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The impact of race and ethnicity on healthcare utilization, medication utilization, and obesity-related clinical measurements in an employee-based insured population

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The impact of race and ethnicity on healthcare utilization, medication utilization, and obesity-related clinical measurements in an employee-based insured population

by

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Dedication

I dedicate this thesis to:

- my family, who have always unconditionally supported me and gone to the utmost ends to pursue my dreams and ambitions;
- my boyfriend, for always giving me the encouragement and stability I needed when navigating through the chaos;
- my friends, for listening to my troubles and being able to keep up with the frenzy that is my life;
- my mentors, for reminding me that as long as I pursue my passions things will ultimately end up fine;
- my dogs, Twinkie and Taco, who gave me solace and rested by my side for pets as I worked long hours typing away.

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Abstract

The impact of race and ethnicity on healthcare utilization, medication utilization, and obesity-related clinical measurements in an employee-based insured population

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Objective: To evaluate an association between race/ethnicity on healthcare and medication utilization, as well as obesity-related clinical measures across weight categories in patients who are overweight or obese within an employee-based commercial insurance plan.

Methods: This retrospective cohort study used administrative claims and electronic health record data from an integrated delivery network in Texas. Patients that were 18 years or older at index, BMI $\geq$ 25 or greater at index, had continuous health plan enrollment throughout the study period, and did not die during the study period were included in the study. Patients were divided into 4 race/ethnicity groups and categorized by obesity classification. The primary outcome of this analysis was healthcare utilization as measured by inpatient, outpatient, and emergency department visits. Kruskal-Wallis tests and chi-square tests were employed to analyze overall differences in continuous and categorical data, respectively.

Results: Among 6,051 patients, 4,384 patients were White, 892 were Black, 439 were Hispanic or Latino, and 336 were categorized as Other. Additionally, 2,386 patients were overweight at

index, followed by 1,914 obese class I patients, 928 obese class II patients, and 823 obese class III patients. The composite outcome of outpatient visits, inpatient visits, and emergency department visits were significantly different across race/ethnicity groups for all patients ($p<0.0001$) and obesity classifications including overweight ($p=0.002$), obese class I ($p<0.0001$), and obese class II ($p=0.0087$). Within obese class III, there were no significant differences in race for outpatient visits ($p=0.6757$), presence of at least one emergency department visit ($p=0.3104$), and composite outcome of all visits ($p=0.5274$).

Conclusion: Despite patients being on an employee-based commercial insurance plan with continued coverage, differences in healthcare utilization, medication utilization, obesity-related clinical measures, and bariatric surgery utilization were present. However, patients with class III obesity demonstrated no significant differences in healthcare utilization, medication utilization, and frequency of clinical measures among race categories. These results suggest that worsening obesity severity is associated with increased healthcare utilization of patients despite racial or ethnic classification, providing real-world evidence for the management of overweight and obese patients, especially in relation to racial and ethnic minorities who are low utilizers of weight loss therapies.

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Chapter 1: Introduction

1.1 BACKGROUND

Obesity is a complex, multifactorial public health epidemic. Overweight and obesity is defined by the World Health Organization (WHO) as abnormal or excessive fat accumulation that presents a risk to health.[1] Body mass index (BMI, the weight in kilograms (kg) divided by the square of the height in meters (m^2)) is the most widely used formula to define overweight (BMI 25-29.9 kg/m^2) and obesity (≥30 kg/m^2).[2] Classification of BMI scores are listed in Table 1.1. The prevalence of overweight and obesity has been increasing drastically worldwide. A recent analysis of data from 195 countries revealed that since 1980, the prevalence of obesity has more than doubled in more than 70 countries.[3] The same study saw that over 600 million adults were obese in 2015, with a high BMI accounting for more than 4 million deaths globally. Data from the 2013-2014 National Health and Nutrition Examination Survey (NHANES) estimated that more than 2 in 3 adults were considered overweight or obese in the U.S.[4] The National Center for Health Statistics (NCHS) February 2020 Data Brief estimates an increase of the age-adjusted prevalence of obesity among U.S. adults has increased from 30.5% to 42.4% from 1999-2000 through 2017-2018.[5]

Table 1.1: World Health Organization (WHO) body mass index (BMI) Classification[6]

Classification	**BMI (kg/m^2)**
Underweight	<18.5
Normal range	18.5-24.9
Overweight	25.0-29.9
Obese	≥30.0
Class I	30.0-34.9
Class II	35.0-39.9
Class III (Severe, Extreme, or Massive Obesity)	≥40.0

1.2 PATHOPHYSIOLOGY OF OBESITY

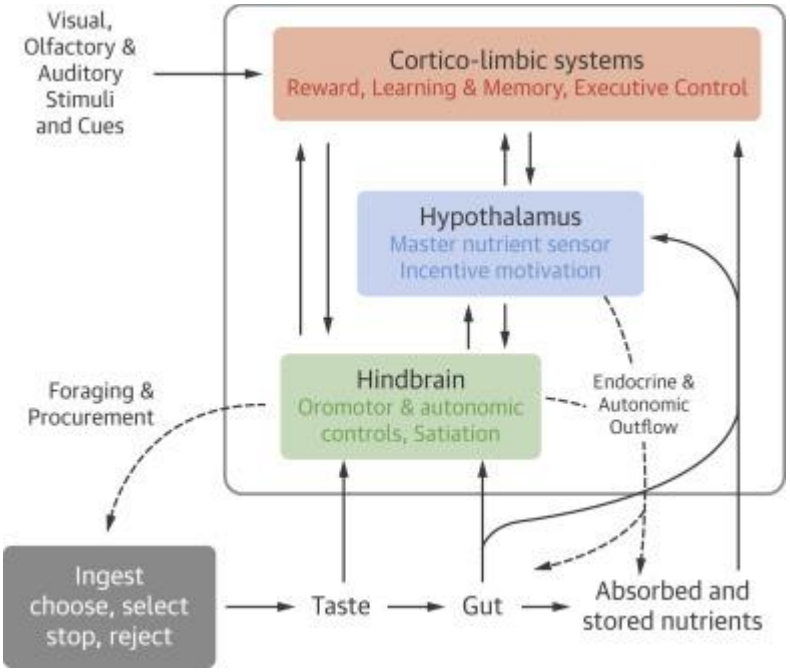
Obesity is broadly defined as excess body weight for a given height.[2] The pathogenesis of obesity is complex and multifactorial, with environmental, sociocultural, physiological, medical, behavioral, genetic, epigenetic, and numerous other factors contributing to causation and maintenance.[7] There is a prime function of the physiologic system to maintain homeostasis of energy stores in response to fluctuating access to nutrition and demands for energy expenditure, having both afferent sensing components and efferent effector limbs.[8] The efferent elements of this physiologic system include regulating the degree of hunger and food-seeking behavior, amount of energy expenditure, levels of key circulating hormones like insulin and glucocorticoids.[8] A coordinated network of central mechanisms and peripheral signals that arise from the microbiome and cells within the stomach, adipose tissue, pancreas, and other organisms operate through a coordinated network to control short-term and long-term energy balance.[9] A diagram of molecular mechanisms that underly the neural circuits regulating food intake and energy balance is shown in Figure 1.2.

Excess adiposity that evolves over time is typically associated with a long-term positive energy balance. Excess weight in people who are overweight or obese include varying proportions of lipids, including triglycerides, in adipose tissue along with increased volume in skeletal muscle, liver, and additional organs and tissues.[10] Hydrolysis of triglycerides within adipocytes release free fatty acids, which are often high in patients with obesity, are transported in plasma to sites throughout the body to be used.[11] Excess lipids are distributed to many body compartments with continued weight gain overtime. Excess adiposity can also increase the size of liposomes in hepatocytes, leading to the formation of large vacuoles that are accompanied by pathological states such as nonalcoholic fatty liver disease and cirrhosis.[12] A person who is overweight or obese has higher proportion of fat tissue and lean mass, higher resting energy expenditure, cardiac output, blood pressure, and greater pancreatic β-cell mass compared to non-overweight or non-obese individuals.[10,13] Both fasting insulin secretion and the total insulin response to oral glucose increase with BMI in an approximately linear fashion.[14] Immune cells such as B cells and macrophages

have been identified in adipose tissue.[15] Obesity affects the quantity and nature of these immune cell subtypes, demonstrating that adipose tissue is a large immunologically active organ during obesity that can modify whole-body metabolism through paracrine and endocrine mechanisms.[15]

Genes and environment also play a role in a complex system that regulates energy balance, linked physiological processes, and weight.[9,16] Environmental factors that have favored positive energy balance and weight gain include an increase of per capita food supplies and consumption[17,18], especially high-calorie foods served in large portions, decrease in occupational physical activities and increase in sedentary activities[19,20], inadequate sleep[21], and an expanding list of medications with weight gain as a side effect.[22] In addition, there has been evidence to suggest an underlying genetic mechanism in obesity. Heterozygous mutations in the melanocortin-4 receptor gene are currently the most common cause of monogenic obesity, appearing in 2 to 5% of children with severe obesity.[9,16] Evidence from genome-wide association studies have identified 227 genetic variants involved in different biological pathways that are associated with polygenic obesity.[16]

