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# Language Barrier: An Unmet Challenge for Low Screening of Colorectal Cancer Among Hispanic Americans in Texas

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This is to certify that the doctoral dissertation by

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Abstract

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MBA, Plymouth State University, 2015

MS, New School University, 2000

B.Sc., Kwame Nkrumah University of Science and Technology, 1994

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health: Epidemiology

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## Abstract

Hispanic population represents the fastest growing minority group in the United States, and only California surpasses Texas with Hispanic residents in the United States. Overall, non-Hispanic Whites have higher rates of colorectal cancer (CRC) incidence than Hispanics; however, Hispanic Americans have lower survival rates than non-Hispanic Whites. Using cross-sectional analysis, CRC screening modalities were examined to assess disparities among White only, non-Hispanic, Black only, non-Hispanic, and Hispanic populations in Texas to evaluate the impact of limited English proficiency (LEP) on CRC screening among Hispanic Americans residents. The age of study participants ranged from 50 to 79 (mean age = 65.8 years), and the data were obtained from the 2020 Texas Behavioral Risk Factor Surveillance System (BRFSS) survey. The primary outcome was self-reported CRC screening status by the respondents. The study had a sample population, N =766, chosen randomly with 68.5% White only, non-Hispanic, 10.1% Black only, non-Hispanic, and 21.4% Hispanic participants. Pearson Chi-square test was used to compare CRC screening rates and modalities and bivariate and multivariate logistic regression to determine predictors of CRC screening among participants in the study. The Chi-square tests indicated that there was a statistically significant association between LEP and non-LEP respondents. The findings showed that Hispanics with LEP have low CRC screening rates. Suggestions for positive social change include improvement in CRC screening using social centers to promote CRC screening, promotion of health literacy and transportation accessibility for vulnerable communities without access to public transport.

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# Dedication

This dissertation is dedicated to my late mother, Madam Deborah Akosua Ankamaa; my wife, Rosemary Barney Owusu; and our children, Patricia, Mimi, Nana, Adwoa, Brenda, and David. I also appreciate the unshakable support from Mr. Kofi Fofie, Elder Francis Koosono, Mr. Augustine Amankona (Peace) (brothers), Auntie Agnes Mmuah, and my sisters in Berekum, Ghana. I am also highly indebted to Dr. Francis Asomah (Australia) who mentored me in academic pursuits during my high school days and remains a bedrock supporter in this journey. Similarly, I am grateful to Dr. Godfred Owusu-Boateng of Kwame Nkrumah University of Science and Technology (Kumasi, Ghana); Mr. Abor Yeboah (Walter Sisulu University, South Africa); and nieces, Salome (Mayo Clinic, Rochester, MN) and Francisca (Berekum, Ghana); Mad. Charlotte Awuku Boateng (mother-in-law); Ms. Stella Green; Dr. Elizabeth Hagan Asamoah; Ms. Leslie Gillman (Walden University); Mr. Patrick Obeng; Ms. Wilhelmina Asabea Adu-Darko; Rev. James Acquaah and Ms. Lydia Acquaah; and my nephews, nieces, family members, distant relatives, and colleagues who encouraged me along the way. Finally, I understand that I could not have completed this journey without the Lord Almighty and His strength and grace. All the glory is accredited unto Him for making this journey fruitful to its successful end.

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# Chapter 1: Introduction to the Study

Colorectal cancer (CRC) is the third leading cause of cancer mortality in both men and women in the United States but assumes a second position when men and women are put together (Siegel et al., 2020). Although CRC morbidity and mortality could be reduced through relevant screening and surveillance measures, such preventive steps are often lacking, particularly among minorities in the United States (Jackson et al, 2016). For 2021, the American Cancer Society (ACS) estimated that CRC incidence cases were estimated to be 149,500, and 52,980 were expected to die from it. Researchers argue that 68% of deaths could be prevented with screening, and CRC at its most treatable state (stage I), it is 90% curable. However, only 38% of CRCs are diagnosed at stage I; that number is further reduced for individuals diagnosed before age 50, whereas approximately 10% often receive late-stage disease (stages III and IV), even though the ACS guidelines recommend screening to be started at 45 years of age (Siegel et al., 2021).

Nationwide, data indicate that African Americans have the highest increased burden of CRC compared to other ethnic groups such as Whites and Asians, with higher incidence, worse outcomes, and earlier-onset of disease (Siegel et al., 2017). However, in recent years, data demonstrate that like African Americans, the proportion of the Hispanic population younger than age 50 and diagnosed with CRC is nearly double the rate seen in Whites (12% vs. 6.7%; Rahman et al., 2015). This is the case even though Hispanics have lower overall CRC incidence than Whites across all age groups, including for individuals younger than 50 years of age (Muller et al., 2021). Yet, recent

epidemiological data show that the incidence of early-onset CRC is rising at a faster rate among Hispanic people (Ellis et al., 2018), with Hispanic men among the fastest growing demographic of early-onset CRC with an annual increase of 2.7% from 1992 to 2005 (Siegel et al., 2009). In contrast, the incidence for Hispanic women increased only 1.2% annually during the same time (Siegel et al., 2009). In total, analysis indicates that annual incidence of early-onset CRC among Hispanics has increased 2.35%, as compared to 2.02% for Whites, and these data reflect similar trends in statewide data obtained from California and Texas (Wang et al., 2017).

According to the Census Bureau, between 2000 and 2010, the United States total population grew steadily at a rate of 9.7% (United States Census Bureau, 2011). More than half of the growth was attributed to the rising population of Hispanics, growing from 35.3 million in 2000 to 50.5 million in 2010, a soaring rate of 43%. The increase in the Hispanic population accounted for over half the 27.3 million increase in the total United States population within the period. In 2010, Hispanics comprised 16% of the total United States population of 308.7 million (United States Census Bureau, 2011), ballooning to 18.5% or 60.6 million in 2020 (United States Census Bureau, 2020). A significant point reveals that in 2019, 30.8% of Hispanics were under the age 18, in comparison to 18.6% of non-Hispanic whites, based on data available at the Office of Minority Health (OMH) at the United States Department of Health and Human Services (HHS; 2021).

Notwithstanding their soaring population growth, English language fluency is a major challenge for many Hispanics. Analysis from the Census Bureau (2019) data on the

profile of Hispanic and Latino Americans demonstrated that English language fluency varies among Hispanic subgroups who reside within the continental United States. The data indicate that 71.1% of Hispanics speak a language other than English at home (OMH, 2021). For example, 70.4% of Mexicans, 58.9% of Puerto Ricans, 77.7% of Cubans, and 86.2% of Central Americans speak different languages at home, while 28.4% of the overall Hispanics state that they are not fluent in English (OMH, 2021). Studies indicate that limited English proficiency (LEP) individuals have difficulty reading, writing, and understanding English (Genoff et al., 2016), which creates hindrances to participation in the English-language dominant healthcare system in the United States. Language impediments contribute to poor health processes and outcomes (Al Shamsi et al., 2020), such as reduced access of preventive services and cancer screening rates among LEP patients (Tatari et al., 2020).

As the largest ethnic minority group in the United States, the rising CRC incidence among the Hispanic group needs a serious public health attention that could influence policymaking to reduce its impact on the population. Barriers, such as language and other cultural considerations, need to be addressed to enhance screening of CRC in this population as a means of addressing its adverse effects on the population. This study focuses on language as an obstacle that leads to challenges for low screening of CRC among Hispanic Americans in Texas. With the limitations of language on health outcomes, this study seeks to understand the impact of the language barrier in CRC screening and treatment among Hispanics in Texas, which ranks only second to California as the largest Hispanic population in the United States.

## Background of the Study

Language barrier describes a roadblock to communication between people who are unable to speak a common language, such as English. In public health sense, language barrier is more than merely speaking limitation of a language. Because LEP individuals have difficulty reading, writing, and understanding English (Genoff et al, 2016), they struggle to participate in the English-dominant healthcare system in the United States. Thus, language barriers contribute significantly to poor health processes and outcomes (Fernandez et al., 2011; Stephen & Zoucha, 2020), including limited ability to access preventive services (Tseng et al., 2008), low cancer screening rates among LEP patients (Busch et al., 2015; Griffey et al., 2015), nonadherence to medication schedules, and skipping physician office visits due to misunderstanding physician instructions (Al Shamsi et al., 2020; Brown & Bussell, 2011).

Clinicians suggest that several types of CRC screening exist, and their respective procedures differ from one to another. While most of them are performed in clinical settings, others could be done at home. Notable recommended tests performed by health care providers in clinical settings include colonoscopy, virtual colonoscopy, and sigmoidoscopy, whereas Cologuard, which is an at-home fecal immunochemical test-DNA **(**FIT-DNA) test, is conducted by patients themselves (Butterly, 2020). These screening tests are important in detecting CRC in its rudimentary stages when prognosis often leads to positive outcomes because precancerous polyps could be removed before they turn into cancer. Without screening, CRC is often detected late because early stages tend to be asymptomatic (Siegel et al., 2021).

A lack of symptoms at its initial stages keeps CRC hidden where it could only be found out with screening at that time. The instructions that patients must follow to undertake CRC screening could be difficult to understand if individuals have limitations in their knowledge of the English language, which is the main medium of communication in the United States. Literature demonstrates that individuals with LEP are often reluctant to seek health care, particularly preventive care, such as CRC screening, owing to difficulties they experience in communicating or following health care provider instructions (Sentell et al., 2013). As a result of LEP challenges, prevalence of patients with cancer and other chronic diseases tends to be significantly higher than in the general population (Gunn et al., 2020).

Similarly, low health literacy (LHL) negatively affects CRC screening due to unmet informational needs over the relevance of interventions, such as CRC screening. Effects of social determinants of health (SDH) like low socioeconomic status (SES) coupled with LHL could potentially exacerbate the effects of LEP on CRC screening (Schillinger, 2020). Studies indicate that while each of these factors (SDH, LHL, and LEP) independently decreases preventive care measures like CRC screening, their combined effects could make the situation worse for individuals identified with all those factors (Sentell et al., 2015). Most immigrants, particularly those whose primary language is not English such as Hispanic Americans, tend to suffer from SDH, LEP, and LHL (Jacobson et al., 2016). Consequently, these factors pose significant public health challenges on health care preventive interventions. With a high Hispanic population in Texas, which ranks only second to California in size, this study sought to understand the

impact of LEP on CRC screening among Hispanic residents in the state. The study also assessed whether gender differences lead to any variations in CRC rates among Hispanics in the state.

## Problem Statement

Studies indicate that the United States Hispanic population, identified by individuals of Mexican, Puerto Rican, Cuban, Dominican, and additional Central/South American as well as other Spanish ancestry based on self-identification (Jackson et al., 2016), particularly reflects low rates of CRC screening, which may be blamed on certain barriers, especially deficits in their ability to use the English language (Wang et al., 2013). While not all individuals suffering from LEP may also have LHL, investigators argue that a vast majority of individuals with LEP also have LHL status (Schillinger, 2020). Because LHL is associated with less cancer knowledge, negative attitudes toward cancer screening, lower self-efficacy, and less likelihood of completing screening, individuals suffering from LEP are confronted with compounded barriers in comprehending and accessing health information and services (Arnold et al., 2016). Researchers suggest that LEP individuals in patient-provider language-concordant relationships experience increased rates of CRC screening as compared to individuals in language-discordant relationships (Hsueh et al., 2021), thereby making LEP a key component of effective health management (Schillinger, 2020). Similarly, other studies indicate that LEP status is associated with multiple suboptimal health outcomes, partly because of misinterpretation of patient complaints. Although hospitals often make provisions for language translations, such provisions do not necessarily enhance the

understanding of patients to appreciate the services available to them, including effective preventive measures like screening for CRC (Al Shamsi et al., 2020).

Because CRC screening involves individuals scheduling beyond a regular doctors' appointment, independent test preparation, and/or complex completion instructions, it is often adversely influenced by LEP (Hill et al., 2021). Consequently, most individuals who are diagnosed with CRC, particularly those with LEP challenges, are found in late stages of the disease (Andrew et al., 2018). To gain a comprehensive understanding of obstacles to CRC screening in the Hispanic population, an integrative analysis of possible factors such as low literacy/educational levels, lack of provider recommendations primarily due to lack of health insurance, cost of screening, and fear of colonoscopy procedure is necessary. Most of these factors may be associated with LEP, which constrains immigrants in the larger American society and culture (Zhang et al., 2012). Researchers suggest that no matter the stage at which CRC is found, challenges remain for patients, even after successful treatments, including surgery, radiotherapy, and/or chemotherapy (Xie et al., 2020).

Late-stage CRC often leads to poor prognosis due to complications in treatment and disease management because the cancer is no longer resectable when it has metastasized to other organs such as the liver and lungs; this leaves chemotherapy as the mainstay treatment option, which involves frequent provider office visits (Huang et al., 2020). Even though the overall incidence of CRC among Hispanics compared to non-Hispanic Whites is lower, the former's incidence rate of 35.5 per 100,000 population is still significant, and overall five-year CRC survival rates are equivalent between

Hispanics and non-Hispanic Whites (Jackson et al., 2016). However, researchers have not observed increases in survival among Hispanics in comparison with non-Hispanic Whites for metastatic CRC, raising questions about nonmedical factors like language barrier and other cultural impediments (Sineshaw et al., 2014).

These findings indicate that the Hispanic population in the United States is confronted with problems associated with CRC screening for early detection and poor management when diagnosed late with CRC. Investigators suggest that several randomized screening trials have shown a decrease in CRC mortality by repeated fecal occult blood test (FOBT) testing annually or biannually, followed by colonoscopy for participants with positive test results (Lin et al., 2021). Whether the low screening rates for CRC among the Hispanic population in Texas are due to their deficiencies in the English language remains unknown. Researchers have sought to understand the impact of language barrier on health outcomes of many diseases elsewhere in the United States and beyond; however, no attempt has been made to study the impact of language barrier on CRC screening among communities of Hispanic origin in the state of Texas. The gap makes this study, which assesses the impact of language barrier as a potential unmet challenge in screening for early detection of CRC among Hispanics in Texas, important to evaluate whether LEP contributes to low screening with its concomitant elevated morbidity and mortality among Hispanic residents in Texas. The study also evaluated whether LEP effects on CRC screening affect both male and female genders differently.

## Purpose of the Study

The purpose of this study was to determine the impact of LEP on CRC screening among Hispanic Americans in Texas. The study also sought to explore the differences in the effect of language proficiency on CRC screening by their male and female counterparts. I compared the CRC screening rate differences between English-speaking and non-English speaking populations in Texas using a quantitative method to analyze data obtained from the 2020 Texas Behavioral Risk Factor Surveillance System (BRFSS, 2020; the latest Texas BRFSS with data on CRC at the time of the study) on the general population to deduce general health information of noninstitutionalized civilian (Hispanic) residents of Texas. The study findings may assist in understanding the impact of LEP and gender differences and CRC screening among Hispanic Americans in Texas. Importantly, it would inform policymakers about any improvements they need to undertake to promote and enhance CRC screening by initiating programs that would reduce LEP in the target population. It would also highlight gender influences on differences in CRC screening within the target community and find means to address any hindrances that suppress CRC screening rates by gender.

Language barrier was the independent variable (IV) of the study. Language ability may be defined by grouping study participants into language barrier or no language barrier categories based on responses to the question, “Which language(s), English or Spanish, do the study participants speak?” Given that English is the main language spoken in Texas, “Spanish only” respondents were categorized as having language barriers, while respondents who spoke “only English” or “both English and Spanish”

were categorized as having no language barriers. CRC screening was the dependent variable (DV), or outcome variable of this study. Potential confounding variables in this study included age and SES, such as income and educational levels of participants, which were controlled in the data analysis. To absolve the confounding variables, age and other factors associated with SES such as education, migration background, marital status, statistical area of residence, employment, and income were considered in the computation to assess LEP as a barrier to low CRC screening among the target population of the study. The research questions were designed to measure the impact of language barrier on screening rates for CRC among the Hispanic population in Texas. By understanding the impact of the English language deficit on the Hispanic population, effective public health measures could be developed to improve upon their CRC screening rates.

## Research Questions and Hypothesis

The main independent variable (IV) was LEP. Because LEP individuals could not communicate well in English, they attempted to respond to the BRFSS questionnaire in Spanish. The IV was divided into eight categories: Non-Hispanic White Men, Non-Hispanic White Women, Non- Hispanic Black Men, Non- Hispanic Black women, Hispanic Men Responding in English, Hispanic Women Responding in English, Hispanic Men Responding in Spanish, and Hispanic Women Responding in Spanish. The dependent variable (DV) was based on CRC screening tests and described as reporting FOBT within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years. The research questions (RQs) and hypotheses were as follows.

RQ1: Are CRC screening rates different between residents in Texas with and without proficiency in English, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$1: There is no significant relationship between language barrier and CRC screening rates among Hispanic and non-Hispanic populations in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*H*a1: There is a significant relationship between language barrier and CRC screening rates among Hispanic and non-Hispanic populations in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

RQ2: Are CRC screening rates different between male and female residents in Texas with and without proficiency in English, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$2: There is no significant relationship between gender and CRC screening of Hispanic and non-Hispanic populations in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*Ha*2: There is a significant relationship between gender and CRC screening of Hispanic and non-Hispanic populations in Texas, when potential confounding variables

including age, income, occupation, health care access, and educational levels of participants are controlled.

## Framework: Conceptual or Theoretical

Developed initially in the 1950s by social psychologists employed by the United States Public Health Service, the health belief model (HBM) has assumed a central position among theoretical frameworks that seek to account for the broad failure of individuals to participate in events to avert or detect asymptomatic disease (Hochbaum, 1958; Rosenstock, 1966, 1974). In addition, HBM seeks to explain individuals' responses based on their experienced symptoms (Kirscht, 1974) and their behavior in response to clinically diagnosed illnesses, especially in compliance to medical regimens (Becker, 1974). Social psychologists developed the HBM due to significant limitations of success regarding various programs within the public health system in the 1950s and thereafter. Consequently, efforts were committed to developing a theory that would delineate public acceptance (or lack thereof) of programs to screen for disease and to vaccinate against viral diseases like poliomyelitis and influenza, as well as attempts to improve on compliance with medical advice regarding diabetes, hypertension, cancer, obesity, exercise, seat-belt use, and HIV-risk behavior (Janz & Becker, 1984; Stretcher & Rosenstock, 1997). Being one of the most broadly applied theories of health behavior, HBM postulates six constructs, including risk susceptibility, risk severity, benefits to action, barriers to action, perceived self-efficacy, and cues to action predict health behavior (Becker, 1974).

The logical connections between HBM and the nature of this study are explained by the HBM postulates. These constructs are relevant to understanding the impact of language barrier in identifying asymptomatic CRC patients through screening for early detection, which leads to positive disease prognosis. The constructs also relate to clinical instructions of managing CRC symptoms and improve on core determinants of disease prognosis (Hochbaum, 1958; Rosenstock, 1966, 1974).

The risk susceptibility describes an individual's subjective awareness of the risk of acquiring an illness or disease. The risk severity deals with an individual's assumptions on the concerns of contracting CRC, and the possibility of not receiving an appropriate treatment, thereby leading them to a wide variation of apprehensiveness, including medical consequences like death or disability, and social consequences that may adversely affect their families with economic hardships. The benefits to action explain an individual's understanding of the effectiveness of available actions to minimize the threats of CRC (or to cure CRC). Individuals who perceive these dangers take actions to prevent or cure the cancer based on their understanding and evaluation of both perceived susceptibility and perceived benefit as a motivation to accept the recommended health action they consider beneficial.

Barriers to action refers to an individual's recognition of impediments to undertake a recommended health action on CRC, which may involve a broad variation of barriers, such as costs, time-consumption, and inconvenience associated with health actions they accept in dealing with CRC. As a result, individuals perform cost and benefit analysis and weigh the effectiveness of decisions they embrace. Perceived self-efficacy

describes individuals' confidence in their ability to appropriately perform a behavior, which was a construct that was added to the model in mid-1980s; it is also a construct in many behavioral theories as it is directly associated with whether an individual takes up the desired behavior. The cues to action, which could be internal factors like fatigue due to anemia, lack of appetite and weight loss, are often associated with CRC residual symptoms; external cues such as advice from close relatives and friends, illness of family member, and newspaper articles serve as a stimulus that influence decision-making process to embrace a recommended health action.

To appreciate the relevance of these constructs, individuals suffering from or prone to acquiring CRC need to overcome the barrier of language limitations to understand the American healthcare delivery system and be able to communicate effectively with healthcare providers. Thus, the fundamental importance of HBM constructs makes it an appropriate public health theory in appreciating the unmet challenges, like language barrier, for individuals in identifying asymptomatic CRC patients and the ability to relate to clinical instructions of managing CRC residual symptoms (Rakhshanderou et al., 2020).

This indicates that HBM demonstrates a value-expectancy theory, where behavior assumes the function of the subjective value of an outcome and the subjective probability, or expectation, where a specific action would lead to the expected outcome (Lewin et al., 1944). In the context of health-associated behavior, the value-expectancy theory demonstrates the willingness to prevent illness or to get well (value), which also signifies the belief that a particular health action available to individuals would avoid or

ameliorate illness (expectancy), where individual's estimate of personal susceptibility to and the severity of an illness could be linked to the likelihood of being able to reduce that threat through personal action.

Like other cognitive theories, HBM underscores those mental processes, such as thinking, reasoning, hypothesizing, or expecting as fundamental components of the model. In the same way, behaviorists like Skinner (1938) maintain that reinforcements or consequences of behavior impact behavior directly, whereas cognitive theorists assume that reinforcements function by influencing expectations (or hypotheses) about situations instead of affecting behaviors directly (Bandura, 1965). The primary tenet in the HBM reveals that people would make sound decisions to ward off, screen for, or control ill-health conditions, such as CRC, if they consider themselves as susceptible to the detrimental effects of the disease; if they perceive that an accessible course of action to them would be helpful in lowering either their susceptibility to or the severity of the condition; and if they perceived that the predicted obstacles or costs related to taking the action are overridden by its benefits (Lin et al., 2019). Thus, the fundamental importance of HBM makes it an appropriate public health theory in understanding language barrier for individuals screening for CRC (Lau et al., 2020).

## Nature of the Study

I employed quantitative method and cross-sectional design to examine the relationships in the RQs and hypothesis between and among the variables using secondary data from the Texas BRFSS (2020) on the general population to deduce general health information of noninstitutionalized civilian residents of Texas. Individuals

younger than 50 years of age were excluded from the study because the United States Preventive Services Task Force (USPSTF) recommendation for CRC screening begins at age 50 to 75 years. Although recommendations from the ACS include individuals who are at least 45 years of age in CRC screenings, because this study used data from BRFSS, which is prepared by the CDC and follows recommendations from the USPSTS, I set the baseline for this study at 50 years of age for participants. The Texas BRFSS provides information on all races and ethnic groups for analyses of cancer incidence to support health care assessment, evaluation, and planning, identifying populations at increased risk of cancer, improving research associated with cancer etiology, prevention, and control with appropriate interventions. The IV, which was represented by LEP in this study, was dichotomous (language as a barrier to screening—yes/no), and the DVs (screening rates among ethnic groups and between male and female gender differences) were categorical variables. The DVs, which were based on CRC screening tests and described as reporting FOBT within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years, could be described as high screening rate, average screening rate and low screening rate, indicating that these categorical variables were ordinal variables.

The secondary data contained sociodemographic information on subjects who participated in the study. To compute for language barrier levels, I employed sociodemographic features such as age, gender, Hispanic origin (place of birth), Spanish as first language, highest educational attainment, income level, and English fluency. To find variables that could promote screening for CRC or improve on poor quality of life

after diagnosis with CRC, I evaluated cancer screening knowledge, accessibility and utilization of health care services, health literacy, and environmental barriers, such as legal status and preparation for and fear of colonoscopy procedure. The Texas BRFSS database provides all sociodemographic characteristics needed to analyze language barrier as an unmet challenge to screen for CRC and improve upon the quality of life after diagnosis.

## Definitions of Study Variables

*Language barrier, which in this study is cited as limited English proficiency (LEP)*: Refers to the inability of a health care provider and individuals they serve to communicate because the former and latter speak different languages. When health care providers and patients speak different languages, quality of care is adversely affected because language concordance between patients and providers is essential for patients to participate in effective preventive medicine, including screening for CRC. Investigators note that language-incongruent encounters within the United States healthcare system suppress individuals whose primary language is not English from participating in preventive measures, such as CRC screening (Cano-Ibáñez et al., 2021). These individuals who suffer from LEP may have difficulty reading, writing, and understanding English, which creates hindrances to participation in the English-language dominant healthcare system in the United States (Genoff et al., 2016).

*Health literacy:* The Centers for Disease Control and Prevention (CDC) defines health literacy as “the degree to which individuals have the ability to find, understand, and use information and services to inform health-related decisions and actions for

themselves and others" (Office of Disease Prevention and Health Promotion, 2021). Researchers state that while literacy and health literacy are different, both factors are interconnected to influence people's eagerness to undertake preventive health measures, such as CRC screening. Thus, health literacy is connected to literacy and implies individuals' knowledge, motivation, competences to access, comprehend, appraise, and apply health information to make informed evaluations that result in suitable decision making on their health. Low literacy promotes nonparticipation, which is influenced by poor SES, defined by factors like income, educational level, and employment status (Horshauge et al., 2020).

*CRC screening:* refers to medical procedures used to detect polyps and early cancers in the large intestine (colon and rectum). CRC screening allows providers to identify such abnormalities and treat them before cancer spreads or metastasizes. Studies indicate that regular CRC screening prevents late detection of CRC and often make it treatable with good prognostic outcomes (Issa & Noureddine, 2017).

*Hispanic American:* The United States Office of Management and Budget (OMB) defines "Hispanic or Latino" as a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race. Individuals who trace their background origins to a Spanish-speaking country are referred to as Hispanic, whereas those described as Latino refer to individuals who identify themselves with the background origin of a Latin American country.

## Assumptions

Costas-Muñiz et al. (2106) proposed that low rates of CRC screening among immigrants, such as Hispanics, in relation to United States natives may be due in part to the different values and beliefs exhibited by immigrants about health services used in the United States. It may also be due to acculturation resistance to adapting the American social norms on CRC screening. While previous studies among Hispanic and Asian Americans found mixed results, it is important to assume that healthy migrant effects could also influence low rates of CRC screening among Hispanic immigrants in the United States; although, established facts indicate that Hispanic Americans tend to improve on CRC screening when socioeconomic factors and access to care are addressed (Velasco-Mondragon et al., 2016). Another important assumption among Hispanic Americans is that this segment of American immigrants come from different countries with varied cultures that may potentially influence their approach to the American native culture on healthcare (Castañeda et al., 2019), an indication that sociocultural factors that influence CRC screening may differ from one country to the other.

## Scope and Delimitations

I focused my research on the noninstitutionalized, civilian, Hispanic American population in Texas at the time of the study. The study focused on individuals who were at least 50 years of age, as recommended by the USPSTF (United States Preventive Services Task Force, 2021). Although ACS recommends that individuals need to be screened at 45 years of age with increased potential benefits to detect early-onset disease and minimize higher incidence and mortality from CRC (Abualkhair et al., 2020), the

BRFSS data are prepared by the CDC, which depends on the recommendations by the USPSTF. Hispanic Americans residing in Texas but younger than 50 years of age were not included in the study because the USPSTF recommendation for CRC screening begins at age 50 to 75 years. Since preparation and screening procedures like a colonoscopy could be complicated and cumbersome, they may pose a health risk for individuals older than 75 years old. For that reason, for individuals aged 76 years or more, USPSTF suggests making decision based on individuals overall health and history of CRC screening (United States Preventive Services Task Force, 2021).

## Limitations

Because my study used secondary data, I was unable to establish the validity of the method used to collect the data. Any errors made in the collection of the data, such as how questions were worded, may elicit responses in a certain way and could lead to a measurement error, which could have introduced misinformation bias or miscalculation into this study. BRFSS data are a probability sample of United States households with both landline and cellphone telephones. Since telephone coverage differs by state and subpopulations, selection bias exists in BRFSS data collection. This means that individuals whose numbers are not selected, and those who do not have telephones could not be covered by BRFSS sampling. Also, the participants' ability to recall details of responses they provide relies on how much time has elapsed since the event, leading to response errors or recall bias in their answers. Notwithstanding its limitations, BRFSS remains the best estimated source of health data for assessment at geographic levels smaller than state employing limited community analysis techniques (Iachan et al., 2016).

## Significance of the Study

This study sought to explore the effects of LEP on CRC screening among Hispanic Americans in Texas and assess whether variations in their gender have any influences on CRC screening. To date, review of literature on CRC health outcomes among Hispanics primarily focuses on the Hispanic population around the United States, with little to no research available on more than 11.5 million Hispanic residents, or nearly 40% of the 29 million people living in Texas (OMH, 2021). This study would offer clues to understanding the impact of the English language as a barrier to low screening rates for early CRC detection. Such clues would contribute to the knowledge in public health about the adverse effects of lack of CRC screening and nonadherence to physician instructions, particularly among migrants whose understanding of the English language is limited, such as the Hispanic population in Texas.

Furthermore, the study findings may assist in understanding the impact of LEP and gender differences on CRC. Importantly, it would inform policymakers on public health policy about any improvements they need to undertake to promote and enhance CRC screening by initiating programs that would reduce LEP in the target population. It would also highlight gender influences on differences in CRC screening within the target community and find means to address perceived hindrances that suppress CRC screening rates by gender. Such a transformation would likely enhance positive social change in those communities.

## Summary

Timely CRC screening leads to early detection of CRC and better treatment outcomes. Although nationwide, Hispanics have lower overall CRC incidence than Whites across all age groups, including for individuals younger than 50 years of age (Muller et al., 2021), recent epidemiological data show that the incidence of early-onset CRC is rising at a faster rate among Hispanic people (Ellis et al., 2018), with Hispanic men among the fastest growing demographic of early-onset CRC, with an annual increase of 2.7% from 1992 to 2005 (Siegel et al., 2009). Whereas the incidence for Hispanic women increased only 1.2% annually during the same time (Siegel et al., 2009), in total, analysis indicates that annual incidence of early-onset CRC among Hispanics has increased 2.35%, compared to 2.02% for Whites; these data reflect similar trends in statewide data obtained from California and Texas (Wang et al., 2017).

As the largest ethnic minority group and fastest growing population in the United States, the rising CRC incidence among the Hispanic group needs serious public health attention that would influence policymaking on applications to reducing its impact on the population. Investigators have studied the impact of language barrier on many diseases, including CRC; however, no attempt has been made to study its impact on the overall Hispanic population in the in the state of Texas. The gap makes this study, which seeks to evaluate the impact of language barrier as a potential unmet challenge in screening for early detection of CRC among Hispanics in Texas important to evaluate whether LEP contributes to low screening with its concomitant elevated morbidity and mortality among Hispanic residents in Texas. The study also evaluates whether LEP effects on

CRC screening affect male and female genders differently. Using HBM, the purpose of this study was to evaluate secondary quantitative data from the Texas BRFSS (2020) to analyze whether there was a significant relationship between language barrier and low CRC screening rate among the target population. Similarly, the study sought to assess whether there was a significant relationship between male and female genders in the target population. Knowledge garnered from the study could contribute to the body of knowledge to guide health enhancement programs within the ethnic group.

To further understand challenges that may confront the Hispanic Americans in Texas about the impact of LEP and gender differences on CRC screening, I undertook an extensive literature review from peer-reviewed journals. I also performed quantitative data analyses using cross-sectional design on publicly available data from the Texas BRFSS (2020) to evaluate the relationships between the variables. The results from this investigation were then compared to the current body of knowledge to examine whether they were in harmony with the literature and offered possible explanation regarding any observed discrepancies. Chapter 2 focuses on the body of literature on CRC, LEP, and sociodemographic data of the population of interest. Chapter 3 includes the methodology, Chapter 4 deals with the results, and Chapter 5 focuses on discussion and analysis of the results, and recommendations.

# Chapter 2: Literature Review

## Introduction

Researchers understand that irrespective of different racial and ethnic backgrounds, health concerns are important to people of all backgrounds (Williams et al., 2016). Significantly, investigators argue that sociocultural differences and socioeconomic disparities in the immigrant communities play a leading role in limiting their access to healthcare in the United States. The complex interplay between numerous factors such as LEP, literacy skills, health knowledge, sociocultural factors, and the established healthcare system, which embodies health care practitioners, health care infrastructure, and quality of health care workforce that work together to promote health access have not been adequately explored (Schillinger, 2020). This is particularly significant in the Hispanic population whose primary language is often different from English, the main language of the United States. Singularly, various factors that influence the LEP are directly related to the effectiveness of CRC screening among Hispanic people in the United States (Schillinger, 2020).

These factors are not limited to basic literacy but are made up of complex interactions of individual limitations and varied sociocultural deficiencies that fail to promote screening for CRC in its rudimentary, localized state. For example, minority status, young age, less education, recent immigration to the United States, or being a foreign born, low knowledge about CRC screening and reduced contact with the United States healthcare system contribute to the poor participation in the CRC screening among Hispanic Americans. The underutilization of CRC screening leads to lost opportunities

for CRC prevention and control (Savas et al., 2015). Overall, Hispanic Americans run into a higher burden of access-associated screening limitations, such as living below the federal poverty level (FPL) and reduced insurance coverage, which could also be blamed on their limitations in English proficiency. Lack of health insurance is consistently related to underutilization of CRC screening, particularly among Hispanic Americans (Ou, et al., 2019). Investigators that have considered individual constituents such as LEP and CRC screening knowledge, awareness, attitudes, beliefs, and availability of health care have not exhaustively accounted for low CRC screening among Hispanic Americans in Texas.

Chapter 2 highlights on peer-reviewed articles exploring the main IVs of ethnicity, LEP and its determinants, while the DV was based on CRC screening, and the association between and among the variables. Most of the literature used include articles and other sources published in English since 2016. The articles in this review were chosen using PubMed/Medline, Biological Abstracts, Biosis Citation Index, Cumulative Index to Nursing and Allied Health, Cochrane Library, Embase Classic, SAGE, ScienceDirect, and Web of Science. Relevant keywords/text words employed in the search for appropriate literature were Texas Hispanics OR Latinos OR Hispanic/Latino/Latina; Language barrier AND Mass screening OR Screening OR Prevention; Colorectal cancer OR Colorectal neoplasms OR Colonic cancer OR Colonic neoplasm OR CRC OR Colorectal carcinoma OR Colon carcinogenesis OR Sigmoid carcinoma or Colon adenocarcinoma OR Colon carcinogenesis. Studies indicate that

these wide range of unique choices of research instruments often provide clear and concise literature on target populations in investigations (Charrois, 2015).

