetes was the seventh leading cause of death in the United States, with an estimated 26.9 million individuals across all ages diagnosed with the condition (CDC, 2020c; Kochanek, 2019). The CDC, in its *National Diabetes Statistics Report*, estimated that of those individuals diagnosed with diabetes, 21.4% were previously undiagnosed and unaware that they had the disease. The 2017 indirect and direct costs of diabetes were estimated at $327 billion, with medical expenditures per person increasing by $1,184 from 2011 to 2017 (CDC, 2020c).

Individuals with diabetes are twice as likely to have comorbid high blood pressure, which in turn puts them at an increased risk for kidney disease and eye complications, such as blindness (CDC, 2019c). Other complications of diabetes include neuropathy, stroke, amputations due to blood vessel damage, depression, and gum disease (CDC, 2019c). Diabetes, especially uncontrolled diabetes, can be dangerous because complications can develop over time if regular visits to health care providers, foot self-exams, dental exams, and other tertiary prevention practices are not put in place to further protect individuals' health (CDC, 2019c).

Management of diabetes can be stressful and complicated, especially for individuals who have developed maladaptive behaviors in response to events they experienced in childhood. Adverse childhood events (ACEs) are defined as any occurrence that causes harm to a child, including abuse, neglect, or exposure to a harmful living environment (Hughes et al., 2017). ACEs create a constant source of chronic stressors that take a physiological, mental, and emotional toll on the child. Physiological stressors can affect the child's development of a proper immune, endocrine, and nervous system, while emotional stressors can affect coping and allostatic load, which occurs when body subjected to increased stress hormones due to repeated stressors (Hughes et al., 2017) . Individuals who grow up having experienced ACEs are more likely to suffer from some type of emotional, social, or cognitive impairment, leading to the formation of maladaptive behaviors (Hughes et al., 2017). The impaired behaviors that ACEs cause can lead to an increased risk of chronic conditions, such as diabetes (Huffhines et al., 2016). In addition, individuals with diabetes perceive that these impaired behaviors influence their ability to manage their chronic condition (Geiger, 2015). These learned maladaptive behaviors can present a barrier to the self-management of diabetes. Furthermore, the behaviors contribute to the overall underlying risks for diabetes.

In this study, I sought to contribute to the knowledge about those psychosocial factors of ACEs that influence the self-management and engagement in tertiary protective health behaviors by individuals with diabetes or diabetes with comorbid heart disease. These behaviors employ tertiary prevention strategies, which aim to reduce the severity and negative outcomes resulting from chronic conditions (Kisling & Das, 2020). The

study may contribute to positive social change by indicating whether these psychosocial factors continue to impact one's ability to manage their chronic condition. In the first section of this study, I discuss the problem and purpose of the study. This discussion is followed by an overview of the research questions (RQs) and hypotheses, the theoretical foundation of the study, and the nature of the study. This section also includes information on the literature search strategy, followed by a literature review related to key variables and concepts. I also provide operational definitions and discuss the assumptions and scope and delimitations of the research.

## Problem Statement

Childhood adverse experiences can result in impairments that present as barriers for individuals with diabetes or diabetes with comorbid heart disease when trying to engage in tertiary protective health behaviors to further protect their health. Engagement in protective health behaviors is integral to managing chronic conditions such as diabetes and heart disease. Examples of common protective health behaviors for tertiary health-protective practices for those with diabetes can include glucose monitoring, foot self-exams, attendance of a self-management class, and/or regular visitation of a physician for one's disease (McEwen et al., 2017). Of those U.S. adults 18 years and older with a diagnosis of diabetes, 77.8% indicated having a source of care for their diabetes, 24.2% reported meeting general physical activity guidelines, and 77.1% indicated losing or managing their weight to aid with their diabetes in data from 2013-2016 (CDC, 2020c).

Adults may experience disrupted physiological responses or impaired decision-making due to childhood adversity, which inhibits their ability to engage in protective

health behaviors or make good decisions concerning their disease (Berens et al., 2017). Although childhood adversity can define a wide range of relevant adverse experiences during adolescents, there are eight main categories of childhood adversity adapted from the original ACEs study in the CDC's Behavioral Risk Factor Surveillance System (BRFSS) adapted module (Felitti et al., 1998). Current research has established the relationship by which physiological disruption caused by these sources of childhood adversity leads to increased chronic disease risk for diseases such as diabetes and heart disease (Bellis et al., 2015; Stojek et al., 2019). After finding a graded association between adverse events in childhood and multiple morbid conditions, Tomasdottir et al. (2015) suggested the need for more research on multimorbidity and the influence of adversity during the lifespan. In reviewing the literature, I found little research on the potential relationship between childhood adversity and engagement in protective health behaviors among populations with diabetes or diabetes with comorbid heart disease.

Current researchers have explored the cumulative effect of ACEs on disease risk but have not fully considered the influence this has on health-protective behaviors (Huffhines et al., 2016). Moreover, the research on this topic is either limited in scope to only those with Type 2 diabetes or focuses on self-perception of childhood adversity and its perceived influence on self-management behaviors (Geiger, 2015). Geiger (2015) found that individuals with Type 2 diabetes perceive that ACEs influence their self-management behaviors. My focus, in this study, differed in that I used a secondary data source to measure the potential association among reported ACEs and distinct health behaviors, rather than self-perceptions of the relationship. The study also included

individuals with Type 1 or Type 2 diabetes and examined the relationship between ACEs and those diagnosed with two chronic conditions, diabetes or diabetes with comorbid heart disease. In conducting this study, I aimed to address a gap in the literature by examining how individuals who have experienced childhood adversity and have developed diabetes or diabetes with comorbid heart disease engage in protective health behaviors to manage their disease(s).

## Purpose of the Study

The purpose of this study was to investigate the extent to which individuals experiencing childhood adversity with either diabetes or diabetes with comorbid heart disease engage in tertiary protective health behaviors. In this quantitative study, I aimed to better understand the process by which childhood adversity impacts disease management by examining the influence of disrupted decision-making and maladaptive behavior development on engagement in health-protective or self-management behaviors. The study variables included a set of specified self-management protective health behaviors and the number of reported ACEs as defined by the BRFSS.

## Research Questions and Hypotheses

RQ1—Quantitative: What is the association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$1: There is no association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$1: There is an association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

RQ2—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$2: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$2: There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

RQ3—Quantitative: What is the association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$3: There is no association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$3: There is an association between the number of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

RQ4—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$4: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$4: There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

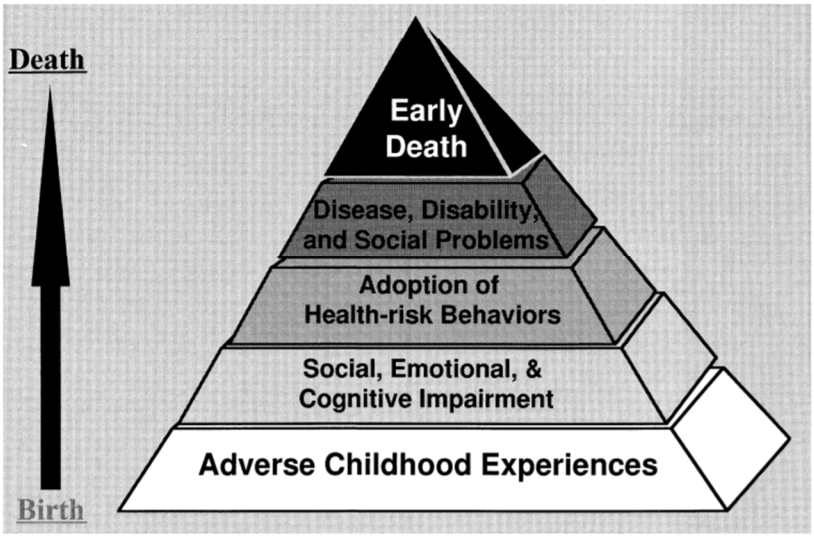
## Theoretical Framework

I used the ACEs pyramid conceptualized in the original ACEs research to support this study. The pyramid, depicted in Figure 1, models the process by which adverse childhood experiences lead to social, emotional, and cognitive impairment, which leads to the adoption of health risk behaviors and then early mortality and morbidity (Felitti et al., 1998). This conceptual model was chosen because of its use in other ACEs-related research and because it establishes the idea that some impairment should influence individual health behaviors as a result of childhood adversity (Cobb et al., 2020). The model depicts the study's independent variable, ACEs, as leading to impairment, which influences the dependent variable of health behaviors. This relationship results in disease risk and a propensity to develop diseases such as diabetes and heart disease, which lead to early mortality. I proposed to fill a gap in the model to examine the continued impact on

health behaviors after the disease is developed. The ACEs model draws a conclusion between the behaviors of two constructs that are important to this study.

**Figure 1**

*Adverse Childhood Experiences Pyramid*




*Note*. From "Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults: The Adverse Childhood Experiences (ACE) Study," by V. J. Felitti, R. F. Anda, D. Nordenberg, D. E. Williamson, A. M. Spitz, V. Edwards, M. P. Koss, and J. S. Marks, 1998, *American Journal of Preventive Medicine, 14*(4), p. 256 (https://doi.org/10.1016/S0749-3797(98)00017-8). Copyright 1998 by the *American Journal of Preventive Medicine*.

## Nature of the Study

The nature of the study was to assess the measure of association between the number of reported ACEs and the number of identified protective health behaviors among those with diabetes or diabetes with comorbid heart disease using multiple linear

regression. To better understand the influence of certain types of childhood adversity on this relationship, I also examined the association between the category of ACEs and the number of identified protective health behaviors. The design of the study was nonexperimental, cross-sectional using secondary data from the publicly available 2019 standardized BRFSS data sets from the CDC. The BRFSS survey focuses on adult U.S. citizens 18 years and older (CDC, 2019b). For this study, the population was further narrowed to those adults indicating either having diabetes or diabetes with comorbid heart disease.