Figure 1.2: Neural Pathways and Systems Controlling Ingestive Behavior and Energy Balance[2]



1.3 CORMORBIDITIES IN OBESITY

People with obesity are at an increased risk for developing many comorbidities, including type 2 diabetes mellitus (T2DM), hypertension, dyslipidemia, cardiovascular disease (CVD), stroke, sleep apnea, gout, and osteoarthritis.[23] Data from a 2017 cross-sectional analysis saw that patients within higher BMI categories had a higher prevalence of comorbidities.[24] Obesity is a strong contributor to insulin resistance, which appears early in T2DM and is primarily compensated by hyperinsulinemia.[23–26] A meta-analysis from the U.S. and Europe saw obese men and women had a 7-fold and 12-fold higher chance, respectively, to develop T2DM compared to non-obese individuals.[29] An important link between obesity, metabolic syndrome and dyslipidemia, seems to be insulin resistance in peripheral tissues that leads to enhanced hepatic flux of fatty acids from dietary sources, intravascular lipolysis and from adipose tissue resistant to the antilipolytic effects of insulin.[30] Approximately 60-70% of patients with obesity are dyslipidemic, with lipid abnormalities such as elevated serum triglycerides, VLDL, apolipoprotein B, and non-HDL-C.[31] Additionally, both obesity and diabetes significantly raise the risk for CVD and stroke.[32] The American Heart Association highlighted a BMI of <25 kg/m^2 and fasting plasma glucose concentration of <100 mg/dL as components of ideal cardiovascular health.[33] Excess weight gain is a major cause of hypertension, accounting for 65% to 75% of the risk for primary hypertension through activation of the renin-angiotensin-aldosterone system and increase sympathetic nervous system activity.[13] Obesity-associated hypertension becomes more difficult to control with prolonged obesity and development of target organ injury, particularly from renal damage.[13] Substantial increases in mortality from all causes, especially cardiovascular disease is associated with overweight individuals.[23] Obesity can lead to additional conditions like obstructive sleep apnea due to an increase in pharyngeal soft tissues that can block airways during sleep.[34] Increased mechanical load via excess adiposity can also make obesity increase the risk of developing osteoarthritis.[35] Certain cancers, such as colorectal, prostate, endometrial, breast, and gallbladder cancer, are also associated with obesity.[23] A 2003 prospective study demonstrated increased death rates for all cancers combined, and cancers at multiple specific sites were

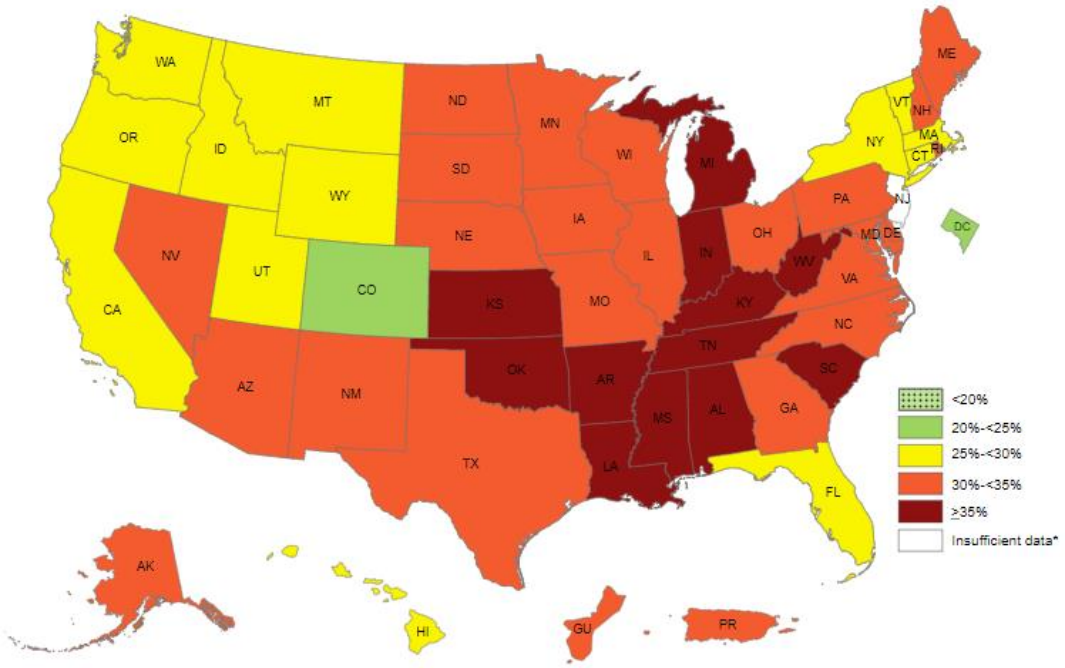
associated with increased body weight.[36] Obesity is also associated with an increased prevalence of psychiatric disorders, especially in people with severe obesity and those seeking bariatric surgery.[37,38] Evidence exists for the bidirectional causal pathways between obesity and psychiatric disorders, with more consistent evidence that obesity is prospectively associated with increased depression.[39]

1.4 SOCIAL DETERMINANTS OF HEALTH AND DISPARITIES IN OBESITY

The WHO defines social determinants of health (SDH) as "conditions in which people are born, grow, live, work and age."[40] SDH encompass a wide away of subjects including social behavior, health equity, global ecology, the global economy, and similarly defined broad areas.[41] SDH can be grouped into five domains: economic stability, education access and quality, healthcare access and quality, neighborhood and built environment, and social and community context.[42] There has been extensive evidence that SDH has been shown to have a causal role in contributing to obesity. Within social epidemiologic research, income was found to be inversely associated with obesity, suggesting lower income as a cause for obesity.[43–45] People with lower income are often more susceptible to obesity due to limited access to healthcare and healthy food that also influences health-related behaviors and activities like diet and exercise.[46,47] Obesity has also been shown to decrease with higher level of education, with adults that did not have a high school degree or equivalent having the highest percentage of self-reported obesity.[48] Data utilized from the National Survey of Children's Health 2016-2017 saw that in children, overweight classification was more frequent in children of single parents and children who lived in neighborhoods with no amenities.[49] Alternatively, health insurance coverage, language spoken at home other than Spanish, and a parent with a college education saw lower frequency of children that were overweight or obese.[49] Food preferences and appetite control are commonly established early in life, likely causing the high correlation between obesity in the parents and respective children.[50–52] In the U.S., the Mid-South region has the highest prevalence of obesity, with Texas ranked 12th and 19th in obesity for childhood and adult obesity, respectively.[48,53]

These SDH seen in obesity, in turn, lead to disparities, defined by the National Institutes of Health (NIH) as the "differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific populations, seen in obesity."[54] There is extensive evidence of the persistent racial and ethnic disparities associated with obesity.[48] In children, the likelihood of obesity was elevated among non-Hispanic black and Hispanic children.[49] This, in turn, can further exacerbate obesity in adulthood, as a systematic review saw that obese children and adolescents were approximately five more times likely to be obese in adulthood compared to those who were not obese as children.[55] The disparities in adulthood obesity has widened among some population subgroups compared to others over time. For example, the prevalence of obesity among white woman increased from 22.9% to 32.8% from 1988-1994 to 2013-2014. Alternatively, for the same periods, non-Hispanic black women and Hispanic women saw an increase from 38.4% to 57.2% and 35.4% to 46.9%, respectively.[56] Furthermore, the prevalence of obesity was higher among non-Hispanic black men (38.0%) and Hispanic men (37.9%) compared to non-Hispanic white men (34.7%) in 2013-2014.[56] Disparities exist regionally within the U.S., with 31 states having an obesity prevalence of 35% or higher among non-Hispanic black adults compared to only one state among non-Hispanic white adults as shown in Figure 1.4.[48]

Figure 1.4: Prevalence of Self-Reported Obesity Among U.S. Adults by State and Territory, Behavioral Risk Factor Surveillance System, 2019[48]



*Sample size <50 or the relative standard error (dividing the standard error by the prevalence) ≥30%, or no data in a specific year.