## Theoretical Foundation

It is well established that early detection of CRC improves prognosis, and many screening tests are available to most of the general population in the United States. Yet, CRC screening is suboptimal, particularly among individuals within the lower SES brackets (Li, 2018). In view of lack of effective participation in CRC screening, various models of public health have been developed by behavioral scientists to identify and assess the elements that contribute to people's participation of CRC screening (Topaloğlu & Aydoğdu, 2021). Researchers suggest that HBM is one of the most important model-based interventions that explains behaviors toward cancer screening, particularly among subjects of low SES (Zare et al., 2016). The HBM could provide guidance for researchers to assess screening behaviors of people and to appreciate their decision to accept screening as a preventive mechanism against cancer. Health analysts indicate that HBM, theory of justified action, theory of planned behavior, social cognitive theory, transtheoretical model and health promotion model assume positions among the models/theories often employed in the literature to understanding adherence with CRC screening. Researchers have also employed other models, such as health behavior framework (HBF), sociocultural health behavior model (SCHBM), and behavioral model of health services use (BMHSU) to study CRC screening. While all these models are approvingly useful in estimating CRC screening behaviors, it is demonstrated that models/theories other than HBM are relatively deficient in predicting these relationships

(Topaloğlu & Aydoğdu, 2021), because the HBM essentially illustrates the association between both internal and external health beliefs and health behaviors or intentions (Feng et al., 2021). In this study, I used the HBM to ascertain the impact of its six constructs on preventive care and how it influences individuals to seek CRC screening.

## Conceptual Framework: Health Belief Model

Health investigators use the HBM as a model to evaluate cancer screenings and other preventive health behaviors, thereby assessing the willingness of individuals to take action to avoid, control, or screen for disease. Such an action leads to identifying particular constructs that alter the individual's behavior. For instance, if people become vulnerable to the negative effects of CRC, they are more likely to accept screening behavior, appreciate the benefits of CRC screening, and exhibit less resistance to screening. As one of the most broadly applied theories of health behavior, the HBM postulates six constructs, including risk susceptibility, risk severity, benefits to action, barriers to action, perceived self-efficacy, and cues to action predict health behavior (Becker, 1974). The logical connections between the HBM and the nature of this study are explained by the HBM postulates. These constructs are relevant to understanding the impact of language barrier in identifying asymptomatic CRC patients through screening for early detection, which leads to positive disease prognosis. The constructs also relate to clinical instructions of managing CRC symptoms and improve on core determinants of disease prognosis (Hochbaum, 1958; Rosenstock, 1966, 1974).

The risk susceptibility describes an individual's subjective awareness of the risk of acquiring an illness or disease. The risk severity deals with an individual's

assumptions on the concerns of contracting CRC, and the possibility of not receiving an appropriate treatment, thereby leading them to a wide variation of apprehensiveness, including medical consequences like death or disability, and social consequences that may adversely affect their families with economic hardships. The benefits to action explain an individual's understanding of the effectiveness of available actions to minimize the threats of CRC (or to cure CRC). Individuals who perceive these dangers take actions to prevent or cure the cancer based on their understanding and evaluation of both perceived susceptibility and perceived benefit as a motivation to accept the recommended health action they consider beneficial.

Barriers to action refers to an individual's recognition of impediments to undertake a recommended health action on CRC, which may involve a broad variation of barriers, such as costs, time-consumption, and inconvenience associated with health actions they accept in dealing with CRC. As a result, individuals perform cost and benefit analysis and weigh the effectiveness of decisions they embrace. Perceived self-efficacy describes individuals' confidence in their ability to appropriately perform a behavior, which was a construct that was added to the model in mid-1980s; it is also a construct in many behavioral theories as it is directly associated with whether an individual takes up the desired behavior. The cues to action, which could be internal factors like fatigue due to anemia, lack of appetite and weight loss, are often associated with CRC residual symptoms; external cues such as advice from close relatives and friends, illness of family member, and newspaper articles serve as a stimulus that influence decision-making process to embrace a recommended health action.

In view of its practical implications on screening, researchers suggest that HBM could be used as an effective theory-based educational intervention model to screen people who are vulnerable to chronic diseases, such as cancer, due to increased factors like unhealthy diet, smoking, and physical inactivity (Rakhshanderou et al., 2020). The HBM proposes that messages like public health campaigns would attain suitable changes in behavior if the message was individualized appropriately to address perceived barriers, benefits, self-efficacy, and threat (Jones et al., 2015).

Applying an interventional study, Rakhshanderou et al. (2020) used a researcher-made questionnaire to recruit 110 employees of Shahid Beheshti University of Medical Sciences in Iran. The participants were randomly grouped into intervention and control groups with cluster sampling. The questionnaire was made up of two portions of 10-dimensional information and HBM constructs, which was administered for 1 month in four sessions. Each session took the form of classroom lecture, pamphlet, educational text messages received on mobile phones, and educational pamphlets via the office automation system. The two groups were assessed at pre-test and post-test levels. The researchers evaluated the data using SPSS-18 software, analysis of covariance (ANCOVA) and independent *t*-test for intergroup comparisons (Rakhshanderou et al., 2020).

Assessing with variables such as age, sex, education level, and family history of CRC, the researchers found no significant variation between the two groups ($p > 0.05$). Aside from the mean score of perceived barriers, which showed no remarkable change after the intervention, the mean scores of knowledge, perceived susceptibility, perceived

severity, perceived benefits, perceived self-efficacy, behavioral intention, and preventive behaviors rose remarkably in the post-intervention analysis in the intervention group as compared to the control group ($p < 0.05$). The outcome demonstrated that administration of the educational intervention using HBM was effective for the personnel and could potentially promote the preventive nutritional behaviors associated with CRC (Rakhshanderou et al., 2020).

In another investigation, Lau et al. (2020) undertook a systemic review using HBM to evaluate CRC screening in the general population. In 2019, the researchers used four databases to assess the impact of sociobehavioral factors on screening participation in line with behavior change, specifically with respect to HBM constructs associated with CRC screening. Reviewing a total of 30 studies that satisfied their criteria for inclusion, the researchers used quantitative observational studies in line with HBM to evaluate CRC screening history, intention, or behavior. All the studies explored used cross-sectional design. The researchers found out that perceived susceptibility, benefits, and cues to action had a direct relationship with screening history or intention, whereas perceived barriers were found to be negatively related to screening history or intention (Lau et al., 2020). Other modifying factors that had influence on the study outcome included sociodemographic and cultural norms. Limitations found by the researchers were self-reporting of screening history, intention or behavior, convenience sampling, and lack of temporality. The researchers concluded that HBM's associations with CRC screening uptake were associated with preventive health behaviors; however, they also noted that

future investigations that explore impact of socioecological factors would present a more concrete understanding of theory-based behavioral interventions (Lau et al., 2020).

To elucidate the efficacy of HBM in comparison with the theory of reasoned action (TRA) in screening practices, Firouzbakht et al. (2021) measured competitive cognitive models through the exploration of women breast cancer screening behaviors using structural equation modelling. The researchers performed population-based cross-sectional study in northern Iran with a sample of 500 women aged 35-85 years. The demographic data features included were awareness, health belief, subjective norms, and screening behaviors gathered with standard instruments. The investigators used SEM to predict the pathways of regression coefficients. The outcome differed between the HBM and TRA model. For the HBM, the standardized coefficient of the knowledge scores showed a remarkable impact on the health belief perception (beta = 0.375); hence, health belief directly influenced screening behaviors (beta = 0.73). On the other hand, in the TRA model, although the direct impact of knowledge on intention was insignificant, the researchers noted a significant inverse association on health belief and subjective norms (indirect beta = 0.35) on behavior intention. Also, an increased coefficient of intention was found by subjective norms (beta = 0.626), and the intention had a higher direct effect on screening behavior (beta = 0.601), indicating that all fitting indexes improved in the TRA model in comparison with HBM.

In another study, researchers blended two health promotion theories, the HBM and the transtheoretical model (TTM) to understand the context of their studies and selected measures.  Both models, which overlap considerably with respect to specific

beliefs that impact on decisions, fundamentally posit that individuals' beliefs and characters are determinants of their decisions, and therefore, their behavior (Jandorf et al., 2010). Based on these assessments, the researchers recruited and evaluated patients, health care, and cultural elements that influence colonoscopy screening among Hispanics. A total of 400 men (28%) and women (72%) were selected and interviewed, all of them from East Harlem in New York City where the Hispanic population is dominant. They assessed five hypothesis, including (1) older people and individuals with higher income or highly educated would likely undertake colonoscopy screening ($p < 0.01$); (2) individuals who have lived in the United States for a considerable period of time, and have access to Medicaid or Medicare, or obtained their health care at an academic versus a community health clinic, would likely undertake colonoscopy screening; (3) individuals whose primary care givers motivated or encouraged them to undertake CRC screening would more likely choose to be screened; (4) individuals who exhibit positive attitudes about screening would likely participate in screening; and (5) individuals who demonstrate high sense of medical mistrust, fatalism, fear, and worry would show adverse correlation with cancer screening ($p < 0.05$) (Jandorf et al., 2010).

Using multivariate analysis, Jandorf et al. (2010) showed that colonoscopy participation was inversely related to Medicaid and positively correlated with English as preferred language, physician recommendation, and motivation for CRC screening and less fear. The multivariate analysis revealed that individuals who opted to participate in the English language were more likely to undergo screening (Wald Chi-Square = 5.36; $p = 0.021$; OR = 2.26; 95% C.I. = 1.13, 4.51). However, individuals who used

Medicaid were less likely to undergo screening (Wald Chi-Square = 17.10; $p < 0.000$; OR = 0.30; 95% C.I. = 0.17, 0.53). Further, provider recommendation was positively correlated with screening (Wald Chi-Square = 21.83; $p < 0.000$; O.R. = 25.83; 95% C.I. = 6.60, 101.04). Physician motivation was also associated with screening (Wald Chi-Square = 3.86; $p = 0.049$; O.R. = 2.27; 95% C.I. = 1.02, 5.14). On the contrary, individuals who showed greater fear were notably less likely to undergo screening (Wald Chi-Square = 4.28; $p = 0.039$; O.R. = 0.52; 95% C.I. = 0.28, 0.97).

While the researchers cited many strengths in their study, they also noted some potential limitations. For example, they used participants who self-reported the colonoscopy screening, which could be affected by participants' bias. By including medical or billing records in a future study, such anomaly could be eliminated or minimized. Also, the researchers noted that their investigation was limited due to its cross-sectional design, and hence, causality could not be assessed. Future study could ameliorate this limitation by using longitudinal research. Furthermore, because the study was done only in one community where the population was predominantly an older sample of mainly Spanish speakers, the outcome could not be generalized to Hispanics in various geographical locations across the United States at varying layers of acculturation. To ensure generalizability, a large base of Hispanic immigrants representing both old and young in different parts of the United States would need to be sampled to test their generalizability (Jandorf et al., 2010).

Other health models have been successfully used to study CRC screening. Few of them include HBF, SCHBM, and BMHSU. Using HBF, Tu et al. (2008) described a

synthesis of constructs of several key health behavior theories that has been applied in multiple cancer control investigations. The HBF posits that independent and health care system elements, and environmental and personal obstacles, jointly influence health characteristics (Jones et al., 2015). According to Tu et al. (2008), interventions designed to influence mutable individual patient-level characteristics, such as knowledge, perceptions of disease susceptibility, cultural beliefs and lineage, among others within the broader context of health system factors frequently function as hindrance to cancer screening. By recognizing immutable factors that generate the context for individual behaviors, interventionists could design health messages to limit health system hindrances, promote knowledge, positively transform beliefs, empower social support, and reduce obstacles to cancer screening (Lau et al., 2020). Thus, health beliefs constitute an accumulation of traditional ideas, knowledge, past and present experiences, which provide framework for cancer interventionists to explore measures to reduce obstacles that suppress basic preventive health measures, such as CRC screening (Lau et al., 2020). Because investigators have found in several studies that Latino adults are more likely to be diagnosed with CRC at later stages compared to white adults (Castañeda et al., 2019), HBF reinforces an appropriate conceptual model to address disparities in screening rates.

In a similar scenario, employing the SCHBM on 801 Vietnamese Americans from community-based organizations, investigators noted through bivariate analysis that a higher number of respondents who never screened for CRC reported LEP. The respondents also reported fewer years of residency in the United States and reduced self-efficacy associated with CRC screening with structural equation model identified self-

efficacy (coefficient = 0.092, $p < .01$) (Ma et., 2021). The SCHBM identifies and describes associations and interplays between different elements that guide health behavior (Ma et al., 2015). The SCHBM integrates six factors related to decision-making and health-seeking characteristics that lead to health care utilization. The factors include: (1) predisposition, such as educational attainment; (2) cultural influences like health beliefs; (3) needs, such as levels of health care; (4) empowering influences, such as health insurance coverage; (5) environmental/health systems, such as provisions of health care resources; and (6) elements at family and community-levels, such as social norms and social support. These factors indicate that SCHBM highlights the overarching importance of socio-cultural factors on health behaviors, which influence decisions on CRC screenings (Ma et al., 2021).

Researchers also used the BMHSU theoretical framework to predict factors that enhance CRC screening among Latinos (Castañeda et al., 2019). In previous investigations, the BMHSU had been used to understand factors influencing access and utilization of hospital, dental, and medical care among diverse adults (Andersen et al., 2000; Miller et al., 2008), obstacles related to access and utilization difficulties and challenges experienced by Latinos (Andersen et al., 1986), and cervical, colorectal, and breast cancer screening among Latinos (Fernandez and Morales, 2007). In using the BMHSU framework, the outcome presumes that healthcare utilization is a function of a person's predisposition to use services (predisposing domain), factors that promote healthcare utilization (enabling domain), and the need for care, or the need domain (Castañeda et al., 2019). The predisposing factors describe the traits that contribute to the

possibility of healthcare utilization, and may include age, sex, income, education, and acculturation (Castañeda et al., 2019). For instance, evidence suggests that lower levels of education and income are related with lower CRC screening rates among Latinos (DuHamel et al., 2020). However, the literature remains unsettled on the role of acculturation factors, such as language-based acculturation, years in the United States, and country of birth in predicting CRC screening among Hispanic Americans (Castañeda et al., 2019). Researchers argue that enabling factors, identified as elements that promote access to services include health insurance, availability of a regular health care source, and utilization of services tend to motivate individuals to seek health care. Similarly, investigators suggest that adherence to other preventive services improves adherence to CRC screening in Latinos (Gonzalez et al., 2012). The BMHSU framework indicates that a person must recognize the need, often measured by health-related quality of life (HRQOL), for the likelihood of illness in order for health care utilization to occur. For example, Latinas with a family history of cancer demonstrate enhanced breast cancer screening use compared to others without family history, which is often credited to the heightened awareness and perceived risk of breast cancer (Castañeda et al., 2019).

## Literature Review Related to Key Variables and/or Concepts

### CRC Screening

Investigators credit screening as a primary mode of cancer prevention and early detection that leads to enhanced prognostic outcomes (Loomans-Kropp & Umar, 2019). Clinical and experimental evidence derived from cancer screenings reveal the molecular level development of benign adenomatous polyps from which the majority of CRCs

develop into adenoma-carcinoma stage (Hviding et al., 2008). Because CRC may have no detectable symptoms while it is developing and metastasizing into nearby lymph nodes, early detection through screening and accompanied treatment minimize tumor stages, which is strongly associated with survival (Hviding et al., 2008; Shaukat et al., 2021).

Currently, several applications of screening are available, and the recommended tests employed by most health care providers in screening for CRC include colonoscopy, FIT, multitarget stool DNA testing (MT-sDNA), and computed tomography colonography (CTC) (Redwood et al., 2021). Other methods of testing for average risk patients include sigmoidoscopy combined with FIT (or sensitive gFOBT), sigmoidoscopy alone, guaiac-based fecal occult blood test, and capsule colonoscopy **(**US Preventive Services Task Force, Davidson et al., 2021). The USPSTF groups individuals at risk for CRC into A, B, and C categories. The A category comprises individuals who are 50 to 75 years old, B category as individuals aged 45 to 49 years old, and C category comprises individuals aged 76 to 85 years old. Using cancer intervention and surveillance modeling network on CRC, the USPSTF recommends that all adults within category A (50 to 75 years) must undergo CRC screening and individuals within category B are highly recommended to undergo CRC screening. The USPSTF also recommends that adults aged 76 to 85 years old (category C) should receive CRC screening based on selective clinician recommendations because the net benefit of screening is limited in this group based on several studies (US Preventive Services Task Force, Davidson et al., 2021).

Clinicians recommend that colonoscopy should be done every 10 years for most patients at average risk for CRC because the procedure is known to be associated with

reduced incidence and mortality due to its high sensitivity for CRC and adenomatous polyps. Moreover, colonoscopy permits simultaneous lesion removal anywhere within the colon during the procedure with the potential to detect and prevent cancer by removing adenomatous polyps prior to malignant transformation (Stauffer & Pfeifer, 2021). For patients unwilling or unable to undergo colonoscopy, clinicians recommend FIT for occult blood annually on a single sample as initial screening. Similarly, where colonoscopy is limited, patients could be screened with FIT and when the result is positive, then colonoscopy could be used promptly (Rex et al., 2017). Studies indicate that colonoscopy and FIT have similar detection rates for CRC, but the latter has lower rates for advanced adenomas (Cross et al., 2019). MT-sDNA, also called FIT-DNA or multitarget fecal DNA, is tested every 3 years and it combines fecal makers for hemoglobin and DNA mutation and methylation, and it uses one stool collection sample (US Preventive Services Task Force, Davidson et al., 2021). Clinicians also recommend CTC, formerly referred to as virtual colonoscopy, particularly to older patients with comorbidities, such as cardiopulmonary disease, diabetes mellitus, or history of stroke because the risks of colonoscopy rise with increased age (Ladabaum et al., 2021). CTC is performed every 5 years, and it is more sensitive than all the methods except colonoscopy (US Preventive Services Task Force, Davidson et al., 2021).

Another procedure is sensitive gFOBT, which is also a diagnostic test to look for occult blood in the stool. Theoretically, the combination of sigmoidoscopy with FIT or guaiac-based FOBT (gFOBT) improves lesion detection by promoting direct visualization up to 60 cm and to also detecting colon lesion better than sigmoidoscope by

testing for occult blood. FIT is preferred over sensitive gFOBT (Meklin et al., 2020). Clinicians may employ sigmoidoscopy alone every 5 to 10 years for patients where adding stool-based test is not available or practical. While this procedure may be conducted with minimal patient preparation and does not require sedation, it could only identify lesions within the distal 60 cm of the bowel. The deficiency presents a challenge for women and older patients because clinicians suggest that such patients often present with higher frequency of more proximal lesions (Kuipers et al., 2015). Another test is gFOBT, which is performed at home by patients and done annually on three samples as a take-home test that patients mail back to the clinician. The gFOBT test has low sensitivity for polyps and relatively low specificity for a clinically important disease, making it less attractive to health care providers. Because of its poor sensitivity and specificity, clinicians recommend that gFOBT is repeated annually if the test result is negative (Elsafi et al., 2015).

Different CRC screening tests present with varying levels of invasiveness, patient time investment, sensitivity for neoplasia, risks, and required supporting infrastructure and costs, which tend to complicate efforts to regulate population effectiveness (Gupta et al., 2014). These attributes cause uncertainty on the eventual community effectiveness of any single modality, specifically for underserved communities. Colonoscopy is the preferred CRC screening tool by most gastroenterologists because of its superior one-time sensitivity for detecting polyps and cancer (Issa & Noureddine, 2017). However, colonoscopy remains the most invasive of all CRC screening modalities, and it requires full bowel preparation, sedation, an adult escort, and absence from work, often leading to

decreased wages on the procedure day for the patient. Besides the complications of invasiveness, it is also expensive, often affordable by only few people and individuals with health insurance (Gupta et al., 2014). Moreover, logistical and psychological complexities due to a colonoscopy procedure have the potential to develop mistrust of the medical system. This may lead to challenges in implementing colonoscopy screening within racial/ethnic minorities and the socioeconomically disadvantaged because empirical data demonstrate significant variations in accepting colonoscopy test among underserved groups (Adams et al., 2017). For example, data suggest that providing an informed choice between gFOBT and colonoscopy tends to promote screening uptake compared with offering only a single modality because certain population subgroups may choose colonoscopy due to its sensitivity and ability to detect and remove lesions simultaneously. Other population subgroups may, however, prefer gFOBT/FIT and sigmoidoscopy for comfort, convenience, and less invasiveness over colonoscopy. These variations need to be considered by practitioners and public health entities to promote CRC screening participation among individuals, particularly in underserved communities, such as newly arrived immigrant populations (Gupta et al., 2014). However, informed choices of types of CRC screening could be made based on patients' ability to understand available options, which is often impacted by their ability to understand and communicate in English.

CRC screening may be developed into phases, including patient identification, screening or rescreening, diagnostic follow-up, and treatment. This setting reflects on patients who have access to care and physicians who provide care for them. Clinicians

need to keep track of such patients and remind them through letters and during office visits, particularly those within the vulnerable ages from 50 to 75 years old. By monitoring and measuring performance and outcome measures, clinicians would be able to monitor CRC screenings for these individuals who have access to healthcare. Patient identification within this group would not be difficult to track since they see such physicians for their primary healthcare needs. Because identifying patients due for CRC screening could be effectively tracked in clinical settings, physicians and their staff need to constantly remind individuals who are due or overdue for CRC screening (Subramanian et al., 2018). For example, using logistic regression to examine 15,866 average-risk patients aged 65 years and older, non-Hispanic white with preferred English language and had health insurance, researchers showed that those individuals were more likely to be up-to-date on CRC screening. In the same study, the researchers found out that patients with no access to a gastroenterologist, who experience extreme poverty rates, and inadequate insurance coverage or underinsured were less likely to be up-to-date on CRC screening (Wang et al., 2018). The findings indicate that a variety of patient, provider, and community characteristics seemed to have an impact on CRC screening. To improve on CRC screening in a community with a variety of people, effective strategies are needed to address multilevel factors, including focusing on patients with identified individual barriers, modifying physician and clinical practices, and targeting populations with low SES or inadequate levels of medical resources (Wang et al., 2018).

On the other hand, there are occasions where low participation of CRC screening, like other preventive measures, such as mammography may be delayed due to factors

beyond the control of patients or limitations, such as LEP. For example, the emergence of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes COVID-19 compelled healthcare providers to postpone preventive care appointments since the pandemic erupted in 2019. The postponement allows healthcare resources to be shunted away from cancer screening services leading to a steep reduction in CRC screening and a backlog of patients awaiting screening tests (Kadakuntla et al., 2021). Such delays in CRC screening and other preventive measures potentially result in abrupt rise in preventable mortalities from many chronic diseases, including cancer, diabetes, and cardiovascular disease (Schoenborn et al., 2022).

Also, most individuals of Hispanic origin confronted with LEP challenges fall under the category of populations with low SES or inadequate levels of medical resources (Steinberg et al., 2016). To improve screening in this underserved population, public health campaigns need to address multiple challenges, starting with identifying unscreened individuals (Gupta et al., 2014). In general, the absence of statewide or national efforts to identify unscreened individuals is a key barrier to enhancing cancer screening in target groups needed to be screened (Ellis et al., 2018). The problem is compounded for individuals, such as foreign nationals with the burden of LEP, a key segment of the underserved populations (Goebel et al., 2015). Systems frequently employed to identify unscreened people depend on insurance or a regular place for health care, such as primary care physician’s office, making data on risk factors and prevalence of CRC screening in underserved populations limited (Song et al., 2021).

While the problems of identifying unscreened populations may be an obstacle to LEP communities in Texas, another challenging factor could be the distance from where residents live and centers where they may seek health care. Being the largest state by land size in continental United States with 254 counties, including a significant number of rural communities, Texas residents often must travel long distances to seek care. Thus, transport availability may be another logistical challenge to Hispanic LEP families, thereby suppressing efforts for CRC screening (Ioannou et al., 2021). In a survey on transportation to the specialist's office for colonoscopy, researchers found out that respondents cited lack of transportation as a key impediment multiple times, "from not having transportation, to not being able to drive the distance to the procedure, and not having someone to go with them" (Muthukrishnan et al., 2019).

Increasingly, effects of social determinants of health (SDH), such as income level, educational opportunities, occupation, employment status and workplace safety, gender inequity, racial segregation, food insecurity and inaccessibility of nutritious food choices, and access to housing and utility services tend to precipitate health issues and could potentially suppress health preventive measures, such as CRC screening (Carethers & Doubeni, 2020). Investigators argue that SDH effects, particularly unmet social needs contribute adversely to poor health of an individual than either insurance status or access to care (Fischer et al., 2021). Health analysts contend that LEP is associated with SDH, and individuals who suffer from both SDH and LEP tend to experience increased risk for poorer access to care, decreased healthcare utilization, and adverse health outcomes, which could also potentially depress health preventive measures like CRC screening

(Sentell & Braun, 2012). These observations were found in a similar study conducted in France where researchers examining cancer-related knowledge, awareness, self-efficacy, and perceptions of screening barriers among low-income, illiterate immigrant women, demonstrated that cancer screening inequalities is partly blamed on lower levels of SES, inadequate health literacy skills, and low education (De Jesus et al., 2021). Most individuals who are confronted with SDH deficits tend to have limited expertise, capital, and infrastructure, all of which are factors that exacerbate poor health preventive measures, such as CRC screening (Unger-Saldaña et al., 2020).

Furthermore, LEP individuals, including most of Hispanic Americans living in Texas may face the calamities of SDH deficits, particularly lack of health insurance. According to the United States Census Bureau, Texas is one of the states with the highest number of people without health insurance (Berchick et al., 2019). For example, in 2018, 17.7% of Texas residents (nearly 5 million people) did not have health coverage, which had ballooned from 17.3% in 2017. In 2017 and 2018, respectively, the United States had a national average of uninsured people of 8.7% and 8.9%, indicating that Texas was more than double the number of uninsured residents compared to the United States (Berchick et al., 2019). The increased lack of health insurance happened in Texas because state leaders refused to expand Medicaid, a joint state-federal program, which is the main source of health insurance for underserved communities across the United States (Sommers et al., 2016). Based on the provisions of the Affordable Care Act of 2010, states receive a huge infusion of financial cushion to support Medicaid expansion for individuals with low income (Manchikanti et al., 2017).

Analysis conducted by the Assistant Secretary for Planning and Evaluation (ASPE) of the Office of Health Policy of the US Department of Health and Human Services in 2019 showed that among the southern states, Texas accounted for a disproportionate share of the uninsured, with a total uninsured population over 4.5 million and an uninsured rate of 19% (Bosworth et al., 2021). Even though Texas has only 9% of the total nonelderly U.S. population, its portion of the uninsured within that population segment exceeds 17% of the uninsured population within that age bracket in the country, according to ASPE analysis of 2019 American Community Survey Public Use Microdata Sample (ACS PUMS) (Bosworth et al., 2021). The ACS PUMS analysis also noted that among the total uninsured population in the country, almost 9% reside in households whose adults have LEP. The investigators documented that in the United States, the highest percentage of uninsured in the LEP population occurred in the households of North Houston, Texas, where 69% of the adults in those households identified Spanish as their primary language. This grim situation is not limited only to Houston area, but cuts across the whole state, where 29% of Hispanics remained uninsured, compared to 12% non-Hispanic whites. Nationwide, among racial and ethnic populations, Hispanic Americans have the second leading uninsured rate at nearly 15%, surpassed only by American Indian and Alaska Native people, whose uninsured population sits at 22% (Bosworth et al., 2021).

Like countless number of poor, uninsured and underinsured individuals, many Hispanic populations in the United States, particularly those without legal status in the country, often fail to gain access to health care services provided across the United States,

and therefore, could not participate in preventive health measures, including CRC screening (Sohn, 2017). This finding indicates that there is a disconnect between the healthcare system and the vulnerable Hispanic populations who may not have legal status. Most of these individuals are poor, uninsured, and/or underinsured, which is an indication that disparities occur when beneficial medical interventions are not shared by all. Similarly, health disparities could emerge from a complex interaction of economic, social, and cultural factors (Brown et al., 2019). Investigators have demonstrated the overlapping factors of poverty, culture, and social injustice act as fundamental culprits of health disparities, which adversely influence all aspects of the healthcare continuum from prevention, detection, diagnosis, treatment, and survival to the end of life (Freeman & Rodriguez, 2011). While LEP is principally connected to communication, culture, and linguistics, most individuals who experience LEP deficiencies also have similar resemblance of insufficient resources, risk-promoting lifestyle and behavior, and social inequities, which are all core factors that exacerbate high rates of low CRC screening (Floríndez et al., 2020).

In promoting CRC screening in the Hispanic community, particularly among the low income, the uninsured, and recent immigrants who tend to underutilize CRC screening, Shokar et al. (2016) used the Against Colorectal Cancer in Our Neighborhoods (ACCION) to understand mechanisms in improving CRC screening. ACCION is an evidence-based cancer control program (EBCCP) designed by the National Cancer Institute (NCI) of the National Institutes of Health (NIH). It was designed to enhance CRC screening among uninsured Hispanic adults. Being a community-based

intervention, ACCION is delivered by promotors, which is made up of an educational program that uses presentations and videos, access to no-cost screening and navigation services to create awareness among the Hispanic populations in medically underserved communities (Kim et al., 2017). Using logistic regression with covariate adjustment, researchers recruited 784 subjects (467 in intervention group, 317 controls) with a mean age of 56.8years; 78.4% were female, 98.7% were Hispanic and 90.0% were born in Mexico. The researchers employed ACCION protocols, where out of 784 participants, screening uptake was 80.5% in the intervention group and 17.0% in the control group [relative risk 4.73, 95% CI: 3.69-6.05, $P<0.001$]. The researchers noted that no educational group differences were observed, and covariate adjustment did not remarkably change the outcome, an indication that ACCION mechanism of promoting CRC screening could be effective (Shokar et al., 2016).

Similarly, to understand mediators of CRC screening intervention among Hispanics, investigators used HBM to create a comprehensive conceptual framework to assess potential effects on CRC screening in the ACCION model. The investigators integrated multiple cofactors and knowledge to explain and predict screening behavior and to guide the development of screening interventions (Shokar et al., 2022). By employing structural equation modelling approach, the researchers identified factors that influence screening test completion in a successful CRC screening program, which they designed for an uninsured Hispanic population. The researchers used generalized structural equation models and surveys to collect information from participants who were randomly assigned CRC screening interventions. The researchers ensured that direct and

indirect pathways through which cofactors, CRC knowledge and individual HBM constructs, including perceived benefits, barriers, susceptibility, fatalism and self-efficacy, and a latent psychosocial health construct mediated the screening efforts (Shokar et al., 2022). The researchers recruited 723 eligible participants with a mean age of 56 years, 79.7% were female, and 98.9% were Hispanic. The researchers identified that the total intervention effect was comparable in both structural equation models, Model 1 and Model 2, with both having direct and indirect effects on screening completion (n = 715, Model 1: RC = 2.46 [95% CI: 2.20, 2.71, $p < 0.001$]; N = 699, Model 2 RC =2.45, [95% CI: 2.18, 2.72, $p < 0.001$]. Shokar et al. (2022) realized that in Model 1, 32% of the total impact was influenced primarily by the latent psychosocial health construct (RC = 0.79, $p < 0.001$), which had its effect due primarily to self-efficacy, perceived benefits, and fatalism. In Model 2, the authors noted that the primary mediators were self-efficacy (RC = 0.24, $p = 0.013$), and fatalism (RC = 0.07, $p = 0.033$). According to the researchers, the outcomes highlighted the importance of mediators in understanding ways to improve on CRC screening, suggesting that a focus on self-efficacy, perceived benefits and fatalism could promote the effectiveness of CRC screening interventions particularly in Hispanic populations (Shokar et al., 2022).

Investigating CRC screening among a group of South Asians in the Metropolitan New York and New Jersey region, Manne et al. (2015) noted that the rates are consistently lower than the United States general population estimates of 65%. A comparable study on Chinese, Japanese, and Vietnamese showed higher CRC rates than most of the South Asian populations, such as Bangladeshi ethnicity who are far less

fluent in English. Also, individuals from the South Asian populations who have lived fewer years in the United States compared to those who have lived in the country much longer indicated low rates of CRC screening (Lee et al., 2011). According to Manne et al. (2015), there is a correlation between low CRC screening among individuals of South Asian origin with less fluency in English. Typically, such individuals also show perspective about the United States healthcare system that may be suggestive of cultural beliefs like those seen in the Hispanic American communities, including the extent of trust in the healthcare system. Also, the inability to communicate freely with health care providers has been reported as a hindrance to CRC screening among South Asians, which is reminiscent of LEP challenges confronting individuals whose primary line of communication is not in English like the Hispanic Americans. Thus, LEP deficiencies transcend through different cultures and bear similar sociocultural resemblances (Berdahl & Kirby, 2019).

While perceptions around healthcare systems bear resemblances, it is inevitable that certain cultural and health concepts differ across cultures. For example, fundamental values like Latino familism, collectivism, and moderation are likely to be varied among Hispanics of different countries of origin, which may be even more widely varied between people of Hispanic origin and the general American society, most of whom take their roots and fundamental beliefs from the sociocultural lineage of Caucasian roots (Valdivieso-Mora et al., 2016). These primary variations in culture between Hispanics and traditional American approach to healthcare tend to influence the way Hispanic populations would seek CRC screening. The appreciation of culture indicates that many

variables affect the ability to adopt to healthy behaviors. However, the integrative behavioral model (IBM) shows that factors such as normative and subjective beliefs, attitudes towards behaviors, perceived control and self-efficacy, and knowledge about replacement behaviors have the potential to raise awareness about preventive health measures, such as CRC screening. The IBM demonstrates that environmental conditions could influence the intention and ability of individuals to adopt desired behaviors that promote primary health screenings (Robb, 2021; Smith-McLallen, & Fishbein, 2008).

To further appreciate CRC screening from a cross-cultural perspective, a study on Korean Americans (KAs), who also report suboptimal CRC screening adherence like Hispanic Americans, was considered. In a study which applied cross-sectional survey through self-report measurements, investigators evaluated factors that motivate KAs to comply with CRC screening guidelines using Andersen's Behavioral Model of Health Services Utilization, which postulates that individuals use health care under the condition that their predisposing characteristics, enabling resources, and need factors all operate fully together (Jin et al., 2019). Investigators recruited 433 KAs aged 50–75 from the Atlanta metropolitan area. Investigators measured factors linked with CRC screening, such as predisposing factors, including gender, age, marital status, educational attainment; enabling factors, such as income, health insurance, regular annual check-ups, doctor's recommendation, English proficiency, CRC knowledge, self-efficacy for CRC screening, decisional balance in CRC screening; and need, which dealt with family cancer history and self-reported health status (Jin et al., 2019). Using a multiple logistic regression model including all 14 predictor variables, the authors found out that most

enabling factors, particularly income, regular annual health check-ups, doctor's recommendation, self-efficacy, and decisional balance independently predicted enhanced CRC screening adherence in KAs. However, no predisposing or need factors could be used independently to show improved CRC screening (Jin et al., 2019). The findings echoed existing literature that high income is related to enhanced utilization of cancer screening (Kelly et al., 2017). Similarly, adequate coverage of health insurance approvingly provides access to cancer screening, and availability to primary care physicians promotes regular check-ups or physician's recommendation for cancer screening, which is associated with improved CRC screening (Jin et al., 2019). Like the Hispanic communities, KAs are also influenced by cultural and psychological factors, such as language barriers limiting people's ability to navigate complications associated with the United States healthcare system and use of CRC screenings, such as colonoscopy preparations. For example, KAs with LEP are less likely to comply with CRC screening (Jin et al., 2019).