The CDC BRFSS ACEs Module consists of 11 questions that each count for an instance of childhood adversity or ACE (see Appendix A; CDC, 2019a). These categories include emotional abuse, physical abuse, sexual abuse, and five categories of household dysfunction (incarceration of one parent, substance use, separation or divorce, mental illness, and domestic violence; Campbell et al., 2019; CDC, 2020a; Merrick et al., 2018). For RQ1, I used a cumulative scale of ACEs as measured by the BRFSS ACEs module as the independent variable. The dependent variables were titled protective health behaviors and, as with the independent variable, were assessed for both their individual and cumulative association with ACEs. As denoted in the CDC (2019a) standardized Diabetes module, these dependent variables and their associated BRFSS question are

- BLDSUGAR: About how often do you check your blood for glucose or sugar?
- FEETCHK3: Including times when checked by a family member or friend, about how often do you check your feet for any sores or irritations?

- DOCTDIAB: About how many times in the past 12 months have you seen a doctor, nurse, or other health professional for your diabetes?
- DIABEDU: Have you ever taken a course or class in how to manage your diabetes yourself?

For RQ2, for the independent variable, I categorized ACEs into the eight categories of adverse childhood events: emotional abuse, physical abuse, sexual abuse, and five categories of household dysfunction (incarceration of one parent, substance use, separation or divorce, mental illness, and domestic violence; Campbell et al., 2019; Merrick et al., 2018). The same dependent variables used in RQ1 were used in RQ2.

For RQ3 and RQ4, I used the same independent and dependent variables as in RQ1 and RQ2. However, the population of interest were those individuals indicating having both diabetes and heart disease as part of the core BRFSS module. The aim was to analyze whether the severity of the disease, with the addition of a comorbid condition, mediated the overall relationship found in RQ1.

## Literature Search Strategy

To support the background of the study, I review the literature related to ACEs; ACEs, diabetes, and heart disease; and tertiary protective health behaviors. The research was performed using the search terms of *ACEs*, *adverse childhood experiences*, *ACEs and diabetes*, *adverse childhood experiences and diabetes*, *childhood diversity and chronic disease*, *heart disease and ACEs, tertiary prevention strategies*, and *protective health behaviors and diabetes*. To find literature, I performed searches in databases such as ProQuest, EBSCOhost, ScienceDirect, and PubMed. Articles used for this study

spanned the years of 2015 to 2020 and included one seminal article relevant to the development of the study's theoretical foundation.

## Literature Review Related to Key Variables

### Adverse Childhood Experiences

ACEs are traumatic events that include mental, physical, emotional, and sexual abuse or any trauma caused by household dysfunction (Steptoe et al., 2019). These events, which can lead to early mortality and morbidity, are linked to an array of negative outcomes in adulthood, including poor quality of life, increased risk for chronic conditions, low self-esteem, and poor self-regulation (Stillerman, 2018). It is imperative to continue to discuss the relationship between childhood adversity and adult outcomes, to better understand the impact ACEs have on adult health. In the original ACEs study, researchers mailed a survey to over 13,000 individuals with a medical evaluation at a partnering HMO (Felitti et al., 1998). The survey measured a range of ACEs that included physical abuse; sexual abuse; psychological abuse; violence against the mother; or having a mentally ill, incarcerated, or substance-abusing individual in the home. A dose-response relationship was found between these measured ACEs, and leading causes of death included cancer and ischemic heart disease. Other dose-response relationships were found between ACEs and emphysema, jaundice, hepatitis B, and poor self-related health. However, a dose-response relationship was not found between ACEs and diabetes or stroke. Overall, the original ACEs study emphasized the need for more research on the cumulative effect of childhood trauma, the intensity and type of trauma, or health outcomes in adulthood (Felitti et al., 1998).

How ACEs have adverse effects on adults' health outcomes is due to the psychosocial and physiological changes that happen during development as an adolescent experiencing adverse events (Stillerman, 2018). The development of a child is affected by external and internal stimuli, which results in micro and macro adaptions. However, adverse experiences can negatively affect this adaption process; this continued effect on development results in impaired functioning, which has a lasting impact on adulthood (Stillerman, 2018). For instance, adverse experiences can over activate the body's stress response, which can lead to dysregulation and the development of chronic diseases (Stillerman, 2018). Similarly, the biological embedding model supports the idea that adversity early in childhood has a physiological impact on the production of important chemicals and responses in the body, increasing inflammation and suppressing immune responses (Berens et al., 2017). The model also suggests that these responses can lead to increased glucose resistance (Berens et al., 2017).

Research involving BRFFS data often involves the use of a cross-sectional methodology to assess various outcomes and their association with cumulative ACEs. These researchers have examined the relationship between the cumulative ACEs reported by BRFSS responders and other survey variables collected, such as quality of life (Jia & Lubetkin, 2020). Similarly, Salas et al. (2019) used a cross-sectional design to compare the varied impact of different categories of ACEs on chronic disease and depression. Those individuals who reported having depression and high adversity were associated with greater odds of having cardiovascular disease than those with no depression. However, those with greater odds of having diabetes were the same across individuals

with and without depression. Geiger (2015) also used a cross-sectional design survey method to assess self-perception by individuals of the impact of ACEs on self-management behaviors, through which it is discovered that the cohort of individuals self-perceived ACEs as having an impact on their diabetes self-management behaviors. Limitations of using a cross-sectional method for studying ACEs include recall bias and that cross-sectional designs measure ACEs' presence but not the extent to which each particular ACE was experienced (Chanlongbutra et al., 2018).

As ACEs continue to have an evident influence on outcomes in adulthood, screening for them in a clinical setting is not only feasible but may help clinicians understand their patients better (Glowa et al., 2016). In their review of related literature, Cohdres and Mauz (2020) found recommendations for timely intervention at the adolescent age to counterbalance the effects of ACEs and proposals for integrating ACEs care in interventions for adults. Emotional stability can help regulate negative life experiences, and resiliency can counterbalance low self-efficacy in children who have experienced childhood adversity (Cohrdes & Mauz, 2020). As such, both concepts should be included in interventions aimed at adolescents who have experienced adversity (Cohrdes & Mauz, 2020).

**ACEs, Diabetes, and Heart Disease**

Research supports a relationship between the risk factors for diabetes and heart disease and the existence of childhood adversity ( Bellis et al., 2015; Stojek et al., 2019). Diabetes disease risk is not equal for all ACEs levels, as research shows that cumulative ACEs, or having experienced more adversity, can lead to increased disease risk over a

low ACE score. An increased risk for diabetes was associated with the reporting of four or more ACEs (Chanlongbutra et al., 2018; Huffhines et al., 2016). Flores-Torres et al. (2020) found an increased disease risk for diabetes when all categories of ACEs were present versus individual categories of ACEs, while household abuse only was associated with hypertension. In a meta-analysis, Huang et al. (2015) found an association between ACEs and the development of diabetes in adulthood, with neglect having the strongest effect on the development of diabetes.

The American Diabetes Association (2020), in its guidelines for standard clinical practices for diabetes care, included integration of some type of psychosocial evaluation during routine visits, as individuals with diabetes are more likely to experience anxiety or depression and/or suffer from posttraumatic disorders. Psychosocial distress can influence one's ability to engage in self-management behaviors and increase mortality risk (American Diabetes Association, 2020). The management of diabetes and the engagement in tertiary preventative health behaviors can be stressful for individuals with or without ACEs resulting in diabetes distress. Xu et al. (2020) found that individuals with uncontrolled Type 2 diabetes mellitus experienced both work and life productivity loss.

The direct causality between the development of diabetes as caused by ACEs seems to be unclear in the research, largely since diabetes is a complex disease with many associated risk factors. Researchers have well established the existence of both having experienced ACEs and having a diagnosis of diabetes (Campbell et al., 2019; Huang et al., 2015; Huffhines et al., 2016). Individuals indicating having diabetes and ACEs had a

mortality rate 2.3 times higher than those without both ACEs and diabetes in one study (Campbell et al., 2019). In contrast, other researchers have focused on the more medical link between ACEs and causes of diabetes, including impaired immune systems, physiological damage, impaired allostatic load, and increased inflammatory responses in the body (Berens et al., 2017; Hughes et al., 2017). Risk factors for diabetes linked to stress responses include increased inflammatory cytokines (Hackett & Steptoe, 2017).

In the original ACEs study, there was no dose-response relationship found between stroke and ACEs, as was the case for diabetes (Felitti et al., 1998). However, more recent literature highlights a need to better research the relationship between heart disease and ACEs (Wade et al., 2019). The American Heart Association (2018) proposed a model by which childhood adverse events influence cardiometabolic health through three avenues: health behaviors, biological mechanisms, and mental health. The association identified the need for more research in the area of cardiometabolic diseases and childhood adversity as causal inferences are limited. Timely interventions that buffer the effects of childhood adversity need to be studied, as modifiable factors that can improve overall health can be influenced by the byproducts of childhood adversity (Suglia et al., 2018).

Researchers have mostly explored how and why individuals with ACEs develop diabetes or diabetes with comorbid heart disease. In reviewing the literature, I found little research on the continued impact of this impairment on the management of the disease after the individual is diagnosed. The ACEs pyramid establishes a process by which ACEs lead to social, cognitive, or emotional impairment, leading to disease development

and ultimately early mortality and morbidity (Felitti et al., 1998). There remains a sizeable gap in knowledge on morbidity and early mortality and if the severity of ACEs is associated with behaviors aimed at preventing early mortality, or as referred to in this study, tertiary protective health behaviors. In this study, I sought to address this identified gap in the literature.

**Tertiary Protective Health Behaviors**

Tertiary prevention strategies aim to lessen the severity of disease and its outcomes after the individual is diagnosed (Kisling & Das, n.d.). These types of preventative strategies can include engagement in health-protective behaviors that preserve health as individuals self-manage their chronic condition. Identified protective health behaviors for individuals with heart disease and diabetes include foot care, daily physical activity, and healthy eating (Dunton, 2018; Kisling & Das, 2020). Other identified protective health behaviors recommended as standards of care by the American Diabetes Association (2020) include ongoing visits to a doctor, mental health evaluations, disease management courses, and medication adherence counseling.