1.5 ECONOMIC BURDEN OF OBESITY

Obesity imposes a large economic burden on the person affected, their families, and on nations.[57,58] Data from the U.S. National Expenditure Accounts from 2000 to 2001 reported that the increased prevalence of obesity may have been responsible for as much as $147 billion of healthcare spending, with private insurers paying the medical bill for approximately half of this total.[59] Additionally, Finklestein and colleagues saw that obesity was attributed to about $40 billion in excess medical spending.[59] Among the working-age population between 1987 and 2001, it is estimated that obesity was responsible for 27% of the rise in inflation-adjusted healthcare spending.[60] Obesity was associated with a 36% increase in annual healthcare costs and an increase of 77% of medication costs compared to non-obese individuals.[61] The mean annual per capita healthcare cost of obesity in the U.S. is immense, estimated at $1,160 for men and $1,650 for women.[62] The combined medical costs associated with treatment of preventable diseases

associated with obesity are estimated to increase by $48 to $66 billion per year in the U.S. by 2030.[63] In regards to indirect costs, increasing rates of absenteeism were also shown to be associated with increasing BMI.[59] For example, women with class III BMI missed an average of approximately one week more of work per year than non-obese women. Furthermore, it has been estimated that obese workers cost U.S. employers an additional $11.7 billion per year as a result of increased absenteeism and presenteeism, compared to non-obese employees.[64]

1.6 OBESITY MANAGEMENT

There are three main modalities that have been utilized to treat the multifactorial problem of obesity: lifestyle intervention, pharmacotherapy, and weight-loss procedures, including bariatric surgery.[65] The American Association of Clinical Endocrinologists and the American College of Endocrinology (AACE/ACE) guidelines recommend that all adults should be screened annually utilizing BMI with a cutoff of 25 kg/m^2 for further evaluation of overweight or obesity.[66] The summary of obesity management guidelines for treatment are listed below in Table 1.6.1.

Table 1.6.1: Endocrine Society Clinical Practice Guideline: Summary of Recommendations[67]

BMI	Pharmacotherapy	Bariatric Surgery	Non-Pharmacological
≥25-29.9	Recommended if ≥27 with comorbidity*	Not recommended	• Diet • Exercise • Behavioral Modification
30-34.9	Recommended	Not recommended	
35-39.9	Recommended	Recommended if ≥35 with comorbidity*	
≥40	Recommended	Recommended	

*Comorbidity such as hypertension, dyslipidemia, type 2 diabetes (T2DM), and obstructive sleep apnea (OSA)

Although BMI remains a primary measurement of overweight and obesity, it should not be used individually but in conjunction with how excess adiposity negatively impacts an individual's health.[66] The efficacy of lifestyle and behavioral interventions in obesity has been long established in clinical trials.[68] The AACE/ACE guidelines recommend various diets that focus on reduced

caloric intake (a daily deficit of 500-750 kilocalories) or individualized based on personal preference.[66] A reduced caloric diet should be followed alongside increased physical activity. The AACE/ACE guidelines recommend physical activity to at least 150 minutes per week to be performed during three to five separate days.[66]

Pharmacotherapy is only indicated for use in addition to lifestyle and behavioral interventions, as it can play a role in adherence to lifestyle and behavioral modifications to create a negative energy balance.[67] Table 1.6.2 summarizes the currently FDA-approved medications for long-term overweight and obesity conditions.[69]

Table 1.6.2: Prescription Medications Approved for Overweight and Obesity[69]

Medication	Approved For	Mechanism	Common Side Effects	Warnings
Orlistat (Xenical)	≥12 years old	Reduces gut absorption of fat from diet	• Diarrhea • Gas • Leakage of oily stools • Stomach Pain	• Severe liver injury • Avoid with cyclosporine • Take with multivitamin
Phentermine-topiramate (Qysmia)	Adults	Phentermine reduces appetite Topiramate reduces appetite or produces feeling of satiety sooner	• Constipation • Dizziness • Dry mouth • Taste changes • Tingling of hands and feet • Trouble sleeping	• Avoid in glaucoma or hyperthyroidism • Do not take if pregnant or planning pregnancy • Avoid if hypertension or a history of heart disease
Naltrexone-bupropion (Contrave)	Adults	Combination reduces appetite or provides feeling of satiety sooner	• Constipation • Diarrhea • Dizziness • Dry mouth • Headache	• Do not take if high blood pressure, history of seizures, and

			• Increased blood pressure • Increased heart rate • Insomnia • Liver damage • Nausea • Vomiting	history of anorexia • Do not use if dependent on opioid pain medications or withdrawing from drugs or alcohol • Do not use if concurrently taking bupropion
Liraglutide (Saxenda)	Adults	Reduces appetite or provides feeling of satiety sooner	• Nausea • Diarrhea • Constipation • Abdominal pain • Headache • Raised pulse	• May increase risk of developing pancreatitis

Short-term FDA-approved pharmacotherapy options for obesity that should only be used for up to 12 weeks include sympathomimetic agents that work to reduce the appetite such as phentermine used alone, diethylpropion, phendimetrazine, and benzphetamine.[66] For overweight or obese patients with T2DM, antidiabetic medications such as glucagon-like peptide-1 (GLP-1) analogs or sodium-glucose-linked transporter-2 (SGLT-2) inhibitors, are recommended due to promoting weight-loss.[67] Patients with cardiovascular disease and hypertension should avoid sympathomimetic agents which can exacerbate their condition. Assessment of response to a patient's weight loss medication should be conducted at least monthly for the first 3 months and every 3 months thereafter to determine efficacy. Efficacy is determined by a weight loss of ≥5% of body weight and if not achieved or if a patient experiences tolerability issues, the therapy should be switched or discontinued.[67] Bariatric surgery remains an AACE/ACE recommended option for certain patients with comorbidities that have failed to achieve targeted clinical outcomes with pharmacotherapy and lifestyle modifications. Improvements in bariatric surgical practices since development have resulted in enhanced patient outcomes, such as reduced mortality.[70] Post-bariatric surgery, patients should still continue to be treated with an intensive lifestyle

interventions. Regardless of treatment modality of obesity, the principal outcome and therapeutic target for the treatment of obesity should be to improve the overall health of the patient by reducing the risk or treating weight-related complications.

1.7 STUDY RATIONALE AND OBJECTIVES

1.7.1 STUDY RATIONALE

The enactment of The Affordable Care Act (ACA) in 2010 provided an opportunity to narrow longstanding racial and ethnic disparities in health coverage, as evidenced by increased insurance coverage for all racial and ethnic groups between 2010 and 2016.[71] Research has shown that having healthcare coverage makes a vital difference in whether, when, and where people receive medical care, and thus affects their health status.[72] For example, patients with private insurance were more likely to undergo a lobectomy for early-stage non-small cell lung cancer and be screened for colorectal cancer compared to uninsured patients.[73,74] However, survey data from a 2014 study of low-income Americans saw that privately insured Blacks and Hispanics are less likely than privately insured White adults to have a usual source of care and a regular provider.[75] The survey data also revealed that, among privately insured adults, Hispanics are less likely than Whites to use medical services or receive preventative care. Although private insurance is linked to increased healthcare utilization, healthcare disparities among Hispanic and Black patients that are privately insured continue to persist.

Obesity is a public health epidemic and its economic burden in the U.S. has been steadily increasing over the past several decades. Despite gains in insurance coverage following the ACA and guideline recommendations from AACE/ACE and the Endocrine Society for management and classification of obesity, there is growing evidence that obesity has continued to be underdiagnosed and undermanaged in clinical practice.[66,67,76] Less than 30% of adults with obesity receive their diagnosis during their primary care visit, and weight counseling during primary care visits has been declining significantly over the past several years.[76,77] Additionally, racial and ethnic disparities in obesity are especially prevalent and have continued to worsen throughout the U.S.[48,56]

A 2010 large cross-sectional study of ten U.S. health plans saw that the availability of BMI measurements for adults ranged immensely across health plans from 28% to 88.[78] However, although these data included a sample size of over 6.5 million adults and children, this study lacked a differentiation of employer-based insurance plans, did not look at health disparities, and was completed more than a decade ago. While studies have highlighted health disparities in privately insured patients, there is a lack of research that separately considers the impacts of employer-provided insurance. This distinction is important to consider as employer-based insurance provides a relative advantage over market insurance and may further reveal racial disparities.[79] To date, there have been no studies examining health disparities of overweight and obese patients within an employer-based insurance plan. Information gathered from a study focusing on an employer-based insurance plan consisting of overweight and obese patients can reveal vulnerable members that would benefit from interventional approaches and thus may reduce costs, underutilization of healthcare resources, and worsening health outcomes.

1.7.2 STUDY OBJECTIVES AND HYPOTHESES

The purpose of this study was to determine if there is an association between race/ethnicity on healthcare and medication utilization, as well as obesity-related clinical measures across weight categories in patients who are overweight or obese. The study population consists of patients on an employee-based commercial insurance plan, Scott & White Health Plan (SWHP), which is part of Baylor Scott & White Health (BSWH), the largest not-for-profit healthcare system in Texas. The analysis focused on healthcare utilization specific to inpatient visits, outpatient visits, and emergency department visits. Medication utilization was assessed through documented use of a prescribed weight-loss medication. Lastly, obesity-related clinical measurements such as those related to BMI, hemoglobin A1c (HbA1c), systolic blood pressure (SBP) and diastolic blood pressure (DBP), and total cholesterol were assessed.

The objectives and their related hypotheses are listed below:

Objective 1: To describe the demographic, socioeconomic, and health characteristics of patients who are overweight or obese across weight categories.