In a related study, researchers used nonexperimental, online survey research design at the Minnesota State Fair to investigate whether male role norms (MRN) (avoidance of femininity, dominance, importance of sex, negativity toward sexual minorities, restrictive emotionality, self-reliance through mechanical skills, and toughness), knowledge, attitudes, and perceptions could affect the intention to screen for CRC among 297 African American men (Rogers et al., 2018). The investigators hypothesized that the target population (Minnesota men aged 18 to 65) did not have adequate CRC knowledge. They found out that only 33% of the sample obtained a

"passing" knowledge score (85% or better). Using a logistic regression model, the investigators noted that three factors remarkably linked to an increased probability of receiving CRC screening, including age, perceived barriers, and perceived subjective norms. While the study focused only on African American men, the authors suggested that their findings led to a solid basis for informing stakeholders on health policy and promotion that early-intervention for CRC prevention programs could be responsive to the needs of African American men (Rogers et al., 2018).

**Health-related LEP**

From the time it was created in 2000, the concept of LEP has affected many policy decisions in a wide spectrum of social and public services, particularly in the areas of healthcare for immigrant communities (Ortega et al., 2021). Using an executive order, President Bill Clinton enshrined LEP in the lexicon of the United States federal government policy and has since become inextricably embedded in the panoply of civil rights protections codified in the Title VI of the Civil Rights Act of 1964 (Office for Civil Rights (OCR), Office of the Secretary, HHS, 2016). Within the arena of public health and health policy, the federal government defines LEP as "Individuals who do not speak English as their primary language and who have a limited ability to read, speak, write, or understand English". Policymakers consider such individuals to be entitled to language assistance with respect to a particular type of service, benefit, or encounter, and this consideration has become operationalized in many federal agencies, such as the Department of Health and Human Services (Foiles Sifuentes, et al., 2020). Despite its provisions to support individuals with limited English language understanding, LEP

presents significant challenges within the healthcare industry. For example, owing to the diverse and growing multilingual communities in the United States, LEP could be problematic in three areas: the ethnocentric notion of a “primary language,” the ambiguous idea of “limited ability,” and the deficit-oriented construct of “language assistance” (Ortega et al., 2021).

The concept of primary language presumably demonstrates that lives of individuals are shaped by the language they speak. However, linguistic repertoires in more than one language show that multilingual individuals distribute their languages along a continuum of domains, preferring to use languages they are more fluent in than the others that they encounter vocabulary deficits (Heller, 2007). The definition of LEP examines limited ability to speak, read, write, or understand English as a fundamental hallmark of the LEP individual, even though principally speaking, reading, writing, and understanding English differ significantly from context to context. Also, an individual may have limited ability to speak, read, write, and understand English, but they may have effective means of collaboratively use family members, such as their English-speaking children to support them in the literacy practices in the English language (Ortega et al., 2021). Language assistance in the LEP definition may be construed to mean handicap, which needs to be remedied so that individuals seeking language assistance would not consider themselves as being deficit of some sort, a condition that may have the potential to adversely affect public health campaigns, such as initiatives for cancer screening (Francis & Silvers, 2016).

Thus, linguistically, LEP has implications for healthcare. Language analysts in healthcare indicate that linguistic minorities who are target population for effective health delivery must be supported with language-appropriate services (Schiaffino, Al-Amin, & Schumacher, 2014). Researchers suggest that two main approaches to providing suitable language in communication are language-concordant care, where services are provided by a clinician who speaks the same language as the patient, and interpreter-mediated care, which includes a medical interpreter participating as a linguistic conduit between the patient and clinician (Ortega et al., 2021). Language-concordant care has been shown to enhance successful treatment outcomes, decrease healthcare costs, improve patient satisfaction, minimize medical errors, and to promote health prevention activities, such as cancer screening (Diamond et al., 2019). Similarly, professional medical interpretation in language-discordant health experiences indicate remarkable benefits in the care of linguistic minorities, although it is often underutilized (Schulson & Anderson, 2022).

Notwithstanding the practical understanding of LEP associated with language-concordant care and interpreter-mediated care, it often assumes complexities for healthcare providers and patients particularly in medical visits involving multigenerational family members. For example, in cases where simultaneous presence of both young and older generations of a family visit a clinic together, the younger ones may prefer to communicate in English while the older generations with limited English preferably seek medical interpreters or language-concordant health care providers. Therefore, the involvement of linguistic practices such as Spanglish, among other ways of translanguaging, are part of everyday lives of multilingual individuals, where a single

language category may not sufficiently meet their language preferences during a medical visit (Ortega & Prada, 2020).

In some cases, direct translation from one's dominant language to English for a medical symptom may be difficult. Therefore, it may not be the patient whose proficiency in English is necessarily limited but the English itself is limited in expressing the concept that the patient would like to communicate to the clinician. Researchers indicate that this complexity in divergent health terminology seems universal to both non-English and English languages, which often present a challenge in health communication. Such handicaps are not related to LEP (Ortega & Prada, 2020). It is also important to appreciate that even people who are competently fluent in English may likely encounter handicaps in communicating complex health concepts, especially under conditions of illness, stress, or emergency. Such difficulties do not fit the current classification of LEP (Ortega et al., 2021).

Patients who are confronted with challenges of LEP may seek physicians who speak a language they understand and could use as a medium of communication, which makes patient-provider language concordance important to CRC screening among individuals who suffer from LEP (Kim et al., 2018). Investigators suggest that although patient-provider language concordance is unable to fully explain all language-based health disparities, they have identified that it predicts both access to health care and health status (Sentell et al., 2013). However, they also find that language concordance and CRC screening are specifically mixed because in some studies, people with LEP in patient-provider language-concordant relationships showed increased rates of CRC

screening compared with individuals in language-discordant relationships (Hsueh et al., 2021). Yet, in other studies, LEP people with language concordant providers showed lower screening prevalence compared with individuals with a language-discordant providers, indicating that LEP alone may not explain the complexities of lower screening (Sentell et al., 2013). Notwithstanding such discrepancies, LEP is seen to be a dominant factor in low rates of CRC screening among foreign-born individuals in the United States (Manne et al., 2015).

To enhance CRC screening for LEP patients, researchers argue that patient navigation, defined as "patient-centered healthcare service delivery model", could guide patients through the complex and disconnected healthcare system to remove obstacles to timely care (Sentell et al., 2013). Because patient navigation has shown the potential to promote effective cancer screening in vulnerable populations such as individuals who suffer from LEP, the Affordable Care Act (ACA) of 2010 employs it as an enhancement tool for healthcare promotion, particularly among individuals with low SES. Since its enactment, the ACA has promoted accessibility standards that necessitate all information to be in simple language that is culturally and linguistically receptive to LEP individuals (Adepoju et al., 2015). Investigators have found that patient navigators significantly augment complete screenings for breast, cervical and/or CRC. Patient navigation could be essentially important for CRC screening among individuals like the Hispanic Americans in Texas with LEP deficiencies since CRC screening methodologies, such as colonoscopy preparation is significantly complex (Cotter et al., 2019).

**Gender and CRC Screening**

Researchers suggest that sex variations from both biological and sociocultural gender differences contribute to CRC in men and women. Therefore, acknowledging the impact of sex and gender on CRC may generate greater understanding on enhancements to early detection and diagnosis with greater treatment outcomes and survival (White et al., 2018). In the United States, investigators have reported higher CRC age-adjusted incidence among men than among women persistently for more than 30 years, even though investigators reveal that gender differences have diminished in individuals ≥60 years. The gap in the incidence of CRC narrows as people advance in age. The highest rate reduction in incidence over a period of time is seen among individuals who are over 80 years of age ($p$<0.001) followed individuals in the 70-79 and 60-69 age brackets (Abotchie et al., 2012). The findings documented by the researchers reflected findings in recent studies conducted in the United States. For example, an investigation conducted by Cook et al. (2009) delineated an incidence rate ratio of 1.37 between men and women in the original 9 SEER areas in 1975–2004. In another study that broke down participants into racial segments, Murphy et al. (2011) used the 13 SEER areas in 1992–2006 to delineate an incidence rate ratio of 1.37 between men and women for non-Hispanic whites, 1.48 for Hispanics, 1.30 for blacks, and 1.43 for Asians, all indicating higher incidence for males than females. In a related study conducted in the United Kingdom, White et al. (2018) reported that more men develop CRC, with age-standardized rates (ASRs) of 86.1 per 100,000 men compared to 56.9 per 100,000 women in the United Kingdom in 2014, which translated into 22,844 men and 18,421 women new cases

annually. Globally, the incidence rate is higher for men than women (746,298 vs 614,304 [20.6 vs14.3 ASR]) and mortality (373,639 vs 320,294 [10 vs 6.9 ASR]) for CRC (Douaiher et al., 2017).

For CRC screening between men and women, studies indicate that both sexes report similar rates, although men preferred a significantly higher rate of colonoscopy use than women based on self-reporting data. However, when investigators examined test-specific screening compliance with medical record data, there was no significance between men and women, which may be an indication of reporting bias (Griffin et al., 2009). Another study also showed that men and women participants reported similar choices for CRC screenings mode, however, the researchers identified remarkable variations in the barriers and facilitators to screening between both sexes (Friedemann-Sánchez et al., 2007). Analysis of data indicated that women consider the preparation for endoscopic procedures as a hindrance to screening while men have no concerns regarding endoscopic procedure preparation. However, women and men showed varying degrees of worry and expressed different information choices about endoscopic procedures. Also, women considered CRC as a male disease, and therefore may be less vulnerable to CRC, presumably due to the impact of reproductive health over women's lifetime (Friedemann-Sánchez et al., 2007). Another study that featured only on African Americans, researchers reported that no stark differences were observed between men and women in their decision to screen for CRC or in their concerns about cancer, even though the researchers found that men and women had significantly varied understanding of CRC knowledge (McKinney & Palmer, 2014).

**Cultural Influences on CRC Screening**

A study by Diaz et al. (2013) cited various potential socio-cultural elements that may describe disparities in CRC screening rates between non-Hispanic Whites and Hispanics. The researchers noted that the relationship between LEP and low CRC screening rates among Hispanics is complicated and may be due to more than a patient-provider communication barrier. Their argument is supported by other studies that indicate that LEP could be a proxy for lower levels of acculturation, which is known to have an inverse relationship with cancer screening behaviors among Hispanics (Mantwill & Schulz, 2017). Assessing a 2005 California Health Interview Survey, Johnson-Kozlow et al. (2009) noted that Mexican-Americans who were highly acculturated were nearly 4 times likely to participate in CRC screening compared with less acculturated Mexican-Americans. Similar findings have been reported in other studies that featured some Asian Americans, including Indians and Filipinos, where CRC screening rates were abysmally low; however, the same study noted that Japanese, Chinese, Korean, and Vietnamese had higher CRC screening rates comparable to non-Hispanic whites in the United States. The researchers noted that higher education, acculturation, and high income was observed among individuals with increased CRC screening, while those with less education and have not been in the United States for a considerable period of time tend to have low CRC screening (Burnett-Hartman et al., 2016; Ghai et al., 2018).

To minimize the impact of cultural effects on CRC screening, researchers indicate that it is crucial to appreciate cultural implications of factors that suppress screening. For example, previous studies showed that a significant proportion of Hispanics erroneously

embrace certain misconceptions about cancer that tend to decrease their participation in cancer screening (Tejeda et al., 2017). These misconceptions may be related to perceptual and behavioral differences associated with cultural and ethnic backgrounds of the community, which may influence their beliefs about cancer prevention and views about etiology of the disease. Consequently, there is likelihood of prolonging the time to seek preventive care, such as CRC screening, leading to late detection and poor prognosis (Diaz et al., 2013). A classic misconception within the Hispanic community highlights the belief that rectal sex is linked with CRC, and this assertion presents as potential socio-cultural barrier to screening among LEP Latino men (Villar-Loubet et al., 2016).

**Methodology**

Ratnapradipa et al. (2021) conducted cross-sectional study in a Latino-serving federally qualified health center (FQHC) to understand obstacles to CRC screening and related factors in a Midwest Latino community in Omaha, Nebraska. The researchers recruited 68 Latinos at a FQHC from June to October 2017 for their investigation, and explored factors related to scheduling, psychological, and financial barriers using t-test, ANOVA, and multiple linear regression analyses. The subjects for the investigation identified themselves with low education, low income, and reduced access to health insurance or a primary care physician. Upon examination, the researchers identified scheduling barriers as the leading obstacle compared with psychological and financial barriers. Ratnapradipa et al. (2021) noted that being married or coupled was identified as the only predictor of higher scheduling barriers ($p < .05$), and that was related to higher psychological barriers in both univariate and multivariate analyses ($p < .05$). The

researchers also found out that higher education level positively correlate with higher psychological barriers in univariate ($p < .05$) only and not in multivariate analysis. In comparison with individual subjects with lower English proficiency, those with higher proficiency obtained a higher financial barrier score in univariate ($p < .05$) only and not in multivariate analysis. The researchers concluded that although interventions focusing on CRC screening barriers, such as the availability of free at-home testing were effectively provided, perceived barriers remained in place. To address the problem, the researchers recommended bilingual patient navigators to support individuals with LEP who would assist them with scheduling without fees for colonoscopy scheduling services. Similarly, individuals who are well educated but are confronted with increased risk of psychological barriers should be given more education on the relevance of CRC screening (Ratnapradipa et al., 2021).

In a randomized clinical trial, Oyalowo et al., (2022) assessed the effectiveness of an intervention via telephone conversation prior to fixing a date for screening or surveillance colonoscopy and its impact on CRC screening completion rates. The researchers argued that CRC screening is underused in the United States. They collected data from July 2017 through August 2018 at the University of Pennsylvania Health System, an urban academic medical center, where subjects recruited included asymptomatic individuals, whose ages ranged from 50 to 75 years. The participants whose primary care physicians had referred them for colonoscopy and were eligible for CRC screening, had no scheduled colonoscopy appointment. The interventions included individuals undergoing block randomization in a 1:1:1 ratio to 1 of 3 study groups,

namely “usual care group”, “generic message group”, and “tailored group”. In the usual care group, subjects received a mailed letter and directed to make a schedule for colonoscopy. In the generic message group, subjects were reached by telephone, completed an evaluation, and were given a uniform, nontailored message that inspired them to set up a colonoscopy appointment. Subjects in the tailored message group were reached by the researchers via telephone, conducted an evaluation and were given a tailored message that inspired them to schedule for colonoscopy appointment based on their identified assessment cohort (Oyalowo et al., 2022).

The researchers performed data analysis from January to September 2019. The researchers considered colonoscopy completion rate as their primary outcome, which occurred within 120 days of enrollment, while colonoscopy scheduling appointment rate was their secondary outcome, which occurred within 120 days of enrollment. The researchers recruited 600 participants (median [IQR] age, 56 [51-63] years; 373 women [62.2%]) were enrolled. The total number was divided evenly into 200 participants each, and were randomized to usual care, generic message, and to the tailored message. Of the total sample, 12 were Asians (2.0%), 324 were Blacks (54.0%), and 227 were Whites (37.8%), while 9 participants (1.5%) were of Latino or Hispanic ethnicity. The analysis indicated that colonoscopy completion was remarkable enhanced for both the individualized message group (69 participants [34.5%]) and the generic message group (64 participants [32.0%]) in comparison with the usual care group (37 participants [18.5%]) ($p < .001$ and $p = .002$, respectively) (Oyalowo et al., 2022). In addition, Oyalowo et al. (2022) noted that scheduling rates were remarkably increased in both

groups, with 106 participants (53.0%) in the individualized message group and 105 participants (52.5%) in the generic message group scheduling appointments in comparison with 54 participants (27.0%) in the usual care group ($p < .001$ for both). Based on the results, the researchers concluded that among people who do not have current CRC screening, either giving them a specific message on intervention or a generic message on intervention was effective in enhancing colonoscopy scheduling and completion rates compared with usual care. The findings indicate that tailoring health communications could improve personal motivation to seek CRC screening.

In assessing equity and practice issues in CRC screening, Buchman et al. (2016) used mixed-method approach to study overall CRC screening rates, patterns in the application of types of CRC screening, and sociodemographic features related to CRC screening. Their effort led them to understand physicians' perceptions regarding the use of FOBT and colonoscopy for individuals at average risk of CRC. The researchers applied and received research ethics board approval for the study, which was permitted by Sunnybrook Health Sciences Centre and St Michael's Hospital in Toronto, Canada, where the study was conducted. The researchers employed cross-sectional administrative data on individual sociodemographic features and semi-structured telephone interviews with physicians. Participants were patients aged 50 to 74 years, and they were recruited from April 1, 2009, to March 31, 2011. The long duration of recruitment allowed for understanding the patterns of CRC screening, and all the important physician-ordered and diagnostic tests were covered in whole without copayments or deductibles. The study used physicians in family health teams in the Toronto Central Local Health Integration

Network. For quantitative analysis, descriptive measurements assessed proportions stratified by income quintile, age, sex, and recent registration with Ontario Health Insurance Plan (OHIP) as well as rate ratios. The researchers measured rates of CRC screening by type; sociodemographic features related to CRC screening and thematic evaluation that assessed constant comparative approach for semi-structured interviews. For the physicians interviewed, their ages ranged from 27 to 62 years and had between 1 and 27 years in independent practice. The interview had an average length of 32 minutes and was conducted between July and November 2012. The interview focused on methods to perform CRC screening, physician preferences with respect to screening varieties, the impact of patient preferences and beliefs, the impact of gastroenterology on screening practices in family medicine, availability of health resources and influence of equity matters, administrative setups and infrastructure, and influence of preventive care financial incentive. All interviews were digitally audiorecorded to ensure exact transcription (Buchman et al., 2016).

The results indicated that Ontario administrative data on CRC screening demonstrated reduced total screening rates for younger individuals, male patients, individuals identified with lower income, and people who had just immigrated into the community. Specifically, individuals with low income and recent immigrants recorded low rates for colonoscopy. Analysis from the semi-structured interviews indicated that physician had divided opinions about CRC screening for average-risk patients, with one batch of physicians noting that the evidence and recommendations for FOBT were appropriate and another batch of physicians considering colonoscopy as the best option

for these patients, citing the inferiority of the FOBT method. The investigators concluded that a clear variation of opinions exist, and physicians depend on specialist recommendations, health care system, and patient expectations to make their choices of CRC screening type (Buchman et al., 2016). The results of the study echoed other studies elsewhere. For example, in the United States, investigators have documented that low SES is an important determinant associated with low screening rates, and often individuals in that category present with advanced CRC (Salem et al., 2021). The findings of the study also showed that providing an informed choice of screening applications to patients would likely promote increased screening rates and reduce disparities, and these assertions might be realized when changes are made to policy and physicians alter their attitudes to allow such changes (Buchman et al., 2016).

The study approach has strengths and limitations. For example, the administrative data used by the investigators broadened the study to cover population-wide perspective on rates of screening and the association between screening and sociodemographic elements. Disparities in screening by area-level income, age, sex, and recent immigration were unfolded in a way that could be generalized for the Toronto Central Local Health Integration Network and in Ontario, although these disparities frequently varied for colonoscopy and FOBT. Administrative data are usually gathered for multiple reasons and not necessarily for investigations (Buchman et al., 2016). Thus, it was possible that not all variables were covered in the data collection. For example, individual-level income or immigration status could be missing from the data, making proxy measures like area-level income obtained from zip codes and past registration with OHIP as

alternative options used in their place. Also, administrative data could not differentiate CRC testing conducted solely for screening from diagnostic testing performed when patients were symptomatic. The researchers also noted that the quantitative analysis showed relevant patterns, even though the data failed to reveal purposes ascribed to varying applications of colonoscopy and FOBT. The strength of the qualitative assessment relies on its tendency to explain the patterns emerged from the screenings obtained. Thorough interviews granted by the physicians about screening preferences and the purposes behind their decision making and office practices allowed a complete evaluation of the methods employed by the physicians (Buchman et al., 2016).

In a study where researchers sought to understand the impact of language barriers on cancer screening for LEP patients, Genoff et al. (2016) reviewed several articles. They set up eligibility criteria and measured the quality of the articles using the Downs and Black Scale. The eligibility criteria focused on articles that had: (1) a study target group of patients with LEP deficiencies suitable for breast, cervical or colorectal cancer screenings, (2) a patient navigator intervention to give services before or at the time of cancer screening, (3) a contrast between patient navigator intervention and either a control group or a different intervention, and (4) language-specific results associated with the patient navigator intervention. Their eligibility criteria were satisfied by fifteen studies that met the inclusion criteria. The researchers measured the screening rates for breast, colorectal, and cervical cancer in 15 language populations, out of which 14 studies had outcomes that enhanced screening rates for LEP patients between 7 and 60%. The researchers found great variability in the patient navigation interventions they measured.

Admittedly, the researchers noted that their study had limitations due to the variability in study designs and limited reporting on patient navigator interventions, which potentially decreased the ability to make conclusions on the complete impact of patient navigators. However, the researchers noted that overall, there was evidence that navigators promote screening rates for breast, cervical, and colorectal cancer screening for LEP patients. They advocated that future investigation must systematically gather data on the training curricula for navigators and evaluate their English and non-English language skills in an attempt to understand means to minimize disparities for LEP patients.

In another investigation, comparing Latino community members' and clinical staff's perspectives on barriers and facilitators to CRC screening, Alpert et al. (2021) used qualitative study to contrast the views of clinical staff (CS) and Latino community members (LCMs) in an urban Southern California community. Analyzing with purposive sampling, 39 LCMs (mean age: 59.4 years, 79.5% female) subjects were selected to participate in one of five focus groups. Also, 17 CS (mean age: 38.8 years, 64.7% female) were chosen to participate in semi-structured comprehensive interviews, together with a demographic survey. The researchers documented the interviews and focus group recordings by transcribing them verbatim, which were then translated, and assessed with direct content analysis. They also documented the demographic data using descriptive statistics, and the themes considered include perspectives about CRC screening, CRC knowledge, access to resources, commitments and responsibilities, social support, vicarious learning, patient-provider communication, trust, and social relationships. The results reveal that both CS and LCMs perceive barriers and facilitators of CRC screening,

which the investigators argue that such findings could be used to guide interventions and policies to enhance access to CRC screening among LCMs (Alpert et al., 2021).

In a similar study, researchers investigated barriers and facilitators for CRC screening in a low-income urban community in Mexico City, Mexico. The researchers argued that owing to integration of changing lifestyles and improved healthcare infrastructure to facilitate diagnosis, clinicians have an opportunity to diagnose CRC early and improve on treatment outcomes (Unger-Saldaña et al., 2020). The researchers sought to determine possible obstacles and facilitators for future application of FIT-based CRC screening in a public healthcare system using qualitative study with semi-structured individual and focus group interviews with different CRC screening stakeholders. The stakeholders included 30 common people at average risk for CRC, 13 health care personnel from a local public clinic, and 7 endoscopy personnel from a cancer referral hospital. The researchers transcribed verbatim all interviews and they evaluated the data with constant comparison method based on theoretical perspectives of the social ecological model (SEM), the PRECEDE-PROCEED model, and the HBM. The results of the analysis at several levels of the SEM identified both obstacles and facilitators. Primarily, the barriers in each of the SEM levels included (1) at the social context level; (2) at the health services organization level; and (3) at the individual level. The social context level comprises poverty, health literacy and lay beliefs linked to gender, cancer, allopathic medicine, and religion. The health services organization level comprises a deficiency of CRC knowledge among health care personnel and the community understanding of low quality of health care. The individual level deals with inadequate

CRC awareness, which presents with absent risk perception in association with fear of participating in screening activities likely to expose a serious disease. Unger-Saldaña et al. (2020) concluded that their findings postulate that multi-level CRC screening initiatives in middle-income countries like Mexico must establish supportive plans of action to find solutions to barriers and facilitators, such as (1) provision of free screening tests, (2) education of primary healthcare personnel, and (3) promotion of benefits of CRC screening information that focuses on the target population, individualized to ease common lay beliefs of fear and uncertainty.

Also, Brand Bateman et al. (2020) conducted a qualitative study on perceptions of Egyptian primary care physicians and specialists to explore their perspectives on CRC screening. According to the investigators, over a third of CRC cases occur in people aged 40 years and younger, which often result in late diagnosis and poor treatment outcomes. The researchers employed the PRECEDE-PROCEED model, which depends on predisposing (intrapersonal), reinforcing (interpersonal), and enabling (structural) factors. These factors were inherent in health behaviors, which they used as their theoretical framework. Individuals who took part in the study as participants were primary health care physicians, oncologists, and gastroenterologists practicing in Alexandria, Egypt. The physicians participated in 1-hour semi-structured interviews, which were audiorecorded, transcribed, translated into English, and assessed using thematic analysis. Based on the results with 17 physician participants (n = 8 specialists and n = 9 primary care physicians), the researchers noted that barriers to CRC screening were identified as SES, inadequate education on prevention, fear, and cost (predisposing). Other barriers

mentioned included people's assumption that only high-risk patients were eligible for screening; disbelief that providers were not qualified to conduct and interpret screening tests properly (reinforcing); astronomical cost of the procedure; unavailability of the tests; and inadequate training for laboratory technicians and providers (enabling). The researchers also identified potential facilitators as establishing a media campaign that educate populations about early detection, curability, and prevention (predisposing); training physicians and inducing physician engagement (reinforcing); and minimizing costs, ensuring that screening tests are adequately provided, and supporting well-trained providers (enabling) (Brand Bateman et al., 2020). The study suggested that Egypt would need a CRC screening program, and for it to be successful, it must address barriers at multiple levels to improve on participation by eligible individuals and vulnerable populations.

Embracing Protection Motivation Theory (PMT), Wei et al. (2022) assessed motivating elements on CRC screening among urban Chinese population in five communities in Wuhan, China. The investigation was a qualitative study where the researchers used cross-sectional survey, and all eligible urban Chinese were recruited and interviewed using paper-and-pencil questionnaires. The intention of CRC screening was assessed on six PMT subconstructs, namely perceived risk, perceived severity, fear arousal, response efficacy, response cost, and self-efficacy. The investigators also gathered data on sociodemographic variables and knowledge of CRC, and they employed structural equation modeling application to conduct data analysis. The researchers had 569 respondents, of whom 83.66% agreed to take part in the CRC screening, which

represented adequate data that fit the proposed structural equation modeling well (Chi-square/df = 2.04, GFI = 0.93, AGFI = 0.91, CFI = 0.91, IFI = 0.91, RMSEA = 0.04).

The researchers found out that 2 subconstructs of PMT (response efficacy and self-efficacy) and CRC knowledge linearly associated and positively related to the screening intention. On the contrary, through at least one of the two PMT subconstructs (response efficacy and self-efficacy), the researchers noted that age, social status, medical history, physical activity, and CRC knowledge were inversely associated with the screening intention. The researchers concluded that their findings demonstrate the significance of enhancing response efficacy and self-efficacy in promoting urban Chinese adults to undertake CRC screening. They also acknowledged that knowledge of CRC is remarkably linked with screening intention (Wei et al., 2022).

Employing the 2016 BRFSS survey, Viramontes et al. (2020) explored screening modalities, predictors, and regional disparities among Hispanics and non-Hispanic whites (NHWs) in the United States using a cross-sectional analysis of Hispanic subjects aged 50 to 75. The researchers depended on participants' self-reported CRC screening status, and they used the Rao-Scott Chi-square test to analyze competing screening rates and modalities in NHWs and Hispanics. The researchers explored regional screening disparities by using univariable and multivariable logistic regression to measure predictors of screening among Hispanics and evaluated Hispanic-NHW screening rate variations for each demographic area/territory. Their assessment revealed a screening rate of 53.4% for Hispanics (N = 12,395), and 70.4% for NHWs (N = 186,331) ($p < 0.001$). The findings also showed that 75.9% of Hispanics preferred colonoscopy to other forms

of CRC screening. Also, uninsured status (aOR = 0.51; 95% CI = 0.38-0.70) and limited access to medical care (aOR = 0.38; 95% CI = 0.29-0.49) was associated with lack of screening. The researchers concluded that comparatively, Hispanics have lower CRC screening rates than NHWs across most United States, but disparities were more significant in some states than other highest screening variations occurring in North Carolina (33.9%), Texas (28.3%), California (25.1%), and Nebraska (25.6%), while New York (2.6%), Indiana (3.1%), and Delaware (4.0%) had smallest disparities (Viramontes et al., 2020).

Hill et al. (2022) undertook a retrospective cohort study to compare mt-sDNA test among participants with LEP and English proficient participants, from 2015 to 2018. The researchers matched participants with LEP to English proficient participants by age at a 3:1 ratio. Results obtained indicated that among participants with LEP, 53% had mt-sDNA tests without useful results compared to 29% among English proficient participants ($p < 0.0001$). Also, individuals with LEP had 62.5 median number of days from order placement to test completion compared to 33 for English proficient individuals ($p = 0.003$). The researchers concluded that disparity was remarkable in CRC screening completion with mt-sDNA test among subjects with LEP, which may be partly a reason for increased disparities in CRC mortality among individuals with LEP challenges (Hill et al., 2022).

## Summary and Conclusions

Studies that use factors of key behavioral theories, such as HBM, TTM, PMT, IBM, BMHSU, SCHBM, and HBF tend to independently identify important elements

that shape the interest of individuals in receiving CRC screening. Understanding the factors that promote participation is critical to raise participation and reduce attendant CRC morbidities and mortalities (Jung, 2020). Several investigations have highlighted screening behavior factors associated with potential participants, providers, or healthcare system. These influencing factors could be described as non-modifiable, which may include demographic factors (e.g., age, sex, race), education, health insurance, or income, and modifiable factors, such as knowledge about CRC and screening, patient and provider attitudes or structural barriers for screening (Wang et al., 2019). Health care providers could not do much to alter the trajectory of nonmodifiable factors. However, modifiable determinants are suitable points of alteration, and they are considered as the plausible targets for intervention, leading to substantial decline in CRC risk. Knowledge, perceived susceptibility, perceived severity, perceived benefits, perceived self-efficacy, behavioral intention, and preventive behaviors tend to promote CRC screening, which low SDH, such as low SES, and recent migration and LEP tend to depress CRC screening participation. Researchers indicate that these factors are influential in public health campaigns that enhance CRC screening (Rakhshanderou et al., 2020). Among Hispanic Americans, particularly those whose primary language is not English, their participation in CRC screening is abysmally low (Heintzman et al., 2022).

Numerous studies confirm that LEP is a hindrance to effective CRC screening due to its limitations on communication between health care providers and their patients who face shortcomings in patient-provider language concordance (Diamond et al., 2019). Researchers extrapolate LEP challenges to potential socio-cultural impediments that

exacerbate disparities in CRC screening because they argue that LEP could be a proxy for lower levels of acculturation, which is known to have an inverse relationship with cancer screening behaviors among Hispanics (Mantwill & Schulz, 2017). To understand the impact of LEP on CRC screening, confounding factors, such as age, income, occupation, health care access, and educational levels of participants could be isolated to appreciate the effects of LEP on low CRC screening among Hispanic Americans in Texas.

# Chapter 3: Research Method

## Overview

The purpose of this study was to explore the perceptions of LEP and its repercussions on Hispanic Americans in Texas about CRC screening rates. In many respects, LEP as a language barrier leads to unmet challenges for non-English speaking communities in the United States. Investigators suggest that poor and marginal levels of English proficiency may be blamed as key culprits in suboptimal participation of CRC screening among individuals whose primary language is not English (Mojica et al., 2015). Because of their low participation in CRC screening, people with LEP tend to receive diagnosis for CRC at late stages of disease, which often results in poor prognosis. According to one study, recent immigrants and LEP populations tend to have greater odds of late-stage diagnosis of CRC (Batai et al., 2019; Stern et al., 2016).

To ensure an effective preparation for a CRC screening procedure, such as colonoscopy, patients need to follow instructions that would lead to proper visualization of the mucosa of the colon and rectum. Studies indicate that colonoscopy preparation involves adequate bowel cleansing, which is critical to ensure good quality of the procedure (Kastenberg et al., 2018). Unfortunately, bowel cleansing has been noted as inadequate in nearly one-third of procedures (Tontini et al., 2021). A key factor noted by health care providers involves drawbacks in patient-dependent factors, mainly their inability to follow instructions needed for bowel preparation. Cleansing quality relies on the understanding of solution preparation, volume, taste, and timing of consumption

(Tontini et al., 2021). This study would bring to light the extent of impact of LEP on CRC screening rates among Hispanic Americans in Texas.

This study would also examine if gender differences existed for CRC knowledge, intention to screen, perceived risk, and cancer worry among Hispanic Americans in Texas when potential confounding variables, such as age, income, occupation, health care access, and educational levels of participants are controlled. The study would highlight differences in gender among individuals who suffer from LEP, which would examine whether sex differences of the participants influenced their CRC screening rates. An investigation conducted by Friedemann-Sánchez et al. (2007) on gender differences in CRC screening barriers and information needs revealed that female and male subjects had similar preferences for CRC screening mode; however, both males and females were noted to have variations in the barriers and facilitators to screening. This study sheds light on variations in the participation of both Hispanic men and women who undertake CRC screening in Texas. The study assesses whether gender alone and/or gender with LEP effects contribute to any differences between men and women of Hispanic origin for CRC screening. Understanding the influence of gender differences on CRC screening would lead policymakers to address shortfalls and improve on the overall CRC screening intervention for both men and women.

**Instrument to Measure Limited English Proficiency**

Hospitals that tend to operate without reliable language screening tools often fail to support their LEP patients with proper interpretation of care they provide. For effective delivery of health, providers need good appraisal of the number of individuals with LEP

in a community to evaluate language need and language service provision (Taira et al., 2020). Boscolo-Hightower et al. (2014) used a capture-recapture approach, which is an audit tool, to identify families with LEP by conducting a cross-sectional assessment of a retrospective cohort of patients on admission at a large pediatric hospital from July 1 to December 31, 2009. The capture-recapture method they employed was used to evaluate language screening, assess the rate of language interpretation, and determine the number of LEP individuals receiving service. The researchers depended on two independent sources to assess the captures, namely identification of language during registration and patients seeking assistance for interpretation when on admission. The researchers determined the number of LEP individuals missed by both captures on an assumption of a closed population, which included 6887 patients on admission. Out of the 6887 patients, the researchers found 948 LEP families during registration, and 847 families who sought interpretation assistance at least once while on admission. The researchers evaluated the size of the "ascertainment corrected" to be 1031 (95% confidence interval: 1022-1040) and the size of patients missing by both approaches was 15 (95% confidence interval: 7-24), leading to only 76% of LEP patients identified in both data sources. Boscolo-Hightower et al. (2014) concluded that a simple language audit tool could be employed to evaluate language need, interpretation rates, and inadequate language services needed by individuals who need interpretation.