The desire to engage in health-protective behaviors depends on the ability to appropriately self-regulate one's short-term and long-term behaviors that impact health. Often this is rooted in models that are supported by the theory of planned behavior, which highlights the influences on behavioral intentions (Traina et al., 2016). Perceived threat and susceptibility are other constructs that influence the intent to engage in health-protective behaviors. However, the perception of Type 2 diabetes threat can differ among those of different genders and races. In a study of rural populations, women were found

likely to have a perceived susceptibility to Type 2 diabetes, while racial minorities were likely to have a lower perceived susceptibility (Paige et al., 2018).

However, traumatic events disrupt the self-regulation process, which can influence an individual's ability to appropriately engage in health-protective behaviors. A study among African American women found that food addiction was associated with exposure to childhood trauma (Stojek et al., 2019). Eating dysregulation may be a behavioral indication of the severity of food addiction mediating the relationship between childhood trauma and insulin resistance leading to Type 2 diabetes, the researchers concluded. This conclusion highlights the need to integrate psychosocial factors and their influence on eating dysregulation in interventions among women with Type 2 diabetes (Stojek et al., 2019).

## Definitions

*ACEs module*: A CDC BRFSS module that consists of 11 questions that each count as for an instance of childhood adversity or ACE (CDC, 2019a). These categories include emotional abuse, physical abuse, sexual abuse, and five categories of household dysfunction (incarceration of one parent, substance use, separation or divorce, mental illness, and domestic violence; Campbell et al., 2019; CDC, 2020a; Merrick et al., 2018).

*Age*, *race*, and *sex*: Variables that were included as covariates in the research model because of their potential influence on the relationship between the independent and dependent variables. In a previous study, researchers found that age, race, and gender affected the relationship between the number of reported ACEs and quality of life variables as measured by the BRFSS (Jia & Lubetkin, 2020).

*Tertiary health protective behaviors*: In this study, behaviors that are part of tertiary preventive strategies to manage the outcomes and reduce the severity of diabetes and diabetes with comorbid conditions. For this study's purpose, these behaviors referred to those measured by the BRFSS diabetes module, which includes the frequency of checking blood glucose, visiting a doctor, engaging in a diabetes self-management course, and/or diabetic foot care (CDC, 2019a). McEwen et al. (2017) supported using these BRFSS diabetes module questions as defined self-management behaviors.

## Assumptions

For this study, I assumed that self-reported data collected through the BRFSS were reported honestly by responders to the best of their ability. It is also assumed that the data were not altered in any way during the collection and cleaning process that would affect the ability to perform secondary analysis and that the data were valid. The assumption is also made that sample procedures were performed in a way that allows the data to be generalizable to the greater population.

## Scope and Delimitations

The study was delimited to the states that opted to collect data through the optional ACEs and Diabetes modules, which contain the independent and dependent variables. The study population is delimited to individuals with Type 1 and Type 2 diabetes, as BRFSS data make no distinction to the type of diabetes among the survey variables (CDC, 2019a). The study population's scope was limited by the population of individuals surveyed through BRFSS, which included individuals 18 years and older. Because I investigated a specific population of individuals with diabetes or diabetes with

comorbid heart disease, this further limited the number of individuals included in the case study. However, I modeled the methodologies of other researchers who have used secondary data analysis of BRFSS data to measure the association between ACEs and other variables collected by the survey (e.g., Jia & Lubetkin, 2020; Merrick et al., 2018).

## Summary and Conclusions

In Section 1 of the study, I provided an overview of the study and presented a thorough literature review related to key study variables. As evident in the literature review, chronic conditions such as diabetes and heart disease have a link to trauma experienced in childhood (Campbell et al., 2019; Chanlongbutra et al., 2018; Huang et al., 2015; Huffhines et al., 2016). The literature supports the impact ACEs have on the individual's physiological, psychological, and physical well-being ( Berens et al., 2017; Hughes et al., 2017; Stillerman, 2018). In addition, some researchers have found that this effect can have a further impact on the ability to engage in protective health behaviors resulting in the diagnosis of disease (Stojek et al., 2019). Although this diagnosis may spur individuals into engaging in protective health behaviors for tertiary prevention, there remains a gap in the literature as to whether the impairment from ACEs continues to present as a barrier.

Section 2: Research Design and Data Collection

## Introduction

In this study, I examined the extent to which individuals with ACEs and diabetes or ACEs, diabetes, and heart disease engage in tertiary protective health behaviors. In section two, I provide a rationale for the research design and present the methodology used to support the study. In addition, the data instrument and constructs from the secondary data set used to support the study are operationalized. Lastly, the threats to validity and ethical procedures for the study are reviewed.

## Research Design and Rationale

The research design consisted of the use of secondary data analysis in a nonexperimental cross-sectional study. I chose this type of research design due to the nature of the data collection procedures for BRFSS, the chosen secondary data source. Because the secondary data source contained quantitative data, a quantitative research design was used. Researchers use quantitative research designs when they seek to hypothesize a causal or outcome relationship between two variables (Rutberg & Bouikidis, 2018). This research design was nonexperimental meaning the variables were not manipulated. A qualitative design was not applicable for this study as qualitative designs include analyzing data that are not quantitative in nature, such as narratives or reports (Rutberg & Bouikidis, 2018).

In addition, previous researchers have used a cross-sectional design to compare other variables contained within the BRFSS data set (Jia & Lubetkin, 2020; Merrick et al., 2018). The independent variable was the number and type of ACEs reported; the

dependent variable consisted of the level (or number) of protective health behaviors. Covariates included age, sex, and race. The populations for the study were individuals with diabetes and individuals with both diabetes and heart disease.

## Methodology

### Population

According to the 2019 BRFSS module by survey category published by the CDC, 14 states elected to use both optional modules for diabetes and ACEs. These states include Alabama, Delaware, Indiana, Iowa, Kansas, Michigan, Missouri, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Virginia, and Wisconsin. The standardized population eligible to be included in the BRFSS across all states included individuals 18 years and older who were noninstitutionalized (CDC, 2020b). I examined two populations from this subset of BRFSS data in the study. One population indicated having diabetes, and the other population indicated having both diabetes and heart disease. Diabetes and heart disease variables were used to subset the data. Population 1 answered "yes" to the question, "Has a doctor, nurse, or other health professional ever told you that you had any of the following? (Ever told you had) diabetes?" (CDC, 2019a). Population 2 answered "yes" to both the diabetes question and the following heart disease question: "Has a doctor, nurse, or other health professional ever told you that you had any of the following? (ever told you had) angina or coronary heart disease?" (CDC, 2019a)

A review of the publicly available 2019 BRFSS data sets shows that 2,778 cases met Population 1 criteria of having diabetes and were not missing the independent, dependent variables, or confounding variables. In addition, 449 cases met Population 2

criteria or having both diabetes and heart disease and were not missing the independent, dependent variables, or confounding variables. All relevant and complete cases were used in the sample. I performed a post hoc power analysis, as discussed in Section 3, to verify that the proposed sample was adequate.

**Sampling and Sampling Procedures**

As part of the CDC requirements of states, sampling methods for BRFSS must be justified as a representative sample of all households with a telephone within that state (CDC, 2019b). The CDC set a disproportionate stratified sample design to be used by states in their collection of the 2019 BRFSS data. Sampling is stratified by two strata, high and medium density, where the number of telephone numbers in the area determines which strata the telephone number is placed. For cellular telephone sampling, Telecordia exchanges were used for the 2019 BRFSS sampling, which is sorted by area code and the exchange within the state. BRFSS data are weighted through iterative proportional fitting or ranking and are designed to adjust for nonresponse and noncoverage errors (CDC, 2019b).

**Instrumentation and Operationalization of Constructs**

The Behavioral Risk Factor Surveillance System is a telephone-based survey initiated in 1984 as a collaborative partnership between the CDC and participating states. In 2011, the BRFSS drastically changed how data were weighted and compiled, making the data before this year incomparable to data collected after 2011. The BRFSS questionnaire consists of three components: the core, optional BRFSS modules, and state added questions (CDC, 2019b). BRFSS is intended to assess health risk behaviors, access

to care, use of preventive services, and chronic condition data in a standardized process across all states (CDC, 2019b).

### *Operationalization*

**ACES.** The BRFSS ACEs module questionnaire consists of 11 standardized questions on childhood adversity, adapted from the original ACEs study (Felitti et al., 1998; see Appendix A). The ACEs experiences module begins with this prompt: "Now looking back before you were the 18 years of age" (CDC, 2019a). The variable and question items for the module are as follows:

1. ACEDEPRS: "Did you live with anyone who was depressed, mentally ill, or suicidal?"
2. ACEDRINK: "Did you live with anyone who was a problem drinker or alcoholic?"
3. ACEDRUGS: "Did you live with anyone who used illegal street drugs or who abused prescription medications?"
4. ACEPRISN: "Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?"
5. ACEDIVRC: "Were your parents separated or divorced?"
6. ACEPUNCH: "How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up? Was it..."
7. ACEHURT1: "Not including spanking, (before age 18), how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Was it..."

8. ACESWEAR: “How often did a parent or adult in your home ever swear at you, insult you, or put you down? Was it...”
9. ACETOUCH: “How often did anyone at least 5 years or older than you or an adult, ever touch you sexually? Was it...”
10. ACETTHEM: “How often did anyone at least 5 years older than you or an adult, try to make you touch sexually? Was it...”
11. ACEHVSEX: “How often did anyone at least 5 years older than you or adult, force you to have sex? Was it...”

The response options for Questions 1 through 4 were “yes,” “no,” “DK/NS,” or “refused.” Response options for Question 5 were “yes,” “no,” “parents not married,” “DK/NS,” and “refused.” For Questions 6-11, response options were “never,” “once,” “more than once,” “DK/NS,” and “refused.” For this study, I counted an answer of “yes” for Questions 1-5 as one instance of ACEs. I was interested in the occurrence of the ACE, not the frequency; therefore, for Questions 8 through eleven, an answer of either “once” or “more than once” was considered an ACE.