Objective 2: To compare the healthcare utilization of overweight or obese patients across weight categories by race/ethnicity.

$H_0$2.1: The difference in frequency of inpatient visits, outpatient visits, and emergency department by race/ethnicity is not statistically significant.

$H_0$2.2: The difference in frequency of outpatient visits by race/ethnicity is not statistically significant.

$H_0$2.3: The difference in proportion of patients having at least one inpatient visit by race/ethnicity is not statistically significant.

$H_0$2.4: The difference in proportion of patients having at least one emergency department visit by race/ethnicity is not statistically significant.

Objective 3: To compare the medication utilization of overweight or obese patients across weight categories by race/ethnicity.

$H_0$3.1: The difference in the proportion of patients being on a weight-loss medication by race/ethnicity is not statistically significant.

$H_0$3.2: The difference in average length of weight-loss medication therapy by race/ethnicity is not statistically significant.

Objective 4: To compare the obesity-related clinical measurements of overweight or obese patients across weight categories by race/ethnicity.

$H_0$4.1: The difference in average BMI by race/ethnicity is not statistically significant.

$H_0$4.2: The difference in number of BMI measurements by race/ethnicity is not statistically significant.

$H_0$4.3: The difference in average change in BMI by race/ethnicity is not statistically significant.

$H_0$4.4: The difference in average change in weight by race/ethnicity is not statistically significant.

$H_0$4.5: The difference in average HbA1c at index by race/ethnicity is not statistically significant.

$H_0$4.6: The difference in number of HbA1c measurements by race/ethnicity is not statistically significant.

$H_0$4.7: The difference in average change in HbA1c by race/ethnicity is not statistically significant.

$H_0$4.8: The difference in average SBP and DBP at index by race/ethnicity is not statistically significant.

$H_0$4.9: The difference in number of SBP and DBP measurements by race/ethnicity is not statistically significant.

$H_0$4.10: The difference in average change in SBP and DBP by race/ethnicity is not statistically significant.

$H_0$4.11: The difference in average total cholesterol at index by race/ethnicity is not statistically significant.

$H_0$4.12: The difference in number of total cholesterol measurements by race/ethnicity is not statistically significant.

$H_0$4.13: The difference in average change in total cholesterol by race/ethnicity is not statistically significant.

Objective 5 (exploratory): To compare the rates of bariatric surgery among overweight or obese patients across weight categories by race/ethnicity.

$H_0$5.1: The difference in the proportion of patients undergoing bariatric surgery by race or ethnicity is not statistically significant.

Chapter 2: Methodology

2.1 CHAPTER OVERVIEW

This study will evaluate the population of overweight and obese individuals among BSWH patients to identify if any disparities are present. This chapter discusses institutional review board approval, study objectives and hypotheses, study design, study data source, study variables, statistical analytical methods, and potential limitations.

2.2 INSTITUTIONAL REVIEW BOARD APPROVAL

This study was reviewed and approved by the Baylor Scott & White Health and the University of Texas Institutional Review Board following expedited review

2.3 STUDY DESIGN AND DATA SOURCE

Baylor Scott & White Health (BSWH) is the largest not-for-profit healthcare system in Texas. BSWH includes 52 hospitals, over 49,000 employees, and the Scott & White Health Plan (SWHP). Currently, SWHP covers approximately 415,000 members and 171 counties in the Central, East, North, and West Texas regions. This was a population-based, observational, retrospective study of BSWH patients in Texas. This study focused on overweight and obese patients within BSWH to identify any disparities in healthcare. By focusing on a large population of patients over several years, patients can be identified that may not be utilizing healthcare resources as frequently or patients who are worsening as evidenced by clinical characteristics like BMI, HbA1c, blood pressure, and total cholesterol.

2.3.1 Inclusion Criteria

Patients who met the following criteria were included in the study:

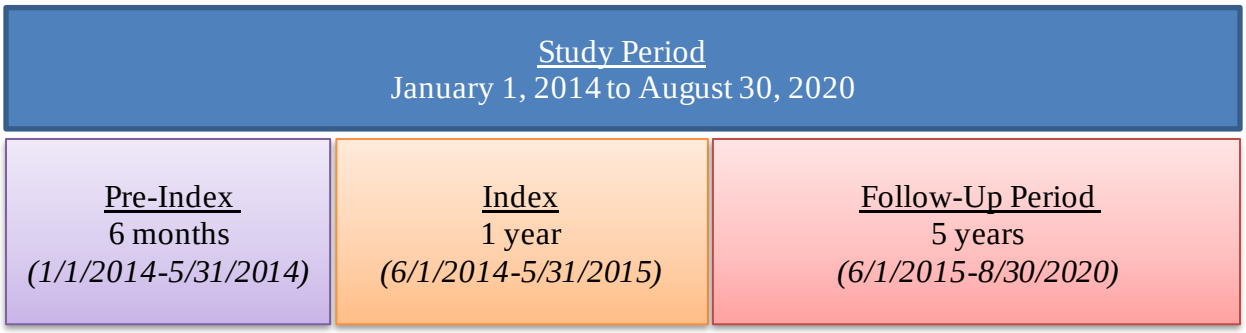
- 18 years or older at the time of cohort entry (index period)

- BMI ≥ 25 or greater at the time of cohort entry (index period)
- Continuous health plan enrollment throughout the study period (pre-index to end of follow-up period)

2.3.2 Study period and index date

The index date was defined as the date of the first recorded BMI measurement when the patient is 18 years of age or older within the enrollment period (June 1, 2014 to May 31, 2015). The study period, illustrated in Figure 2.3.2, included a 6-month baseline period prior to the index date and a 5-year follow-up period to accurately capture the patient population for observation and ensure continuous plan enrollment. Patients were followed from baseline until the end of study period (May 31, 2020). For patients who were under 18 years of age and become 18 years of age at any time point during the study period, all measurements recorded prior to their 18th date of birth were excluded from the analysis.

Figure 2.3.2:Study Period



2.3.3 Data source and data collection

The study utilized administrative claims data and BSWH electronic medical record data (EMR) from January 1, 2014 to August 30, 2020. BSWH EMR data was linked longitudinally to pharmacy and medical claims data from the Virtual Data Warehouse (VDW), which is a database of SWHP members, for the duration of the study period. Pharmacy claims provided details for all dispensed prescriptions, including fill date and quantity dispensed. Medical claims provided

detailed information regarding inpatient and outpatient services. SWHP covers approximately 415,000 lives that are geographically located within the central and northern Texas regions. The combined retrospective data provided thorough patient-level information such as enrollment, diagnoses, medications, demographics, and clinical measures. The focus was on SWHP commercial employee-based patients, but SWHP also includes a payer mix of commercial non-employee based, Medicare, and Medicaid populations.

2.5 STUDY VARIABLES

The following sections detail the study's dependent and independent variables, followed by operational definitions. A summary of operational definitions of all variables and covariates are presented in Table 2.5.2.

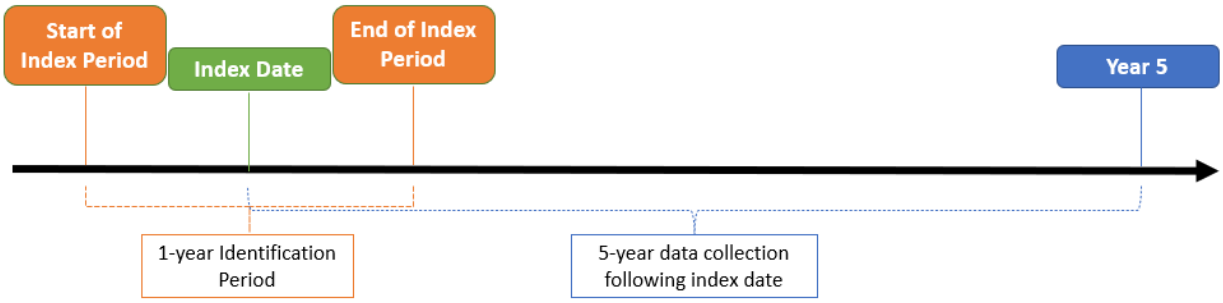
2.5.1 Dependent Variables

The primary dependent variable for this study was healthcare utilization as defined by the number of inpatient, outpatient, and emergency department visits. Healthcare utilization was defined by at least one medical claim for an inpatient, outpatient, or emergency department visit during the follow-up period. For medication utilization, the number of patients and the length of therapy was analyzed for the following medications: phentermine-hydrochloride, liraglutide, orlistat, phentermine-topiramate, and bupropion-naltrexone. Medication utilization was also measured by length of therapy in days. Clinical measurements included in this study were BMI, weight (kg), HbA1c, SBP and DBP, and total cholesterol. Development of obesity-related comorbidities were observed in this study. Clinical measures were analyzed by the frequency of measurement and the change in average for each respective demographic characteristic.