In another study, to identify LEP patients in clinical care, Karliner et al. (2008) used the United States Census English proficiency question (Census-LEP) to assess patients' preparedness to communicate effectively in English. The researchers recruited

302 patients older than 18 years of age from a cardiology clinic and an inpatient general medical-surgical ward from 2004-2005. The participants spoke Spanish and/or English. The study focused on the sensitivity and specificity of the Census-LEP alone, or in integration with, a question on a chosen language for medical care. That would be used to estimate patient-reported capacity to understand provider recommendation on how to address symptomatic conditions associated with their health. The researchers determined that 198 (66%) participants reported speaking English less than "very well," while 166 (55%) were documented as less than "well." Also, 157 (52%) opted to have their medical care in Spanish, and in total, 135 (45%) had the ability to discuss symptoms; further, 43 (48%) indicated that they understood physician recommendations in English. Karliner et al. (2008) set up the Census-LEP as high-threshold (less than "very well"), which had the highest sensitivity for estimating effective communication (100% Discuss; 98.7% Understand).

The researchers also determined the lowest specificity (72.6% Discuss; 67.1% Understand), noting that the composite assessment of Census-LEP and chosen language for medical care led to a remarkable rise in specificity (91.9% Discuss; 83.9% Understand), with only a marginal reduction sensitivity (99.4% Discuss; 96.7% Understand). The analysis led to the conclusion that it was recommended to opt for a suitable language for medical care questions and the Census-LEP provision with a high-threshold of less than "very well" and a screening question. The researchers stated that such an approach would lead to inclusive and precise identification of patients most likely to gain from language support (Karliner et al., 2008).

## Research Design and Rationale

In this study, I used quantitative methodology and cross-sectional design to examine the association between LEP and CRC screening among Hispanic Americans in Texas at the time of the study. The investigation explores the relationships in the RQs and hypothesis between and among the variables using secondary data from the Texas BRFSS (2020) on the general population to deduce general health information of noninstitutionalized civilian residents. The Texas BRFSS provides information on all races and ethnic groups for analyses, including cancer incidence to support health care assessment, evaluation, and planning, identifying populations at increased risk of cancer, improving research associated with cancer etiology, prevention, and control with appropriate interventions. Using the BRFSS, the LEP was divided into 8 categories: Non-Hispanic White Men, Non- Hispanic White Women, Non- Hispanic Black Men, Non-Hispanic Black women, Hispanic Men Responding in English, Hispanic Women Responding in English, Hispanic Men Responding in Spanish, and Hispanic Women Responding in Spanish. The dependent variable (DV) was based on CRC screening tests and described as reporting FOBT within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years.

The IV in this study was dichotomous (LEP as a barrier to screening - yes/no). Thus, responses to the LEP were dichotomized, where responses representing LEP individuals were coded “1-Yes,” and categorical responses showing English proficiency or no LEP were coded “2-No.” Given that English is the main language spoken in Texas, “Spanish only” respondents were categorized as having LEP, whereas respondents who

spoke “only English” or “both English and Spanish” were categorized as having no LEP. CRC screening was the dependent variable (DV), or outcome variable of this study. The DVs (screening rate differences between male and female gender) were categorical variables. The DVs may be described as “high screening rate, average screening rate, and low screening rate,” indicating that these categorical variables were ordinal variables.

The secondary data contained sociodemographic information on participants in the study. To compute for LEP levels, I employed sociodemographic features such as age, gender, Hispanic origin (place of birth), Spanish as first language, highest educational attainment, income level, and English proficiency. To find variables that could promote screening for CRC, I evaluated cancer screening knowledge, accessibility and utilization of health care services, health literacy, and environmental barriers such as legal status and preparation for and fear of colonoscopy procedure. The Texas BRFSS database provided all sociodemographic characteristics needed to analyze LEP as an unmet challenge to screen for CRC and improve upon early detection of CRC for good prognosis and improved quality of life after diagnosis.

To ensure that only IVs of interest would influence the statistical outcome, the covariates of age, income, and education were assessed on a continuous dependent-response Likert-type scale (Russell & Bobko, 1992). Using SPSS, I recoded some of the continuous variables such as LEP level as categorical variables, for analytic purposes. I also used the data to examine the relationship between gender and CRC screening rates, where age and SES (income, education, and employment) were controlled. The IV of

gender and LEP (based on sociodemographic features) were measured against the DV of CRC screening.

The BFRSS is publicly available secondary data from the CDC enabled this study into the relationship between the variables and provided answers to the RQs. The application of secondary data enhanced the research to be completed in a timely fashion and assisted in facilitating scientific knowledge and comprehensiveness of the investigation. Moreover, the application of primary data may be difficult to obtain because of the high cost involved in gathering of data and extended follow-up time that could be futile if there was a loss to follow up (Trinh, 2018).

**Population**

In the United States, the Hispanic population is identified by individuals of Mexican, Puerto Rican, Cuban, Dominican, and additional Central/South American as well as other Spanish ancestry based on self-identification (Jackson et al., 2016). According to the United States Census Bureau (2020), the Hispanic American population was 18.5% (60.6 million) of the total population in the country in 2020. The United States Census Bureau projects that the Hispanic population would be 28% (111 million) of the entire United States population in 2060 (United States Census Bureau, 2018). In 2020, the population of Hispanics in Texas was 11.4 million or more than 39% of the total state population of 29.1 million (United States Census Bureau, 2020).

The study focused on the target population with a minimal age of 50 years old up to individuals aged 79 years old. The age limits were chosen based on the recommendations from the USPSTF. The USPSTF recommendation for CRC screening

begins at age 50 and up to 75 years. For individuals 85 years of age or older, health care providers consider benefits to be minimal, but may be accompanied by increased risk, especially procedures, such as colonoscopy which is invasive. I also used the data to evaluate if gender differences existed for CRC screening among men and women of Hispanic origin in Texas when potential confounding variables, such as age, income, occupation, health care access, and educational levels of participants are controlled. Thus, the study would highlight gender differences among individuals who suffer from LEP, which would examine whether sex differences of the participants impacted their CRC screening rates.

**Sampling Design**

The BFRSS (2020) cross-sectional study involved random-digit-dialed telephone survey of noninstitutionalized adults who were at least 18 years old residing in the state of Texas. In general, the BRFSS survey is an ongoing, state-based program that is conducted across the United States and the Commonwealth of Puerto Rico, Guam, and other territories. The BRFSS data gathering dwells on health risk behaviors, chronic diseases and conditions, access to health care, and use of preventive health services and practices associated with the main causes of mortality and morbidity in the United States and participating territories (Gamble et al., 2017). This indicates that BRFSS survey helps understand underlying challenges that people experience, such as excessive alcohol intake, tobacco use, unhealthy diet, recurrent mental instability, and insomnia, which are key culprits associated with pathophysiology of chronic diseases and conditions, including heart disease, cancer, stroke, arthritis, and diabetes, which are often the leading

causes of morbidity and mortality in the United States (Blackwelder et al., 2021; Liu et al., 2013; Williams et al., 2016). Using BRFSS survey, researchers could appreciate positive health behaviors like maintaining physically active, avoiding smoking use, undertaking routine physical checkups, such as CRC screening, monitoring blood pressure and cholesterol levels, which are fundamental public health applications to decrease preventable deaths and disability (Gamble et al., 2017).

Based on the target population in this study, I excluded individuals less than 50 years of age, non-Texas residents, individuals older than 79 years of age, active-duty military personnel, and individuals incarcerated. Like the BRFSS in other states, the Texas BRFSS initiated in 1987, is a federally supported landline and cellular telephone survey. The Texas BRFSS gathers data on Texas residents about risk characteristics associated with health, chronic health conditions, and application of preventive services, which make it a useful tool for health policymakers in the state's Department of State Health Services (DSHS). Texas BRFSS is used by both public and private health personnel at the federal, state, and local levels to identify public health challenges, develop informed priorities and goals, develop policies and interventions, and assess their impacts over a definite period (Texas Department of State Health Services, 2022).

In a previous study using a BRFSS survey, participants were asked demographic and health-related questions to know their insurance status, doctors' office visits, types of preventive measures they received, impacts of uninsured status and out-of-pocket payments for provider services. The researchers noted that among participants with cost constraints, the rates of visiting a doctor's office for CRC screening was low (Perisetti et

al., 2018). In another study, Sauer et al., (2018) estimated cancer screening by comparing BRFSS and National Health Interview Survey (NHIS). The BRFSS was designed to give state-level estimates, while the NHIS was used to give national estimates. Both surveys were used to estimate progress control in cancer prevalence. By deducting NHIS estimates from BRFSS estimates, the researchers calculated the direct differences (*DD*), and by dividing the *DD* by NHIS estimates, the researchers obtained relative differences (RR). Sauer et al. (2018) used two-sample *t*-test (2-tails) to test for statistically significant differences, BRFSS screening estimates showed higher than those from NHIS for breast (78.4% vs. 72.5%; *DD* = 5.9%, $p<0.0001$); colorectal (65.5% versus 57.6%; *DD*=7.9%, $p<0.0001$); and cervical (83.4% versus 81.8%; *DD*=1.6%, $p<0.0001$) cancers. Based on their computations, the researchers noted that *DDs* were higher in racial/ethnic minorities than whites. Similarly, individuals with limited education and those without health insurance obtained higher *DDs* compared with most educated individuals and fully insured individuals, respectively (Sauer et al., 2018).

## Data Collection

The Institutional Review Board (IRB) of Walden University approved the dissertation topic and provided an approval number 07-29-22-0638019 that permitted me to begin data collection. I used data collected through the BRFSS survey. The BRFSS is a collaborative project initiated in 1984 by the CDC in partnership with all the 50 states in the United States and participating US territories. This statewide project is conducted and assisted by the National Center for Chronic Disease Prevention and Health Promotion, an umbrella unit of the CDC. The BRFSS is a system of ongoing health-related telephone

surveys conducted monthly by state departments over landline and cellular telephones. For the landline telephone survey, data collection is conducted randomly with selected adults in a household. For the cellular telephone survey, data collection is conducted on participants residing in private homes or college housing. The project is designed to collect data using a standardized questionnaire with technical and methodologic support from CDC on health-related risk behaviors and chronic health conditions. It also collects data on preventive services, such as cancer screening from the noninstitutionalized adult residents in the United States who are at least 18 years old (Centers for Disease Control and Prevention, 2021). In 2020, the core factors assessed by the BRFSS health status and healthy days, exercise, inadequate sleep, chronic health conditions, oral health, tobacco use, cancer screenings, and health-care access, while its optional module topics covered prediabetes and diabetes, cognitive decline, electronic cigarettes, cancer survivorship (type, treatment, pain management) and sexual orientation/gender identity (SOGI).

Many questions are extracted from national surveys that have been developed, such as the National Health Interview Survey or the National Health and Nutrition Examination Survey. In addition to both core and optional questionnaire generated by the CDC, states are allowed to add their own questionnaire to the survey. All new questions that are proposed by states, federal agencies, or other organizations are subjected to cognitive evaluation and field assessment as well as voting for approval from state representatives on the BRFSS project prior to be accepted into BRFSS questionnaire. States with significant populations of individuals who speak another language other than English must have the BRFSS translated into such languages. Currently, the CDC has a

Spanish version of BRFSS questionnaire, which states may adapt if they need it for their Hispanic communities (Centers for Disease Control and Prevention, 2021).

The BRFSS telephone survey follows a sample description, where a sample record indicates a telephone number among a group of all telephone numbers the system randomly chooses for dialing. The BRFSS employs a disproportionate stratified sample (DSS) design for landline samples, where the BRFSS divides telephone numbers into two groups, or strata, which are sampled separately. These groups are referred to as the high-density and medium-density strata, which have telephone numbers expected to be owned by households. The determination of high-density or medium-density stratum depends on the number of listed household numbers in its block, or a set of 100 telephone numbers having the same area code, prefix, and first 2 digits of the suffix in addition to all possible combinations of the last 2 digits (Centers for Disease Control and Prevention, 2021).

**Variables**

The main IV was LEP. I grouped LEP into 8 categories in the BRFSS in Spanish, including Non-Hispanic White Men, Non- Hispanic White Women, Non- Hispanic Black Men, Non- Hispanic Black women, Hispanic Men Responding in English, Hispanic Women Responding in English, Hispanic Men Responding in Spanish, and Hispanic Women Responding in Spanish. The DV was based on CRC screening tests, and it was described as reporting FOBT within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years. The DVs were described as “high screening rate, average screening rate, and low screening rate”. Entries excluded from the

analysis included those missing a language variable, gender, race, or Hispanic/Latino background.

Sociodemographic variables investigated in the analyses were categorized as: age (50–54, 55–59, 60–64, 65–74, 75-79); educational status (less than high school, some high school, high school graduate, some college, college graduate); gender of participants (male or female). Availability of health insurance was an important determinant for effective CRC screening, making access to care variables important to be investigated: insurance status (private, public, uninsured) and having a reliable source of health care (yes/no). The models constructed to examine the association between LEP and CRC screening among Hispanic Americans were conducted with logistic regression analyses. CRC screening was DV and LEP was IV for Module I, adjusting for age, income, occupation, health care access, educational levels of participants and gender status and Module II involved LEP and gender status (male or female), adjusting for age, income, occupation, health care access, and educational levels of participants.

## Threats to Validity

The validity of a study is important for other researchers and readers to accept the outcome of a study, and it is affected by both internal and external threats. Researchers stress that a catalog of threats to validity may be blamed for why empirical studies would fail to deliver causal effects (Matthay & Glymour, 2020). There are four key types of a thread to validity, including statistical conclusion validity, internal validity, construct validity, and external validity (Campbell & Stanley, 2015). The statistical construct validity refers to the proper application of statistical methods to evaluate the association

among variables of interest. In this study, I used the 2020 BFRSS data surveyed on noninstitutionalized adults who were at least 18 years old and residing in the state of Texas. This geographical limitation ensured that participants were only residents of Texas.

The threats to internal validity, which are often a central concern of most causal analyses, are blamed on violations corresponding to factors, such as history (extraneous effects), group composition effects, and regression. All these factors are associated with confounding, which could adversely affect the estimated association between the target population and the causal effect from exposure to outcome (Matthay & Glymour, 2020). Even though my efforts to minimize internal threats were limited because my study depended on secondary data, the BRFSS data are generally collected by random telephone calls. The randomization of the selection of participants minimized selection bias, a key factor in confounding as an internal threat (Lesko et al., 2020). Also, to improve on internal validity, researchers need to take necessary precautions for study planning and sufficient quality control and implementation mechanisms, such as sufficient recruitment plans, data gathering, data evaluation, and sample size (Patino & Ferreira, 2018).

The construct validity focuses on the quality of choices of the independent and dependent variables. The threats of construct validity may arise from the operationalization of the IV and the choice of outcome measure, which refers to the operationalization of the DV (Petursdottir & Carr, 2018). For example, lack of reliability (when IV varies significantly from one occasion to the other, thereby potentially

increasing variability, which may obscure an association intended to be studied) and lack of representativeness of the IV that deviates significantly from the theoretical construct of interest (Deaton & Cartwright, 2018). For situations where the relationship between IV and DV fail to capture all aspects of the variables that are operating to establish the relationship, there becomes a possibility of threats conceptualized as measurement error, confounding or a violation of consistency (Rothman et al., 2008). My study focused on LEP and CRC screening among Hispanic Americans resident in Texas, with the main IV as LEP and DV as CRC screening RQ1. For RQ2, the study focused on gender and CRC screening, with the main IV as gender and CRC screening as DV. The operationalization of the IVs were related to the operationalization of the DVs, in that the IVs would likely have direct impacts on the DVs.

Also, the threats to statistical conclusion validity could adversely affect the outcome of a study. Significant threats to statistical conclusion validity may include conditions that affect measurement error or modifications, which are measured variables that tend to diminish statistical power. Low statistical power, violated assumptions of statistical tests, fishing, and the error rate problem refer to null hypothesis significance testing, which contribute significantly to problematic outcomes of studies, thereby presenting as threats. Such threats are important to estimation as they tend to negatively alter estimates, leading to imprecise and potentially uninformative outcomes, which promote wrong establishments of policies that depend on the study (Matthay & Glymour, 2020).

Similar to threats of internal validity, threats to external validity have a profound impact on the outcome of research. Concerns about external validity tend to be associated with populations and communities where research outcomes may be generalized. Under such conditions, causal associations of choice may demonstrate interactions with participant traits, surroundings, and the types of outcomes evaluated. Often, threats of external validity are controlled in the explanation of results, where researchers seek to depict population of the participants referred to in the results about their sociodemographics or geography. To overcome the threats of external validity, researchers address concerns with design or analytic characteristics, such as oversampling of underrepresented groups or modeling casual interactions. External validity may also be maximized through application of broad inclusion strategies, which may result in the target population that more actually resembles real-life participants (Patino & Ferreira, 2018). Because my study used Texas BRFSS, which is a statewide data, the sample population was adequate to overcome underrepresentation of the target population. Thus, the outcome would be safely generalized to extrapolate the results to address the Hispanic American population in Texas, the target group in the study.

## Descriptive Statistical Analysis

Investigators use descriptive statistics to describe the fundamental characteristics of data in a study, and they provide simple summaries about the sample and the estimates (Kaliyadan & Kulkarni, 2019). There are three main types of descriptive statistics, including estimations of frequency (frequency and percent), estimations of central tendency (mean, median, and mode), and estimations of dispersion or variation (standard

deviation, standard error, quartile, interquartile range, percentile, range, and coefficient of variation [CV]), which are used to describe quantitative data. While researchers consider an estimation of frequency for the categorical data, they use other forms of descriptive statistical estimates, such as measures of central tendency and dispersion to describe quantitative data (Mishra et al., 2019). In assessing continuous data, researchers use test of the normality to evaluate the estimates of central tendency and statistical methods for data analysis. The mean or median measurements, skewness, and kurtosis were documented on the continuous variables of age, income, and the highest level of educational achievements. On the other hand, for the categorical and nominal variables (CRC screening rate, ethnicity, health insurance status, and health care use), the descriptive statistics were considered as the total counts and their related percentages (Kaliyadan & Kulkarni, 2019).

## Inferential Statistics

The research questions (RQs) and hypotheses were as follows.

RQ1: Are CRC screening rates different between residents in Texas with and without proficiency in English, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$1: There is no significant relationship between language barrier and CRC screening rates among residents with and without proficiency in English in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*H*a1: There is a significant relationship between language barrier and CRC screening rates among residents with and without proficiency in English in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

RQ2: Are CRC screening rates different between male and female residents in Texas with and without proficiency in English, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$2: There is no significant relationship between gender and CRC screening among residents with and without proficiency in English in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*Ha*2: There is a significant relationship between gender and CRC screening among residents with and without proficiency in English in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

## Test of Assumption

Prior to testing the hypotheses, I analyzed the normality of the data as a prerequisite for the statistical test by assessing the sampling distribution means and the appropriate parameter estimates. I explored statistical tests of normality to the data to test normality, which is considered as an underlying assumption in parametric testing (Kim & Park, 2019). To assess for a nonsignificant *p* value for the Levene's test to measure for

the presence of homoscedasticity or homogeneity of variance, I performed ANOVA. I considered a *p* value of .05 or higher as not significant, making it possible to reject the null hypothesis, taken as equal variance among varying groups.

### Continuous and Categorical Variables

I used *t* test to detect any significant differences between respondents with LEP deficiency and others without LEP deficiency by evaluating all continuous variables (age, income, and highest education achieved: some high school, High school, some college, college). The categorical variables of health care access (yes/no) and language barrier were assessed with Chi-square test to examine the presence of significant differences between respondents with LEP and respondents without LEP. Similarly, *t*he t test was used to examine the differences of CRC screening with respect to the gender status by evaluating all continuous variables (age, income, and highest education achieved).

### Inferential Statistical Analysis

The IV of LEP was dichotomized into low LEP (fluent in English/both English and Spanish) and high LEP (fluent in Spanish only), while the DV of CRC screening was assessed on nominal scales where a Chi-square test for the association was conducted to measure whether there was a significant relationship between the variables of interest. I used the Chi-square goodness-of-fit test to measure the normality of distribution by assessing the magnitude of the Chi-square statistic and the *p*-value. In addition, counts with related percentages and 95% CIs for the CRC screening were evaluated by sociodemographic features. For bivariate comparisons, I performed bivariate logistic regression and Chi-square tests. Bivariate analysis permits an evaluation of how the value

of the CRC screening (outcome variable) relies upon the extent of LEP (explanatory variable). Also, in comparing gender (explanatory variable) and CRC screening (outcome variable). While CRC screening may be influenced by gender, gender may not depend on the CRC screening (Bertani et al., 2018). Additionally, I employed forced multivariate logistic regression analysis to assess the relationship between the variables of interest, such as LEP and CRC screening among the target population. I used bivariate logistic regression to establish the association between LEP and CRC screening variables. I conducted a multivariate logistic regression for odds ratio (ORs) of CRC screening between respondents with low LEP (fluent in English/both English and Spanish) and high LEP (fluent in Spanish only). The model was modified for the impact of clustering design. All statistical analyses were performed with the application of SPSS version 28.

## Ethical Procedures

I used secondary data from 2020 Texas BRFSS database. Secondary data deals with the use of existing research data to answer a RQ, which most often differs from the intended question answered with the data in its original work (Tripathy, 2013). Ethical concerns raised about the use of secondary data often relates to potential harm to individual participants and matters of return consent. Secondary data may differ based on identifying information it may contain. The data may be de-identified or appropriately coded so that investigators do not have access to the codes for identification. De-identification refers to a mechanism of removing identifiers, such as names of individuals and social security numbers that directly or indirectly relate to participants (or entity) and removing such identifiers from the data (Kayaalp, 2018). Under such circumstances,

ethical procedures may not necessarily be required for full review by the IRB. Prior to such a waiver, the IRB needs to confirm that the data are devoid of information needed for identification. On the contrary, if the data contain associated information on participating subjects, or information that could link the subjects to the data, IRB would need researchers to meet the full confidentiality, security, and informed consent requirements. The researchers would have to demonstrate how the subjects' privacy and confidentiality would be protected (Tripathy, 2013).

Because the BRFSS is de-identified publicly available data, it is exempted from IRB approval (Crews et al., 2014). Even though the BRFSS data are publicly available, they are managed and regulated by the CDC (federal), states, and participating territories in charge of their respective BRFSS data. For my study I requested permission from the Texas DSHS who are responsible for managing and regulating the use of the BRFSS data. In my submission I explained that I needed to use their BRFSS data for dissertation as part of requirements to complete my study at the Walden University. Prior to the application, I applied for IRB approval from Walden University with the same request, where I was cleared to seek permission to use the Texas BRFSS data for my study. For both applications, I explained that the data would be kept safe from unauthorized access, accidental loss, or destruction. To ensure that the data were kept safe and secured, hardcopies shall be kept in locked cabinets and softcopies in encrypted files on my computer, which was password protected. Since secondary data could be used for various studies, I evaluated it to determine whether important criteria, such as the methodology of data collection, accuracy, period of data collection, purpose for which it was collected,

and the content of the data were suitable to answer my RQs. The data would not be kept for no longer than was necessary for my investigation. I would delete it completely to prevent it from getting into unintended hands.

## Summary

The Texas BRFSS was used to extract sociodemographic and CRC screening and language data for analysis. The data were cleaned to remove cases with missing variables. All sociodemographic characteristics necessary to measure LEP levels, motivation variables, such as the availability of health insurance, and the CRC screening rates were obtained from the 2020 Texas BRFSS data. The data were selected carefully to ensure that only noninstitutionalized adults with a minimum age of 50 years old and not more than 79 years old were chosen for the study.

The selection was based on recommendations by both USPSTF and ACS. Comparing the invasive nature of some of the CRC screening procedures, such as colonoscopy, clinicians suggest that elderly patients older than 85 years old may receive minimal benefits compared with the risk involved. The ACS recommended to begin CRC screening from 45 years of age due to cases found in individuals who fall within that age category, however, this study used data from BFRSS, which is created by the CDC, a federal government agency that uses recommendations from the USPSTF, not from ACS. Only residents of the state of Texas were included in the study to support the descriptive statistics analyzed. The two RQs were answered using the inferential statistics such as the t test, multivariate logistical regression, and chi-square, which were all extracted from the BRFSS (2020) data on Hispanic Americans residing in the state of Texas.

In the data analysis section, I performed a series of statistical analyses to compare the associations between the variables. As part of the statistical analyses, I assessed the two null hypotheses in this study and the accompanied statistical assumptions. I employed *t* test to detect any significant differences between respondents with LEP deficiency and others without LEP deficiency by evaluating all continuous variables. I used bivariate logistic regression to establish the association between LEP and CRC screening variables. I conducted a multivariate logistic regression for odds ratio (ORs) of CRC screening between respondents with low LEP (fluent in English/both English and Spanish) and high LEP (fluent in Spanish only). I conducted Chi-square goodness-of-fit test to measure the normality of distribution by assessing the magnitude of the Chi-square statistic and the *p*-value.

# Chapter 4: Results

## Introduction

In this study, I conducted analysis to assess whether there was a relationship between LEP and CRC among Hispanic Americans living in Texas. The study focused on variations on CRC screening rates among Hispanic, non-Hispanic White, and non-Hispanic Black Americans, with the sample population aged 50 to 79 years old. I used the 2020 Texas BRFSS on the overall population to deduce general health information of noninstitutionalized civilian residents of Texas for the study. Respondents' CRC screening rates were analyzed by comparing sociodemographic variables, including age, income, LEP, employment status, health care access, and educational levels, employing a validated model by Diaz et al (2013) based on CDC's BRFSS 2008 survey.

The second purpose of the research was to assess whether CRC screening rates varied between male and female residents in Texas with and without LEP. LEP and gender were the IVs, and CRC screening was the DV. The IV was divided into 8 categories: non-Hispanic White Men, non- Hispanic White Women, non- Hispanic Black Men, non- Hispanic Black women, Hispanic Men Responding in English, Hispanic Women Responding in English, Hispanic Men Responding in Spanish, and Hispanic Women Responding in Spanish. The DV was defined as CRC screening as described by the USPSTF for individuals aged 50 to 79 years old, and/or reporting FOBT within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years. Age, income, employment status, health care access, and educational levels of participants were considered as other explanatory variables.

I measured the relationships between the IVs of LEP and gender and the DV of CRC screening using the Texas BRFSS (2020). All statistical analyses on the data were conducted using the application of SPSS version 28. I conducted a *t*-test for continuous variables (age, income, and highest education achieved: some high school, high school, some college, college) and Chi-square tests for categorical variables to detect any significant differences between respondents with LEP deficiency and others without LEP deficiency. Similarly, the *t*-test was used to examine the differences of CRC screening with respect to the gender status by evaluating all continuous variables (age, income, and highest education achieved). I used the Chi-square goodness-of-fit test to measure the normality of distribution by assessing the magnitude of the Chi-square statistic and the *p*-value. In addition, counts with related percentages and 95% CIs for the CRC screening were evaluated by sociodemographic features. I used bivariate logistic regression to establish the association between LEP and CRC screening variables. Additionally, I conducted a multivariate logistic regression for ORs of CRC screening between respondents with low LEP (fluent in English/both English and Spanish) and high LEP (fluent in Spanish only). To control endogeneity, I employed a two-stage, predicted, residual inclusion technique with the application of the instrumental variables and confounders.

## Research Questions and Hypotheses

The RQs and hypotheses were as follows.

RQ1: Are CRC screening rates different between Hispanic and non-Hispanic residents in Texas with and without LEP, when potential confounding variables including

age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$1: There is no significant relationship between LEP and CRC screening rates among Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*H*a1: There is a significant relationship between LEP and CRC screening rates among Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

RQ2: Are CRC screening rates different between male and female residents in Texas with and without LEP, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled?

$H_0$2: There is no significant relationship between gender and CRC screening of Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

*Ha*2: There is a significant relationship between gender and CRC screening of Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

## Data Analysis

The data analysis focused on descriptive and inferential statistics. The predictor variables in the study were LEP and gender; the outcome variable was CRC screening. The descriptive statistics provided information on the sociodemographic variables that supported the computation of the LEP and gender, the predictor variables in the study.

## Descriptive Statistics

### Sociodemographic Factors

The study had a total of 766 participants. The descriptive statics showed the sociodemographic factors of participants grouped into 5-year age groups, sex, race, language of participants, income of participants, employment status, healthcare access, and education status, which were applied to the validated model by Diaz et al (2013) to measure the LEP of participants. The statistics indicated that there were some participants who were missing from certain categories; for example, 162 participants failed to show income status, 12 participants did not show employment status, one participant did not indicate healthcare status, and three participants did not have education status. Besides those missing participants, other categories of participants under sex, race, and language of participants all had all the total respondents of 766 (Table 1).

**Table 1**

*Sample Size per Instrumental Variables*

| | | 5-year age groups | Sex of participants | Race of participants | Language of participants | Income of participants | Employment status | Healthcare access | Education status |
|---|---|---|---|---|---|---|---|---|---|
| N | Valid | 766 | 766 | 766 | 766 | 604 | 754 | 765 | 763 |
| | Missing | 0 | 0 | 0 | 0 | 162 | 12 | 1 | 3 |

### *Sex and Age*

The study participants selected randomly from the 2020 Texas BRFSS included 450 females or 58.7% and 316 males or 41.3% (Table 2). The minimum age of the subjects was 50 years, and the maximum age was 79 years, with a mean age of 65.81 years. Age categories were not grouped based on sex. The ages of the participants showed a standard deviation of 8.432, indicating the age distribution was widespread across the range of the participants' age. Also, the age distribution was approximately symmetric (skewness = -.281) and platykurtic (kurtosis = -1.006).

**Table 2**

*Sex of Participants*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Male | 316 | 41.3 | 41.3 | 41.3 |
| | Female | 450 | 58.7 | 58.7 | 100.0 |
| | Total | 766 | 100.0 | 100.0 | |

### *Participants Grouped by Age*

Study participants were categorized into 5-year age groups from 50 to 79 years of age. All the age groups had significant representations, with the age group 70-74 having the largest group of 163 (21.3%) out of the overall subjects of 766 in the study. The age group 55-59 had the least representation with 91 participants, or 11.9%, with the other age groups falling in between (Table 3). The CRC screening characteristics varied between age groups. For individuals within the age brackets 50-54, only 52 or 55.3% screened for cancer, with 44.7% unscreened. Individuals within the 75-79 years age group had the lowest sample of 22 out of 766 participants; however, they had 20 of them

or 90.9% screened, with only 2 or 9.1% unscreened. There were more screened individuals among participants within the 70-74 age group with 125 participants screened, representing 83.3% with 25 or 16.7% unscreened. The analysis had $p < .001$ (Table 5). The study sample indicated that there were more females than males with 486 or 58.7% female subjects compared with 316 or 41.3% males (Table 3). With a $p > .5$, female participants had a higher CRC screening rate with 251 or 74.3% screened compared with males 189 or 72.9% who screened (Table 5).

***Race and Language***

The study focused on three major races in Texas, including White only, non-Hispanic, Black only, non-Hispanic, and Hispanic residents. The White only, non-Hispanic variable was represented by 525 or 68.5% of the participants, Black only, non-Hispanic was represented by 77 subjects, or 10.1%, and Hispanic was represented by 164 subjects or 21.4% (Table 3). When languages spoken by participants were considered, an overwhelming 696 out 766 or 90.9% chose English, including a significant number of individuals who identified themselves as Hispanic, non-White, non-Black. Out of 164 individuals who identified themselves as Hispanic, only 70 or 42.7% indicated that they speak Spanish (Table 3). The race assessment indicated a $p < .05$. White only, non-Hispanic had more participants of 313 or 76.7% screened and 95 or 23.3% unscreened compared with Black only, non-Hispanic participants of 40, or 71.4% screened, and 16 or 28.6% unscreened, while Hispanic had 87 or 64.9% screened and 47 or 35.1% unscreened (Table 5).

***Income (Annual Household)***

Many study participants had incomes of $75,000 or more, representing 200 out of the 766 subjects, or 26.1%. However, an overwhelming 52.4% had an annual household income of less than $50,000. Also, 162 or 21.1% of the participants did not report an income at all in 2020, or their income data were missing (Table 4). Among the participants, 180 had annual household income of $75,000 or more, 136 or 75.6% were screened, and 44 or 24.4% were not screened. For individuals within the lowest bracket of annual household income of less than $20,000, 62 or 72.9% underwent screening for CRC while 23 or 27.1% did not receive screening for CRC. Participants with annual household income from $50,000 to under $75,000, 56 or 80.0% received CRC screening compared with 14 or 20.0% who did not receive screening for CRC, and all had a $p < .001$ (Table 5).

***Employment Status***

Out of 766 participants, 516 or 67.4% indicated that they were unemployed, 238 or 31.1% identified themselves as employed while 12 or 1.6 were identified as missing. The huge number of unemployed participants may be partly due to retirement since all participants were at least 50 years of age (Table 4). For individuals employed, 142 or 66.4% received screening for CRC while 72 or 33.6% did not. For the unemployed, 294 or 77.6% received screening while only 85 or 22.4% did not screen for CRC. The $p < .05$ (Table 5).

### *Healthcare Access*

Because many of the study participants were Medicare eligible, 710 or 92.8% had healthcare access while 55 individuals did not have healthcare access with one person's healthcare access information missing (Table 4). Health care access indicated that individuals with access, 420 or 76.5% of the study participants received CRC screening compared to 129 or 23.5 who had health insurance but did not screen for CRC. Conversely, for individuals without healthcare access only 19 or 39.6% received CRC screening, while 29 or 60.4% did not undertake CRC screening, $p < .001$ (Table 5).

### *Education Status*

A significant number, 311 of the participants or 40.6% had college education compared to 90 individuals or 11.7% who had less than high school education status. Also, 209 or 27.3% had some college education while 153 or 20% of the participants had completed high school. There were three individuals in the study whose educational status was missing (Table 4). Considering the impact of education on CRC screening, the trend of undertaking screening increased from less educated participants to more educated participants. For individuals with less than high school education, 41 or 64.1% received CRC screening with 23 or 35.9% not receiving screening. For high school graduates/GED, 80 or 67.8% received screening and 38 or 32.2 stayed away from screening. Participants who attained some college education, 119 or 74.4% received CRC screening and 41 or 25.6% did not receive screening. The participants with college degree or higher, 198 or 78.3% received CRC screening, while 55 or 21.7% did not receive it, $p < .05$ (Table 5).