**Categories of ACEs.** I used the ACEs variables to answer RQs 2 and 4. ACE variables and their abbreviations and codenames were categorized as follows:

- household mental illness (HMI): ACEDEPRS
- household substance abuse (HSA): ACEDRINK and ACEDRUGS
- family member incarceration (FMI): ACEPRISN
- parental divorce (PD): ACEDIVRC
- witnessing domestic violence (WDV): ACEPUNCH

- physical abuse (PA): ACEHURT1
- emotional abuse (EA): ACESWEAR
- Sexual abuse (SA): ACETOUCH, ACETTHEM, and ACEHVSEX

These categories are operationalized in the BRFSS study and similarly are used in other studies (CDC, 2020a; Jia & Lubetkin, 2020).

**Protective Health Behaviors.** I operationalized the dependent variable of protective health behaviors from the BRFSS diabetes module. I used the questions from the BRFSS diabetes module (CDC, 2019a) to operationalize the level of protective health behaviors. The variable names and associated questions were as follows:

1. BLDSUGAR: "About how often do you check your blood for glucose or sugar?"
2. FEETCHK3: "Including times when checked by a family member or friend, about how often do you check your feet for any sores or irritations?"
3. DOCTDIAB: "About how many times in the past 12 months have you seen a doctor, nurse, or other health professional for your diabetes?"
4. DIABEDU: "Have you ever taken a course or class in how to manage your diabetes yourself?"

***Categories of Protective Health Behaviors.*** The protective health behaviors were categorized as followed:

1. Low engagement (LE): 0-2 protective health behaviors
2. High engagement (HE): 3-4 protective health behaviors

**Diabetes.** The variable of DIABET4 was used for population inclusion/exclusion criteria and was measured through the following BRFSS core module question: “Has a doctor, nurse, or other health professional ever told you that you had any of the following? (Ever told you had) diabetes?” Responses for this question included “yes”; “yes, but female told only during pregnancy”; “no”; “no, pre-diabetes or borderline diabetes”; “don’t know/not sure”; or “refused.” Only data for those respondents answering “yes” were included in the study populations (CDC, 2019a).

**Heart Disease.** The variable CVDCRHD4 was used for population inclusion and exclusion criteria for Population 2 and was measured through the following BRFSS core module question: Has a doctor, nurse, or other health professional ever told you that you had any of the following? (ever told you had) angina or coronary heart disease? Responses for this question include “yes,” “no,” “don’t know/not sure,” “refused”. Only data for those respondents answering “yes,” to this and the diabetes question was included in the dataset for Population 2 (CDC, 2019a).

**Age.** The variable _AGE80 was used as a confounding variable and an imputed calculated variable based upon the BRFSS question: “What is your age?” The responses to this question are coded in years, a response of “don’t know/not sure” ,Or “refused”(CDC, 2019a).

**Race.** The variables MRACE1 and ORACE3 were used as confounding variables and are measured through the BRFSS question: “Which one or more of the following would you say is your race?” Responses to these two questions include “White,” “Black or African American,” “American Indian or Alaska Native,” “Asian,” Asian Indian,”

“Chinese,” “Filipino,” “Japanese,” “Korean,” “Vietnamese,” “Other Asian,” “Pacific Islander,” “Native Hawaiian,” “Guamanian or Chamorro,” “Samoan,” “Other Pacific Islander,” “Other,” “No additional choices,” “Don’t Know/Not Sure,” “Refused”. The ORACE3 allows for the capture of an additional race but were used if a MRACE1 is not recorded in the dataset (CDC, 2019a).

**Sex.** The variables LANDSEX and COLGSEX were used to determine reported sex, two variables are used in the questionnaire depending upon if the respondent was using a household landline or cellphone and was in college. The question for both variables was, "Are you male or female?”  And responses include “male” and “female” (CDC, 2019a).

**Data Analysis Plan**

The CDC makes publicly available the 2019 BRFSS data in ASCII and SAS format. Data was downloaded and imported into SPSS for data analysis. All applicable codebooks, questionnaires, and information on weighting and analysis were also downloaded from the CDC website. Analysis was performed to subset the data into two sets containing the study variables, dataset one for Population 1 and dataset two for Population 2.

Using SPSS statistical software, I performed univariate analysis to analyze descriptive statistics for each independent, dependent, and confounding variable. These descriptive statistics gave a detailed view of the types and amount of data for the variables of interest in the aggregated data sets. This analysis includes frequencies and distribution of the data. Identified variables in the diabetes and ACEs modules were be

coded into new study variables as described above in the operationalization of study constructs.

***RQs and Hypotheses***

RQ1—Quantitative: What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$1: There is no association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$1: There is an association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

RQ2—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$2: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$2: There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

RQ3—Quantitative: What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$3: There is no association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$3: There is an association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

RQ4—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$4: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$4: There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

***Analysis of RQ1 and RQ3***

Multiple linear regression (MLR) was used to assess the association between the independent variable (ACEs Score) and the dependent variable (number of Protective Health Behaviors). The variables of age, sex, and race were added to the linear regression

model to test for confoundedness. Statistical significance was tested with an alpha value of (a=0.05). The null hypotheses were rejected if the *P-value* of the multiple linear regression tests was at or below the alpha value. The MLR statistical test assumes that the data are continuous, that the observations are independent, that a linear relationship was present between all of the individual independent variables to be introduced into the model and the dependent variable as well as the collective independent variable and dependent variable, that multicollinearity and homoscedasticity does not exist, that the variables are normally distributed, and that residual error was normally distributed (Laerd Statistics, 2018). Statistical testing was performed to see if these assumptions are met. If not, the dependent variable was recoded into a dichotomous variable (low and high engagement in Protective Health Behaviors), and a binomial logistic regression was performed.

### *Analysis of RQ2 and RQ4*

I used binomial logistic regression to assess the difference between the dependent variable (the number of Protective Health Behaviors) and the independent variable (ACE Category). The ACE Category was operationalized into a dichotomous (Yes/No) variable for each ACE category. The variables of age, sex, and race were included in the binomial logistic regression to see if these variables affect the proposed relationship as outlined in the hypotheses.

## Threats to Validity

External and internal threats to the study's validity were expected due to the nature of the secondary data that was used for the study. External threats can include non-

response bias and oversight of key populations in the randomization of the telephone survey, which is typical of how data were collected for the BRFSS (Esser et al., 2020). A threat to internal validity is the complicated weighting used in the BRFSS data collection and analysis process. This threat was addressed by using the CDC manual on preparing and using BRFSS data for individual analysis, which is provided for some core and optional modules. Other studies have validated the BRFSS data findings by using comparative analysis with NHIS survey data (Iachan et al., 2016). BRFSS data are used in multiple studies to estimate the prevalence of health outcome indicators for national and state-level estimates and have been found to be valid through the comparison of other national survey data sets. The results of this study are cautiously considered generalizable to a larger population due to the complex and thorough sampling procedures of the secondary data source.

## Ethical Procedures

I applied all applicable ethical procedures to the study. As stated by the CDC, BRFSS data are federally produced data sets and are available in the public domain for reproduction and use without needing permission. These data are publicly available and de-identified. An application for Walden University's Institutional Review Board was submitted and approved under study number 04-22-21-0992397.

## Summary

In Section 2, I reviewed the research design and rationale. All variables were defined, and the process for operationalizing the study was described. This section also included a review of the BRFSS testing instrument and the sampling methods and

procedures. A data analysis plan including proposed statistical testing and test statistics were given for the proposed study. Lastly, threats to validity and ethical procedures were reviewed. In Section 3, the data collection and results are analyzed.

Section 3: Presentation of the Results and Findings

## Introduction

The purpose of the study was to assess the association between experienced ACEs and engagement in tertiary protective health behaviors by individuals with diabetes or diabetes with comorbid heart disease. As exhibited in the literature review, the covariates of age, race, and sex can influence both ACEs and other BRFSS variables such as quality of life (Jia & Lubetkin, 2020), and therefore these variables have been included in the study models (Jia & Lubetkin, 2020). In this section, I describe the data collection and cleaning process, present descriptive and inferential statistics, and summarize the study. The RQs and hypotheses in this study were as follows:

RQ1—Quantitative: What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$1: There is no association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$1: There is an association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

RQ2—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race?

$H_0$2: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

$H_1$2—There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race.

RQ3—Quantitative: What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$3: There is no association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$3: There is an association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

RQ4—Quantitative: What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race?

$H_0$4: There is no association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

$H_1$4: There is an association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race.

**Data Collection and Cleaning of Secondary Data Set**

I downloaded the 2019 BRFSS data from the CDC website. The combined telephone data set, including the Version 1 and Version 2 data sets, were downloaded as the 2019 BRFSS data documentation indicated that these data files contained either ACEs or diabetes module data (CDC, 2019b). Each of these data sets were subset with the study variables and then combined to create a master study dataset. I cleaned data by deleting listwise all cases not containing the study variables as was outlined in Section 2's Methodology subsection. However, after additional analysis, I noted that the race category included two responses ("don't know/not sure" and "refused") that needed to be excluded. This reduced the number of cases for Population 1 to 2,740 and for Population 2 to 441, which is slightly less than what was originally stated in the Methodology subsection.

**Study Variable Race and Sex**

In the BRFSS questionnaire, MRACE1 is Question in Core Module 8. In the codebook, this is referred to as PRACE. The ORACE3 is Question Number 4 in Core Module 8, and it is referred to as MRACE1 in the codebook. In the BRFSS Questionnaire, these two variables have the same values for responses, but in the codebook they do not. Therefore, I used MRACE1 as the defining race variable. As both MRACE and PRACE have the same number of systems missing, don't know, and

refused to answer responses. Because COLGSEX has more missing variables than LANDSEX, the study variable SEX was set to the value of LANDSEX, and then if missing was set to the value of COLGSEX.