All dependent variables were measured as a sum of its occurrence over the 5-year study period. For example, inpatient visits were measured as the number of inpatient visits from the index date to the end of the five-year follow-up period. For clinical measurements and development of comorbidities, change from the index date to the end of the follow-up period were

also recorded. The timeline of study variable measurements from index to the end of the 5-year follow-up is depicted below in Figure 2.5.1.

Figure 2.5.1:Timeline of Study Variable Measurements for Sub-Analysis of Clinical Measures



2.5.2 Independent Variables and Covariates

Race/ethnicity and obesity class at index served as the primary independent variables. Race and ethnicity were categorized into White or Caucasian/Not Hispanic or Latino, Black or African/Not Hispanic or Latino, Hispanic or Latino, and Other. Covariates were included in the regression analysis since several factors can potentially confound the relationship between the independent and dependent variables. Covariates included demographics (age, gender) and socioeconomics (median income). The total number of diagnoses of obesity-related comorbidities recorded within the 6 months before the index date served as covariates for Objectives 2-5. Median household income was extrapolated by linking patient zip codes to the corresponding median household income reported by the United States Census Bureau Healthcare, 2019 American Community Survey.[80] Covariates for Objective 4 measures specifically included the diagnosis of each type of comorbidity for respective clinical measures (e.g. hypertension for SBP and DBP, T2DM for HbA1c, etc.). A summary of study variables is provided in Table 2.5.2.

Table 2.5.2: Operational Definitions of Study Variables

Variables	Operational Definitions
Dependent Variables	
Objective 2: Healthcare Utilization	Continuous • Outpatient visits (number of outpatient visits in follow-up period) • All types of visits (number of outpatient, inpatient, and emergency department visits in follow-up period) Categorical – Binary (Yes/No) • Presence of at least 1 emergency department visit in follow-up period • Presence of at least 1 inpatient visit in follow-up period
Objective 3: Weight Loss Medication Utilization	Categorical -Binary (Yes/No) • Number (and proportion) of patients with at least one claim of a weight loss medication Continuous • Length of therapy (Number of days in which a weight loss medication was continually used during the post-index period without a gap) • Gap period: last days supply + 60 days (sensitivity analyses: last days supply + 45 days; last days supply + 90 days)
Objective 4: Clinical Measurements	
Weight-related	Continuous • Mean or Median BMI at Index • Mean or Median BMI at Year 5 • Number of BMIs in EHR from Index Date to Year 5 • Difference in BMI: mean or median BMI at Year 5 subtracted by mean or median BMI at Index • Difference in weight: mean or median weight (kg) at Year 5 subtracted by mean or median weight
Other clinical measures	Continuous • Mean or median HbA1c, SBP and DBP, and total cholesterol at Index • Mean or median HbA1c, SBP and DBP, and total cholesterol at Year 5 • Number of HbA1c, SBP and DBP, and total cholesterol in EHR from Index Date to Year 5

	• Difference in BMI: mean or median HbA1c, SBP and DBP, and total cholesterol at Year 5 subtracted by mean or median HbA1c, SBP and DBP, and total cholesterol at Index
Objective 5: Rates of Bariatric Surgery	Categorical – Binary (Yes/No) • Number (and proportion) of patients with at least one claim of bariatric surgery
Independent Variables	
Racial/Ethnic Groups	Categorical • 1 = White or Caucasian • 2 = Black or African American • 3 = Hispanic • 4 = Other
Obesity Classification	Ordinal • 1 = Overweight • 2 = Obese – Class I • 3 = Obese – Class II • 4 = Obese – Class III
Sociodemographics and Covariates for ANCOVA Analyses	
Age Groups	Ordinal • 1 = 18-30 • 2= 31-50 • 3 = 51-64 • 4 = ≥65
Gender	Categorical - Binary • 0 = Male • 1 = Female
Median Household Income, with zip code as a proxy	Ordinal • 1 = <$33,000 • 2 = $33,000 - $49,999 • 3 = $50,000 - $74,999 • 4 = $75,000 - $99,999 • 5 = >$100,000
Obesity-related comorbidities	Categorical – Binary (Yes/No) Presence of at least one obesity-related comorbidity at index: • T2DM • Prediabetes • Hypertension • Hyperlipidemia • Obstructive sleep apnea • Cardiovascular disease • Congestive heart failure • Depression

	• Psychiatric disease • Osteoarthritis • Musculoskeletal pain • Urinary incontinence • Non-alcoholic fatty liver disease • Asthma

2.6 STATISTICAL ANALYSIS

This study used various statistical methods to meet the objectives. All statistical tests were performed with SAS Enterprise Guide 8.4 (SAS Institute, Cary, NC). Statistical tests were two-sided with a prior significance level of $p<0.05$. A summary of objectives with their respective hypotheses and statistical tests are presented in Table 2.6. Descriptive statistics (mean, standard deviation, percentage, and frequency) were used to address Objective 1. Analysis of covariance (ANCOVA), Kruskal-Wallis, and Chi-Square Tests were used to address Objectives 2-5 and sample size calculations for these tests are below.

2.6.1 Statistical Tests Assumptions and Sample Size Calculations

This section details the test assumptions and sample size calculations for the statistical tests presented in Table 2.3. Objective 1 did not involve sample size calculations because it was descriptive.

ANCOVA was used to address Objectives 2-5. A one-way ANCOVA test was run for one set of a measurement variables (e.g. number of inpatient visits, length of therapy on a weight-loss medication, number of BMI measurements) and one categorical variable (race/ethnic group). There are three basic assumptions: normality, homogeneity of variance, and random independent samples. For ANCOVA, the total sample size was calculated using G-power software. For race, the total sample size needed was 259 per group (medium effect size (f) = 0.25, $\alpha = 0.05$, power = 0.8, number of groups = 4, number of covariates = 4, degrees of freedom = 9). Duncan's post-hoc analyses were performed to determine which groups were significantly different than others.

The Kruskal-Wallis test was used for non-normal distributions. The following assumptions must be met in order to complete a Kruskal-Wallis test: independent treatment groups, ordinal or

continuous dependent variables, and random samples. The sample size required for the Kruskal-Wallis test was 247 (sample size calculated for ANCOVA multiplied by a correction factor, asymptotic relative efficiency, of 0.955).

A chi-square test was employed for Objectives 3 and 5 to determine if there were overall differences in the proportions of patients using a weight loss medication or having bariatric surgery among the different racial and ethnic groups. The following assumptions for a chi-square test that are required include frequency or count data, categorical variables, independent and mutually exclusive study groups, and adequate sample size. Using the G-power software, the required total sample size was 122 (medium effect size (f) = 0.3, $\alpha = 0.05$, power = 0.8, degrees of freedom = 3). Pairwise chi-square comparisons were performed to identify which groups differed significantly from each other if the chi-square test was significant. To restrict the family-wise error rate to 0.05, a smaller alpha level was calculated by dividing 0.05 by the number of comparisons for individual pairwise chi-square comparisons. A summary of objectives, hypotheses, and statistical tests are detailed below in Table 2.6.

Table 2.6: Summary of Objectives, Hypotheses, and Statistical Tests

Objective	Hypotheses	Dependent Variable	Independent Variable	Procedure/Statistical Test
1. To describe the demographic, socioeconomic, and health characteristics of patients who are overweight or obese across weight categories.	N/A		Age (ordinal/continuous)[a]	Descriptive statistics: Median, frequencies
			Gender (categorical - binary)[a]	Descriptive statistics: Median, frequencies
			Race/Ethnicity (categorial)	Descriptive statistics: Median, frequencies
			Obesity Classification (ordinal)	Descriptive statistics: Median, frequencies
			BMI (continuous)	Descriptive statistics: Median, frequencies
			Median Household Income (ordinal)[a]	Descriptive statistics: Median, frequencies
			Number of obesity-related comorbidities (continuous)[a, b]	Descriptive statistics: Median, frequencies
2. To compare the healthcare utilization of overweight or obese patients across weight categories by race/ethnicity.	**$H_0$2.1**: The difference in frequency of inpatient visits, outpatient visits, and emergency department visits by race/ethnicity is not statistically significant.	Median total number of visits (inpatient, outpatient, emergency department) during follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$2.2: The difference in frequency of outpatient visits by race/ethnicity is not statistically significant.	Median total number of outpatient visits during follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05

	$H_0$2.3: The difference in proportion of patients with at least one inpatient visit by race/ethnicity is not statistically significant.	Proportion of patients with at least one inpatient visit during follow-up period	Race/Ethnicity (categorial)	Chi-square test; Pairwise chi-square comparisons with reduced alpha level to maintain family-wise error rate of 0.05/Bonferroni correction
	$H_0$2.4: The difference in proportion of patients with at least one emergency department visit by race/ethnicity is not statistically significant.	Proportion of patients with at least one emergency department visit during follow-up period	Race/Ethnicity (categorial)	Chi-square test; Pairwise chi-square comparisons with reduced alpha level to maintain family-wise error rate of 0.05/Bonferroni correction
3. To compare the medication utilization of overweight or obese patients across weight categories by race/ethnicity.	**$H_0$3.1**: The difference in the proportion of patients being on a weight-loss medication by race/ethnicity is not statistically significant.	Proportion of patients with at least one weight-loss medication pharmacy claim.	Race/Ethnicity (categorial)	Chi-square test; Pairwise chi-square comparisons with reduced alpha level to maintain family-wise error rate of 0.05/Bonferroni correction
	$H_0$3.: The difference in average length of therapy by race/ethnicity is not statistically significant.	Mean number of days in which a weight loss medication was continually used during the post-index period without a gap)	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05