**Table 3**

*Frequency Table 1: Five-year Groups, Sex, Race, Language*

| Demographic Category | | Frequency | % | Valid % | Cumulative % |
|---|---|---|---|---|---|
| Five-year Groups | | | | | |
| Valid | 50-54 | 102 | 13.3 | 13.3 | 13.3 |
| | 55-59 | 91 | 11.9 | 11.9 | 25.2 |
| | 60-64 | 118 | 15.4 | 15.4 | 40.6 |
| | 65-69 | 154 | 20.1 | 20.1 | 60.7 |
| | 70-74 | 163 | 21.3 | 21.3 | 82.0 |
| | 75-79 | 138 | 18.0 | 18.0 | 100.0 |
| | Total | 766 | 100.0 | 100.0 | |
| Sex | | | | | |
| Valid | Male | 316 | 41.3 | | 41.3 |
| | Female | 450 | 58.7 | | 58.7 |
| | Total | 766 | 100.0 | | 100.0 |
| Participant's Race | | | | | |
| Valid | White only, non-Hispanic | 525 | 68.5 | 68.5 | 68.5 |
| | Black only, non-Hispanic | 77 | 10.1 | 10.1 | 78.6 |
| | Hispanic | 164 | 21.4 | 21.4 | 100.0 |
| | Total | 766 | 100.0 | 100.0 | |
| Participant's Language | | | | | |
| Valid | English | 696 | 90.9 | 90.9 | 90.9 |
| | Spanish | 70 | 9.1 | 9.1 | 100.0 |
| | Total | 766 | 100.0 | 100.0 | |

**Table 4**

*Frequency Table 2: Participant Annual Income, Employment Status, Healthcare Access, Education Status*

| Demographic Category | | Frequency | % | Valid % | Cumulative % |
|---|---|---|---|---|---|
| Participant Annual Income | | | | | |
| | $0 — < $20,000 | 109 | 14.2 | 18.0 | 18.0 |
| | $20,000 — < $50,000 | 208 | 27.2 | 34.4 | 52.4 |
| Valid | $50,000 — < $75,000 | 87 | 11.4 | 14.4 | 66.8 |
| | $75,000 or more | 200 | 26.1 | 33.1 | 100.0 |
| | Total | 604 | 78.9 | 100.0 | |
| Missing | System | 162 | 21.1 | | |
| | Total | 766 | 100.0 | | |
| Employment Status | | | | | |
| | Yes, Employed | 238 | 31.1 | 31.6 | 31.6 |
| Valid | No, not employed | 516 | 67.4 | 68.4 | 100.0 |
| | Total | 754 | 98.4 | 100.0 | |
| Missing | System | 12 | 1.6 | | |
| | Total | 766 | 100.0 | | |
| Healthcare Access | | | | | |
| | Yes, Healthcare access | 710 | 92.7 | 92.8 | Yes, Healthcare access |
| Valid | No healthcare access | 55 | 7.2 | 7.2 | No healthcare access |
| | Total | 765 | 99.9 | 100.0 | |
| Missing | System | 1 | .1 | 100.0 | |
| | Total | 766 | 100.0 | | |
| Education Status | | | | | |
| | Less than high school | 90 | 11.7 | 11.8 | 11.8 |
| | High school graduate | 153 | 20.0 | 20.1 | 31.8 |
| | Some college | 209 | 27.3 | 27.4 | 59.2 |
| | College graduate | 311 | 40.6 | 40.8 | 100.0 |
| | Total | 763 | 99.6 | 100.0 | |
| Missing | System | 3 | .4 | | |
| | Total | 766 | 100.0 | | |

**Table 5**

*Descriptive Statistics of Study Population Based on Screened and Unscreened for Colorectal Cancer (N=766).*

| Characteristics | | Screened N (%) | Unscreened N (%) | Total N | *p*-value |
|---|---|---|---|---|---|
| Age | | | | | |
| | 50-54 | 52 (55.3) | 42 (44.7) | 94 | <.001 |
| | 55-59 | 54 (63.5) | 31 (36.5) | 85 | |
| | 60-64 | 79 (74.5) | 27 (25.5) | 106 | |
| | 65-69 | 110 (78.0) | 31 (22.0) | 141 | |
| | 70-74 | 125 (83.3) | 25 (16.7) | 150 | |
| | 75-79 | 20 (90.9) | 2 (9.1) | 22 | |
| Sex | | | | | |
| | Male | 189 (72.9) | 71 (27.3) | 260 | >.5 |
| | Female | 251 (74.3) | 87 (25.7) | 338 | >.5 |
| Participant's Race | | | | | |
| | White only, non-Hispanic | 313 (76.6) | 95 (23.2) | 408 | <.05 |
| | Black only, non-Hispanic | 40 (71.4) | 16 (28.6) | 56 | <.05 |
| | Hispanic | 87 (64.9) | 47 (35.1) | 143 | <.05 |
| Language | | | | | |
| | English | 410 (75.4) | 134 (24.6) | 544 | <.05 |
| | Spanish | 30 (55.6) | 24 (44.4) | 54 | <.05 |
| Education Status | | | | | |
| | Less than high school | 41 (64.1) | 23 (35.9) | 64 | <.05 |
| | High school graduate | 80 (67.8) | 38 (32.2) | 118 | <.05 |
| | Some college | 119 (74.4) | 41 (25.6) | 160 | <.05 |
| | College degree or higher | 198 (78.3) | 55 (21.7) | 253 | <.05 |
| Employment Status | | | | | |
| | Employed | 142 (66.4) | 72 (33.6) | 214 | <.05 |
| | Unemployed | 294 (77.6) | 86 (22.4) | 379 | <.05 |
| Annual Household Income ($) | | | | | |
| | $0 — < $20,000 | 62 (72.9) | 23 (27.1) | 85 | <.001 |
| | $20,000 — < $50,000 | 111 (68.1) | 52 (31.9) | 163 | <.001 |
| | $50,000 — < $75,000 | 56 (80.0) | 14 (20.0) | 70 | <.001 |
| | $75,000 or more | 136 (75.6) | 44 (24.4) | 180 | <.001 |
| Health Insurance Coverage | | 763 | 99.6 | 100.0 | |
| | Yes | 420 (76.5) | 129 (23.5) | 549 | <.001 |
| | No | 19 (39.6) | 29 (60.4) | 48 | <.001 |

Using standard means for continuous variables and proportions/frequencies for categorical variables, I calculated respondent characteristics. Chi-square tests were employed to assess the association between the dependent and independent variables as well as each potential confounder. The study participants were grouped into 5-year age groups from 50 to 79 years of age with their screening rates increasing from the youngest age group to oldest age group. However, the number of participants screened was higher within groups 60-64, 65-69, and 70-74 compared to age groups 50-54, 55-59, and 75-79. Also, groups 60-64, 65-69, and 70-74 had higher screening rates compared to age groups 50-54 and 55-59. While individuals in 75-79 age group were only 22 study participants, 20 or 90.1% received screening. Overall, 440 out of 766 or 73.6% study participants received CRC screening (Table 6).

**Table 6**

*Five-year Age Groups and Colorectal Screening Status*

| | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | Total |
|---|---|---|---|---|
| 50-54 | Count | 52 | 42 | 94 |
| | % within 5-year age groups | 55.3% | 44.7% | 100.0% |
| 55-59 | Count | 54 | 31 | 85 |
| | % within 5-year age groups | 63.5% | 36.5% | 100.0% |
| 60-64 | Count | 79 | 27 | 106 |
| | % within 5-year age groups | 74.5% | 25.5% | 100.0% |
| 65-69 | Count | 110 | 31 | 141 |
| | % within 5-year age groups | 78.0% | 22.0% | 100.0% |
| 70-74 | Count | 125 | 25 | 150 |
| | % within 5-year age groups | 83.3% | 16.7% | 100.0% |
| 75-79 | Count | 20 | 2 | 22 |
| | % within 5-year age groups | 90.9% | 9.1% | 100.0% |
| Total | Count | 440 | 158 | 598 |
| | % within 5-year age groups | 73.6% | 26.4% | 100.0% |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 32.754$, $p < .001$, showing that there was a statistically significant association between different age groups (Table 7).

**Table 7**

*Chi-Square Tests on Five-Year Age Groups*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 32.754[a] | 5 | <.001 |
| Likelihood Ratio | 32.403 | 5 | <.001 |
| Linear-by-Linear Association | 31.668 | 1 | <.001 |
| N of Valid Cases | 598 | | |

*Note*: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.81. Considering symmetric measures of Phi and Cramer's V of 0.234, each at $p < .001$ indicated a relatively stronger association between age and CRC screening (Table 8).

**Table 8**

*Symmetric Measures on Five-year Age Groups*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .234 | <.001 |
| | Cramer's V | .234 | <.001 |
| N of Valid Cases | | 598 | |

Among 260 male study participants, 189 underwent CRC screening while 71 did not. Male study participants represented 43.0% of 43.5 of the total study participants. The number of females in the study was 338, out of which 251 underwent CRC screening while 87 stayed away. In all, females represented 56.5% of the study participants with 74.3% receiving screening compared to 72.7% of men who received the CRC screening. Together, 73.6% of both sexes received CRC screening while 26.4% did not (Table 9).

**Table 9**

*Sex of Participants and Colorectal Screening Status*

| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | Total |
|---|---|---|---|---|---|
| Sex of participants | Male | Count | 189 | 71 | 260 |
| | | % within Sex of participants | 72.7 | 27.3 | 100.0 |
| | Female | Count | 251 | 87 | 338 |
| | | % within Sex of participants | 74.3 | 25.7 | 100.0 |
| Total | | Count | 440 | 158 | 598 |
| | | % within Sex of participants | 73.6 | 26.4 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 0.186$, $p = .666$, showing that there was no statistically significant association between different sexes of participants (Table 10).

**Table 10**

*Chi-Square Tests on Sex of Participants and Colorectal Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | .186 [a] | 1 | .666 | | |
| Continuity Correction [b] | .114 | 1 | .736 | | |
| Likelihood Ratio | .186 | 1 | .667 | | |
| Fisher's Exact Test | | | | .708 | .367 |
| Linear-by-Linear Association | .186 | 1 | .667 | | |
| N of Valid Cases | 598 | | | | |

*Note*: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 68.70; b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were -0.018 and 0.018, respectively, each at p = 0.666. The Phi and Cramer's V values being less than 0.10 indicated no association between gender differences and CRC screening (Table 11).

**Table 11**

*Symmetric Measures on Sex of Participants and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.018 | .666 |
| | Cramer's V | .018 | .666 |
| N of Valid Cases | | 598 | |

Out of the 766 study participants, 440 received CRC screening, of which 313 or 71.1% were White only, non-Hispanic, 40 or 9.1% were Black only, non-Hispanic, and 87 or 19.8% were Hispanic. Among White only, non-Hispanic 76.7% underwent screening, Black only, non-Hispanic 71.4% received screening, while 64.9% of Hispanic also received screening. The data also indicated that 95 or 23.3% White only, non-Hispanic, 16 or 10.1% Black only, non-Hispanic, and 47 or 29.7% Hispanic did not screen for CRC. In all, 440 or 73.6% of respondents screened for CRC, another 158 or 26.4% of respondents did not screen, while 168 or 21.9% were missing from screening among study participants (Table 12).

**Table 12**

*Participant Race and Colorectal Screening Status*

| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer |
|---|---|---|---|---|
| Race of participants | White only, non-Hispanic | Count | 313 | 95 |
| | | % within Race of participants | 76.7% | 23.3% |
| | Black only, non-Hispanic | Count | 40 | 16 |
| | | % within Race of participants | 71.4% | 28.6% |
| | Hispanic | Count | 87 | 47 |
| | | % within Race of participants | 64.9% | 35.1% |
| Total | | Count | 440 | 158 |
| | | % within Race of participants | 73.6% | 26.4% |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 7.360$, $p = <.025$, showing that there was a statistically significant association among White only, non-Hispanic, Black only, non-Hispanic, and Hispanic samples of participants (Table 13).

**Table 13**

*Chi-Square Tests on Race of Participants and Colorectal Screening Status*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 7.360[a] | 2 | .025 |
| Likelihood Ratio | 7.113 | 2 | .029 |
| Linear-by-Linear Association | 7.011 | 1 | .008 |
| N of Valid Cases | 598 | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.80.

Symmetric measures of Phi and Cramer's V were the same, 0.111, each at $p = 0.025$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among White only, non-Hispanic, Black only, non-Hispanic, and Hispanic samples of participants and CRC screening (Table 14).

**Table 14**

*Symmetric Measures on Participant Race and Colorectal Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .111 | .025 |
| | Cramer's V | .111 | .025 |
| N of Valid Cases | | 598 | |

This study focused only on two languages used by participants, English and Spanish. While 544 or 90% of respondents identified themselves as English speakers, 54 or 9.0% identified themselves as Hispanic. Out of the 544 English speakers, 410 or 75.4% received CRC screening, while 134 or 24.6% did not. Among the Spanish-speaking respondents, 30 or 55.6% received CRC screening, while 24 or 44.4% did not receive CRC screening (Table 15). The data indicated that some participants who identified themselves as Hispanic respondents in the BRFSS survey, chose to respond to the survey questionnaire in English instead of their native Spanish language, thereby decreasing the Spanish respondents from 134 Hispanic only participants to 54 as Spanish-speaking respondents (Table 12).

**Table 15**

*Language of Participants and Colorectal Screening Status*

| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | |
|---|---|---|---|---|---|
| Language of participants | English | Count | 410 | 134 | 544 |
| | | % within Language of participants | 75.4% | 24.6% | 100.0% |
| | Spanish | Count | 30 | 24 | 54 |
| | | % within Language of participants | 55.6% | 44.4% | 100.0% |
| Total | | Count | 440 | 158 | 598 |
| | | % within Language of participants | 73.6% | 26.4% | 100.0% |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 9.918$, $p = <.002$, showing that there was a statistically significant association between English- and Spanish-speaking respondents (Table 16).

**Table 16**

*Chi-Square Tests on Participants' Language and Colorectal Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 9.918[a] | 1 | .002 | | |
| Continuity Correction[b] | 8.926 | 1 | .003 | | |
| Likelihood Ratio | 9.014 | 1 | .003 | | |
| Fisher's Exact Test | | | | .003 | .002 |
| Linear-by-Linear Association | 9.902 | 1 | .002 | | |
| N of Valid Cases | 598 | | | | |

*Note*: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 14.27; b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were the same, 0.129, each at $p = 0.002$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among English- and Spanish-speaking respondents (Table 17).

**Table 17**

*Symmetric Measures on Language of Participants and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .129 | .002 |
| | Cramer's V | .129 | .002 |
| N of Valid Cases | | 598 | |

The study indicated that out of 214 participants in the study who were employed, 142 or 66.4% screened and 72 or 33.6% did not screen for CRC. Also, 379 participants in the study were unemployed but 294 or 77.6% received screening while 85 or 22.4% did not

receive screening for CRC. The increased higher number of unemployment would likely be due to retirement. Because individuals who are at least 65 years of age are Medicare-eligible, most of those unemployed but retired would have Medicare for health screening, including CRC screening (Table 18).

**Table 18**

*Employment Status and Colorectal Cancer Screening*

| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | |
|---|---|---|---|---|---|
| Employment status | Yes, Employed | Count | 142 | 72 | 214 |
| | | % within Employment status | 66.4% | 33.6% | 100.0% |
| | No, not employed | Count | 294 | 85 | 379 |
| | | % within Employment status | 77.6% | 22.4% | 100.0% |
| Total | | Count | 436 | 157 | 593 |
| | | % within Employment status | 73.5% | 26.5% | 100.0% |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 8.841$, $p = .003$, showing that there was a statistically significant association between employment and CRC screening (Table 19).

**Table 19**

*Chi-Square Tests on Employment of Participants and Colorectal Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 8.841 [a] | 1 | .003 | | |
| Continuity Correction [b] | 8.274 | 1 | .004 | | |
| Likelihood Ratio | 8.676 | 1 | .003 | | |
| Fisher's Exact Test | | | | .004 | .002 |
| Linear-by-Linear Association | 8.826 | 1 | .003 | | |
| N of Valid Cases | 593 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 56.66. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were -0.122 and 0.122, respectively, each at $p = 0.003$. The Phi and Cramer's V values being more than 0.10 indicated there was an association between employment status and CRC screening (Table 20).

**Table 20**

*Symmetric Measures on Employment of Participants and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.122 | .003 |
| | Cramer's V | .122 | .003 |
| N of Valid Cases | | 593 | |

Out of 549 respondents who had healthcare access, 420 or 76.5% screened for CRC while 129 or 23.5% did not. Among the uninsured, only 19 or 39.6% underwent CRC screening with 29 or 60.4% not undertaking CRC screening, an indication that healthcare access plays a role in CRC screening (Table 21).

**Table 21**

*Healthcare Access and Colorectal Cancer Screening*

| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | Total |
|---|---|---|---|---|---|
| Healthcare access | Yes, Healthcare access | Count | 420 | 129 | 549 |
| | | % within Healthcare access | 76.5 | 23.5 | 100.0 |
| | No healthcare access | Count | 19 | 29 | 48 |
| | | % within Healthcare access | 39.6 | 60.4 | 100.0 |
| Total | | Count | 439 | 158 | 597 |
| | | % within Healthcare access | 73.5 | 26.5 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 30.915$, $p < .001$, showing that there was a statistically significant association between healthcare access and CRC screening (Table 22).

**Table 22**

*Chi-Square Tests on Healthcare Access of Participants and Colorectal Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 30.915 [a] | 1 | <.001 | | |
| Continuity Correction [b] | 29.047 | 1 | <.001 | | |
| Likelihood Ratio | 26.889 | 1 | <.001 | | |
| Fisher's Exact Test | | | | <.001 | <.001 |
| Linear-by-Linear Association | 30.864 | 1 | <.001 | | |
| N of Valid Cases | 597 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.70. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were both 0.228, each at $p$ <.001. The Phi and Cramer's V values being more than 0.10 indicated there was an association between healthcare access and CRC screening (Table 23).

**Table 23**

*Symmetric Measures on Health Care Access of Participants and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .228 | <.001 |
| | Cramer's V | .228 | <.001 |
| N of Valid Cases | | 597 | |

I performed a one-sample *t* test to assess the age variations within the English and Spanish study participants for CRC screening. Table 24 shows the result of the *t* test. The English-speakers had a sample mean age of 65.86 (SD = ± 8.43) and the Spanish-speakers had a sample mean age of 65.34 (SD = ± 8.55), $t(596)=-3.170$, $p$ =.002 (two-tailed), 95% CI (-.321, -.075) (Table 26). The result in Table 24 shows that while the English-speaking participants largely outnumbered the Spanish-speaking participants, their mean ages were similar, with the English-speaking group at 65.86 years and Spanish-speaking group at 65.34 years of age (Table 24). The Levene's test for equality of variance, $F$ = 16.803, $p$ <.001, an indication that the variances are not equal (Table 25).

**Table 24**

*Group Statistics for English Speaking and Spanish Speaking Participants in CRC Screening*

| | Language of participants | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Colorectal cancer screening status | English | 544 | 1.25 | .431 | .018 |
| | Spanish | 54 | 1.44 | .502 | .068 |
| Age of participants | English | 696 | 65.86 | 8.426 | .319 |
| | Spanish | 70 | 65.34 | 8.545 | 1.021 |

**Table 25**

*One Sample Statistics 1: Independent Samples Test on Colorectal Cancer Screening and Age of Participants*

| | | Levene's Test for Equality of Variances (EV) | |
|---|---|---|---|
| | | F | Sig. |
| Colorectal cancer screening status | Equality of variances assumed | 16.80 | <.001 |
| | Equality of variances not assumed | 3 | |
| Age of participant | Equality of variances assumed | .013 | .909 |
| | Equality of variances not assumed | | |

**Table 26**

*One Sample Statistics 2: Independent Samples Test on Colorectal Cancer Screening and Age of Participants*

| | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | t | df | One-Sided p | Two-Sided p | Mean Difference | Std. Error Difference | Lower | Upper |
| Colorectal cancer screening status | EV assumed | 3.170 | 596 | <.001 | .002 | -.198 | .062 | -.321 | -.075 |
| | EV not assumed | 2.802 | 61.032 | .003 | .007 | -.198 | .071 | -.340 | -.057 |
| Age of participant | EV assumed | .485 | 764 | .314 | .628 | .513 | 1.058 | -1.563 | 2.590 |
| | EV not assumed | .480 | 83.076 | .316 | .633 | .513 | 1.070 | -1.615 | 2.642 |

Also, conducted a one-sample *t* test for continuous variables (income and highest education achieved: some high school, high school, some college, college) to assess the implications of income and higher education on CRC screening. Table 25 shows the result of the *t* test. The income of participants had a sample mean age of 5.83 (SD = ± 2.202) and the education status of participants had a sample mean age of 2.97 (SD = ± 1.039), $t(597) = 70.057$, $p < .001$(two-tailed), 95% CI (1.23, 1.30) (Table 28). The result in Table 27 shows that participants with income and education, *N* was 604 and 763, respectively.

**Table 27**

*Number of Participants (N), Mean, Std Deviation, and Std Error Mean and CRC Screening and Participants with Income and Education*

| | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| Colorectal cancer screening status | 598 | 1.26 | .441 | .018 |
| Income of participants | 604 | 5.83 | 2.202 | .090 |
| Education status | 763 | 2.97 | 1.039 | .038 |

**Table 28**

*One-Sample T Test for CRC Screening with Income and Education of Participants*

| | Test Value = 0 | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | Significance | | Mean Difference | 95% Confidence Interval of the Difference | |
| | t | df | One-Sided p | Two-Sided p | | Lower | Upper |
| Colorectal cancer screening status | 70.057 | 597 | <.001 | <.001 | 1.264 | 1.23 | 1.30 |
| Income of participants | 65.041 | 603 | <.001 | <.001 | 5.828 | 5.65 | 6.00 |
| Education status | 78.953 | 762 | .000 | .000 | 2.971 | 2.90 | 3.05 |

Colonoscopy screening was more prominent among groups 60-64, 65-69, 70-74, and 75-79 compared to age groups 50-54 and 55-59. Groups 60-64 (82 or 15.6%), 65-69 (109 or 20.8%), 70-74 (126 or 24.0%), and 75-79 (110 or 21.0%) had colonoscopy compared to groups 50-54 (45 or 8.6%) and 55-59 (52 or 9.9%) had colonoscopy (Table 29).

**Table 29**

*Crosstabulation of Five-year Age Groups and Colonoscopy Screening Status*

| | | | 5-year age groups | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | |
| Have you ever had a colonoscopy? | Yes | Count | 45 | 52 | 82 | 109 | 126 | 110 | 524 |
| | | % within Have you ever had a colonoscopy? | 8.6 | 9.9 | 15.6 | 20.8 | 24.0 | 21.0 | 100.0 |
| | No | Count | 52 | 33 | 26 | 36 | 27 | 22 | 196 |
| | | % within Have you ever had a colonoscopy? | 26.5 | 16.8 | 13.3 | 18.4 | 13.8 | 11.2 | 100.0 |
| Total | | Count | 97 | 85 | 108 | 145 | 153 | 132 | 720 |
| | | % within Have you ever had a colonoscopy? | 13.5 | 11.8 | 15.0 | 20.1 | 21.3 | 18.3 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 55.326$, $p < .001$, showing that there was a statistically significant association among five-year age groups 50-54, 55-59, 60-64, 65-69, 70-74, and 75-79 (Table 30).

**Table 30**

*Chi-Square Tests on Five-year Age Groups and Colonoscopy Screening Status*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 55.326 [a] | 5 | <.001 |
| Likelihood Ratio | 52.254 | 5 | <.001 |
| Linear-by-Linear Association | 47.064 | 1 | <.001 |
| N of Valid Cases | 720 | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 23.14.

Symmetric measures of Phi and Cramer's V were the same, 0.277, each at $p < .001$. The Phi and Cramer's V values being more than 0.10 indicated there were

differential influences among five-year age groups and colonoscopy screening status (Table 31).

**Table 31**

*Symmetric Measures on Five-year Age Groups and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .277 | <.001 |
| | Cramer's V | .277 | <.001 |
| N of Valid Cases | | 720 | |

There was a significant variation between males and female for colonoscopy screening, with 315 or 60.1% of females undergoing colonoscopy screening compared to 209 or 39.9% of males who received the same screening (Table 32).

**Table 32**

*Sex of Participants and Colonoscopy Screening Status*

| | | | Sex of participants | | |
|---|---|---|---|---|---|
| | | | Male | Female | Total |
| Have you ever had a colonoscopy? | Yes | Count | 209 | 315 | 524 |
| | | % within Have you ever had a colonoscopy? | 39.9 | 60.1 | 100.0 |
| | No | Count | 92 | 104 | 196 |
| | | % within Have you ever had a colonoscopy? | 46.9 | 53.1 | 100.0 |
| Total | | Count | 301 | 419 | 720 |
| | | % within Have you ever had a colonoscopy? | 41.8 | 58.2 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 2.917$, $p < .088$, showing that there was no statistically significant association between male and female participants in the study (Table 33).

**Table 33**

*Chi-Square Tests on Males and Females and Colonoscopy Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 2.917 [a] | 1 | .088 | | |
| Continuity Correction [b] | 2.634 | 1 | .105 | | |
| Likelihood Ratio | 2.900 | 1 | .089 | | |
| Fisher's Exact Test | | | | .090 | .053 |
| Linear-by-Linear Association | 2.913 | 1 | .088 | | |
| N of Valid Cases | 720 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 81.94. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were - 0.064 and 0.064, respectively, each at $p = .088$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences between males and females and colonoscopy screening status (Table 34).

**Table 34**

*Symmetric Measures on Sex of Participants and Colorectal Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.064 | .088 |
| | Cramer's V | .064 | .088 |
| N of Valid Cases | | 720 | |

The choice of colonoscopy among racial groups in the study varied significantly. Among White only, non-Hispanic, 387 or 73.9% had colonoscopy compared with 47 or 9.0% of Black only, non-Hispanic, while 90 or 17.2% of Hispanics had colonoscopy (Table 35).

**Table 35**

*Race of Participants and Colonoscopy Screening Status*

| | | | Race of participants | | | |
|---|---|---|---|---|---|---|
| | | | White only, non-Hispanic | Black only, non-Hispanic | Hispanic | Total |
| Have you ever had a colonoscopy? | Yes | Count | 387 | 47 | 90 | 524 |
| | | % within Have you ever had a colonoscopy? | 73.9 | 9.0 | 17.2 | 100.0 |
| | No | Count | 108 | 22 | 66 | 196 |
| | | % within Have you ever had a colonoscopy? | 55.1 | 11.2 | 33.7 | 100.0 |
| Total | | Count | 495 | 69 | 156 | 720 |
| | | % within Have you ever had a colonoscopy? | 68.8 | 9.6 | 21.7 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 25.973$, $p < .001$, showing that there was a statistically significant association among White, non-Hispanic, Black, non-Hispanic, and Hispanic participants in the study (Table 36).

**Table 36**

*Chi-Square Tests on Race of Participants and Colonoscopy Screening Status*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 25.973[a] | 2 | <.001 |
| Likelihood Ratio | 24.765 | 2 | <.001 |
| Linear-by-Linear Association | 24.342 | 1 | <.001 |
| N of Valid Cases | 720 | | |

*Note*: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 18.78.

Symmetric measures of Phi and Cramer's V were the same, 0.190, each at p <.001. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among White, non-Hispanic, Black, non-Hispanic, and Hispanic and colonoscopy screening status (Table 37).

**Table 37**

*Symmetric Measures on Race of Participants and Colonoscopy Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .190 | <.001 |
| | Cramer's V | .190 | <.001 |
| N of Valid Cases | | 720 | |

The study indicated that 524 participants received colonoscopy screening. However, 492 or 93.9% were English-speaking while only 32 or 6.1% were Spanish-speaking participants in the study (Table 38).

**Table 38**

*Language of Participants and Colonoscopy Screening Status*

| | | | English | Spanish | Total |
|---|---|---|---|---|---|
| Have you ever had a colonoscopy? | Yes | Count | 492 | 32 | 524 |
| | | % within Have you ever had a colonoscopy? | 93.9 | 6.1 | 100.0 |
| | No | Count | 163 | 33 | 196 |
| | | % within Have you ever had a colonoscopy? | 83.2 | 16.8 | 100.0 |
| Total | | Count | 655 | 65 | 720 |
| | | % within Have you ever had a colonoscopy? | 91.0 | 9.0 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 19.996$, $p < .001$, showing that there was a statistically significant association between English-speaking and Spanish-speaking participants in the study (Table 39).

**Table 39**

*Chi-square Tests on Language of Participants and Colonoscopy Screening Status*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 19.996[a] | 1 | <.001 | | |
| Continuity Correction[b] | 18.711 | 1 | <.001 | | |
| Likelihood Ratio | 17.957 | 1 | <.001 | | |
| Fisher's Exact Test | | | | <.001 | <.001 |
| Linear-by-Linear Association | 19.969 | 1 | <.001 | | |
| N of Valid Cases | 720 | | | | |

*Note:* 0 cells (0.0%) have expected count less than 5. The minimum expected count is 17.69. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were the same, 0.167, each at $p < .001$. The Phi and Cramer's V values being less than 0.10 indicated there were differential

influences between English-speaking and Spanish-speaking study participants and colonoscopy screening status (Table 40).

**Table 40**

*Symmetric Measures on Language of Participants and Colonoscopy Screening Status*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .167 | <.001 |
| | Cramer's V | .167 | <.001 |
| N of Valid Cases | | 720 | |

The study indicated that within the past 10 years, 381 participants received colonoscopy screening, with the highest screening taking place among individuals in 70-74 age group (112 or 29.4%), followed by individuals in 65-69 age group (92 or 24.1%). Groups 50-54 (41 or 10.8%), 55-59 (50 or 13.1%), 60-64 (68 or 17.8%), and 75-79 (18 or 4.7%) (Table 41).

**Table 41**

*Five-year Age Groups and Colonoscopy Screening Status Within the Past 10 Years*

| | | | 5-year age groups | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | |
| Colonoscopy within the past 10 years | Yes | Count | 41 | 50 | 68 | 92 | 112 | 18 | 381 |
| | | % within Colonoscopy within the past 10 years | 10.8 | 13.1 | 17.8 | 24.1 | 29.4 | 4.7 | 100.0 |
| | No | Count | 55 | 35 | 39 | 49 | 39 | 4 | 221 |
| | | % within Colonoscopy within the past 10 years, 50-75 | 24.9 | 15.8 | 17.6 | 22.2 | 17.6 | 1.8 | 100.0 |
| Total | | Count | 96 | 85 | 107 | 141 | 151 | 22 | 602 |
| | | % within Colonoscopy within the past 10 years, 50-75 | 15.9 | 14.1 | 17.8 | 23.4 | 25.1 | 3.7 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 29.415$, $p < .001$, showing that there was a statistically significant association among five-year age groups in the study (Table 42).

**Table 42**

*Chi-square Tests on Five-year Age Groups and Colonoscopy Screening Status Within the Past 10 Years*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 29.415 [a] | 5 | <.001 |
| Likelihood Ratio | 29.403 | 5 | <.001 |
| Linear-by-Linear Association | 27.004 | 1 | <.001 |
| N of Valid Cases | 602 | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.08.

Symmetric measures of Phi and Cramer's V were the same, 0.221, each at $p < .001$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among five-year age groups and colonoscopy screening status (Table 43).

**Table 43**

*Symmetric Measures on Five-year Age Groups and Colonoscopy Screening Status Within the Past 10 Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .221 | <.001 |
| | Cramer's V | .221 | <.001 |
| N of Valid Cases | | 602 | |

The results indicated that within the past 10 years, 162 males (42.5%) and 219 females (57.5%) received colonoscopy screening (Table 44).

**Table 44**

*Sex of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | | Sex of participants | | |
|---|---|---|---|---|---|
| | | | Male | Female | Total |
| Colonoscopy within the past 10 years | Yes | Count | 162 | 219 | 381 |
| | | % within Colonoscopy within the past 10 years | 42.5 | 57.5 | 100.0 |
| | No | Count | 100 | 121 | 221 |
| | | % within Colonoscopy within the past 10 years | 45.2 | 54.8 | 100.0 |
| Total | | Count | 262 | 340 | 602 |
| | | % within Colonoscopy within the past 10 years | 43.5 | 56.5 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 0.424$, $p = .515$, showing that there was no statistically significant association between male and female participants in the study (Table 45).

**Table 45**

*Chi-Square Tests on Sex of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | .424 [a] | 1 | .515 | | |
| Continuity Correction [b] | .320 | 1 | .572 | | |
| Likelihood Ratio | .423 | 1 | .515 | | |
| Fisher's Exact Test | | | | .551 | .286 |
| Linear-by-Linear Association | .423 | 1 | .515 | | |
| N of Valid Cases | 602 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 96.18.
b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were -.027 and .027, respectively each at $p = .515$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences between male and female study participants and colonoscopy screening status (Table 46).

**Table 46**

*Symmetric Measures on Sex of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.027 | .515 |
| | Cramer's V | .027 | .515 |
| N of Valid Cases | | 602 | |

The results indicated that within the past 10 years, 274 (71.9%) White, non-Hispanic, 34 (8.9%) Black only, non-Hispanic, and 73 (19.2%) Hispanic participants received colonoscopy screening (Table 47).

**Table 47**

*Race of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | | Race of participants | | | Total |
|---|---|---|---|---|---|---|
| | | | White only, non-Hispanic | Black only, non-Hispanic | Hispanic | |
| Colonoscopy within the past 10 years | Yes | Count | 274 | 34 | 73 | 381 |
| | | % within Colonoscopy within the past 10 years | 71.9 | 8.9 | 19.2 | 100.0 |
| | No | Count | 133 | 24 | 64 | 221 |
| | | % within Colonoscopy within the past 10 years | 60.2 | 10.9 | 29.0 | 100.0 |
| Total | | Count | 407 | 58 | 137 | 602 |
| | | % within Colonoscopy within the past 10 years | 67.6 | 9.6 | 22.8 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 9.295$, $p = .010$, showing that there was statistically significant association between male and female participants in the study (Table 48).

**Table 48**

*Chi-Square Tests on Race of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 9.295[a] | 2 | .010 |
| Likelihood Ratio | 9.159 | 2 | .010 |
| Linear-by-Linear Association | 8.276 | 1 | .004 |
| N of Valid Cases | 602 | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 21.29.

Symmetric measures of Phi and Cramer's V were the same, .124, each at $p = .010$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among White, non-Hispanic, Black, non-Hispanic, and Hispanic study participants and colonoscopy screening status (Table 49).

**Table 49**

*Symmetric Measures on Race of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .124 | .010 |
| | Cramer's V | .124 | .010 |
| N of Valid Cases | | 602 | |

The results indicated that within the past 10 years, 356 (93.4%) English-speaking and 25 (6.6%) of Spanish-speaking study subjects received colonoscopy screening (Table 50).