**ACE Transition Variables**

I had to recode six BRFSS variables into a transition variable before I coded them into the final study variable. A transition variable was used to maintain the integrity of the original BRFSS variable for ease of tracking within the study. The questions and variables were as follows:

- "How often did your parents beat each other up?" (ACE PUNCH)
- "How often did a parent physically hurt you in any way?" (ACEHURT1)
- "How often did a parent swear at you?" (ACESWEAR)
- "How often did anyone ever touch you sexually?" (ACETOUCH)
- "How often did anyone make you touch them sexually?" (ACETTHEM)
- "How often did anyone ever force you to have sex?" (ACEHVSEX)

All of these questions have two responses--"once" and "more than once"--that indicate that the ACE occurred. I recoded the responses into a value of 1 = yes for the corresponding transition variable, which also indicates "yes" for the other ACE questionnaire variables. Therefore, I used a count function within SPSS to recode the transition variable into the final study variable. A frequency tabulation was conducted to ensure that the same number of cases were still present and that the number of cases aggregated into 1 = yes for the transition variable equaled the same number of cases from

the original BRFSS variable in which 2 = once or 3 = more than once. A summary of the original, transition, and study variables are found in Table 1.

**Table 1**

*Summary of Original, Transition, and Study Variables From the Behavioral Risk Factor Surveillance System Survey, 2019*

| Original BRFSS variable | Transition variable | Study variable |
|---|---|---|
| DIABETE4 | N/A | Diabetes |
| CVDCRHD4 | N/A | Heart disease |
| LANDSEX<br>COLGSEX | N/A | Sex |
| MRACE1 | N/A | Race |
| ACEDEPRS | | Type of ACE |
| ACEDRINK | | Category 1 |
| ACEDRUGS | | Household mental illness (HMI) |
| ACEPRISN | | Household substance abuse (HSA) |
| ACEDIVRC | | |
| ACEPUNCH | ACEPUNCH_TR | Witnessing domestic violence (WDV) |
| ACEHURT1 | ACEHURT1_TR | |
| ACESWEAR | ACESWEAR_TR | Category 2: |
| ACETOUCH | ACETOUCH_TR | Family member incarceration (FMI) |
| ACETTHEM | ACETTHEM_TR | |
| ACEHVSEX | ACEHVSEX_TR | Parental divorce (PD) |
| | | Category 3: |
| | | Physical abuse (PA) |
| | | Emotional abuse (EA) |
| | | Sexual abuse (SA) |
| ACEDEPRS | | |
| ACEDRINK | | |
| ACEDRUGS | | |
| ACEPRISN | | |
| ACEDIVRC | | ACEs |
| ACEPUNCH | ACEPUNCH_TR | |
| ACEHURT1 | ACEHURT1_TR | |
| ACESWEAR | ACESWEAR_TR | |
| ACETOUCH | ACETOUCH_TR | |
| ACETTHEM | ACETTHEM_TR | |
| ACEHVSEX | ACEHVSEX_TR | |
| BLDSUGAR | BLDSUGAR_TR | Protective health behaviors (PHBs) |

| Original BRFSS variable | Transition variable | Study variable |
|---|---|---|
| FEETCHK3 | FEETCHK3_TR | |
| DOCTDIAB | DOCTDIAB_TR | |
| DIABEDU | | |
| BLDSUGAR | BLDSUGAR_TR | Categories of protective health behaviors (COPHB)* |
| FEETCHK3 | FEETCHK3_TR | Low engagement (LE) |
| DOCTDIAB | DOCTDIAB_TR | High engagement (HE) |
| DIABEDU | | |

*Note*. BRFSS = Behavioral Risk Factor Surveillance System; ACE = adverse childhood experience.
*The study variable of PHB was used to code for categories of protective health behaviors.

**Type of ACEs Variable**

Originally, as discussed in the Methodology subsection of Section 3, I had planned to calculate the types of ACEs variable into eight separate variables. However, this resulted in the need to conduct eight different binomial logistic regression tests for RQ2 and RQ4. In order to make the data analysis more concise, the data were analyzed to group the types of ACES into three groups that allowed for the coverage of the most cases within each population. For both populations, I coded types of ACEs into three categories:

- Category 1: household mental illness, household substance abuse, and witnessing domestic violence
- Category 2: family member incarceration and parental divorce
- Category 3: sexual, physical, and emotional abuse

These categories included 54% coverage of cases for Population 1 and 52% coverage of cases for Population 2.

# Results and Findings

## Descriptive Statistics

I produced descriptive statistics including frequencies, percentages, mean, standard deviation, minimum, and maximum for both population 1 and 2 and the study variables.

### *Population 1*

**Demographics.** There were a total of 2,740 cases that were included in Population 1 who had all study variables and reported having diabetes. The mean age of Population 1 was 71.46 (*SD* = 8.576) with ages ranging from 26 years old to 80 years old (see Table 3). The majority of respondents in Population 1 were female, 67.5%, while males accounted for only 32.5% of the population. In regard to race, 2,197 (80.2%) reported being White only; 414 (15.1 %) reported being Black or African American only; 53 (1.9%) reported being American Indian or Alaskan Native only; 9 (.3%) reported being Asian only; 21 (.8%) reported being other race only; and 46 (1.7%) reported being multiracial.

**ACEs and Protective Health Behaviors.** The majority of individuals within Population 1 reported having no ACES (*n* = 12,221). In addition, 628 individuals (22.9%) reported having experienced one ACE while only one individual (.0%) reported experiencing all 11 ACEs. Most of Population 1 reported four or fewer ACEs. Additional descriptive statistics for the frequencies and percentages of the number of individuals reporting the other counts of ACEs can be found in Table 2. I coded the categories of protective health behaviors so that zero to two behaviors were included in the category of

low engagement and three to four were included in the category of high engagement; the descriptive statistics for this variable can be found in Table 2. Most of Population 1 reported high engagement (*n* = 2,112, 77.1%) in tertiary protective health behaviors when it came to disease management, while 22.9% (*n* = 628) reported low engagement.

**Table 2**

*Descriptive Statistics of Adults 18 Years and Older With Diabetes, Behavioral Risk Factor Surveillance System, 2019*

| Variable | Frequency | Percentage |
|---|---|---|
| Sex (*n* = 2,740) | | |
| Male | 891 | 32.5 |
| Female | 1849 | 67.5 |
| Race (*n* = 2,740) | | |
| White Only | 2197 | 80.2 |
| Black or African America Only | 414 | 15.1 |
| American Indian or Alaskan Native Only | 53 | 1.9 |
| Asian Only | 9 | .3 |
| Other race only | 21 | .8 |
| Multiracial | 46 | 1.7 |
| Category of Protective Health Behavior (*n* = 2,740) | | |
| Low Engagement | 628 | 22.9 |
| High Engagement | 2112 | 77.1 |
| ACEs (*n* = 2,740) | | |
| Zero | 1221 | 44.6 |
| One | 628 | 22.9 |
| Two | 343 | 12.5 |
| Three | 205 | 7.5 |
| Four | 138 | 5.0 |
| Five | 80 | 2.9 |
| Six | 63 | 2.3 |
| Seven | 33 | 1.2 |
| Eight | 14 | .5 |
| Nine | 7 | .3 |
| Ten | 7 | .3 |
| Eleven | 1 | .0 |

*Note*. ACE = adverse childhood experience.

**Table 3**

*Descriptive Statistics for Age of Adults 18 Years and Older With Diabetes, Behavioral Risk Factor Surveillance System, 2019*

| Variable | N | Min | Max | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age | 2,740 | 26 | 80 | 71.46 | 8.576 |

### *Population 2*

**Demographics.** There was a total of 441 cases that were included in Population 2 who had all study variables and reported having diabetes with comorbid heart disease. The mean age of Population 2 is 72.30 (*SD* = 7.822) with ages ranging from 33 years old to 80 years old (Table 5). The majority of Population 2 is female, 61%, while males accounted for only 39% of the population. In regard to Race, 369 (83.7%) reported being White Only; 51 (11.6 %) reported being Black or African American Only; 9 (2.0%) reported being American Indian or Alaskan Native Only; 1 (.2%) reported being Asian Only; 3 (.7%) reported being Other Race Only; and 8 (1.8%) reported being Multiracial.

**ACEs and Protective Health Behaviors.** The majority of individuals within Population 1 reported having no ACES (*n* = 178). In addition, 104 individuals (23.6%) reported having experienced one ACE while no individuals reported having experienced all 11 ACEs. Most of Population 2 reported four ACEs or less. Additional descriptive statistics for the frequencies and percentages of the number of individuals reporting the other counts of ACEs can be found in Table 4. The categories of protective health behaviors were coded so that zero to two behaviors were included in the category of low engagement and three to four included in the category of high engagement, the

descriptive statistics for this variable can be found in Table 4. Most of Population 2 reported high engagement ($n$ = 334, 75.7%) in tertiary protective health behaviors when it comes to disease management, while 24.3% ($n$ = 107) reported low engagement.

**Table 4**

*Descriptive Statistics of Adults 18 Years and Older With Diabetes and Heart Disease, Behavioral Risk Factor Surveillance System, 2019*

| Variable | Frequency | Percentages |
|---|---|---|
| Sex ($n$ = 441) | | |
| Male | 172 | 39 |
| Female | 269 | 61 |
| Race ($n$ = 441) | | |
| White Only | 369 | 83.7 |
| Black or African America Only | 51 | 11.6 |
| American Indian or Alaskan Native Only | 9 | 2.0 |
| Asian Only | 1 | .2 |
| Other race only | 3 | .7 |
| Multiracial | 8 | 1.8 |
| Category of Protective Health Behavior ($n$ = 441) | | |
| Low Engagement | 107 | 24.3 |
| High Engagement | 334 | 75.7 |
| ACEs ($n$ = 441) | | |
| Zero | 178 | 40.4 |
| One | 104 | 23.6 |
| Two | 58 | 13.2 |
| Three | 28 | 6.3 |
| Four | 30 | 6.8 |
| Five | 14 | 3.2 |
| Six | 15 | 3.4 |
| Seven | 7 | 1.65 |
| Eight | 4 | .9 |
| Nine | 2 | .5 |
| Ten | 1 | .2 |
| Eleven | 0 | 0 |

*Note*. ACE = adverse childhood experience.

**Table 5**

*Descriptive Statistics for Age of Adults 18 Years and Older With Diabetes, Behavioral Risk Factor Surveillance System, 2019*

| Variable | N | Min | Max | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Age | 441 | 33 | 80 | 72.30 | 7.822 |

## Binomial Logistic Regression

### *RQ1*

RQ was, What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race? Table 6 provides a crosstabulation of the independent variable, Count of ACEs, by the dependent variable, Category of Protective Health Behavior. For both low and high engagement in protective health behaviors the highest number of cases within Population 1 had no reported ACEs.