4. To compare the obesity-related clinical measurements of overweight or obese patients across weight categories by race/ethnicity.	**$H_0$4.1**: The difference in average BMI by race/ethnicity is not statistically significant.	Mean BMI measurement at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.2: The difference in number of BMI measurements by race/ethnicity is not statistically significant.	Mean total number of BMI measurements at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.3: The difference in average change in BMI by race/ethnicity is not statistically significant.	Difference in the mean BMI at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.4: The difference in average change in weight by race/ethnicity is not statistically significant.	Difference in the mean weight (kg) at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05

	$H_0$4.5: The difference in average HbA1c at index by race/ethnicity is not statistically significant.	Mean HbA1c measurement at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.6: The difference in number of HbA1c measurements by race/ethnicity is not statistically significant.	Mean total number of HbA1c measurements at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.7: The difference in average change in HbA1c by race/ethnicity is not statistically significant.	Difference in the mean HbA1c at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.8: The difference in average SBP and DBP at index by race/ethnicity is not statistically significant.	Mean SBP and DBP measurement at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05

	$H_0$4.9: The difference in number of SBP and DBP measurements by race/ethnicity is not statistically significant.	Mean total number of SBP and DBP measurements at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.10: The difference in average change in SBP and DBP by race/ethnicity is not statistically significant.	Difference in the mean SBP and DBP at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.11: The difference in average total cholesterol at index by race/ethnicity is not statistically significant.	Mean total cholesterol measurement at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
	$H_0$4.12: The difference in number of total cholesterol measurements by race/ethnicity is not statistically significant.	Mean total number of total cholesterol measurements at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05

	$H_0$4.13: The difference in average change in total cholesterol by race/ethnicity is not statistically significant.	Difference in the mean total cholesterol at index and at the end of follow-up period	Race/Ethnicity (categorial)	ANCOVA/Kruskal-Wallis test; Duncan's post-hoc analysis for parametric data/Pairwise chi-square comparisons with family-wise error rate of 0.05
5. To compare the rates of bariatric surgery among overweight or obese patients across weight categories by race/ethnicity.	**$H_0$5.1:** The difference in the proportion of patients undergoing bariatric surgery by race or ethnicity is not statistically significant.	Proportion of patients with at least one bariatric surgery medical claim.	Race/Ethnicity (categorial)	Chi-square test; Pairwise chi-square comparisons with reduced alpha level to maintain family-wise error rate of 0.05/Bonferroni correction

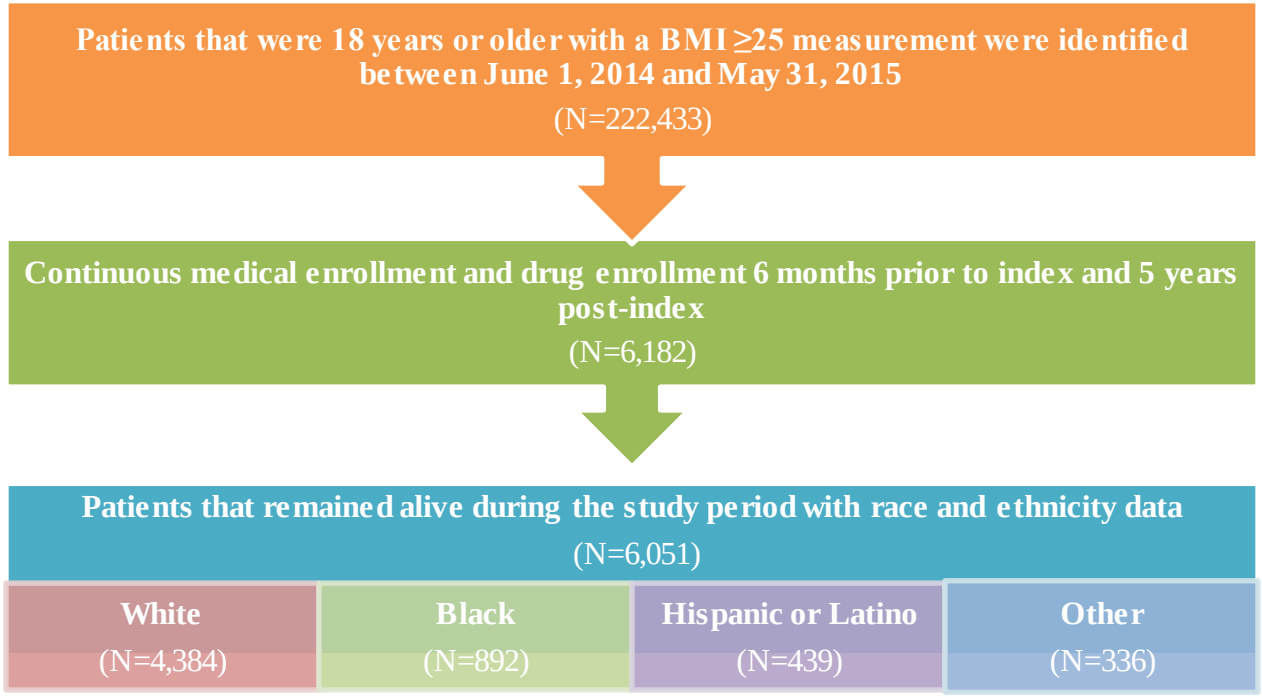
BMI=Body mass index; HbA1c=hemoglobin A1c; SBP=systolic blood pressure; DBP=diastolic blood pressure;
[a]Covariates for Objectives 2, 3, and 4 related to weight and BMI
[b]Covariates for objective not related to weight and BMI are specific to disease state (ie. diagnosis of pre-diabetes or T2DM will be a covariate for HbA1c, diagnosis of hypertension will be a covariate for SBP and DBP, and diagnosis of hyperlipidemia will be a covariate for total cholesterol)

Chapter 3: Results

3.1 STUDY SAMPLE

From June 1, 2014 to May 31, 2015, a total of 222,433 patients that were 18 years or older with a BMI ≥25 measurement were identified. After applying continuous medical enrollment and drug enrollment criteria, 6,182 patients were identified. Following removal of patients that died during the study period, the final study cohort of 6,051 patients remained, consisting of 4,384 White patients, 892 Black patients, 439 Hispanic or Latino patients, and 336 in the Other race/ethnicity group. Figure 3.1 provides the flow chart for patient selection.

Figure 3.1: Patient Selection Flow Chart



3.2 BASELINE DEMOGRAPHICS AND CLINICAL CHARACTERISTICS

Table 3.2.1 describes and compares the baseline patient characteristics by race/ethnicity group. There were 46 patients that had "Unknown", missing race and ethnicity information, or declined to give race and ethnicity information that were not included in the analysis. The median age for

the entire population of overweight patients was 54 years (IQR: 44-63), with significant differences between race/ethnicity groups ($p<0.0001$). There were also significant differences in the proportion of patients within each age group, with most patients being within the 51-64 years old range (42.9%). Most patients were female (55.6% vs 44.4%), remaining consistent across the race/ethnic groups. The median BMI for all race/ethnicity groups ranged from 31-33, with a median BMI of 32 (IQR: 28-36) for all patients. Most patients were categorized as overweight (39.4%) or obese class I (31.6%) overall and within the race/ethnic groups. A majority of patients were in the median income group of $50,000 to $74,999 (64.2%). Overall, 607 patients (10%) had at least one obesity-related comorbidity at the time of index, with no significant differences demonstrated between racial classifications. Full results of the incidence of obesity-related comorbidities are provided in Table A.1. Table 3.2.2 demonstrates that when looking at BMI at index and presence of at least 1 obesity-related comorbidity at index, that there are no significant differences when organized by obesity classification.