**Table 50**

*Language of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | | Language of participants | | |
|---|---|---|---|---|---|
| | | | English | Spanish | Total |
| Colonoscopy within the past 10 years | Yes | Count | 356 | 25 | 381 |
| | | % within Colonoscopy within the past 10 years | 93.4 | 6.6 | 100.0 |
| | No | Count | 191 | 30 | 221 |
| | | % within Colonoscopy within the past 10 years | 86.4 | 13.6 | 100.0 |
| Total | | Count | 547 | 55 | 602 |
| | | % within Colonoscopy within the past 10 years | 90.9 | 9.1 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 8.286$, $p = .004$, showing that there was statistically significant association between English-speaking and Spanish-speaking participants in the study (Table 51).

**Table 51**

*Chi-Square Tests on Language of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 8.286 [a] | 1 | .004 | | |
| Continuity Correction [b] | 7.463 | 1 | .006 | | |
| Likelihood Ratio | 7.970 | 1 | .005 | | |
| Fisher's Exact Test | | | | .005 | .004 |
| Linear-by-Linear Association | 8.273 | 1 | .004 | | |
| N of Valid Cases | 602 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.19. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were the same, .117, each at $p = .004$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences between English-speaking and Spanish-speaking study participants and colonoscopy screening status (Table 52).

**Table 52**

*Symmetric Measures on Language of Participants and Colonoscopy Screening Status Within the Past 10 Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .117 | .004 |
| | Cramer's V | .117 | .004 |
| N of Valid Cases | | 602 | |

Sigmoidoscopy screening was more prominent among groups 60-64, 65-69 and 70-74 compared to age groups 50-54, 55-59, and 74-79 age groups. However, in comparison to colonoscopy, fewer participants in the study used sigmoidoscopy screening. Groups 60-64 (4 or 12.9%), 65-69 (8 or 25.8%), 70-74 (11 or 35.5%) had sigmoidoscopy compared to groups 50-54 (3 or 9.7%), 55-59 (2 or 6.5%), and 75-79 (3 or 9.7%) had sigmoidoscopy. In all, only 31 participants had sigmoidoscopy while 555 respondents stated that they had not received sigmoidoscopy (Table 53).

**Table 53**

*Five-year Age Groups and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | | 5-year age groups | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | |
| Sigmoidoscopy within the past 5 years | Yes | Count | 3 | 2 | 4 | 8 | 11 | 3 | 31 |
| | | % within Sigmoidoscopy within the past 5 years | 9.7 | 6.5 | 12.9 | 25.8 | 35.5 | 9.7 | 100.0 |
| | No | Count | 92 | 80 | 99 | 130 | 135 | 19 | 555 |
| | | % within Sigmoidoscopy within the past 5 years | 16.6 | 14.4 | 17.8 | 23.4 | 24.3 | 3.4 | 100.0 |
| Total | | Count | 95 | 82 | 103 | 138 | 146 | 22 | 586 |
| | | % within Sigmoidoscopy within the past 5 years | 16.2 | 14.0 | 17.6 | 23.5 | 24.9 | 3.8 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 7.196$, $p = .206$, showing that there was no statistically significant association between male and female participants in the study (Table 54).

**Table 54**

*Chi-Square Tests on Five-year Age Groups and Sigmoidoscopy Screening Status Within the Past Five Years*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 7.196[a] | 5 | .206 |
| Likelihood Ratio | 6.645 | 5 | .248 |
| Linear-by-Linear Association | 5.637 | 1 | .018 |
| N of Valid Cases | 586 | | |

*Note*: a. 2 cells (16.7%) have expected count less than 5. The minimum expected count is 1.16.

Symmetric measures of Phi and Cramer's V were the same, 0.111, each at $p$ =.206. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among five-year age groups and sigmoidoscopy screening status (Table 55).

**Table 55**

*Symmetric Measures on Five-year Age Groups and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .111 | .206 |
| | Cramer's V | .111 | .206 |
| N of Valid Cases | | 586 | |

Among respondents only 31 had taken sigmoidoscopy screening within the past 5 years, out of which 19 or 61.3% were females and 12 or 38.7% were females (Table 56).

**Table 56**

*Sex of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | | Sex of participants | | |
|---|---|---|---|---|---|
| | | | Male | Female | Total |
| Sigmoidoscopy within the past 5 years | Yes | Count | 12 | 19 | 31 |
| | | % within Sigmoidoscopy within the past 5 years | 38.7 | 61.3 | 100.0% |
| | No | Count | 240 | 315 | 555 |
| | | % within Sigmoidoscopy within the past 5 years | 43.2 | 56.8 | 100.0% |
| Total | | Count | 252 | 334 | 586 |
| | | % within Sigmoidoscopy within the past 5 years | 43.0 | 57.0 | 100.0% |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 0.246$, $p = .620$, showing that there was no statistically significant association between male and female participants in the study (Table 57).

**Table 57**

*Chi-Square Tests on Sex of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | .246 [a] | 1 | .620 | | |
| Continuity Correction [b] | .096 | 1 | .757 | | |
| Likelihood Ratio | .248 | 1 | .618 | | |
| Fisher's Exact Test | | | | .711 | .381 |
| Linear-by-Linear Association | .246 | 1 | .620 | | |
| N of Valid Cases | 586 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.33. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were -.020 and .020, respectively, each at $p = .620$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences between male and female study participants and sigmoidoscopy screening status (Table 58).

**Table 58**

*Symmetric Measures on Sex of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.020 | .620 |
| | Cramer's V | .020 | .620 |
| N of Valid Cases | | 586 | |

Sigmoidoscopy screening within the past 5 years was highest among White only, non-Hispanic (16 or 51.6%) and lowest among Black only non-Hispanic (5 or 16.1%) with Hispanics (10 or 32.3%) fallen in between (Table 59).

**Table 59**

*Race of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | | Race of participants | | | |
|---|---|---|---|---|---|---|
| | | | White only, non-Hispanic | Black only, non-Hispanic | Hispanic | Total |
| Sigmoidoscopy within the past 5 years | Yes | Count | 16 | 5 | 10 | 31 |
| | | % within Sigmoidoscopy within the past 5 years | 51.6 | 16.1 | 32.3 | 100.0 |
| | No | Count | 382 | 53 | 120 | 555 |
| | | % within Sigmoidoscopy within the past 5 years | 68.8 | 9.5 | 21.6 | 100.0 |
| Total | | Count | 398 | 58 | 130 | 586 |
| | | % within Sigmoidoscopy within the past 5 years | 67.9 | 9.9 | 22.2 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 4.063$, $p = .131$, showing that there was no statistically significant association among White only, non-Hispanic, Black only non-Hispanic, and Hispanics participants in the study (Table 60).

**Table 60**

*Chi-Square Tests on Race of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 4.063[a] | 2 | .131 |
| Likelihood Ratio | 3.802 | 2 | .149 |
| Linear-by-Linear Association | 2.336 | 1 | .126 |
| N of Valid Cases | 586 | | |

*Note:* a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 3.07.

Symmetric measures of Phi and Cramer's V were the same, 0.083, each at $p = .131$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences among White, non-Hispanic, Black, non-Hispanic, and Hispanic study participants and sigmoidoscopy screening status (Table 61).

**Table 61**

*Symmetric Measures on Race of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .083 | .131 |
| | Cramer's V | .083 | .131 |
| N of Valid Cases | | 586 | |

Out of 31 respondents who indicated that they had taken sigmoidoscopy screening within the past 5 years, 25 or 80.6% responded in English and 6 or 19.4% responded in Spanish to the survey questions (Table 62).

**Table 62**

*Language of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | | Language of participants | | |
|---|---|---|---|---|---|
| | | | English | Spanish | Total |
| Sigmoidoscopy within the past 5 years | Yes | Count | 25 | 6 | 31 |
| | | % within Sigmoidoscopy within the past 5 years | 80.6 | 19.4 | 100.0 |
| | No | Count | 510 | 45 | 555 |
| | | % within Sigmoidoscopy within the past 5 years | 91.9 | 8.1 | 100.0 |
| Total | | Count | 535 | 51 | 586 |
| | | % within Sigmoidoscopy within the past 5 years | 91.3 | 8.7 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 4.674$, $p = .031$, showing that there was statistically significant association between English-speaking and Spanish-speaking participants in the study (Table 63).

**Table 63**

*Chi-Square Tests on Language of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 4.674 [a] | 1 | .031 | | |
| Continuity Correction [b] | 3.366 | 1 | .067 | | |
| Likelihood Ratio | 3.641 | 1 | .056 | | |
| Fisher's Exact Test | | | | .044 | .044 |
| Linear-by-Linear Association | 4.666 | 1 | .031 | | |
| N of Valid Cases | 586 | | | | |

*Note:* a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.70. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were -0.089 and 0.089, respectively, each at $p = .031$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences between English-speaking and Spanish-speaking study participants and sigmoidoscopy screening status (Table 64).

**Table 64**

*Symmetric Measures on Language of Participants and Sigmoidoscopy Screening Status Within the Past Five Years*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | -.089 | .031 |
| | Cramer's V | .089 | .031 |
| N of Valid Cases | | 586 | |

Among respondents 105 had taken blood stool test screening for CRC within the past year. Groups 50-54 (13 or 12.4%), 60-64 (18 or 17.1%), 65-69 (25 or 23.8%), 70-74 (40 or 38.1%) had blood stool test screening within the past year compared to groups 55-59 (5 or 4.8%) and 75-79 (4 or 3.8%) had blood stool test screening (Table 65).

**Table 65**

*Five-year Age Groups and Blood Stool Test Within the Past Year*

| | | | 5-year age groups | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | |
| Blood stool test within the past year | Yes | Count | 13 | 5 | 18 | 25 | 40 | 4 | 105 |
| | | % within Blood stool test within the past year | 12.4 | 4.8 | 17.1 | 23.8 | 38.1 | 3.8 | 100.0 |
| | No | Count | 81 | 80 | 91 | 117 | 113 | 17 | 499 |
| | | % within Blood stool test within the past year | 16.2 | 16.0 | 18.2 | 23.4 | 22.6 | 3.4 | 100.0 |
| Total | | Count | 94 | 85 | 109 | 142 | 153 | 21 | 604 |
| | | % within Blood stool test within the past year | 15.6 | 14.1 | 18.0 | 23.5 | 25.3 | 3.5 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 16.933$, $p = .005$, showing that there was a statistically significant association among five-year age group participants in the study (Table 66).

**Table 66**

*Chi-Square Tests for Five-year Age Groups and Blood Stool Test Within the Past Year*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 16.933[a] | 5 | .005 |
| Likelihood Ratio | 18.312 | 5 | .003 |
| Linear-by-Linear Association | 10.566 | 1 | .001 |
| N of Valid Cases | 604 | | |

*Note*: a. 1 cells (8.3%) have expected count less than 5. The minimum expected count is 3.65

Symmetric measures of Phi and Cramer's V were the same, 0.167, each at $p$ =.005. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among five-year age groups and blood stool test screening status (Table 67).

**Table 67**

*Symmetric Measures on Five-year Age Groups and Blood Stool Test Within the Past Year*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .167 | .005 |
| | Cramer's V | .167 | .005 |
| N of Valid Cases | | 604 | |

Among respondents 105 had taken blood stool test screening for CRC within the past year, with 52 or 49.5% males and 53 or 50.5% females involved. This indicated that blood stool test was nearly even between males and females (Table 68).

**Table 68**

*Sex of Participants and Blood Stool Test Within the Past Year*

| | | | Sex of participants | | Total |
|---|---|---|---|---|---|
| | | | Male | Female | |
| Blood stool test within the past year | Yes | Count | 52 | 53 | 105 |
| | | % within Blood stool test within the past year | 49.5 | 50.5 | 100.0 |
| | No | Count | 206 | 293 | 499 |
| | | % within Blood stool test within the past year | 41.3 | 58.7 | 100.0 |
| Total | | Count | 258 | 346 | 604 |
| | | % within Blood stool test within the past year | 42.7 | 57.3 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 2.408$, $p = .121$, showing that there was no statistically significant association between male and female participants in the study (Table 69).

**Table 69**

*Chi-Square Tests on Sex of Participants and Blood Stool Test Within the Past Year*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | 2.408 [a] | 1 | .121 | | |
| Continuity Correction [b] | 2.083 | 1 | .149 | | |
| Likelihood Ratio | 2.389 | 1 | .122 | | |
| Fisher's Exact Test | | | | .129 | .075 |
| Linear-by-Linear Association | 2.404 | 1 | .121 | | |
| N of Valid Cases | 604 | | | | |

*Note:* a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 44.85. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were the same, 0.063, each at $p = .121$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential

influences between male and female participants and blood stool test screening status (Table 70).

**Table 70**

*Symmetric Measures on Sex and Blood Stool Test Within the Past Year*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .063 | .121 |
| | Cramer's V | .063 | .121 |
| N of Valid Cases | | 604 | |

The results indicated that 68 or 64.8% of White only, non-Hispanic, 15 or 14.3% of Black, non-Hispanic, and 22 or 21.0% Hispanic had taken blood stool test screening for CRC within the past year (Table 71).

**Table 71**

*Race of Participants and Blood Stool Test Within the Past Year*

| | | | Race of participants | | | Total |
|---|---|---|---|---|---|---|
| | | | White only, non-Hispanic | Black only, non-Hispanic | Hispanic | |
| Blood stool test within the past year | Yes | Count | 68 | 15 | 22 | 105 |
| | | % within Blood stool test within the past year | 64.8 | 14.3 | 21.0 | 100.0 |
| | No | Count | 341 | 44 | 114 | 499 |
| | | % within Blood stool test within the past year | 68.3 | 8.8 | 22.8 | 100.0 |
| Total | | Count | 409 | 59 | 136 | 604 |
| | | % within Blood stool test within the past year | 67.7 | 9.8 | 22.5 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 2.957$, $p = .228$, showing that there was no statistically significant association among White, non-Hispanic, Black, non-Hispanic, and Hispanic study participants in the study (Table 72).

**Table 72**

*Chi-Square Tests on Race of Participants and Blood Stool Test Within the Past Year*

| | Value | df | Asymptotic Significance (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 2.957[a] | 2 | .228 |
| Likelihood Ratio | 2.701 | 2 | .259 |
| Linear-by-Linear Association | .063 | 1 | .802 |
| N of Valid Cases | 604 | | |

Symmetric measures of Phi and Cramer's V were the same, 0.063, each at $p = .121$. The Phi and Cramer's V values being less than 0.10 indicated there were no differential influences among White, non-Hispanic, Black, non-Hispanic, and Hispanic study participants and blood stool test screening status (Table 73).

**Table 73**

*Symmetric Measures on Race and Blood Stool Test Within the Past Year*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .070 | .228 |
| | Cramer's V | .070 | .228 |
| N of Valid Cases | | 604 | |

The results indicated that 97 or 92.4% of English-speaking and 8 or 7.6% of Spanish-speaking participants in the study had taken blood stool test screening for CRC within the past year (Table 74).

**Table 74**

*Language of Participants and Blood Stool Test Within the Past Year*

| | | | Language of participants | | |
|---|---|---|---|---|---|
| | | | English | Spanish | Total |
| Blood stool test within the past year | Yes | Count | 97 | 8 | 105 |
| | | % within Blood stool test within the past year | 92.4 | 7.6 | 100.0 |
| | No | Count | 451 | 48 | 499 |
| | | % within Blood stool test within the past year | 90.4 | 9.6 | 100.0 |
| Total | | Count | 548 | 56 | 604 |
| | | % within Blood stool test within the past year | 90.7 | 9.3 | 100.0 |

The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 0.413$, $p = .521$, showing that there was no statistically significant association between English-speaking and Spanish-speaking participants in the study (Table 75).

**Table 75**

*Chi-Square Tests on Language of Participants and Blood Stool Test Within the Past Year*

| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|---|---|---|---|---|---|
| Pearson Chi-Square | .413 [a] | 1 | .521 | | |
| Continuity Correction [b] | .209 | 1 | .648 | | |
| Likelihood Ratio | .432 | 1 | .511 | | |
| Fisher's Exact Test | | | | .711 | .334 |
| Linear-by-Linear Association | .412 | 1 | .521 | | |
| N of Valid Cases | 604 | | | | |

*Note*: a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.74. b. Computed only for a 2x2 table.

Symmetric measures of Phi and Cramer's V were the same, 0.026, each at p =.521. The Phi and Cramer's V values being less than 0.10 indicated there were no

differential influences between English-speaking and Spanish-speaking study participants and FOBT screening status (Table 76).

**Table 76**

*Symmetric Measures on Language of Participants and Blood Stool Test Within the Past Year*

| | | Value | Approximate Significance |
|---|---|---|---|
| Nominal by Nominal | Phi | .026 | .521 |
| | Cramer's V | .026 | .521 |
| N of Valid Cases | | 604 | |

## Inferential Statistical Analysis

I performed bivariate logistic regression and Chi-square tests to evaluate whether there were significant associations between the DV and the motivating variables of CRC screening including 5-year age groups, race, language, annual household income, employment status, healthcare access, and education status. Bivariate analysis permits an evaluation of how the value of the CRC screening (outcome variable) relies upon the extent of LEP (explanatory variable). Also, I used bivariate analyses to compare gender (explanatory variable) and CRC screening (outcome variable). Additionally, I employed forced multivariate logistic regression analysis to assess the relationship between the variables of interest, such as LEP and CRC screening among the target population. I conducted a multivariate logistic regression for odds ratio (ORs) of CRC screening between respondents with low LEP (fluent in English/both English and Spanish) and high LEP (fluent in Spanish only).

**Model with Interaction Effects**

In a forced logistic regression that included 362 respondents representing 73.4% of the total sample, Table 25 shows how the DV of CRC screening status was recorded. For the BRFSS question, "Have you ever screened for CRC?" individuals who answered Yes were coded 0, and all "No" respondents were coded 1 (Table 77). Table 78 shows that the model itself explained 73.4% of the variance.

**Table 77**

*DV Encoding*

| Original Value | Internal Value |
|---|---|
| Yes, screened for colorectal cancer | 0 |
| No, not screened for colorectal cancer | 1 |

**Table 78**

*Classification Table: Colorectal Cancer Status*

| | | Observed | Predicted Colorectal cancer screening status: Yes, screened for colorectal cancer | Predicted Colorectal cancer screening status: No, not screened for colorectal cancer | Percentage Correct |
|---|---|---|---|---|---|
| Step 0 | Colorectal cancer screening status | Yes, screened for colorectal cancer | 362 | 0 | 100.0 |
| | | No, not screened for colorectal cancer | 131 | 0 | .0 |
| | Overall Percentage | | | | 73.4 |

*Note:* a. Constant is included in the model. b. The cut value is .500.

The Omnibus Tests of Model Coefficients (Table 79) indicated that the overall fit of the model was significant: $\chi 2\ (7) = 47.080$, $p < .001$. The Hosmer and Lemeshow Test, $\chi 2\ (8)$

= 16.886, $p$ = .031, was significant, indicating that the model was not predictable (Table 80).

**Table 79**

*Omnibus Tests of Model Coefficients*

| | | Chi-square | df | Sig. |
|---|---|---|---|---|
| Step 1 | Step | 47.080 | 7 | <.001 |
| | Block | 47.080 | 7 | <.001 |
| | Model | 47.080 | 7 | <.001 |

**Table 80**

*Hosmer and Lemeshow Test*

| Step | Chi-square | df | Sig. |
|---|---|---|---|
| 1 | 16.886 | 8 | .031 |

Table 81 indicates that the Nagelkerke $R^2$ value of 13.3%, which is adjusted version of Cox and Snell $R^2$, and it shows that the predictor variables explained 13.3% of the variance. The predictor variables improved the overall predictability of the model from 73.4% to 75.3% (Table 82).

**Table 81**

*Model Summary*

| Step | -2 Log likelihood | Cox & Snell R Square | Nagelkerke R Square |
|---|---|---|---|
| 1 | 523.769 [a] | .091 | .133 |

*Note:* a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

**Table 82**

*Improved Predictor Variables*

| | | Observed | Predicted Colorectal cancer screening status | | |
|---|---|---|---|---|---|
| | | | Yes, screened for colorectal cancer | No, not screened for colorectal cancer | Percentage Correct |
| Step 1 | Colorectal cancer screening status | Yes, screened for colorectal cancer | 347 | 15 | 95.9 |
| | | No, not screened for colorectal cancer | 107 | 24 | 18.3 |
| | Overall Percentage | | | | 75.3 |

*Note:* a. The cut value is .500.

I performed a series of bivariate analyses to evaluate whether there were significant associations between the DV and the motivating variables of CRC screening including 5-year age groups, race, language, annual household income, employment status, healthcare access, and education status. The Wald test is employed to assess statistical significance for the IVs. From Table 83, race with a Wald value of 0.087, $p$ =.768; language Wald value of 0.574, $p$ =.449; income of participants Wald value of 0.175, $p$ =.675; employment status Wald value of 1.168, $p$ =.280; healthcare access Wald value of 4.857, $p$ <.028; education status Wald value of 5.070, $p$ <.024; and 5-year age groups with a Wald value of 16.163 had a $p$ <.001. From these results, variables with $p$ <.05 were significant, while the variables with $p$ >.05 were not significant. Thus, 5-year age groups, healthcare access, and education status were significant, while race of participants, language of participants, income of participants, and employment status were not significant (Table 83).

Table 83 presents the unadjusted bivariate ORs for sociodemographic variables. The sociodemographic variables and their associations with the unadjusted OR vary from one another. For race of participants, OR = 0.987; 95% CI 0.902, 1.079, $p$ = .768; language, OR = 1.415; 95% CI 0.576, 3.476, $p$ = .449; income, OR = 0.973; 95% CI 0.854, 1.108, $p$ = .675; employment status, OR = 0.753; 95% CI 0.451, 1.259, $p$ = .280; healthcare access, OR = 2.448; 95% CI, 1.104, 5.429, $p$ = .028; education status, OR = 0.746; 95% CI 0.578, 0.963, $p$ = .024; sex, OR = 0.912; 95% CI 0.595, 1.398, $p$ = .673, and 5-year age groups, OR = 0.717; CI 95% 0.610, 0.843, $p$ <.001. From the analyses, race, language, income, employment status, and sex were not significant predictors of CRC screening since their respective $p$ >.05. On the other hand, healthcare access, education status, and 5-year groups, all had $p$ < .05, indicating that they were significant predictors of CRC screening among participants in the study.

**Table 83**

*Variables in the Equation*

| | | | | | | | | 95% C.I. for EXP(B) | |
|---|---|---|---|---|---|---|---|---|---|
| | | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Step 1[a] | Race of participants | -.013 | .046 | .087 | 1 | .768 | .987 | .902 | 1.079 |
| | Language of participants (1) | .347 | .458 | .574 | 1 | .449 | 1.415 | .576 | 3.476 |
| | Income of participants | -.028 | .066 | .175 | 1 | .675 | .973 | .854 | 1.108 |
| | Employment status | -.283 | .262 | 1.168 | 1 | .280 | .753 | .451 | 1.259 |
| | Healthcare access | .895 | .406 | 4.857 | 1 | .028 | 2.448 | 1.104 | 5.429 |
| | Education status | -.293 | .130 | 5.070 | 1 | .024 | .746 | .578 | .963 |
| | Sex of participants | -.092 | .218 | .178 | 1 | .673 | .912 | .595 | 1.398 |
| | 5-year age groups | -.332 | .083 | 16.163 | 1 | <.001 | .717 | .610 | .843 |
| | Constant | 2.709 | 1.219 | 4.939 | 1 | .026 | 15.022 | | |

*Note*: a. Variable(s) entered on Step 1: race, language, income, employment status, healthcare access, education status, sex, 5-year age groups

**Interaction of the Independent Variable**

In accordance with the 2021 USPSTF CRC screening guidelines, I considered those who had a FOBT within the past year, flexible sigmoidoscopy within the past five years, and colonoscopy within the past ten years for the analysis, leaving other forms of CRC screening out of the study (Davidson et al., 2021).

Tables 84 - 88 showed the parameter estimates, which described the coefficients of the model and adjusted ORs that explained various forms of CRC screenings based on various IVs. I conducted multivariate logistic regressions to evaluate the interaction effect of the variables based on *p*-values. For there to be a significant interaction effect, *p*-value must be <.05 and no significant interaction effect would show a $p > .05$. I found an interaction effect between CRC screening and the following IVs: healthcare access, education status, and 5-year age groups. The adjusted OR for healthcare access = 0.400; 95% CI 0.180, 0.889, $p = .025$; education status = 1.358; 95% CI 1.015, 1.755, $p = .019$, and 5-year age groups = 1.390; 95% CI 1.182, 1.635, $p < .001$ (Table 84). There were no interaction effects between CRC screening and language spoken by participants, annual household incomes, employment status, sex, and race of participants. For colonoscopy and IVs (Table 85), I found interactive effects with annual household incomes, employment status, sex, 5-year age groups. The adjusted OR for annual household = 1.238; 95% CI 1.095, 1.400, $p < .001$; employment status = 1.713; 95% CI 1.027, 2.857, $p = .039$; and 5-year age groups = 1.449; 95% CI 1.256, 1.672, $p < .001$. There was no interaction with healthcare access, education status, race, and language spoken by participants (Table 85). For participants who had colonoscopy within the past 10 years

(Table 86), no interaction effect was observed in annual household incomes, employment, healthcare access, education status, sex, race, and language. For participants who had sigmoidoscopy within the past 5 years (Table 87), only annual household income had a positive interaction effect with an adjusted OR = 0.767; 95% CI 0.621, 0.949, $p$ = .014. In these participants, employment status, education status, healthcare access, sex, race, and language showed no significant interaction effect. With FOBT within the past year (Table 88), only annual household income showed a positive interaction effect with adjusted OR = 0.868; 95% CI 0.758, 0.993, $p$ = .040, while employment status, education status, healthcare access, sex, race, and language all showing no significant interaction effect (Table 88).

**Table 84**

*Parameter Estimates of Variables on Colorectal Cancer: Yes - Screened for Colorectal Status*

| | | | | | | | 95% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Wald | df | Sig. | Exp(B) | Lower Bound | Upper Bound |
| Intercept | -2.702 | 1.137 | 5.651 | 1 | .017 | | | |
| Income of participants | .018 | .067 | .074 | 1 | .786 | 1.018 | .893 | 1.161 |
| Employment status | .284 | .262 | 1.177 | 1 | .278 | 1.329 | .795 | 2.222 |
| Healthcare access | -.917 | .408 | 5.050 | 1 | .025 | .400 | .180 | .889 |
| Education status | .306 | .131 | 5.466 | 1 | .019 | 1.358 | 1.051 | 1.755 |
| 5-year age groups | .329 | .083 | 15.860 | 1 | <.001 | 1.390 | 1.182 | 1.635 |
| Sex of participants=1 | -.103 | .218 | .224 | 1 | .636 | .902 | .588 | 1.383 |
| Sex of participants=2 | 0[b] | . | . | 0 | . | . | . | . |
| Race of participants=1 | -.080 | .321 | .062 | 1 | .803 | .923 | .492 | 1.732 |
| Race of participants=2 | -.454 | .455 | .998 | 1 | .318 | .635 | .261 | 1.548 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Race of participants=8 | 0[b] | . | . | 0 | . | . | . | . |
| Language of participants=1 | .382 | .461 | .686 | 1 | .407 | 1.465 | .593 | 3.617 |

## Table 85

*Parameter Estimates of Variables on Colorectal Cancer: Yes - Had a Colonoscopy*

| | | | | | | | 95% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Wald | df | Sig. | Exp(B) | Lower Bound | Upper Bound |
| Intercept | -4.720 | 1.076 | 19.228 | 1 | <.001 | | | |
| Income of participants | .213 | .063 | 11.583 | 1 | <.001 | 1.238 | 1.095 | 1.400 |
| Employment status | .538 | .261 | 4.257 | 1 | .039 | 1.713 | 1.027 | 2.857 |
| Healthcare access | -.710 | .407 | 3.046 | 1 | .081 | .492 | .222 | 1.091 |
| Education status | .174 | .121 | 2.073 | 1 | .150 | 1.190 | .939 | 1.509 |
| 5-year age groups | .371 | .073 | 25.731 | 1 | <.001 | 1.449 | 1.256 | 1.672 |
| Sex of participants=1 | -.468 | .209 | 5.018 | 1 | .025 | .626 | .416 | .943 |
| Sex of participants=2 | 0[b] | . | . | 0 | . | . | . | . |
| Race of participants=1 | .255 | .295 | .750 | 1 | .387 | 1.291 | .724 | 2.302 |
| Race of participants=2 | -.031 | .423 | .005 | 1 | .942 | .969 | .423 | 2.223 |
| Race of participants=8 | 0[b] | . | . | 0 | . | . | . | . |
| Language of participants=1 | .418 | .422 | .979 | 1 | .322 | 1.519 | .664 | 3.477 |

**Table 86**

*Parameter Estimates of Variables on Colorectal Cancer: Yes - Colonoscopy Within Past 10 Years*

| | | | | | | | 95% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Wald | df | Sig. | Exp(B) | Lower Bound | Upper Bound |
| Intercept | -3.463 | 1.073 | 10.416 | 1 | .001 | | | |
| Income of participants | .099 | .060 | 2.745 | 1 | .098 | 1.104 | .982 | 1.241 |
| Employment status | .241 | .241 | .994 | 1 | .319 | 1.272 | .793 | 2.041 |
| Healthcare access | -.717 | .413 | 3.014 | 1 | .083 | .488 | .217 | 1.097 |
| Education status | .222 | .120 | 3.430 | 1 | .064 | 1.248 | .987 | 1.578 |
| 5-year age groups | .315 | .076 | 17.207 | 1 | <.001 | 1.370 | 1.181 | 1.590 |
| Sex of participants=1 | -.204 | .199 | 1.046 | 1 | .306 | .816 | .552 | 1.205 |
| Sex of participants=2 | 0[b] | . | . | 0 | . | . | . | . |
| Race of participants=1 | .001 | .288 | .000 | 1 | .998 | 1.001 | .569 | 1.760 |
| Race of participants=2 | -.385 | .412 | .873 | 1 | .350 | .680 | .304 | 1.526 |
| Race of participants=8 | 0[b] | . | . | 0 | . | . | . | . |
| Language of participants=1 | .357 | .437 | .666 | 1 | .415 | 1.429 | .606 | 3.365 |

**Table 87**

*Parameter Estimates of Variables on Colorectal Cancer: Yes - Sigmoidoscopy Within Past 5 Years*

| | | | | | | | 95% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Wald | df | Sig. | Exp(B) | Lower Bound | Upper Bound |
| Intercept | -3.737 | 2.245 | 2.770 | 1 | .096 | | | |
| Income of participants | -.265 | .108 | 5.981 | 1 | .014 | .767 | .621 | .949 |
| Employment status | -.214 | .542 | .156 | 1 | .693 | .807 | .279 | 2.336 |
| Healthcare access | -.105 | .823 | .016 | 1 | .898 | .900 | .179 | 4.512 |
| Education status | .119 | .228 | .272 | 1 | .602 | 1.126 | .720 | 1.761 |
| 5-year age groups | .284 | .163 | 3.036 | 1 | .081 | 1.329 | .965 | 1.830 |
| Sex of participants=1 | -.134 | .414 | .105 | 1 | .746 | .875 | .389 | 1.969 |
| Sex of participants=2 | 0[b] | . | . | 0 | . | . | . | . |
| Race of participants=1 | -.054 | .608 | .008 | 1 | .929 | .947 | .287 | 3.120 |
| Race of participants=2 | .665 | .740 | .809 | 1 | .368 | 1.945 | .456 | 8.292 |
| Race of participants=8 | -.286 | .767 | .138 | 1 | .710 | .752 | .167 | 3.382 |
| Language of participants=1 | -.265 | .108 | 5.981 | 1 | .014 | .767 | .621 | .949 |

**Table 88**

*Parameter Estimates of Variables on Colorectal Cancer: Yes – Blood Stool Test Within the Past Year*

| | | | | | | | 95% Confidence Interval for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Wald | df | Sig. | Exp(B) | Lower Bound | Upper Bound |
| Intercept | -2.566 | 1.378 | 3.466 | 1 | .063 | | | |
| Income of participants | -.142 | .069 | 4.225 | 1 | .040 | .868 | .758 | .993 |
| Employment status | .318 | .319 | .990 | 1 | .320 | 1.374 | .735 | 2.568 |
| Healthcare access | -.616 | .588 | 1.100 | 1 | .294 | .540 | .171 | 1.708 |
| Education status | -.104 | .145 | .515 | 1 | .473 | .901 | .678 | 1.198 |
| 5-year age groups | .168 | .095 | 3.099 | 1 | .078 | 1.183 | .981 | 1.425 |
| Sex of participants=1 | .459 | .247 | 3.452 | 1 | .063 | 1.583 | .975 | 2.569 |
| Sex of participants=2 | 0[b] | . | . | 0 | . | . | . | . |
| Race of participants=1 | .031 | .361 | .007 | 1 | .932 | 1.031 | .509 | 2.092 |
| Race of participants=2 | .392 | .487 | .647 | 1 | .421 | 1.479 | .570 | 3.842 |
| Race of participants=8 | .419 | .548 | .585 | 1 | .444 | 1.520 | .520 | 4.446 |
| Language of participants=1 | -.142 | .069 | 4.225 | 1 | .040 | .868 | .758 | .993 |

*Note:* a. The reference category is: No, not screened for colorectal cancer; b. This parameter is set to the 0 because it is redundant.

Table 89 showed CRC screening based on sex, race, and language of participants. Out of 766 sample size, the number of valid participants indicated 598 with 168 missing. Among the valid participants, 440 or 73.6% received CRC screening. There were fewer males than females with 260 or 43.5% representing males and 338 or 56.5% representing females. Because all White, non-Hispanic, all Black, non-Hispanic and some Hispanic participants chose English as their medium of communication, individual participants who identified themselves with the English was 544 or 91.0%, while only 54 or 9.0% identified themselves as Spanish-speaking participants in the study.

**Table 89**

*Case Processing Summary*

| | | N | Marginal Percentage |
|---|---|---|---|
| Colorectal cancer screening status | Yes, screened for colorectal cancer | 440 | 73.6% |
| | No, not screened for colorectal cancer | 158 | 26.4% |
| Sex of participants | Male | 260 | 43.5% |
| | Female | 338 | 56.5% |
| Race of participants | White only, non-Hispanic | 408 | 68.2% |
| | Black only, non-Hispanic | 56 | 9.4% |
| | Hispanic | 134 | 22.4% |
| Language of participants | English | 544 | 91.0% |
| | Spanish | 54 | 9.0% |
| Valid | | 598 | 100.0% |
| Missing | | 168 | |
| Total | | 766 | |
| Subpopulation | | 46 [a] | |

*Note:* a. The dependent variable has only one value observed in 8 (17.4%) subpopulations.