**Table 6**

*Crosstabulation for Count of ACEs (Independent Variable) by Category of Protective Health Behavior (Dependent Variable) for RQ1*

| | ACEs | | Low Engagement | High Engagement |
|---|---|---|---|---|
| ACES | Zero | Count | 296 | 925 |
| | | % within ACEs | 24.2 | 75.8 |
| | | % within COPHB | 47.1 | 43.8 |
| | | % Total | 10.8 | 33.8 |
| | One | Count | 138 | 490 |
| | | % within ACEs | 22.0 | 78 |
| | | % within COPHB | 22.0 | 23.2 |
| | | % Total | 5.0 | 17.9 |
| | Two | Count | 71 | 272 |
| | | % within ACEs | 20.7 | 79.3 |
| | | % within COPHB | 11.3 | 12.9 |
| | | % Total | 2.6 | 9.9 |
| | Three | Count | 47 | 158 |
| | | % within ACEs | 22.9 | 77.1 |
| | | % within COPHB | 7.5 | 7.5 |
| | | % Total | 1.7 | 5.8 |
| | Four | Count | 27 | 111 |
| | | % within ACEs | 19.6 | 80.4 |
| | | % within COPHB | 4.3 | 5.3 |
| | | % Total | 1.0 | 4.1 |
| | Five | Count | 12 | 68 |
| | | % within ACEs | 15.0 | 85.0 |
| | | % within COPHB | 1.9 | 3.2 |
| | | % Total | 0.4 | 2.5 |
| | Six | Count | 18 | 45 |
| | | % within ACEs | 28.6 | 71.4 |
| | | % within COPHB | 2.9 | 2.1 |
| | | % Total | 0.7 | 1.6 |
| | Seven | Count | 10 | 23 |
| | | % within ACEs | 30.3 | 69.7 |
| | | % within COPHB | 1.6 | 1.1 |
| | | % Total | 0.4 | 0.8 |
| | Eight | Count | 3 | 11 |
| | | % within ACEs | 21.4 | 78.6 |
| | | % within COPHB | 0.5 | 0.5 |
| | | % Total | 0.1 | 0.4 |

| ACEs | | Low Engagement | High Engagement |
|---|---|---|---|
| Nine | Count | 2 | 5 |
| | % within ACEs | 28.6 | 71.4 |
| | % within COPHB | 0.3 | 0.2 |
| | % Total | 0.1 | |
| Ten | Count | 3 | 4 |
| | % within ACEs | 42.9 | 57.1 |
| | % within COPHB | 0.5 | 0.2 |
| | % Total | 0.1 | 0.1 |
| Eleven | Count | 1 | 0 |
| | % within ACEs | 100 | 0.0 |
| | % within COPHB | 0.2 | 0.0 |
| | % Total | 0.0 | 0.0 |

*Note*. COPHB = category of protective health behavior; ACE= adverse childhood experience.

Binomial logistic regression was conducted to assess the association between the independent variables of age, sex, race, and ACEs on the dependent variable category of protective health behaviors (low or high engagement) among individuals reporting to have diabetes (Table 7). The Hosmer and Lemeshow test is a measure of goodness of fit for the overall logistic regression model. For RQ1, the model was a good fit $p = .209$. On the other hand, the model explained only between 1.1% (Cox & Snell $R^2$) and 1.7% (Nagelkerke $R^2$) of variance in the category of protective health behaviors and classified 77.1% of the cases correctly. The variables of age ($p = .000$) and sex ($p = .000$) contributed significantly to the model; however, the variables of ACEs ($p = .290$) and Race ($p = .178$) did not contribute significantly to the model. For every unit increase in the variable age, there was a 0.024 unit decrease in the odds of high engagement in protective health behaviors, $OR = .977$, 95% CI[.966-.988]. Males were .696 times less

likely than females (referent) to have high engagement in protective health behaviors, *OR* = .696, 95% CI[.576-.821].

The odds ratios for ACEs and Race were not found statistically significant. When sex, age, and race are present in the model the independent variable ACEs does not statistically significantly predict the odds of engagement in protective health behaviors by individuals with diabetes. Since ACEs did not contribute significantly to the model, the null hypothesis cannot be rejected. There is no statistically significant association between ACEs and engagement in protective health behaviors when controlling for race, sex, and age among individuals with diabetes.

**Table 7**

*Binomial Logistic Regression for Category of Protective Health Behavior (Dependent Variable) With Predictors Age, ACEs, and Sex*

| | | | | | Odds | 95% C.I for OR | |
|---|---|---|---|---|---|---|---|
| | *B* | S.E. | Wald | *p-value* | Ratio | Lower | Upper |
| Age | -.024 | .006 | 15.826 | .000 | .977 | .966 | .988 |
| ACEs | -.028 | .026 | 1.118 | .290 | .973 | .924 | 1.024 |
| Race | .071 | .053 | 1.818 | .178 | 1.074 | .968 | 1.191 |
| Sex (ref: female) | -.362 | .096 | 14.139 | .000 | .696 | .576 | .841 |
| Constant | 2.965 | .455 | 42.496 | .000 | 19.398 | | |

*Note*. ACE = adverse childhood experience.

### *RQ2*

RQ2 was, What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes when controlling for age, sex, and race? Table 8 provides a crosstabulation of the independent variable, Type of ACEs, by the dependent variable, Category of

Protective Health Behavior. The most frequent type of ACEs for those reporting low and high engagement in protective health behaviors, was category three: sexual, physical, and emotional abuse.

**Table 8**

*Crosstabulation for Type of ACEs (Independent Variable) by Category of Protective Health Behavior (Dependent Variable) for RQ2*

| | | | Low Engagement | High Engagement |
|---|---|---|---|---|
| Type of ACEs | One: Household Mental Illness, Household Substance Abuse, and Witnessing Domestic Violence | Count | 54 | 182 |
| | | % within ACEs | 22.9 | 77.1 |
| | | % within COPHB | 29.3 | 28.8 |
| | | % Total | 6.6 | 22.3 |
| | Two: Family Member Incarceration and Parental Divorce | Count | 32 | 112 |
| | | % within ACEs | 22.2 | 77.8 |
| | | % within COPHB | 17.4 | 17.7 |
| | | % Total | 3.9 | 13.7 |
| | Three: Sexual, Physical, and Emotional Abuse | Count | 98 | 339 |
| | | % within ACEs | 22.4 | 77.6 |
| | | % within COPHB | 53.3 | 53.6 |
| | | % Total | 12.0 | 41.5 |

*Note*. COPHB = category of protective health behavior; ACE= adverse childhood experience.

Binomial logistic regression was conducted to assess the association between the independent variables of age, sex, race, and type of ACEs on the dependent variable category of protective health behaviors (low or high engagement) among individuals reporting to have diabetes. The logistic regression statistics can be found in Table 8. The types of ACEs among Population 2 were coded to achieve coverage of the most data. This resulted in a subset of the Population 2 used in RQ1, of 817 cases that could be sorted into one of the three types of ACEs. These three types were coded as follows:

- One: Household Mental Illness, Household Substance Abuse, and Witnessing Domestic Violence
- Two: Family Member Incarceration and Parental Divorce
- Three: Sexual, Emotional, and Physical Abuse

The overall logistic regression model was a good fit $p = .837$ (Hosmer and Lemeshow). The model explained between 2.1% (Cox & Snell $R^2$) and 3.2% (Nagelkerke $R^2$) of variance in the category of protective health behaviors and classified 77.5% of the cases correctly. The variable of age ($p = .000$) contributed significantly to the model; however, the variables of Type of ACEs ($p = .863$), Sex ($p = .087$), and Race ($p = .462$) did not contribute significantly to the model. For every unit increase in the variable age, there is a 0.044 unit decrease in the odds of high engagement in protective health behaviors, *OR*=.957, 95% CI[.935-.980]. A post-hoc power analysis was performed for the significant result; statistical power was found to be 9.5%. The low statistical power of the observed effect may be due to the smaller population or due to the small $R^2$ (2.1% Cox & Snell and 3.2% Nagelkerke) which may mean that to better explain the effect a different set of predictor variables is needed. Since Type of ACEs did not contribute significantly to the model, the null hypothesis cannot be rejected. There is no statistically significant association between Type of ACEs and engagement in protective health behaviors when controlling for race, sex, and age among individuals with diabetes.

**Table 9**

*Binomial Logistic Regression for Category of Protective Health Behavior (Dependent variable) With Predictors Age, ACEs, and Sex*

| | | | | | Odds | 95% C.I for OR | |
|---|---|---|---|---|---|---|---|
| | *B* | S.E. | Wald | *p-value* | Ratio | Lower | Upper |
| Age | -.044 | .012 | 13.539 | .000 | .957 | .935 | .980 |
| Type of ACEs | | | .294 | .863 | | | |
| Type of ACEs (1) | -.007 | .195 | .001 | .927 | .993 | .678 | 1.455 |
| Type of ACEs (2) | -.126 | .239 | .279 | .597 | .881 | .552 | 1.408 |
| Race | .082 | .111 | .541 | .462 | 1.085 | .873 | 1.349 |
| Sex (ref: female) | -.303 | .177 | 2.936 | .087 | .739 | .523 | 1.044 |
| Constant | 4.411 | .900 | 24.013 | .000 | 82.322 | | |

*Note*. ACE = adverse childhood experience.

### *RQ3*

RQ3 was, What is the association between ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race? Table 10 provides a crosstabulation of the independent variable, Count of ACEs, by the dependent variable, Category of Protective Health Behavior. For both low and high engagement in protective health behaviors the highest number of cases within Population 1 had no reported ACEs (Table 10).