Table 3.2.1: Patient Demographics and Index Clinical Characteristics Results Table by Race/Ethnicity Group

	White (N=4,384)	**Black (N=892)**	**Hispanic (N=439)**	**Other (N=336)**	**p-value**	**All Patients (N=6,051)**
Age at Index Date (Median [IQR])	56.0 (47.0-66.0)	52.0 (45.0-58.0)	51.0 (41.0-57.0)	51.0 (41.0-57.0)	<0.001	54.0 (46.0-63.0)
Age groups, N (col%)						
18-30	176 (4.0%)	38 (4.3%)	35 (6.0%)	20 (6.0%)	<0.001	269 (4.5%)
31-50	1,188 (27.1%)	322 (36.1%)	168 (38.3%)	140 (41.7%)	<0.001	1,818 (30.0%)
51-64	1,831 (41.8%)	435 (48.8%)	186 (42.4%)	145 (43.2%)	<0.001	2,597 (42.9%)
≥65	1,189 (28.1%)	97 (10.9%)	50 (11.4%)	31 (9.2%)	<0.001	1,367 (22.6%)
Gender, N (col%)						
Female	2,335 (53.3%)	600 (67.3%)	245 (55.8%)	184 (54.8%)	<0.001	3,364 (55.6%)
Male	2,049 (46.7%)	292 (32.7%)	194 (41.2%)	152 (45.2%)	<0.001	2,687 (44.4%)
BMI (Median [IQR])	31.0 (28.0-36.0)	33.0 (29-38)	32.0 (29.0-36.0)	31.0 (28.0-35.0)	<0.001	32.0 (28.0-36.0)
BMI Classification, N (col%)						
Overweight	1,815 (41.4%)	257 (28.8%)	175 (39.9%)	139 (41.4%)	<0.001	2,386 (39.4%)
Obese Class I	1,373 (31.3%)	287 (32.2%)	142 (32.4%)	112 (33.3%)	<0.001	1,914 (31.6%)
Obese Class II	630 (14.4%)	181 (20.3%)	65 (14.8%)	52 (15.5%)	<0.001	928 (15.3%)
Obese Class III	566 (12.9%)	167 (18.7%)	57 (13.0%)	33 (9.8%)	<0.001	823 (13.6%)
Median Household Income* (N, col%)						
<$33,000	88 (2.0%)	66 (7.4%)	14 (3.2%)	16 (4.8%)	<0.001	184 (3.0%)
$33,000-$49,999	730 (16.7%)	225 (25.2%)	98 (22.3%)	55 (16.4%)	<0.001	1,108 (18.3%)
$50,000-$74,999	2,873 (65.5%)	523 (58.6%)	268 (61.1%)	220 (65.5%)	<0.001	3,884 (64.2%)
$75,000-$99,999	579 (13.2%)	60 (6.7%)	42 (9.6%)	40 (11.9%)	<0.001	721 (11.9%)
≥$100,000	114 (2.6%)	18 (2.0%)	17 (3.9%)	5 (1.5%)	<0.001	154 (2.6%)
Presence of at least 1 Obesity-related	447 (10.2%)	80 (9.0%)	42 (9.6%)	38 (11.3%)	0.581	607 (10.0%)

Comorbidity at Index (N, col%)						

IQR: interquartile range

*Extrapolated by matching patient zip code and U.S. Census Bureau Data, in 2019 inflation-adjusted dollar

Table 3.2.2: Patient Demographics and Index Clinical Characteristics Results Table by Race/Ethnicity Group and Obesity Classification

	White (N=4,384)	**Black (N=892)**	**Hispanic (N=439)**	**Other (N=336)**	**p-value**	**All Patients (N=6,051)**
Age at Index Date (Median [IQR])						
Overweight	57.0 (48.0-68.0)	54.0 (47.0-59.0)	52.0 (42.0-59.0)	53.0 (42.0-48.0)	<0.001	2,386 (39.4%)
Obese Class I	56.0 (48.0-66.0)	52.0 (46.0-58.0)	50.0 (41.0-57.0)	52.0 (41.0-57.0)	<0.001	1,914 (31.6%)
Obese Class II	55.0 (46-64)	52.0 (44.0-58.0)	51.0 (43.0-58.0)	48.0 (39.0-57.0)	<0.001	928 (15.3%)
Obese Class III	52.0 (44.0-48.0)	49.0 (41.0-57.0)	45.0 (38.0-53.0)	46.0 (42.0-50.0)	<0.001	823 (13.6%)
BMI at Index (Median [IQR])						
Overweight	27.4 (16.1-28.6)	27.3 (26.0-28.7)	27.8 (26.5-28.9)	27.4 (26.2-28.7)	0.1512	2,386 (39.4%)
Obese Class I	32.3 (31.0-33.3)	32.4 (31.1-33.5)	32.3 (20.9-33.6)	32.1 (30.9-33.6)	0.467	1,914 (31.6%)
Obese Class II	37.0 (36.0-38.3)	37.0 (35.9-38.4)	37.6 (36.3-38.4)	37.2 (36.4-38.6)	0.612	928 (15.3%)
Obese Class III	44.3 (41.9-48.2)	43.6 (41.2-47.9)	44.6 (41.6-49.1)	44.9 (42.4-48.2)	0.399	823 (13.6%)
Presence of at least 1 Obesity-related Comorbidity at Index (N, col%)						
Overweight	177 (9.8%)	23 (8.9%)	16 (9.1%)	16 (11.5%)	0.861	232 (9.7%)
Obese Class I	139 (10.1%)	22 (7.7%)	15 (10.5%)	13 (11.6%)	0.548	189 (9.8%)
Obese Class II	65 (10.3%)	16 (8.8%)	5 (7.7%)	5 (9.6%)	0.871	91 (9.8%)
Obese Class III	66 (11.7%)	19 (11.4%)	6 (10.5%)	4 (12.1%)	0.994	95 (11.5%)

IQR: interquartile range

3.3 HEALTHCARE UTILIZATION ACROSS WEIGHT CATEGORIES BY RACE/ETHNICITY

During the 5-year follow-up following index date, the composite outcome of outpatient visits, inpatient visits, and emergency department visits were significantly different across race/ethnicity groups for all patients ($p<0.0001$) and obesity classifications including overweight ($p=0.002$), obese class I ($p<0.0001$), and obese class II ($p=0.0087$). For obesity classifications overweight and obese class I, White and Black patients had the highest mean number of all types of visits but for obesity class II and III, Hispanic patients had the highest mean number. Outpatient visits were the predominant type of visit utilized by all patients, with significant differences in the mean number of outpatient visits demonstrated between race/ethnicity groups for all patients ($p<0.0001$), overweight ($p=0.0003$), obese class I ($p<0.0001$), and obese class II ($p=0.0168$) patients. For all weight classifications, Other patients had the lowest mean for the composite of outpatient, inpatient, and emergency department visits, as well as the for solely outpatient visits. Means were relatively similar between White, Black, and Hispanic patients across most weight classifications except for obesity class II, which demonstrated much higher average utilization. For utilization of inpatient visits, there were significant differences across all patients and most obesity classifications. Emergency department visits demonstrated no significant differences between race/ethnicity groups for overweight patients [X^2 (3, N=2,368) =7.4513, p=0.0588], and obese class III patients [X^2 (3, N=821) =3.5811, p=0.3104]. The results of Pairwise Chi-square analyses group demonstrated a statistically significant lower proportion of at least 1 inpatient visit or emergency department visit for Other patients compared to White, Black, and Hispanic patients. No statistically significant differences were seen between racial classifications in the Obesity Class III group. Full results of objective 2 are presented in Table 3.3.1, Table 3.3.2, and Table 3.3.3.

The medians for healthcare utilizations of inpatient visits and emergency department results are presented in Table A.2, demonstrating similar trends of no significant differences between race/ethnicity groups for overweight and obese class III patients.

Table 3.3.1: Five-Year Healthcare Utilization Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
Outpatient Visits (median [IQR])					
White	24.4 (14.0-38.0)	26.0 (15.0-44.0)	26.0 (15.0-45.0)	29.0 (18.0-47.0)	26.0 (15.0-42.0)
Black	23.0 (14.0-40.0)	25.0 (14.0-40.0)	26.0 (16.0-48.0)	29.0 (18.0-46.0)	25.0 (15.0-43.0)
Hispanic	23.5 (14.0-40.0	24.0 (13.0-37.5)	36.0 (20.0-49.0)	29.0 (19.0-38.0)	26.0 (15.0-41.0)
Other	16.0 (10.0-28.0)	15.0 (9.0-30.0)	23.5 (10.0-36.0)	25.0 (13.0-39.0)	18.0 (10.0-33.0)
p-value	0.0003	<0.0001	0.0168	0.6757	<0.0001
Presence of at least 1 Inpatient Visits (N, col%)					
White	448 (24.7%)	379 (27.6%)	181 (28.7%)	180 (31.8%)	1188 (27.1%)
Black	52 (20.2%)	54 (18.8%)	48 (26.5%)	39 (23.4%)	193 (21.6%)
Hispanic	44 (25.1%)	30 (21.1%)	19 (29.2%)	18 (31.6%)	111 (25.3%)
Other	20 (14.4%)	7 (6.3%)	3 (5.8%)	5 (15.2%)	35 (10.4%)
Total	564 (23.6%)	470 (24.6%)	251 (27.0%)	242 (29.4%)	1527 (25.2%)
p-value (X^2)	0.0214 (9.6881)	<0.0001 (32.7780)	0.0061 (12.4083)	0.0461 (0.0461)	<0.0001 (75.7379)
Presence of at least 1 Emergency Department Visits (N, col%)					
White	637 (35.1%)	524 (38.2%)	221 (35.1%)	232 (41.0%)	1614 (36.8%)
Black	88 (34.2%)	121 (42.2%)	78 (43.1%)	75 (44.9%)	362 (40.6%)
Hispanic	69 (39.4%)	55 (38.7%)	31 (47.7%)	29 (50.9%)	184 (41.9%)
Other	35 (25.2%)	28 (25.0%)	12 (23.1%)	11 (33.3%)	86 (25.6%)
Total	829 (34.7%)	728 (38.0%)	342 (36.9%)	347 (42.2%)	2,246 (37.1)
p-value (X^2)	0.0588 (7.4513)	0.0172 (10.1688)	0.0138 (10.6489)	0.3104 (3.5811)	<0.0001 (46.5951)
All Visits (median [IQR])					
White	25.0 (14.0-42.0)	28.0 (16.0-47.0)	28.0 (16.0-48.0)	31.0 (19.0-51.5)	27.0 (16.0-46.0)
Black	25.0 (14.0-44.0)	27.0 (14.0-43.0)	32.0 (17.0-53.0)	30.0 (19.0-49.0)	27.0 (16.0-47.0)
Hispanic	24.5 (14.0-43.0)	26.5 (14.0-42.5)	40.0 (22.0-53.0)	32.0 (21.0-46.0)	28.0 (15.0-46.0)
Other	18.0 (10.0-29.0)	16.0 (9.0-32.0)	23.5 (10.0-37.0)	25.0 (13.0-42.0)	19.5 (10.0-35.0)
p-value	0.0002	<0.0001	0.0087	0.5274	<0.0001