The observed and predicted frequencies indicate varied percentages for the CRC screening participants. White only, non-Hispanic male and female and Black only, non-Hispanic male and female participants communicate in English. For the Hispanic participants, some Hispanic males and females speak English, while some other Hispanic males and females speak Spanish only. From Table 90, for White only, non-Hispanic males and females, there were 146 or 78.1% and 167 or 75% of participants who received CRC screening, respectively. Among the Black only, non-Hispanic males and females, 12 or 60.0% and 28 or 77.8% received CRC screening in that order. Hispanics who speak English, 22 or 66.7% of males received CRC screening while 35 or 74.5% of females also had CRC screening. For Hispanic male and female participants who speak Spanish, 9 or 45.0% of males had CRC screening and 21 or 61.8% of females had CRC screening.

These variations in the percentages indicated that individuals who speak Spanish had the lowest rates of CRC screening (Table 90).

Considering colonoscopy (Table 90), there were stark variations in the results. White only, non-Hispanic, 167 or 76.6% of males and 220 or 79.4% of females; Black only, non-Hispanic, 15 or 62.5% of males and 32 or 71.1% of females; English-speaking Hispanic, 21 or 56.8% of males and 37 or 68.5% of females; and Spanish-speaking Hispanic, 6 or 27.3% of males and 26 or 60.5% of females received colonoscopy. For colonoscopy within the past 10 years (Table 90), White only, non-Hispanic, 128 or 68.8% of males and 146 or 66.1% of females; Black only, non-Hispanic, 11 or 52.4% of males and 23 or 62.2% of females; English-speaking Hispanic, 18 or 51.4% of males and 30 or 63.8% of females; and Spanish-speaking Hispanic, 5 or 25.0% of males and 20 or 57.1% of females received colonoscopy. For sigmoidoscopy within the past 5 years (Table 90), White only, non-Hispanic, 7 or 3.9% of males and 9 or 4.1% of females; Black only, non-Hispanic, 1 or 5.0% of males and 4 or 10.5% of females; English-speaking Hispanic, 1 or 3.0% of males and 3 or 6.5% of females; and Spanish-speaking Hispanic, 3 or 15.0% of males and 3 or 9.7% of females received sigmoidoscopy. For FOBT in the past year (Table 90), White only, non-Hispanic, 34 or 18.6% of males and 34 or 15.0% of females; Black only, non-Hispanic, 6 or 28.6% of males and 9 or 23.7% of females; English-speaking Hispanic, 6 or 18.2% of males and 8 or 17.0% of females; and Spanish-speaking Hispanic, 6 or 28.6% of males and 2 or 5.7% of females received blood stool test in the past year (Table 90).

**Table 90**

*Observations and Predicted Frequencies of Males and Females Among the Racial Groups in the Study*

| Race of participants | Language of participants | Sex of participants | Have you ever had colorectal cancer screening | Frequency | | | Percentage | |
|---|---|---|---|---|---|---|---|---|
| | | | | Observed | Predicted | Pearson Residual | Observed | Predicted |
| White only, non-Hispanic | English | Male | Yes | 146 | 140.451 | .938 | 78.1% | 75.1% |
| | | | No | 41 | 46.549 | -.938 | 21.9% | 24.9% |
| | | Female | Yes | 167 | 170.505 | -.562 | 75.6% | 77.2% |
| | | | No | 54 | 50.495 | .562 | 24.4% | 22.8% |
| Black only, non-Hispanic | English | Male | Yes | 12 | 14.869 | -1.469 | 60.0% | 74.3% |
| | | | No | 8 | 5.131 | 1.469 | 40.0% | 25.7% |
| | | Female | Yes | 28 | 27.515 | .190 | 77.8% | 76.4% |
| | | | No | 8 | 8.485 | -.190 | 22.2% | 23.6% |
| Hispanic | English | Male | Yes | 22 | 22.919 | -.347 | 66.7% | 69.5% |
| | | | No | 11 | 10.081 | .347 | 33.3% | 30.5% |
| | | Female | Yes | 35 | 33.740 | .408 | 74.5% | 71.8% |
| | | | No | 12 | 13.260 | -.408 | 25.5% | 28.2% |
| | Spanish | Male | Yes | 9 | 10.761 | -.790 | 45.0% | 53.8% |
| | | | No | 11 | 9.239 | .790 | 55.0% | 46.2% |
| | | Female | Yes | 21 | 19.239 | .609 | 61.8% | 56.6% |
| | | | No | 13 | 14.761 | -.609 | 38.2% | 43.4% |
| White only, non-Hispanic | English | Male | Ever had a colonoscopy? | | | | | |
| | | | Yes | 167 | 160.776 | .958 | 76.6% | 73.8% |
| | | | No | 51 | 57.224 | -.958 | 23.4% | 26.2% |
| | | Female | Yes | 220 | 221.549 | -.233 | 79.4% | 80.0% |
| | | | No | 57 | 55.451 | .233 | 20.6% | 20.0% |
| Black only, non-Hispanic | English | Male | Yes | 15 | 17.217 | -1.005 | 62.5% | 71.7% |
| | | | No | 9 | 6.783 | 1.005 | 37.5% | 28.3% |
| | | Female | Yes | 32 | 35.237 | -1.171 | 71.1% | 78.3% |
| | | | No | 13 | 9.763 | 1.171 | 28.9% | 21.7% |
| Hispanic | English | Male | Yes | 21 | 21.452 | -.150 | 56.8% | 58.0% |
| | | | No | 16 | 15.548 | .150 | 43.2% | 42.0% |
| | | Female | Yes | 37 | 35.769 | .354 | 68.5% | 66.2% |
| | | | No | 17 | 18.231 | -.354 | 31.5% | 33.8% |
| | Spanish | Male | Yes | 6 | 9.555 | -1.529 | 27.3% | 43.4% |
| | | | No | 16 | 12.445 | 1.529 | 72.7% | 56.6% |
| | | Female | Yes | 26 | 22.445 | 1.085 | 60.5% | 52.2% |
| | | | No | 17 | 20.555 | -1.085 | 39.5% | 47.8% |

(*table continues)*

**Table 90**

*Observations and Predicted Frequencies of Males and Females Among the Racial Groups in the Study cont.*

| Race of participants | Language of participants | Sex of participants | Sigmoidoscopy within the past 5 years | Frequency | | | Percentage | |
|---|---|---|---|---|---|---|---|---|
| | | | | Observed | Predicted | Pearson Residual | Observed | Predicted |
| White only, non-Hispanic | English | Male | Yes | 7 | 7.367 | -.138 | 3.9% | 4.1% |
| | | | No | 172 | 171.633 | .138 | 96.1% | 95.9% |
| | | Female | Yes | 9 | 10.577 | -.497 | 4.1% | 4.8% |
| | | | No | 210 | 208.423 | .497 | 95.9% | 95.2% |
| Black only, non-Hispanic | English | Male | Yes | 1 | .846 | .171 | 5.0% | 4.2% |
| | | | No | 19 | 19.154 | -.171 | 95.0% | 95.8% |
| | | Female | Yes | 4 | 1.886 | 1.579 | 10.5% | 5.0% |
| | | | No | 34 | 36.114 | -1.579 | 89.5% | 95.0% |
| Hispanic | English | Male | Yes | 1 | 1.642 | -.514 | 3.0% | 5.0% |
| | | | No | 32 | 31.358 | .514 | 97.0% | 95.0% |
| | | Female | Yes | 3 | 2.682 | .200 | 6.5% | 5.8% |
| | | | No | 43 | 43.318 | -.200 | 93.5% | 94.2% |
| | Spanish | Male | Yes | 3 | 2.145 | .618 | 15.0% | 10.7% |
| | | | No | 17 | 17.855 | -.618 | 85.0% | 89.3% |
| | | Female | Yes | 3 | 3.855 | -.465 | 9.7% | 12.4% |
| | | | No | 28 | 27.145 | .465 | 90.3% | 87.6% |
| | | | Blood stool test within the past year | | | | | |
| White only, non-Hispanic | English | Male | Yes | 34 | 37.137 | -.577 | 18.6% | 20.3% |
| | | | No | 149 | 145.863 | .577 | 81.4% | 79.7% |
| | | Female | Yes | 34 | 34.966 | -.178 | 15.0% | 15.5% |
| | | | No | 192 | 191.034 | .178 | 85.0% | 84.5% |
| Black only, non-Hispanic | English | Male | Yes | 6 | 4.291 | .925 | 28.6% | 20.4% |
| | | | No | 15 | 16.709 | -.925 | 71.4% | 79.6% |
| | | Female | Yes | 9 | 5.923 | 1.376 | 23.7% | 15.6% |
| | | | No | 29 | 32.077 | -1.376 | 76.3% | 84.4% |
| Hispanic | English | Male | Yes | 6 | 7.029 | -.437 | 18.2% | 21.3% |
| | | | No | 27 | 25.971 | .437 | 81.8% | 78.7% |
| | | Female | Yes | 8 | 7.655 | .136 | 17.0% | 16.3% |
| | | | No | 39 | 39.345 | -.136 | 83.0% | 83.7% |
| | Spanish | Male | Yes | 6 | 3.543 | 1.432 | 28.6% | 16.9% |
| | | | No | 15 | 17.457 | -1.432 | 71.4% | 83.1% |
| | | Female | Yes | 2 | 4.457 | -1.246 | 5.7% | 12.7% |
| | | | No | 33 | 30.543 | 1.246 | 94.3% | 87.3% |

(*table continues)*

**Table 90**

*Observations and Predicted Frequencies of Males and Females Among the Racial Groups in the Study cont.*

| | | | Colonoscopy within the past 10 years | | | | | |
|---|---|---|---|---|---|---|---|---|
| White only, non-Hispanic | English | Male | Yes | 128 | 120.459 | 1.157 | 68.8% | 64.8% |
| | | | No | 58 | 65.541 | -1.157 | 31.2% | 35.2% |
| | | Female | Yes | 146 | 150.082 | -.588 | 66.1% | 67.9% |
| | | | No | 75 | 70.918 | .588 | 33.9% | 32.1% |
| Black only, non-Hispanic | English | Male | Yes | 11 | 13.343 | -1.062 | 52.4% | 63.5% |
| | | | No | 10 | 7.657 | 1.062 | 47.6% | 36.5% |
| | | Female | Yes | 23 | 24.693 | -.591 | 62.2% | 66.7% |
| | | | No | 14 | 12.307 | .591 | 37.8% | 33.3% |
| Hispanic | English | Male | Yes | 18 | 19.551 | -.528 | 51.4% | 55.9% |
| | | | No | 17 | 15.449 | .528 | 48.6% | 44.1% |
| | | Female | Yes | 30 | 27.872 | .632 | 63.8% | 59.3% |
| | | | No | 17 | 19.128 | -.632 | 36.2% | 40.7% |
| | Spanish | Male | Yes | 5 | 8.647 | -1.646 | 25.0% | 43.2% |
| | | | No | 15 | 11.353 | 1.646 | 75.0% | 56.8% |
| | | Female | Yes | 20 | 16.353 | 1.236 | 57.1% | 46.7% |
| | | | No | 15 | 18.647 | -1.236 | 42.9% | 53.3% |

## Summary

Statistical analysis of the data led to the rejection of the null hypothesis ($H_0$1) which stated that there is no significant relationship between LEP and CRC screening rates among Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled. The results showed significant associations between LEP and CRC screening uptake. However, the analysis of the data did not indicate that the null hypothesis ($H_0$2) could not be rejected as gender did not independently show a significant relationship between males and females with CRC screening of Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled.

Nonetheless, Hispanic males are likely to be exposed to increased risk for CRC due to their low screening rates among all participants in the study.

To understand any discrepancies in this study, it was important to compare its findings with extant knowledge with possible explanation. The next chapter would focus on discussion of the results and implications of the findings. It would also present recommendations and discuss the social change associated with the study.

# Chapter 5: Discussion, Conclusions, and Recommendations

## Introduction

Numerous studies have focused on the impact of language barrier as a fundamental cause of low screening of CRC among non-English-speaking ethnic groups in the United States, including Spanish-speaking Americans (DuHamel et al., 2020). However, no study has been done to confirm this finding in the state of Texas where nearly 11.3 million or 40.2% of the population were Hispanic in 2020 (United States Census Bureau, 2021). I conducted this study using descriptive statistics, such as frequencies and percentages, to assess the association between each of the two main IVs, LEP and sex, and the DV, which was the CRC screening. To understand the preferences of CRC screening methods among participants, I ran statistical analyses on several types of screening for CRC (ever taken colonoscopy, colonoscopy in the past 10 years, sigmoidoscopy in the past 5 years, and blood stool test or fecal occult blood test (FOBT) within the past year), using crosstabulation descriptive analysis, bivariate, and multivariate models. These models demonstrated the associations between LEP and sex on CRC screening. Whereas English language preference correlated with increased screening uptake in bivariate comparisons, in multivariate logistic regression models, LEP did not independently predict CRC screening. I assessed the crude relationship between each covariate and the binary outcome by using univariate logistic regression models, followed by a series of multivariable logistic regression models. Such models include various sets of independent variables, namely demographic variables (age, sex,

and language) and socioeconomic and health-related variables (household income, employment status, education attainment, and health care access).

## Sample Description Summary

The study sample of 766 noninstitutionalized civilian residents of Texas was chosen randomly from the 2020 Texas BRFSS. The sample population was made up of non-Hispanic White, non-Hispanic Black, and Hispanic adults aged from 50-79 years old. Out of the 766 participants, 525 or 68.5% described themselves as non-Hispanic White, 77 or 10.1% as non-Hispanic Black, and 164 or 21.4% identified themselves as Hispanic. However, not all the self-described Hispanic sample population identified themselves with the Spanish language in the BRFSS sample when they responded to the questionnaire on CRC screening. Only 70 participants or 9.1% identified themselves as Spanish-speaking individuals (or limited English proficient participants), whereas 696 individuals or 90.9% identified themselves as English-speaking (English proficient) participants in the survey. With the CRC screening, 544 participants in the study who underwent CRC screening did the BRFSS survey in English, while 54 individuals who did the CRC screening were Spanish speakers.

Also, in terms of age, 696 participants considered themselves as English speakers, whereas 70 participants identified themselves as Spanish speakers. The study sample had 450 female, or 58.7%, and 316 male, or 41.3% participants. Out of the total sample of 766 participants, 604 reported earning income while 162 did not indicate their incomes; 754 indicated that they were employed with 12 showing no employment status; 765 had

healthcare access with one participant not providing a healthcare access status; and 763 showed education status while 3 did not indicate their education status.

## Interpretation of Findings

### Participants Grouped by Age

Analysis from the study participants categorized into 5-year age groups from 50 to 79 years of age indicated that 598 out of 766 had CRC screening. Within the groups, CRC screening rates increased as the group age advanced from 50-54, 55-59, 60-64, 65-69, 70-74, and 75-79; the 50-54 group reported 55.3% CRC screening, and 75-79 reported 90.9% screened for CRC, with the rest in between the percent ranges. Similarly, the unscreened rates decreased as the group age advanced. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 32.754$, $p < .001$, showing that there was a statistically significant association between different age groups. Considering symmetric measures of Phi and Cramer's V of 0.234, each at $p < .001$, indicated a relatively stronger association between age and CRC screening. The bivariate logistic analysis of the 5-year age groups showed a Wald value of 16.163 and a $p < .001$. From the multivariate analysis, the adjusted OR for 5-year age groups = 1.449; 95% CI 1.256, 1.672, $p < .001$.

The results from this statewide representative sample were consistent with the literature that CRC screening increases with age from 50 years age (US Preventive Services Task Force, Davidson et al., 2021); however, recent studies have revealed increased incidence rates of CRC in individuals younger than 50 years of age, even if there were no genetic connections associated with their family lines, despite the vast majority of CRC diagnoses still occurring in individuals aged 65 to 74 years (Rawla et

al., 2019; US Preventive Services Task Force, Davidson et al., 2021). For example, the US Preventive Services Task Force (2021) noted in a publication that 10.5% of new CRC cases occur in individuals younger than 50 years old, citing particularly adenocarcinoma with a significant incidence rate of nearly 15% from 2000-2002 to 2014-2016 in persons aged 40 to 49 years.

**Sex**

Analysis of the results showed that female participants had a relatively higher CRC screening rate, with 74.3% vs. 72.9% males screened for CRC, $p > .5$, indicating that statistically, the difference was not significant. Similarly, the Chi-square tests showed that Pearson Chi-square $\chi(1) = 0.186$, $p = .666$. Thus, there was no statistically significant association between males and females. Also, symmetric measures of Phi and Cramer's V were -0.018 and 0.018, respectively, each at $p = 0.666$, with the Phi and Cramer's V values being less than 0.10, which indicated no association between gender differences and CRC screening. Bivariate analysis on sex indicated OR = 0.912; 95% CI 0.595, 1.398, $p = .673$. For both Hispanic men and women, a personal history of cancer survival has been found to be correlated to increased CRC screening (Shah et al., 2022). For women, acculturation, which involves learning new language, adopting new customs, and changing religious beliefs was seen as embraced by Hispanic females. Such individuals prefer learning English language, leading them to become nearly assimilated into the American society, which improves health screening rates. Also, people who have been in the American society for at least 10 years are associated with higher odds of receiving CRC screening (Castañeda et al., 2019).

**Race**

This study analyzed three major races in Texas, including White only, non-Hispanic; Black only, non-Hispanic; and Hispanic residents. The results showed that within the White only, non-Hispanic, 76.7% underwent CRC screening; Black only, non-Hispanic, 71.4% received screening, while 64.9% of Hispanic also received screening, with 23.2%, 28.6%, and 35.1% of White only, non-Hispanic; Black only, non-Hispanic; and Hispanic participants not receiving CRC screening, in that order. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 7.360$, $p < .025$, showing that there was a statistically significant association among White only, non-Hispanic; Black only, non-Hispanic; and Hispanic samples of participants. Although the results of bivariate analysis of race indicated OR = 0.987; 95% CI 0.902, 1.079, $p = .768$, symmetric measures of Phi and Cramer's V were the same, 0.111, each at $p = 0.025$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among White only, non-Hispanic; Black only, non-Hispanic; and Hispanic samples of participants and CRC screening.

The results support a consistent disparity in the literature that while there have been increasing CRC screening rates among Hispanics in recent years, there remains persistent gaps in comparison with White only, non-Hispanic groups (Wittich et al., 2019). In another study, May et al. (2020) found that CRC screening was 17% lower in Hispanic population compared to Whites in the United States. In the same study, the authors showed that CRC screening rates among Blacks were 4% lower than Whites ($p < .001$).

**Language**

Even though disparities exist in CRC screening among White only, non-Hispanic and Hispanic populations, this disparity widened more significantly when language was considered. The results revealed that 44.4% of Hispanics who speak Spanish did not receive CRC screening, while 35.1% of the general Hispanic participants did not receive CRC screening, indicating that language limitation contributes to low rates of CRC screening. For the individuals who speak English, CRC screening rate was 75.4% compared to 55.6% for Spanish speakers. The results showed that the Pearson Chi-square $\chi(1) = 9.918$, $p < .002$, indicating that there was a statistically significant association between English- and Spanish-speaking respondents. Similarly, the symmetric measures of Phi and Cramer's V were the same, 0.129, each at $p = 0.002$, showing there were differential influences among English- and Spanish-speaking respondents for screening. Although English language preference correlated with increased screening uptake in bivariate comparisons, language did not seem to indicate a remarkable predictor of CRC screening uptake in multivariate logistic regression models in the study (OR = 1.415, $p = .449$). This was likely resulted from inter-relations with other notable predictors like education and income, which have the propensity to promote increased awareness of screening, a necessary drive to achieving greater screening compliance (Juon et al., 2018).

**Income (Annual Household)**

Analysis of the results with respect to income indicators showed that among participants with an income of $75,000 or higher, 75.6% had screening, individuals

whose incomes ranged from $50,000 to under $75,000, 80% had screening, while 72.9% compared to 68.1% for those whose incomes ($0 — < $20,000 vs. $20,000 — < $50,000) received screening, $p < .001$. For individuals at least 65 years of age, income status could not predict a particular trend regarding health care access or CRC screening because people who are 65 years or older have health care access through Medicare with most of them having primary care physicians. Because CRC incidence is higher within their age brackets, screening rates are often higher. Thus, income may not be an influential factor affecting screening among individuals who are eligible for Medicare (Shapiro et al., 2021). The multivariate analyses showed that the adjusted OR for annual household = 1.238; 95% CI 1.095, 1.400, $p < .001$. On the other hand, those with income of $75,000 or higher are likely to be those in the 50-54 and 55-59 age groups who are likely actively employed and relatively stronger than their older counterparts. Analysis of the study indicated that those aged 50-59 had lower CRC screening rates.

**Employment Status**

Considering the employment status and CRC screening of participants in the study, 77.6% of individuals who were unemployed compared with 66.4% of those employed received CRC screening, $p < .05$. The discrepancy arose from the age of the study participants (50-79 years of age) with the majority of individuals aged 65 years or older most likely retired from the active workforce. In the United States, people who are 65 years or older have Medicare, a federal health insurance program that guarantees health care access, thereby addressing obstacles of uninsurance for individuals who want

to undertake CRC screening (Zhao et al., 2018). In the multivariate analyses, the adjusted OR for employment status = 1.713; 95% CI 1.027, 2.857, $p = .039$.

**Healthcare Access**

The results showed that 76.5% of those with health insurance compared to 39.6% of those without it screened for CRC. For individuals who did not screen, comparing people with access to health insurance to those without health insurance access (23.5% vs. 60.4%), the uninsured individuals were nearly threefold those insured, indicating that health care access contributes significantly to screening, $p < .001$. This shows that lack of health care access is a major obstacle to screening. Health analysts blame Texas as the state with the least health care access because the state fails to provide Medicaid to most eligible residents even though the Affordable Care Act (ACA) has been successful in expanding Medicaid to all eligible individuals across the United States (Allen et., 2017). Texas is one of the few states where there is a Medicaid gap, defined as people whose annual household income is less than $35,000 per family with only one person, or $47,000 with two-person without any health insurance (Zhang & Wu, 2021). The multivariate analyses showed that the adjusted OR for healthcare access = 0.400; 95% CI 0.180, 0.889, $p = .025$.

**Education Status**

The results indicated that individuals with higher educational attainments, such as college graduates, had increased screening rates compared to those whose educational attainments were lower than high school. For individuals with college degree or higher, 78.3% received screening, 74.4% of individuals who had some college education

received screening, 67.8% of participants with high school/GED had screening, while only 64.1% of individuals with less than high school education had screening of CRC, all these comparisons had a $p < .05$. Studies have shown that in the general United States population, age, health care access, nativity, level of education, language, socioeconomic elements, overall health, and provider practices are seen as some influential factors associated with increased CRC screening (Mayhand et al., 2021). In the bivariate analyses, the adjusted OR for education status = 1.358; 95% CI 1.015, 1.755, $p = .019$.

## Colorectal Screening Types

### Colonoscopy

The crosstabulation analysis showed that colonoscopy screening was more prominent among groups 60-64, 65-69, 70-74, and 75-79 compared to age groups 50-54 and 55-59. For individuals in age groups 70-74, 24%, 75-79, 21%, 65-69, 20.8%, and 60-64, 15.6%, had colonoscopy compared to groups 50-54 and 55-59 where only 8.6% and 9.9% had colonoscopy. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 55.326$, $p < .001$, showing that there was a statistically significant association among five-year age groups 50-54, 55-59, 60-64, 65-69, 70-74, and 75-79 participants in the study. Symmetric measures of Phi and Cramer's V were the same, 0.277, each at $p < .001$. The Phi and Cramer's V values being more than 0.10 indicated there were differential influences among five-year age groups and colonoscopy screening status. The results also showed that although the USPSTF recommends CRC screening from age 50-75 years, people older than 75 participate in CRC screening to some extent, despite the

benefits of CRC screening diminishes as individuals get much older (US Preventive Services Task Force, Davidson et al., 2021).

Studies demonstrate that because of shorter life expectancy and more frequent comorbidities commonly correlated with old age, certain adverse reactions associated with colonoscopy, such as bleeding and perforation of the colon, which exacerbate morbidity factors in elderly people (Kim et al., 2019), the USPSTF recommends colonoscopy up to 75 years of age. Healthcare providers may encourage patients older than 75 years old to undertake colonoscopy only after careful consideration of potential benefits, risks, and patient preferences due to other pathophysiological factors that may be clinically visible (Lin, 2014). The adjusted OR from covariates, such as household annual income 1.238; 95% CI 1.095, 1.400, $p < .001$; employment status = 1.713; 95% CI 1.027, 2.857, $p = .039$; and 5-year age groups = 1.449; 95% CI 1.256, 1.672, $p < .001$, indicated interactive effects in the multivariate analysis for colonoscopy.

However, multivariate logistic regression analysis showed that there was no interaction with healthcare access, education status, race, and language spoken by participants, $p > .05$. Researchers indicate that SES, such as healthcare access and education status, represent one of the strongest and most consistent predictors of health (Carethers & Doubeni, 2020). Despite the profound significance of SES on predictors of health, other factors may also alter their expected impacts. For example, effective preventive healthcare may be positively influenced by health literacy, which has a fundamental impact on how individuals consider the importance of health (Coughlin et al. 2020). Thus, low health literacy could potentially limit the positive impact of health

care access and education status, although education may somehow (but not absolutely) be associated with improved health literacy (Bayati et al., 2018; Wigfall & Tanner, 2018).

In this study, the descriptive analysis from crosstabulation showed that the choice of colonoscopy among racial groups in the study varied significantly. Among White only, non-Hispanic, 73.9% had colonoscopy compared with 9.0% of Black only, non-Hispanic and 17.2% of Hispanics who had colonoscopy. The Chi-square tests revealed that Pearson Chi-square $\chi(1) = 25.973$, $p < .001$, showing that there was a statistically significant association among White, non-Hispanic, Black, non-Hispanic, and Hispanic participants in the study. Symmetric measures of Phi and Cramer's V were the same, 0.190, each at $p < .001$ with Phi and Cramer's V values being more than 0.10, indicating there were differential influences among White, non-Hispanic, Black, non-Hispanic, and Hispanic and colonoscopy screening status. When language used for the survey was considered, the analysis of the results showed that 93.9% of 524 of study participants took the survey in English and only 6.1% identified themselves as Spanish-speaking participants with Pearson Chi-square $\chi(1) = 19.996$, $p < .001$, showing that there was a statistically significant association between English-speaking and Spanish-speaking participants in the study. Phi and Cramer's V symmetric measures were the same, 0.167, each at $p < .001$, with the Phi and Cramer's V values being more than 0.10, an indication that there were differential influences between English-speaking and Spanish-speaking study participants and colonoscopy screening status. The multivariate logistic regression analysis, however, showed that like healthcare access and education status, there was no

interaction with race and language spoken by participants, $p > .05$. Thus, it was likely other factors could have potentially influenced the interactions between race and language and colonoscopy screening. For example, acculturation and improved health literacy could reduce the adverse impact of race and language and decrease their perceived differences in colonoscopy screening (Rogers et al., 2021).

Crosstabulation analysis showed a variation between males and female for colonoscopy screening, more than 60% of females underwent colonoscopy screening compared to nearly 40% of males who received the same screening. However, the Pearson Chi-square $\chi(1) = 2.917$, $p < .088$, showing that there was no statistically significant association between male and female participants in the study. Also, symmetric measures of Phi and Cramer's V were - 0.064 and 0.064, respectively, each at $p = .088$, with the Phi and Cramer's V values being less than 0.10 indicating there were no differential influences between males and females and colonoscopy screening status. This discrepancy based on previous studies may be due to other factors, such as acculturation, which tends to minimize some cultural effects on preventive healthcare, including colonoscopy screening (Ma et al., 2020; Savas et al., 2015).

The clinical summary released by the USPSTF (2021) recommended that colonoscopy screening should be done once every 10 years. Analysis from crosstabulation on 5-year age groups showed that 381 participants received colonoscopy screening within the past 10 years, with the highest screening taking place among individuals in 70-74 age group (29.4%), followed by individuals in 65-69 age group (24.1%). Groups 50-54 (10.8%), 55-59 (13.1%), 60-64 (17.8%), and 75-79 (4.7%) had

rates that were less, with individuals in 75-79 age group having the least rate. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 29.415$, $p < .001$, showing that there was a statistically significant association between male and female participants in the study, while symmetric measures of Phi and Cramer's V were the same, 0.221, each at $p < .001$. The Phi and Cramer's V values indicated there were differential influences among five-year age groups and colonoscopy screening status. The lowest rate shown in the age group 75-79 reflects recommendations by the USPSTF that benefits for colonoscopy diminishes, but is also associated with increased risk, as individuals get older (US Preventive Services Task Force, Davidson et al, 2021).

Analysis of the results of males and females who received colonoscopy screening within the past 10 years showed that 42% of males and 57.5% of females had colonoscopy screening. The $p = .515$, showing that there was no statistically significant association between male and female participants, Pearson Chi-square $\chi(1) = 0.424$ and symmetric measures of Phi and Cramer's V were -.027 and .027, which also indicates that there were no differential influences between male and female study participants and colonoscopy screening status within the past 10 years. Considering race, colonoscopy uptake within the past 10 years shows that 71.9 % of White, non-Hispanic, 8.9% of Black only, non-Hispanic, and 19.2% Hispanic participants received colonoscopy screening. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 9.295$, $p = .010$, showing that there was statistically significant association the racial groups. Symmetric measures of Phi and Cramer's V were the same, .124, each at $p = .010$, an indication that there were differential influences among White, non-Hispanic, Black, non-Hispanic, and

Hispanic study participants and colonoscopy screening status. While the results showed that Black only, non-Hispanic had the least rate of colonoscopy screening among the races in the study, another study conducted in New York City indicated that Black only non-Hispanic had the highest colonoscopy rate of 72.2%, Latinos 71.1%, Whites 67.2%, and Asians, 60.9% (Brown et al., 2021). The discrepancy between the outcomes from New York City and the state of Texas may be due to other factors, such as health care access. In New York State, 27% of New York population was low-income (<200 FPL), but 28% of New York population or 2 in 9 adults aged 19-64 years old was covered by Medicaid/CHIP compared to 17% of Texas population or 1 in 14 adults aged 19-64 years old was covered by Medicaid/CHIP where 33% of the population was low-income (<200 FPL), according to a study by the Kaiser Permanente in October 2022 (Kaiser Family Foundation, 2022).

Assessing the colonoscopy rates between English-speaking and Spanish-speaking participants in the study, the results showed that within the past 10 years, 93.4% English-speaking and 6.6% of Spanish-speaking study subjects received colonoscopy screening. The Chi-square tests showed that Pearson Chi-square $\chi(1) = 8.286$, $p = .004$, indicating that there was statistically significant association between English-speaking and Spanish-speaking participants in the study, with symmetric measures of Phi and Cramer's V were the same, .117, each at $p = .004$, showing there were differential influences between English-speaking and Spanish-speaking study participants and colonoscopy screening status. Thus, within the study, while Hispanic participants had 19.2% of colonoscopy screening within the past 10 years, individual Hispanics who responded to the survey

questions in Spanish, only 6.6% received colonoscopy screening within the same period. This was an indication that LEP may have contributed to the low rate of colonoscopy screening among the limited English proficient participants in the study.

Investigations into social, behavioral, and medical sciences show that there are remarkable perceptual and behavioral variations associated with patients' cultural and ethnic backgrounds that could potentially impact cancer prevention behaviors, such as delay in seeking preventive care, understanding the concerns of adverse impact about etiology of disease, and expectations about treatment outcomes and prognosis (Diaz et al., 2013; Hall et al., 2022; Yedjou et al., 2019). For the covariates in the study, such as annual household incomes, employment, healthcare access, and education status, the multivariate logistic regression showed no significance for colonoscopy within the past 10 years as the $p > .05$.

**Sigmoidoscopy**

Procedural preparations for both colonoscopy and sigmoidoscopy require patient preparation to clear out the colon, and most sigmoidoscopy and colonoscopy preparations involve large intake of cleansing solutions, such as polyethylene glycol (MiraLAX). In addition, patients take laxatives, enemas, and possibly several days of a clear liquid diet prior to the procedure. Despite their similarities, many people consider colonoscopy as more painful than sigmoidoscopy, and they tend to choose the latter for screening. To understand these options as a choice, I analyzed sigmoidoscopy screening alongside colonoscopy and FOBT. In assessing sigmoidoscopy screening among 5-year age groups,

the procedure was found to be more prominent among age groups 60-64, 65-69 and 70-74 compared to age groups 50-54, 55-59, and 74-79.

However, in comparison to colonoscopy, fewer participants in the study used sigmoidoscopy screening. Groups 60-64 (12.9%), 65-69 (25.8%), 70-74 (35.5%) had sigmoidoscopy compared to groups 50-54 (9.7%), 55-59 (6.5%), and 75-79 (9.7%) who also had sigmoidoscopy. In all, only 31 participants had sigmoidoscopy while 555 respondents stated that they had not received sigmoidoscopy within the past 5 years vs 381 who had colonoscopy within the past 10 years, and 221 who did not have the procedure within the past 10 years. The Chi-square tests for the sigmoidoscopy indicated that Pearson Chi-square $\chi(1) = 7.196$, $p = .206$, which showed no statistically significant association among the age groups. Symmetric measures of Phi and Cramer's V were the same, 0.111, each at $p = .206$.

Considering gender, there were more women (61.3%) than men (38.7%) who took sigmoidoscopy screening. In terms of race, sigmoidoscopy screening within the past 5 years was highest among White only, non-Hispanic (51.6%) and lowest among Black only non-Hispanic (16.1%) with Hispanics (32.3%) fallen in between White only, non-Hispanic and Black only, non-Hispanic. For English-speaking (80.6%) and Spanish-speaking (19.4%) of 31 participants received sigmoidoscopy screening within the past 5 years. The trend was the same as in colonoscopy, with English-speaking individuals receiving more sigmoidoscopy than Spanish-speaking individuals, most likely due to LEP as a hindrance. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 4.674$, $p = .031$, showing that there was a statistically significant association between English-

speaking and Spanish-speaking participants in the study. In evaluating the results from the multivariate logistic regression, only annual household income had a positive interaction effect with an adjusted OR = 0.767; 95% CI 0.621, 0.949, $p$ = .014. for participants who had sigmoidoscopy within the past 5 years, while employment status, education status, healthcare access, sex, race, and language showed no significant interaction effect among participants.