**Table 10**

*Crosstabulation for Count of ACEs (Independent Variable) by Category of Protective Health Behavior (Dependent Variable) for RQ3*

| | ACEs | | Low Engagement | High Engagement |
|---|---|---|---|---|
| ACES | Zero | Count | 42 | 136 |
| | | % within ACEs | 23.6 | 76.4 |
| | | % within COPHB | 39.3 | 40.7 |
| | | % Total | 9.5 | 30.8 |

| ACEs | | Low Engagement | High Engagement |
|---|---|---|---|
| One | Count | 29 | 75 |
| | % within ACEs | 27.9 | 72.1 |
| | % within COPHB | 27.1 | 22.5 |
| | % Total | 6.6 | 17 |
| Two | Count | 14 | 44 |
| | % within ACEs | 24.1 | 75.9 |
| | % within COPHB | 13.1 | 13.2 |
| | % Total | 3.2 | 10.0 |
| Three | Count | 6 | 22 |
| | % within ACEs | 21.4 | 78.6 |
| | % within COPHB | 5.6 | 6.6 |
| | % Total | 1.4 | 5.0 |
| Four | Count | 5 | 25 |
| | % within ACEs | 16.7 | 83.3 |
| | % within COPHB | 4.7 | 7.5 |
| | % Total | 1.1 | 5.7 |
| Five | Count | 2 | 12 |
| | % within ACEs | 14.3 | 85.7 |
| | % within COPHB | 1.9 | 3.6 |
| | % Total | 0.5 | 2.7 |
| Six | Count | 6 | 9 |
| | % within ACEs | 40 | 60.0 |
| | % within COPHB | 5.6 | 2.7 |
| | % Total | 1.4 | 2.0 |
| Seven | Count | 2 | 5 |
| | % within ACEs | 28.6 | 71.4 |
| | % within COPHB | 1.9 | 1.5 |
| | % Total | 0.5 | 1.1 |
| Eight | Count | 0 | 4 |
| | % within ACEs | 0.0 | 100 |
| | % within COPHB | 0.0 | 1.2 |
| | % Total | 0.0 | 0.9 |
| Nine | Count | 1 | 1 |
| | % within ACEs | 50.0 | 50.0 |
| | % within COPHB | 0.9 | 0.3 |
| | % Total | 0.2 | 0.2 |
| Ten | Count | 0 | 1 |
| | % within ACEs | 0.0 | 100.0 |
| | % within COPHB | 0.0 | 0.3 |
| | % Total | 0.0 | 0.2 |
| Eleven | Count | 0 | 0 |
| | % within ACEs | 0.0 | 0.0 |

| ACEs | | Low Engagement | High Engagement |
|---|---|---|---|
| | % within COPHB | 0.0 | 0.0 |
| | % Total | 0.0 | 0.0 |

*Note*. COPHB = category of protective health behavior; ACEs = adverse childhood experiences.

Binomial logistic regression was conducted to assess the association between the independent variables of age, sex, race, and ACEs on the dependent variable category of protective health behaviors (low or high engagement) among individuals reporting to have diabetes (Table 11). The Hosmer and Lemeshow test is a measure of the fit of the model. For RQ3, the model was a good fit *p=.481*. The model explained between .2% (Cox & Snell $R^2$) and .2% (Nagelkerke $R^2$) of variance in the category of protective health behaviors and classified 75.7% of the cases correctly. The predictor variables of age, sex, race, and ACEs did not contribute significantly to the model. Since ACEs did not contribute significantly to the model, the null hypothesis cannot be rejected. There is no statistically significant association between ACEs and engagement in protective health behaviors when controlling for race, sex, and age among individuals with diabetes with comorbid heart disease.

**Table 11**

*Binomial Logistic Regression for Category of Protective Health Behavior (Dependent variable) With Predictors Age, ACEs, and Sex*

| | | | | | Odds | 95% C.I for OR | |
|---|---|---|---|---|---|---|---|
| | *B* | S.E. | Wald | *p*-value | Ratio | Lower | Upper |
| Age | -.011 | .015 | .558 | .455 | .989 | .960 | 1.019 |
| ACEs | .000 | .059 | .000 | .994 | 1.000 | .890 | 1.122 |
| Race | .013 | .118 | .013 | .910 | 1.014 | .804 | 1.278 |
| Sex (ref: female) | -.085 | .232 | .133 | .715 | .919 | .583 | 1.448 |
| Constant | 1.979 | 1.173 | 2.847 | .092 | 7.235 | | |

*Note*. ACE = adverse childhood experience.

### *RQ4*

RQ4 was, What is the association between the type of ACEs and level of engagement in protective health behaviors among individuals self-reporting to have diabetes with comorbid heart disease when controlling for age, sex, and race? Table 12 provides a crosstabulation of the independent variable, Type of ACEs, by the dependent variable, Category of Protective Health Behavior. The most frequent type of ACEs for those reporting low and high engagement in protective health behaviors, was category three: sexual, physical, and emotional abuse.

**Table 12**

*Crosstabulation for Type of ACEs (Independent Variable) by Category of Protective Health Behavior (Dependent Variable) for RQ4*

| | | | Low Engagement | High Engagement |
|---|---|---|---|---|
| Type of ACEs | One: Household Mental Illness, Household Substance Abuse, and Witnessing Domestic Violence | Count | 10 | 34 |
| | | % within ACEs | 22.7 | 77.3 |
| | | % within COPHB | 27.8 | 34.3 |
| | | % Total | 7.4 | 25.2 |
| | Two: Family Member Incarceration and Parental Divorce | Count | 6 | 15 |
| | | % within ACEs | 28.6 | 71.4 |
| | | % within COPHB | 16.7 | 15.2 |
| | | % Total | 4.4 | 11.1 |
| | Three: Sexual, Physical, and Emotional Abuse | Count | 20 | 50 |
| | | % within ACEs | 28.6 | 71.4 |
| | | % within COPHB | 55.6 | 50.5 |
| | | % Total | 14.8 | 37.0 |

*Note*. COPHB = category of protective health behavior; ACE = adverse childhood experience.

Binomial logistic regression was conducted to assess the association between the independent variables of age, sex, race, and type of ACEs on the dependent variable category of protective health behaviors (low or high engagement) among individuals reporting to have diabetes with comorbid heart disease. The logistic regression statistics can be found in Table 13. The types of ACEs among Population 2 were coded to achieve coverage of the most data. This resulted in a subset of the Population 2 used in RQ2, of 135 cases that could be sorted into one of the three types of ACEs. These three types were coded as follows:

- One: Household Mental Illness, Household Substance Abuse, and Witnessing Domestic Violence
- Two: Family Member Incarceration and Parental Divorce
- Three: Sexual, Emotional, and Physical Abuse

The overall logistic regression model was a good fit $p = .767$ (Hosmer and Lemeshow). The model explained between 2.4% (Cox & Snell $R^2$) and 3.5% (Nagelkerke $R^2$) of variance in the category of protective health behaviors and classified 73.3% of the cases correctly. The predictor variables of age, sex, race, and Type of ACEs did not contribute significantly to the model. Since Type of ACEs did not contribute significantly to the model, the null hypothesis cannot be rejected. There is no statistically significant association between Type of ACEs and engagement in protective health behaviors when controlling for race, sex, and age among individuals with diabetes with comorbid heart disease.

**Table 13**

*Binomial Logistic Regression for Category of Protective Health Behavior (Dependent variable) With Predictors Age, ACEs, and Sex*

| | | | | | Odds | 95% C.I for OR | |
|---|---|---|---|---|---|---|---|
| | *B* | S.E. | Wald | *p*-value | Ratio | Lower | Upper |
| Age | .026 | .026 | 1.060 | .303 | 1.027 | .977 | 1.079 |
| Type of ACEs | | | .373 | .830 | | | |
| Type of ACEs (1) | .271 | .452 | .360 | .548 | 1.312 | .541 | 3.180 |
| Type of ACEs (2) | .029 | .571 | .003 | .959 | 1.030 | .336 | 3.156 |
| Race | .093 | .191 | .235 | .628 | 1.097 | .754 | 1.595 |
| Sex (ref: female) | .612 | .440 | 1.935 | .164 | 1.844 | .779 | 4.365 |
| Constant | -1.288 | 1.910 | .455 | .500 | .276 | | |

*Note*. ACE = adverse childhood experiences.

## Summary

In section 3, I reviewed the results of the descriptive statistics and binomial logistic regression that were run on the 2019 BRFSS data. The research questions proposed to test the association between ACEs and Types of ACEs on tertiary protective health behaviors when controlling for the influencing factors of age, sex, and race. However, none of the null hypotheses were rejected during the analysis for both populations of individuals with diabetes and individuals with diabetes with comorbid heart disease. A statistically significant relationship was not found between ACEs/Type of ACEs and Tertiary Protective Health Behaviors for those with diabetes and diabetes with comorbid heart disease. In the population with diabetes, the variables of age and sex were found to contribute significantly to the overall model. A unit increase in age was found to correlate with a unit decrease in high engagement in protective health behaviors. In addition, males were less likely to exhibit high engagement in protective health

behaviors than females within the same sample. In section 4, I discuss the results of the study and the implications for future research and professional and social change.

Section 4: Presentation of the Results and Findings

## Introduction

ACEs cause social, emotional, and cognitive impairment that result in the micro and macro adaptation of development during childhood (Stillerman, 2018). This adaptation in development negatively impacts the physiological and psychosocial responses and can lead to early mortality and morbidity through the formation of health risk behaviors (Felitti et al., 1998). In this study, I assessed the relationship between incidents and types of ACEs and engagement in protective health behaviors among individuals with diabetes or diabetes with comorbid heart disease. The purpose of the study was to address the gap in knowledge about the continued impact of ACEs on health behaviors after disease diagnosis. Most of the research that I found on this topic focused on establishing a relationship between diabetes and ACEs (e.g., Campbell et al., 2019; Chanlongbutra et al., 2018; Huang et al., 2015; Huffhines et al., 2016).

## Interpretation of the Findings

Results revealed that individuals in the 2019 BRFSS study population with diabetes or diabetes with comorbid heart disease were predominately White and female, with a mean age in the low 70s. In a previous study using BRFSS ACE data, the authors reported that most of their population reported having no or one ACE (Jia & Lubetkin, 2020). In this study, most individuals reported having no ACEs and were more likely to have reported high engagement in protective health behaviors. In addition, the number of ACEs increased as the number of individuals engaging in both high and low levels of the tertiary protective health behaviors of engaging in foot checks, visiting a doctor to

manage diabetes, measuring glucose levels, and attending a diabetes education class decreased. Overall, the number of cumulative ACEs was low among both those with diabetes or diabetes with comorbid heart disease. Other researchers have only found an association between diabetes and ACEs when four or more cumulative ACEs were present (Chanlongbutra et al., 2018; Huffhines et al., 2016).

RQ1 concerned whether there was a relationship between the number of ACEs and high/low engagement in tertiary protective health behaviors among those with diabetes, while RQ3 addressed the same variables for those with diabetes and heart disease. I found no significant relationship between ACEs and tertiary protective health behaviors for either RQ1 or RQ3. As discussed in the review of literature in Section 2, the research on the relationship between ACEs and health behaviors is very limited. Therefore, these results cannot confirm or disconfirm findings in the literature review. However, a significant relationship was found for the covariates of age and sex for those with diabetes.

Also using BRFSS data, Jia and Lubetikin (2020) found that the impact on the quality adjusted life expectancy was three-fold greater for women than for men when three or more ACEs were present as compared to zero ACEs. The significance of age as a mediator between ACEs and quality adjusted life expectancy is that men and women have been found to experience quality of life behavioral risk factors differently (Jia & Lubetikin, 2020). This finding supports the current study in that men and women were found to engage in different levels of tertiary protective health behaviors. The findings indicated that men were less likely to engage in high levels of tertiary protective health

behaviors. However, in the Jia and Lubetikin (2020) study, women were more likely to experience decreases in quality of life in the presence of experienced ACEs. The implication is that members of these sexes experience different levels of tertiary protective health behaviors, which can in turn influence the impact ACEs has on that engagement. This may be because men who had experienced ACEs were more likely to engage in health-risk behaviors, whereas women are more likely to experience mental distress (Almuneef et al., 2017).

RQ2 addressed whether there was a relationship between the types of ACEs and high/low engagement in tertiary protective health behaviors among individuals with diabetes, while RQ4 addressed the same variables for those with diabetes and heart disease. For both populations, the highest number of individuals fell into the type of ACEs Category 3: Sexual, Physical, and Emotional Abuse. The relationships between tertiary protective health behaviors and any of the three categories of types of ACEs were not significant. Again, although there is a gap in the literature concerning diabetes management behaviors and ACEs, Flores-Torres (2020) did find an increased risk for diabetes when all categories of ACEs were present versus individual categories. However, in this study a significant relationship was found only for the covariate of age for those with diabetes when assessing for a relationship between types of ACEs and tertiary protective health behaviors. For every unit increase in age, there was a 0.44 decrease in the odds of high engagement in protective health behaviors.

The statistically significant impact of the variable age on the dependent variable for both research questions is similar to the findings of Jia and Lubetkin (2020), who

found that age affected the relationship between ACEs and quality adjusted life expectancy (QALE). It appeared that QALE declined with increasing age among the different counts of ACES. However, this was mediated by the fact that individuals who were younger had already experienced higher levels of QALE. This may be the same with the current study in that those individuals who are younger may be primed to engage in higher levels of tertiary protective health behaviors.

The ACEs pyramid, which served as a conceptual model for the study, proposes that some type of impairment leads to the development of health risk behaviors which, in turn, lead to early mortality and morbidity (Felitti et al., 1998). The process by which the model depicts the relationship between childhood trauma and early morbidity is through social, emotional, and cognitive impairment, which leads to health risk behavior adaption. The nonsignificant results between ACEs and tertiary protective health behaviors for the current study may mean that a stronger relationship exists when a different set of factors or variables are included in the regression model.

## Limitations of the Study

I included in the study cases only individuals who reported having either diabetes or diabetes with comorbid heart disease who also had a valid response for age, sex, race, ACEs, and the tertiary protective health behaviors questions. Because most of the study variables came from optional BRFSS modules, this means that the number of cases in both study populations was paired down from the total population participating in the 2019 BRFSS. To conduct the binomial logistic regression for the types of ACEs in RQ2 and RQ4, I categorized cases into groupings that allowed for the most coverage of data.

Therefore, some cases were omitted in the regression model. Other limitations of the study are due to the nature of the data source used. The BRFSS is a cross-sectional survey with self-report responses, which can be subject to recall bias (Chanlongbutra et al., 2018). The post-hoc power analysis showed a low power level at 9.4% for the significant findings of RQ2, this is a limitation of the study in that a different set of predictors may be needed in the model to better explain the effect as is supported by the low $R^2$.

## Recommendations

Although the aim of this study was to analyze the relationship between ACEs and tertiary protective health behaviors, it was limited in scope due to the nature of the secondary data source. I recommend that this area of study be further explored as I found, when reviewing the literature, that psychosocial factors can have an impact on health behaviors, even if a direct relationship between ACEs and diabetic tertiary protective health behaviors has not been established in this study. Recommendations for future research could include using a primary or secondary data source that may have more data on ACEs for both populations, but especially for individuals with diabetes with comorbid heart disease. In addition, researchers may consider isolating specific behaviors instead of grouping behaviors. Another recommendation to improve the regression models is to add other covariates that have previously been used in ACEs research for their influence on the relationship between ACEs and chronic diseases such as diabetes and hypertension. These covariates include socioeconomic variables such as education, marital status, and

having health insurance, which have been used to determine childhood socioeconomic status (Flores-Torres et al., 2020).

## Implications for Professional Practice and Social Change

While the null hypotheses could not be rejected given the study parameters, this does not mean that there are not implications for professional practice and social change. As highlighted in the literature review, trauma informed care for individuals with chronic conditions such as diabetes and heart disease are important in addressing the social determinants of health for an individual. The premise behind this study is of interest to those in professional practices that address behavioral health issues for individuals with chronic conditions such as diabetes educators, community health workers, primary care physicians, etc. The significant results of age in both models for count of ACEs and type of ACEs, shows that further research is needed on how age impacts tertiary protective health behavior engagement among those with childhood trauma.

As found in the literature review, there may be timely interventions based upon age if the association between childhood trauma and engagement in health preservation behaviors is mediated by the age of the individual (Cohrdes & Mauz, 2020). In addition, sex was also found to be a significant covariate in assessing the relationship between count of ACEs and tertiary protective health behaviors for those with diabetes. The significant finding of the current study could help guide targeted interventions for different sexes, by enabling a better understanding of how men vs. women engage in tertiary protective health Behaviors and how this may mediate the influence of ACEs.

This is particularly important as men and women experience ACEs differently (Jia and Lubetikin (2020).

Further extrapolating the areas in which ACEs may impact tertiary protective health behaviors engaged in by those with diabetes, could contribute to focalized care in addressing psychosocial barriers to health. Overall, contribution to the knowledge about trauma informed care for individuals with prevalent chronic conditions can help better inform public health policy.

## Conclusion

This study primarily aimed to evaluate the association between ACEs and tertiary protective health behaviors among individuals with diabetes and diabetes with comorbid heart disease. While a significant relationship was not found for either population, it was found that as the number of ACEs increased the number of individuals reporting engaging in either low or high levels of tertiary protective health behaviors decreased. A significant relationship was found for the variables of age and sex among individuals with diabetes when assessing the relationship between count of ACEs and health behaviors. A unit increase in age resulted in a decrease in the likelihood of engaging in high levels of tertiary protective health behaviors. While women were found to be more likely to engage in high levels of tertiary protective health behaviors. The significant covariate of this study means that further research on ACEs and tertiary protective health behaviors should further explore how both of these variables are affected by one's age and sex.

The overarching goal of this study is important because diabetes and its comorbid diseases are complicated chronic conditions that cause loss of life and productivity. The self-management of this disease can be overwhelming without the added impairment due to childhood trauma. Professionals working with individuals with diabetes and diabetes with heart disease would be interested in this topic of study as it explores a relatively limited area of research in the field of ACEs and diabetes. Diabetes is a complex and prevalent chronic condition, whose management can be negatively impacted by underlying childhood trauma. Understanding the extent to which this trauma affects one's ability to engage in health preservation behaviors can contribute to the overall knowledge on the promotion of tertiary prevention strategies for individuals with diabetes.

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# Appendix A: BRFSS ACE Module (CDC, 2020b)

**BRFSS Adverse Childhood Experience (ACE) Module**

Prologue: I'd like to ask you some questions about events that happened during your childhood. This information will allow us to better understand problems that may occur early in life, and may help others in the future. This is a sensitive topic and some people may feel uncomfortable with these questions. At the end of this section, I will give you a phone number for an organization that can provide information and referral for these issues. Please keep in mind that you can ask me to skip any question you do not want to answer. All questions refer to the time period before you were 18 years of age. Now, looking back before you were 18 years of age—.

1) Did you live with anyone who was depressed, mentally ill, or suicidal?

2) Did you live with anyone who was a problem drinker or alcoholic?

3) Did you live with anyone who used illegal street drugs or who abused prescription medications?

4) Did you live with anyone who served time or was sentenced to serve time in a prison, jail, or other correctional facility?

5) Were your parents separated or divorced?

6) How often did your parents or adults in your home ever slap, hit, kick, punch or beat each other up?

7) Before age 18, how often did a parent or adult in your home ever hit, beat, kick, or physically hurt you in any way? Do not include spanking. Would you say—

8) How often did a parent or adult in your home ever swear at you, insult you, or put you down?

9) How often did anyone at least 5 years older than you or an adult, ever touch you sexually?

10) How often did anyone at least 5 years older than you or an adult, try to make you touch sexually?

11) How often did anyone at least 5 years older than you or an adult, force you to have sex?

**Response Options**

| Questions 1-4 | Question 5 | Questions 6-11 |
|---|---|---|
| 1=Yes | 1=Yes | 1=Never |
| 2=No | 2=No | 2=Once |
| 7=DK/NS | 8=Parents not married | 3=More than once |
| 9=Refused | 7=DK/NS | 7=DK/NS |
| | 9=Refused | 9=Refused |

# Appendix B: Permission to Reuse ACE Study Pyramid Figure