**Fecal Occult Blood Test**

Because several choices are available as CRC screening procedures, I chose to consider both invasive and noninvasive approaches to understand which options are chosen often for screening among participants in the study. Study results showed that 105 respondents had taken FOBT screening for CRC within the past year. The age groups with higher rates of participants included 50-54 (12.4%), 60-64 (17.1%), 65-69 (23.8%), 70-74 (38.1%) compared to age groups 55-59 (4.8%) and 75-79 (3.8%) whose FOBT screening rates were much lower, with Chi-square tests indicating Pearson Chi-square $\chi(1) = 16.933$, $p = .005$, showing that there was a statistically significant association among five-year age group participants in the study. Symmetric measures of Phi and Cramer's V were the same, 0.167, each at $p = .005$, and the Phi and Cramer's V values being more than 0.10, indicates differential influences among five-year age groups and FOBT screening status. Out of the 105 participants who took FOBT screening for CRC within the past year, 49.5% were males and 50.5% were females, demonstrating that FOBT was nearly even between males and females. The Chi-square tests indicated that Pearson Chi-square $\chi(1) = 2.408$, $p = .121$, showing that there was no statistically

significant difference between male and female participants with respect to FOBT within the past year. The FOBT rates among the racial groups varied with 64.8% White only, non-Hispanic, 14.3% Black, non-Hispanic, and 21.0% Hispanic undertaken it within the past year. When FOBT rates were assessed using the language respondents used for the survey, 92.4% of the respondents were identified with English and 7.6% of respondents were identified with Spanish, demonstrating that LEP was likely a reason for lower rates of FOBT screening for CRC. The multivariate logistic analysis of FOBT within the past year showed that annual household income had a positive interaction effect with adjusted OR = 0.868; 95% CI 0.758, 0.993, $p$ = .040. However, employment status, education status, healthcare access, sex, race, and language all show no significant interaction effect, $p$ >.05.

### Sensitivity, Compliance, and Access of CRC Screening Types

Researchers suggest that effective CRC screening emanates from the combination of 3 critical factors, namely sensitivity, compliance, and access. Screening methodologies, such as colonoscopy, sigmoidoscopy, and FOBT, vary in their sensitivity or accuracy. While sensitivities for early-stage CRC are essentially equivalent between colonoscopy and MT-sDNA, they are notably higher than with FOBT whose sensitivity for detecting CRC is about 70%-75% the sensitivity of colonoscopy (Ahlquist, 2019). Also, investigators argue that sensitivity is poor for precursor lesions, nearly 20% to 25% for advanced adenomas and less than 5% for advanced sessile serrated polyps, thereby making it difficult for tests like FOBT that inherently have low sensitivities (Chang et al., 2017). Because of their low sensitivities, such tests are recommended to be performed

annually, a situation considered as a disadvantage by some patients due to increased inconvenience of performing it annually, resulting in an increased possibility of low patient compliance (Ahlquist, 2019).

Although test sensitivity is important, program logistics to maintain an effective intervention needs to address challenges associated with compliance and access. Among other things, individuals eligible to undertake CRC screening may be less compliant if they have to do the test every year, find it difficult to follow instructions for the test, do not have access to health care, and do not have a primary care physician (Barthold et al., 2022). Other researchers also note that although stool collection may be offputting to some patients and affects FOBT compliance, a significant number of surveys has demonstrated that patients prefer noninvasive over invasive tests, which was seen in this study where FOBT rates were higher than sigmoidoscopy (Ahlquist, 2019; Ferrari et al., 2021). Thus, notwithstanding its outcome as being the gold standard for CRC screening, because of its labor-intensiveness, invasiveness, and potential for injury among elderly persons, colonoscopy is not universally preferred over other types of CRC screening, such as FOBT, which is used by a significant number of individuals as an alternative screening test despite its associated detection inaccuracies and the need to do it annually (Tepus & Yau, 2020).

**Gender Influences on CRC Screening**

The multivariate logistic regression analysis that featured observed and predicted frequencies for CRC screening using colonoscopy, sigmoidoscopy, and FOBT showed varied percentages for CRC screening among English-speaking White only, non-Hispanic

male and female; Black only, non-Hispanic male and female; English-speaking Hispanic male and female; and Spanish-speaking Hispanic male and female participants. The Spanish-speaking Hispanic participants are considered as individuals who speak Spanish only and have LEP. The results indicated that overall, English-speaking participants in the state of Texas received significantly higher rates of CRC screening, with slight variations from one race or gender to the other. However, both male and female LEP individuals had low rates of CRC screening, particularly when rates were compared males to males and females to females within the Hispanic English-speaking and Hispanic LEP groups. Taking all forms of CRC screening together, the results indicated White only, non-Hispanic males (78.1%) and females (75.0%); Black only, non-Hispanic males (60.0%) and females (77.8); and Hispanics who did the survey in English, males (66.7%) and females (74.5%), while LEP Spanish males (45.0%) and females (61.8%). The results are consistent with previous studies where Hispanic men with LEP were found with lower CRC screening, suggesting that limited-English proficient Hispanic males are at the greatest risk of not being screened for CRC compared to non-Hispanic Whites and Blacks, English proficient Hispanics, and even Hispanic females with LEP (Diaz et al., 2013; Hall et al., 2022).

For colonoscopy, females in each racial group had higher screening rates than their male counterparts, with White, non-Hispanic females (79.4%) vs males (76.6%); non-Hispanic Black females (71.1%) vs males (62.5%); English proficient Hispanic females (68.5%) vs males (56.8%); and limited-English proficient Hispanic females (60.5%) vs males (27.3%). The USPSTF (2022) recommends that colonoscopy screening

should be taken every 10 years for individuals aged 50-75 years old. From the results, however, colonoscopy taken within the past 10 years was lower for each gender when compared to colonoscopy taken overall. For example, colonoscopy within the past 10 years had a lower rate for White only, non-Hispanic females (66.1%) compared with overall colonoscopy taken by White only, non-Hispanic females (79.4%). For limited-English proficient Hispanic females (60.5%) vs males (27.3%) were the overall rates of colonoscopy compared with colonoscopy taken within the past 10 years by limited-English proficient Hispanic females (57.1%) vs males (25.0%). This indicates that effective CRC screening requires an adequate public health campaign to educate communities about health literacy and the importance of adhering to colonoscopy schedules as recommended by the USPSTF (Edwardson et al., 2023).

Among the 3 choices of CRC screening in this study, sigmoidoscopy was used least by the participants. For White only, non-Hispanic, 3.9% of males and 4.1% of females; Black only, non-Hispanic, 5.0% of males and 10.5% of females; English-speaking Hispanics, 3.0% of males and 6.5% of females; and Spanish-speaking Hispanics, 15.0% of males and 9.7% of females received sigmoidoscopy. Out of 766 participants in the sample, 586 responded to the questionnaire on sigmoidoscopy, of which 31 responded to have taken sigmoidoscopy screening and 555 stated that they did not. In comparison, 720 surveyed participants responded to the questionnaire on colonoscopy, and 524 stated to have received colonoscopy while 196 did not.

Health care providers indicate that flexible sigmoidoscopy is quicker, safer, less complicated, and more affordable than colonoscopy, and usually it does not require

intravenous sedation while enemas employed in its preparation have fewer side effects and greater acceptability than oral solution employed in the preparation for colonoscopy. Also, because its procedural approach is relatively less complicated than colonoscopy, sigmoidoscopy could be performed competently by non-physician endoscopists (Cross et al., 2019; Maslekar et al., 2010; Riegert et al., 2020).

Several reasons account for colonoscopy as a preferred choice over sigmoidoscopy. While sigmoidoscopy has high sensitivity for CRC screening in the distal colon and rectum, it could only reach splenic flexure at best, making it ineffective in accessing abnormalities in the proximal colon (Cross et al., 2019). On the contrary, colonoscopy could examine the whole large bowel up to the ileocecal valve, which is the end of the small intestine. Colonoscopy is also both diagnostic and therapeutic, capable of detecting and removing adenomas, which are precancerous polyps (Safiyeva & Bayramov, 2019). Sigmoidoscopy is only diagnostic and does not have the capability of removing adenomas (Issa & Noureddine, 2017). Another possible reason why colonoscopy is preferred over sigmoidoscopy is that the former is recommended to be performed every 10 years as against the latter, which is recommended to be done every 5 years (Bénard et al., 2018).

In comparing FOBT and colonoscopy, multivariate logistic regression showed that for FOBT in the past year, White only, non-Hispanic, 18.6% of males and 15.0% of females; Black only, non-Hispanic, 28.6% of males and 23.7% of females; English-speaking Hispanics, 18.2% of males and 17.0% of females; and Spanish-speaking Hispanics, 28.6% of males and 5.7% of females received FOBT in the past year. While

participants engaged with higher rates of FOBT than sigmoidoscopy, their overall use of FOBT was much lower than colonoscopy. Also, similar to both colonoscopy and sigmoidoscopy, Hispanic with LEP had lower rates of screening with FOBT compared with other participants who took the 2020 Texas BRFSS survey in English.

## Research Questions and Hypotheses

This study explored the impact of LEP on CRC screening among Hispanic Americans living in the state of Texas. The data was obtained from the 2020 Texas BRFSS survey on CRC. Language that participants used to respond to the BRFSS survey questionnaires was considered as the language they speak. Thus, Hispanics who responded to the survey in Spanish were individuals who did not speak English, or they were limited English proficient individuals. The main IV was LEP. I grouped the IV into 8 categories, including White only, non-Hispanic males; White only, non-Hispanic females; Black only, non-Hispanic males; Black only, non-Hispanic females; Hispanic males responding in in English; Hispanic females responding in English; Hispanic males responding in Spanish; and Hispanic females responding in Spanish. The CRC screening rates define the DV. The variations in the IV caused changes in the rates of the CRC screening test, which was the DV. The study focused on three forms of the DV, namely FOBT (blood stool test) within the past year, and/or sigmoidoscopy within the past 5 years, and/or colonoscopy within the past 10 years. Entries excluded from the analysis included those missing a language variable, gender, race, or Hispanic/Latino origin.

The RQs and hypotheses were addressed using the analyses from the results. The RQ 1 stated: Are CRC screening rates different between Hispanic and non-Hispanic

residents in Texas with and without LEP, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled? The results showed that White only, non-Hispanic, both male and female participants in the study, had higher rates of CRC screening, using colonoscopy, sigmoidoscopy, and FOBT compared to Black only, non-Hispanic and Hispanic participants, irrespective of the language they speak. However, when language was considered, English-speaking participants in the study had far higher rates of screening compared to Hispanics with LEP whether they used colonoscopy, sigmoidoscopy, or FOBT. For example, participants who were English proficient had 93.9% colonoscopy screening compared with 6.1% of Hispanics with LEP, $p < .001$. For English-speaking (80.6%) and Hispanics with LEP (19.4%) of 31 participants received sigmoidoscopy screening within the past 5 years, $p = .031$. Similarly, when FOBT rates were assessed using the language respondents used for the survey, 92.4% of the respondents were identified with English and 7.6% of respondents were identified with Spanish, demonstrating that LEP was likely a reason for lower rates of FOBT screening for CRC, $p = .040$. This analysis showed that, the null hypothesis, $H_0 1$, which states that there is no significant relationship between LEP and CRC screening rates among Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled should be rejected, since the CRC screening demonstrated that $p < .05$. Thus, the alternative hypothesis, $H_a 1$, which states that there is a significant relationship between LEP and CRC screening rates among Hispanic and non-Hispanic residents in Texas,

when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled could be accepted.

The RQ 2 stated: Are CRC screening rates different between male and female residents in Texas with and without LEP, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled? Grouping the study participants into 8 categories, including White only, non-Hispanic males; White only, non-Hispanic females; Black only, non-Hispanic males; Black only, non-Hispanic females; Hispanic males proficient in English; Hispanic females proficient in English; Hispanic males with LEP; and Hispanic females with LEP, I used multivariate regression analysis to assess the observed and predicted frequencies and percentages for CRC screening using colonoscopy, sigmoidoscopy, and FOBT. The results showed varied percentages and frequencies for CRC screening among English-speaking White only, non-Hispanic male and female; Black only, non-Hispanic male and female; Hispanic male and female; and Hispanic with LEP male and female participants. The limited English proficient Hispanic participants are considered as individuals who speak Spanish only. Analysis of the results indicated that overall, English-speaking participants in the state of Texas received significantly higher rates of CRC screening, with variations between males and females. However, both male and female LEP individuals had significantly low rates of CRC screening, particularly when rates were compared males to males and females to females within the Hispanic English-speaking and Hispanic LEP groups. In comparing all forms of CRC screening together, the following results were obtained: White only, non-Hispanic males (78.1%) and females

(75.0%); Black only, non-Hispanic males (60.0%) and females (77.8); and Hispanics who did the survey in English, males (66.7%) and females (74.5%), while LEP Spanish males (45.0%) and females (61.8%). The multivariate logistic regression analysis showed that OR for sex = 0.894; 95% CI 0.599, 1.333, $p = .581$. The OR < 1.0 indicates that the odds of difference between male and female CRC screening is smaller or less significant. This assessment showed that, the null hypothesis, $H_0 2$, which states that there is no significant relationship between gender and CRC screening of Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled could not be rejected. Also, the $p > .05$ indicates that there is no significant relationship between gender and CRC screening among the study participants. Thus, the alternative hypothesis, $Ha 2$, which states that there is a significant relationship between gender and CRC screening of Hispanic and non-Hispanic residents in Texas, when potential confounding variables including age, income, occupation, health care access, and educational levels of participants are controlled, could not be accepted.

Although generally, there was no clear significance between males and females for CRC screening, in considering Hispanic groups alone, the differences in the CRC screening showed remarkable differences between males and females. For Hispanics who did the survey in English, males (66.7%) and females (74.5%), while LEP Spanish males (45.0%) and females (61.8%) had CRC screening, showing an uptake of screening among the female groups vs their male counterparts. These results are consistent with previous studies where Hispanic men with LEP were found with lower CRC screening, suggesting

that limited-English proficient Hispanic males are at the greatest risk of not being screened for CRC compared to non-Hispanics Whites and Blacks, English proficient Hispanics, and even Hispanic females with LEP (Diaz et al., 2013; Hall et al., 2022).

## Analysis: The Health Belief Model Conceptual Framework

The HBM has assumed a central position among theoretical frameworks that seek to account for the broad failure of individuals to participate in events to avert or detect asymptomatic disease (Hochbaum, 1958; Rosenstock, 1966, 1974). In addition, HBM seeks to explain individuals' responses based on their experienced symptoms (Kirscht, 1974) and to their behavior in response to clinically diagnosed illnesses, especially in compliance with medical regimens (Becker, 1974). The HBM integrates six constructs, including risk susceptibility, risk severity, benefits to action, barriers to action, perceived self-efficacy, and cues to action predict health behavior (Becker, 1974). Historically, the HBM was developed to screen for disease and to immunize against viral diseases like poliomyelitis and influenza, and of attempts to improve on compliance with medical advice regarding diabetes, hypertension, cancer, obesity, exercise, seat-belt use, and HIV-risk behavior (Janz & Becker, 1984; Stretcher & Rosenstock, 1997).

The constructs of HBM form a logical connection that explain the nature of this study. These constructs do not only highlight the impact of language barrier in identifying asymptomatic CRC patients through screening for early detection, which leads to positive disease prognosis, but also associate clinical approach of managing CRC symptoms and improve on core determinants of disease prognosis (Hochbaum, 1958; Rosenstock, 1966, 1974). The risk susceptibility describes an individual's subjective awareness of the risk of

acquiring an illness or disease. The risk of severity creates awareness on individual's assumptions of contracting CRC, and the possibility of not receiving an appropriate treatment, which may result in a wide variation of apprehensiveness (Karl et al., 2022). Such apprehensiveness may include medical consequences like death or disability and social consequences that could negatively affect their families with economic hardships. The benefits to action explain an individual's appreciation of the effectiveness of available actions to reduce the adverse impacts of CRC (or to cure CRC).

Individuals who recognize these dangers take actions to avoid or cure the cancer based on their understanding and evaluation of both perceived susceptibility and perceived benefit as a motivation to accept the recommended health action they consider beneficial (Sharifikia et al., 2019). Barriers to action refers to an individual's perception of barriers to take a recommended health action on CRC, which may include a wide variation of obstacles, such as costs, time-consumption, and inconvenience related to health actions they accept in dealing with CRC (Rakhshanderou et al., 2020). Consequently, individuals perform cost and benefit analysis and weigh the effectiveness of decisions they accept. Perceived self-efficacy highlights on individuals' confidence in their ability to appropriately perform a behavior, which was a construct that was added to the model in mid-1980s, and it is a construct in many behavioral theories as it is directly associated with whether an individual takes up the desired behavior (Rosenstock, Strecher, & Becker, 1988). The cues to action, which could be internal, such as fatigue due to anemia, lack of appetite and weight loss, which are often associated with CRC residual symptoms, or external, such as advice from closed relatives and friends, illness

of family member, and newspaper articles, serve as a stimulus that influence decision-making process to embrace a recommended health action (Tsai et al., 2021).

Therefore, the fundamental importance of HBM constructs makes it a suitable public health theory in appreciating the unmet challenges, such as language barrier for individuals in identifying asymptomatic CRC patients and the ability to associate it with clinical instructions of managing CRC residual symptoms (Rakhshanderou et al., 2020). This demonstrates that HBM serves as an example of a value-expectancy theory, where behavior assumes the function of the subjective value of an outcome and the subjective probability, or expectation, where a specific action would lead to the expected outcome (Lewin et al., 1944). In the context of health-related behavior, the value-expectancy theory shows the willingness to prevent illness or to get well (value), which also signifies the belief that a particular health action available to individuals would avoid or ameliorate illness (expectancy), where individual's estimate of personal susceptibility to and the severity of an illness could be linked to the likelihood of being able to reduce that threat through personal action (Ban & Kim, 2020).

## Mediating Effects of Limited English Proficiency

To understand the mediating effect of LEP on each motivating variable included in the model, a series of bivariate logistic regression on the full sample that included LEP and other motivating variables as regressors indicated that age was remarkably significant in the presence of LEP. Healthcare access and education status were also significant, while race of participants, income of participants, and employment status were not significant. Besides these factors that were assessed using bivariate logistic regression

model, several other factors, including prevailing environmental conditions, such as Coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2, which erupted in China and spread around the globe from the latter part of 2019 throughout 2020 and beyond, had serious effects on health screening on almost all chronic diseases, including CRC.

Researchers found out that the COVID-19 pandemic decreased physician's office visits significantly from the early months of 2020. For example, in the United States, one study found out that the COVID-19 pandemic decreased the total number of outpatient visits per provider by 70% during the week of April 5-11, 2020, when the effects of the pandemic became acutely significant relative to the same week in prior years (Chatterji & Li, 2021). Because of acute reduction in primary care visitations, several chronic diseases, such as hypertension, diabetes, asthma, chronic obstructive pulmonary disease (COPD), and cancer conditions exacerbated and became unstoppably top comorbidities with COVID-19, which led to increased mortality and morbidity among such patients (Fekadu et al., 2021). Among cancers, due to the precipitous reduction in lung cancer screening, health care providers reported unprecedented proportions of nodules suspicious for malignancy when COVID-19 spread was abated and screening resumed (Van Haren et al., 2021).

Several other factors potentially mediated low CRC screening rates, such as lack of transportation, poor health literacy, physician-patient communications in situations like physician-patient concordant and discordant relationships. Transportation is an important social determinant of health, particularly in rural and suburban communities where public transportation services are often unavailable. Researchers identify that

transportation barriers disproportionately affect the most vulnerable groups of society who carry the highest burden of chronic diseases, such as cancer, cardiovascular disease, diabetes, and COPD (Lin & Cui, 2021).

For individuals to undertake CRC screening in a physician's office, they need to travel to the office. Transportation becomes an obstacle to screening when individuals do not have the means to visit the physician's office. Such an impediment could discourage vulnerable people from scheduling an appointment for screening. Thus, it is critical to identify interventions that improve access to transportation for individuals to be able to visit their primary care physicians (Starbird et al., 2019). Importantly, individuals who have high knowledge about health could seek preventive care through regular visits to their primary care physicians and often request screening for any pathophysiological variations in their health systems. Studies show that higher health literacy supports guideline-concordant screening which could identify a disease (Rutan et al., 2021), such as cancer in its rudimentary stage before it becomes cancerous (Cartwright et al., 2022). Furthermore, stage 1 cancers are easier to treat than stage 3 or 4, which has already metastasized to distant organs (Welch & Hurst, 2019). Lack of health care access is an impediment that makes cancer screening rates lower even when individuals have concerns of potential cancer like individuals aware of the disease in their families (Aleshire et al., 2021). While some studies indicate that physician-patient concordance do not play any significant role in primary care effectiveness (Saha & Beach, 2020), other researchers also argue that physician-patient concordant relationships contribute immensely to effective health care delivery and screening for chronic diseases, such as

CRC (Shen et al., 2018). Physician-patient concordant relationships often tend to trace both physicians and patients to similar cultures, where relatedness in culture enhance dual understanding and appreciation of values (Moore et al., 2022).

## Summary

Low utilization of screening is a major barrier to minimizing CRC morbidity and mortality. Barriers, such as limited language proficiency, cultural values that may obscure the importance of screening, new migration status, low health literacy, lack of health care access, prevailing environmental conditions, such as acute pandemics, and lack of transportation to visit doctor's office are some of the principal constraints that depress health screening to identify and treat chronic diseases in the early stages. Among Hispanic communities in the United States, LEP has been particularly a challenge, and the impact of LEP is more prominent in situations such as CRC screening because of complex process involved in preparation for procedures, new immigration status, ineffective communication, and low health literacy. For example, colonoscopy preparation entails a complex web of processes in ensuring that solutions that patients must drink to clear their colon must be of certain concentration to achieve the desired goals. Other methods, such as FOBT, involve the embarrassing process of collecting one's stool for laboratory analysis, an offputting process that tends to diminish people's interest in undertaking FOBT.

This study revealed that LEP is a central barrier to improved CRC screening. For example, within the past 10 years Hispanic participants in the study had 19.2% of colonoscopy screenings, however separation of English proficient Hispanics from

Hispanics with LEP revealed that only 6.6% of individuals with LEP received colonoscopy screening within the same period. Considering sigmoidoscopy, 32.3% of all Hispanics in the study received screening, but when only Spanish-speaking group was assessed, the rate decreased to 19.4% for Hispanics who received sigmoidoscopy within the past 5 years. Similarly, 21.0% of Hispanic respondents participated in FOBT for CRC within the past year, but when only LEP Hispanics were considered, only 7.6% of used FOBT within the same period. Thus, the trend was the same for all the three forms of CRC screening with LEP Hispanics receiving the least rates of screening. The study did not indicate that gender influences were prominent in undertaking CRC screening, although in most cases, females had higher rates of CRC screening than their male counterparts.

## Strengths and Limitations

This study focused on three forms of CRC screening to assess the impact of LEP on screening among Hispanic and non-Hispanic residents of Texas using the 2020 BRFSS. Because the study assessed three forms of screening, it created a clear picture of the impact of LEP on screening. The study was also the first to be conducted in the state of Texas, although it has been conducted elsewhere in the United States as well as nationally. The results were consistent with the outcome of the past studies. Although the study did not include all eligible participants in the BRFSS data, the selection was conducted randomly thereby minimizing any potential selection bias. Also, because the study focused only on White only, Black only, and Hispanic only populations for sample collection, the data for the study excluded all individuals who did not identify with the

definitions set up for the study. The study sample's population was from 50 to 79 years old. All other individuals outside the defined age range were excluded from the study.

The number of study participants was 766, which was large enough to ensure the power of the study, which is the probability of finding a difference that exists in a population. The power relies on the chosen level of significance ($p$ <.05 for this study), effect size, variability of the measured variables, and sample size (Serdar et al., 2021). However, out of the 766 participants, 525 or 68.5% were White only, non-Hispanic, 77 or 10.1% were Black only, non-Hispanic, and 164 or 21.4% were Hispanic. Although the Black only, non-Hispanic participants were far fewer than either White or Hispanic participants, their representation reflected their population in the state of Texas, where Black only, non-Hispanic were 13.2% in 2020. However, the sample size of Hispanics in the study could have been higher than 21.4% since in 2020, the Hispanic population in the state of Texas was more than 39% (nearly 11.4 million) compared to White only, non-Hispanic population of nearly 40.0% (over 11.6 million). Thus, while the size of the Hispanic representation of 164 participants was an adequate sample size, the difference of 361 or 47.1% in representation between White only, non-Hispanic and Hispanic sample sizes was likely to potentially influence the generalizability of the findings. Thus, the results should be interpreted with caution and generalized only within the state of Texas and not in the United States. In 2020, Black only, non-Hispanic population was 13.2% of the state of Texas population, making their representation of 10.1% in the study reasonably adequate.

The BRFSS data depends on respondents' responses to questionnaire in the survey. Any incorrect information the respondents provided was likely to find their way into the data, which could be influenced by social desirability bias or recall bias. This means that the accuracy of the data depended partly on the correct information provided by the survey respondents. This study could not establish validity tests for the participants' responses to the survey, and therefore, did not verify any potential misinformation bias or misclassification. Researchers also cite an inherent challenge in the BRFSS as the effectiveness in managing an increasingly complex surveillance system that serves the needs of several programs in the ever-evolving environment of telecommunication technology and the higher demand for more local-level data (Mokdad et al., 2003). Any inherent disadvantages of BRFSS data collection could potentially affect the quality of the results.

## Recommendations

The study indicated that CRC screening was lower among individuals younger than 59 years of age. The USPSTF recommends that CRC screening should start from age 50 up to 75 years old in both males and females. However, studies demonstrate that a significant number of individuals between ages 45 and 50 are being diagnosed with CRC. Because the USPSTF has not lowered the initial age, BRFSS data are available only for individuals 50 years and older. Due to increased incidence of CRC in individuals younger than 50 years old, it would be beneficial to the general population for the CDC to recommend 45 years as the initial screening age for CRC. By so doing health care providers may be motivated to educate their patients to receive CRC screening at a

younger age than current initial screening age of 50 years old. That would also ensure that all health insurance providers would be obliged to pay for such screenings. Even at the current initial screening age of 50 years old where individuals aged 50 -59 are not undertaking screening as effectively as recommended, public health campaign needs to be used to create awareness in the general population to motivate individuals within the age bracket of 50 - 59 to ensure that they receive screening. Such a campaign could involve health insurance organizations and employers to remind their employees to take CRC screening when they attain 50 years of age.

Individuals of Hispanic origin, particularly Hispanic men, have wrong perceptions of cancer, which affect their understanding and preparedness to undergo screening for early detection of cancer. Several investigations in the social, behavioral, and medical sciences suggest that there are notable variations in their perception and behavior toward patients' cultural and ethnic backgrounds (Wittich et al., 2019). Such characteristics may influence cancer prevention behaviors, including delay in seeking preventive care, views about etiology of disease, and beliefs about treatment and prognosis (Gast et al., 017). To address cultural misgivings and misperceptions, public health practitioners and policymakers may need to use social and community centers, such as religious centers like the church to educate the Hispanic communities, especially new immigrants to understand the importance of health screening for early detection of cancer and other chronic diseases, such as diabetes and hypertension. Also, Hispanic nonprofit organizations that specialize on cultural integration into the American society could provide health care education materials in both English and Spanish to support them.

Future studies may investigate the impact of such cultural tendencies on Hispanic interest in CRC screening, and how social organizations and nonprofits that engage with the Hispanic community may promote CRC screening.

## Implications

Several studies on Hispanic Americans and CRC implicate them as one of the key racial groups that are often diagnosed with CRC at advanced states compared to their White counterparts; the other racial group that are also diagnosed with CRC in later stages is African Americans. Hispanics and Blacks are diagnosed at advanced stages because they fail to seek CRC screening as recommended by the USPSTF (Muller et al., 2021). In this study, LEP Hispanic men results highlight the particularly low odds of CRC screening relative to their female counterparts, and other racial/ethnic groups. The poor screening rates were consistent with multiple studies conducted on Hispanics across the United States (Diaz et al., 2013; Garcia et al., 2018; Wittich et al., 2019). Qualitative studies suggest that maintenance of masculinity, embarrassment about invasive procedures, such as colonoscopy, and fear are some of the reasons why low screening rates are seen among Hispanic males (Christy et al., 2014; Rogers et al., 2022). Understanding the challenges confronting Hispanic men about the implications of their low participation in CRC screening and the possible health burdens, including increased cost of treatment to themselves and their families as well as morbidity and potential death may influence them to consider screening with some degree of seriousness. In this regard, health care providers and public health practitioners could use the available resources to educate them through public health campaigns using community centers, religious

groups, employers, and health insurance organizations to engage them with preventive health promotion initiatives.

Epidemiological evidence on CRC survival possibilities could be compelling facts that public health practitioners and other stakeholders need to use as part of the education for individuals eligible for CRC screening. For example, the overall 5-year survival rate for CRC is approximately 65.2%, however, according to stages defined by the American Joint Committee on Cancer (AJCC) fifth edition system, 5-year stage-specific survivals were 93.2% for stage I, 82.5% for stage II, 59.5% for stage III, and 8.1% for stage IV, with stages III and IV already spread to distant organs (Joachim et al., 2019). This indicates that survival rates with good prognosis are associated with CRC detection at its rudimentary stage up to stage II before it metastasizes to distant organs.

Although in recent years, CRC incidence rates declined among older (age ≥50 years) Whites, non-Hispanic and Hispanic populations, the former underwent a steeper decline (31% vs. 27%) relative decline among Hispanics. However, CRC incidence among young adults (age 20-49) have experienced increased incidence rates from 2001 to 2014 (Garcia et al., 2018). The authors noted that the largest relative rise in incidence was seen among Hispanics from 20–29 years (90% vs. 50% relative increase among Whites, non-Hispanic). These changes in disease onset must influence the USPSTF to make changes from the recommended initial screening age of 50 years to age 45, which is currently recommended by the ACS.

## Social Change

The HBM conceptual framework employed to highlight its constructs and their relevance to CRC screening lays the foundation to motivate eligible people to undertake screening for CRC. All the six HBM constructs, namely risk susceptibility, risk severity, benefits to action, barriers to action, perceived self-efficacy, and cues to action predict health behavior seek to promote preventive health care (Zewdie et al., 2022). The constructs lay the roadmap for health care providers and public health campaigners to engage society and communities to participate in health screening to avoid the glaring consequences of poor health (Karimy et al., 2021). Using the HBM constructs as motivating factors, public health campaigners, health care advocates, and health care providers could promote the importance of health screening as a basis to empower eligible individuals to undergo CRC screening (Rakhshanderou et al., 2020). Social groups may be used as a conduit to embark on health screening drive and spur communities to accept screening as a basic method to minimize increased incidence of chronic diseases, including CRC.

In addition to serving an impetus to push public health practitioners and other stakeholders to promote CRC screening, it is also a wealth of knowledge regarding inherent advantages in screening to detect CRC early enough for good prognosis and treatment. Similarly, it is a rich source of academic information that could drive health policies in the right direction where policymakers would be able to utilize it in formulating workable policies to enhance public health initiatives for the target populations in the study. For example, some policies may be tailored to meet the needs of

Hispanic males who are historically the least likely to seek CRC screening. The study also identified important variables, particularly types of screening employed to identify CRC, such as colonoscopy, sigmoidoscopy, and FOBT. Health care providers need to educate the eligible public about these types of screening and their advantages and disadvantages so that individuals could make informed choices when they need to undertake screening for CRC detection.

## Conclusion

Results of the study confirmed the low CRC screening rates among LEP Hispanic Americans in the state of Texas. The results are consistent with other studies done elsewhere in the United States, which concluded that limited English proficient Hispanics are at an increased risk for CRC due to late diagnosis of the disease blamed principally on lack of screening for early detection. The results are also consistent with other studies that Hispanic men, particularly those with LEP, do not participate in CRC screening compared with their female counterparts and men of White only, non-Hispanic and Black only, non-Hispanic origins. It also shows that Blacks are at an increased risk for CRC due to their low participation in CRC screening, possibly due to lack of health insurance or reasons I did not investigate. Despite the availability of Medicaid through the ACA, the state of Texas remains one of the few states in the United States where Medicaid-eligible citizens remain uninsured in huge numbers. The study found out that while women undertake CRC screening more than men, the difference is not significant.

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# Appendix: Abbreviations

| | |
|---|---|
| ACA | Affordable Care Act |
| ACCION | Against Colorectal Cancer in Our Neighborhood |
| ACS | American Cancer Society |
| ACS PUMPS | American Community Survey Public Use Microdata Sample |
| AJCC | American Joint Committee on Cancer |
| ANCOVA | Analysis of Covariance |
| ANOVA | Analysis of Variance |
| ASPE | Assistant Secretary for Planning and Evaluation |
| ASR | Age-standardized Rates |
| BMHSU | Behavioral Model of Health Services Use |
| BRFSS | Behavioral Risk Factor Surveillance System |
| CDC | Centers for Disease Control and Prevention |
| CI | Confidence Interval |
| COVID-19 | Coronavirus-2019 |
| CRC | Colorectal Cancer |
| CS | Clinical Staff |
| CTC | Computed Tomography and Colonography |
| DSHS | Department of State Health Services, Texas |
| DSS | Disproportional Stratified Sample |
| DV | Dependent Variable |
| EBCCP | Evidence-based Cancer Control Program |
| FIT-DNA | Fecal Immunochemical Test-DNA |
| FOBT | Fecal Occult Blood Test |
| FPL | Federal Poverty Level |
| FQHC | Federally Qualified Health Center |
| gFOBT | Guaiac-based FOBT |
| Ha | Alternative Hypothesis |
| HBF | Health Behavioral Framework |
| HBM | Health Belief Model |
| HHS | Health and Human Services |
| HIV | Human Immunodeficiency Virus |
| Ho | Null Hypothesis |
| HRQOL | Health-related Quality of Life |
| IBM | Integrative Behavioral Model |
| IRB | Institutional Review Board |
| IV | Independent Variable |
| KA | Korean American |
| LCM | Latino Community Members |

| | |
|---|---|
| LEP | Limited English Proficiency |
| LHL | Low Health Literacy |
| MRN | Male Role Norm |
| MT-sDNA | Multitarget Fecal DNA |
| NCI | National Cancer Institute |
| NHIS | National Health Interview Survey |
| NHW | non-Hispanic White |
| NIH | National Institutes of Health |
| OCR | Office of Civil Rights |
| OHIP | Ontario Health Insurance Plan |
| OMB | Office of Management and Budget |
| OMH | Office of Minority Health |
| OR | Odds Ratio |
| P | Power (Statistics) |
| PMT | Protection Motivation Theory |
| RQ | Research Question |
| SARS-CoV-2 | Severe Acute Respiratory Syndrome Coronavirus 2 |
| SCHBM | Sociocultural Health Behavioral Model |
| SDH | Social Determinants of Health |
| SEER | Surveillance, Epidemiology, and End Results |
| SEM | Social Ecological Model |
| Sensitive gFOBT | Sigmoidoscopy combined with FIT |
| SES | Socioeconomic Status |
| SOGI | Sexual Orientation Gender Identity |
| SPSS | Statistical Package for the Social Sciences |
| TRA | Theory of Reasoned Action |
| TTM | Transtheoretical Model |
| USPSTF | United States Preventive Services Task Force |