IQR: interquartile range

Table 3.3.2: Inpatient Visits Pairwise Chi-square Comparisons Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
White vs Black	0.1103 (2.5504)	0.0022 (9.3947)*	0.5558 (0.3471)	0.0006 (11.6390)	0.1336 (2.378)
White vs Hispanic	0.0135 (0.066)	0.1106 (2.5460)	0.9572 (0.0029)	0.9586 (0.0027)	0.6556 (0.4181)
White vs Other	0.0060 (7.5629)*	<0.0001 (24.4084)*	0.0005 (12.2716)*	0.0430 (4.0966)	<0.0001 (44.7555)*
Black vs Hispanic	0.2240 (1.4784)	0.5460 (0.3645)	0.6910 (0.1580)	0.2183 (1.5156)	0.1299 (2.2932)
Black vs Other	0.1539 (2.0335)	0.0017 (9.7962)	0.0019 (9.6847)*	0.2987 (1.0802)	<0.0001 (19.9198)*
Hispanic vs Other	0.0190 (5.5000)	0.0008 (11.2653)*	0.0017 (9.8583)*	0.0851 (2.9646)	<0.0001 (27.2382)*

Results presented as p-value (X^2)

*Significant results as determined with adjusted p-value following Bonferroni correction is 0.008

Table 3.3.3: Emergency Department Pairwise Chi-square Comparisons Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
White vs Black	0.7507 (0.1009)	0.1942 (1.6853)	0.0494 (3.8629)	0.3852 (0.7539)	0.0370 (4.3519)
White vs Hispanic	0.2622 (1.2570)	0.8251 (0.0488)*	0.0483 (3.9008)	0.1556 (2.0167)	0.0339 (4.4984)
White vs Other	0.0171 (5.6886)	0.0060 (7.5373)*	0.1056 (2.6191)	0.3753 (0.7861)	<0.0001 (16.5660)*
Black vs Hispanic	0.2643 (1.2459)	0.5329 (0.3889)	0.5444 (0.3674)	1.0000 (0.013)	0.6179 (0.2489)
Black vs Other	0.0655 (3.3919)	0.0015 (10.1064)*	0.0132 (6.1406)	0.4354 (0.6083)	<0.0001 (22.9709)*
Hispanic vs Other	0.0078 (7.0750)*	5.5302 (0.0187)	0.0092 (6.7763)	0.2196 (1.5067)	<0.0001 (21.9621)*

Results presented as p-value (X^2)

*Significant results as determined with adjusted p-value following Bonferroni correction is 0.008

3.4 MEDICATION UTILIZATION ACROSS WEIGHT CATEGORIES BY RACE/ETHNICITY

A total of 227 (3.8%) of patients utilized medications related to weight loss and due to the low sample size, Fisher's exact test was utilized for more accurate results. Significant differences between race/ethnicity groups for all patients [X^2 (3, N =227) =9.168, p=0.0253] and for obese class I [X^2 (3, N =61) =12.58, p=0.0068]. Medication utilization varied between race groups among different weight categories. Black patients had the highest proportion of patients on a weight-loss medication within the overweight class (3.1%), while Hispanics were the highest for Obese Class I (7.0%) and Obese Class II (10.8%). Patients in the Other group however, had the highest medication utilization for Obese Class III (15.2%) and in all patients (5.7%). Significant differences in medication utilization were present among Obese Class I [X^2 (1, N=61) =9.514, p=0.0058] and in the overall patient group [X^2 (1, N=227) =9.514, p=0.0058]. Alternatively, there were no significant differences between race/ethnicity groups for patients that were overweight [X^2 (3, N =39) =5.839, p=0.1028], obese class II [X^2 (3, N =61) =2.435, p=0.4499], and obese class III [X^2 (3, N =66) =1.357, p=0.6754]. Full results for the Fisher's exact test are provided in Table 3.4.1. Pairwise Chi-square analyses were conducted to compare group differences for medication utilization and tested against a Bonferroni-adjusted alpha level of 0.008 (0.05/6). The results of these analyses demonstrated a statistically significant higher medication utilization in Hispanic versus White patients in Obese Class I [X^2 (1, N =1,515) =9.514, p=0.0058]. For overweight, obese class II, obese class III patients, and all patients, there were no significant differences between White vs Black, White vs Hispanic, White vs Other, Black vs Hispanic, Black vs Other, and Hispanic vs Other comparisons. Full results for the results of the Pairwise Chi-square analyses are presented in Table 3.4.3.

The relationship between race/ethnicity groups and median length of therapy for patients was analyzed. For all, overweight, obese class I, obese class II, and obese class III, there were no significant differences between medication length of therapy by race/ethnicity (p=0.0924,

p=0.1922, p=0.6551, p=0.1325, and p=0.7029, respectively). Full results for the analysis of medication length of therapy are presented in Table 3.4.3.

Table 3.4.1: Medication Utilization Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
White	25 (1.4%)	34 (2.5%)	40 (6.3%)	47 (8.3%)	146 (3.3%)
Black	8 (3.1%)	10 (3.5%)	10 (5.5%)	11 (6.6%)	39 (4.4%)
Hispanic	2 (1.1%)	10 (7.0%)	7 (10.8%)	4 (7.0%)	23 (5.2%)
Other	4 (2.9%)	7 (6.3%)	4 (7.7%)	5 (15.2%)	19 (5.7%)
Total	39 (1.6%)	61 (3.2%)	61 (6.6%)	66 (8.0%)	227 (3.8%)
p-value (X^2)	0.1028 (5.839)	0.0068 (12.58)	0.4499 (2.345)	0.6754 (1.357)	0.0253 (9.168)

Table 3.4.2: Medication Utilization Pairwise Chi-square Comparisons Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
White vs Black	0.0557 (4.326)	0.3157 (0.934)	0.8608 (0.165)	0.5188 (0.522)	0.1336 (2.378)
White vs Hispanic	1.0000 (0.066)	0.0058 (9.514)*	0.1905 (1.826)	1.0000 (0.114)	0.0548 (4.300)
White vs Other	0.1464 (1.988)	0.0302 (5.493)	0.7662 (0.144)	0.5138 (0.583)	0.0308 (4.998)
Black vs Hispanic	0.2127 (1.787)	0.1418 (2.706)	0.1615 (2.045)	1.0000 (0.013)	0.4909 (0.498)
Black vs Other	1.0000 (0.017)	0.2687 (1.511)	0.5206 (0.336)	0.2796 (1.217)	0.3658 (0.892)
Hispanic vs Other	0.4115 (1.244)	1.0000 (0.063)	0.7526 (0.321)	0.4581 (0.672)	0.8732 (0.064)

Results presented as p-value (X^2)

*Significant results as determined by adjusted p-value following Bonferroni correction is 0.008

Table 3.4.3: Medication Length of Therapy Results by Obesity Class and Race/Ethnicity

	Overweight (N=39)	**Obese Class I (N=61)**	**Obese Class II (N=61)**	**Obese Class III (N=66)**	**All Patients (N=227)**
White	404 (140-932)	233.5 (70-630)	377 (145-638)	270 (112-544)	317 (98-616)
Black	177 (119-355)	115 (60-364)	150 (90-364)	240 (45-420)	140 (90-364)
Hispanic	66 (42-90)	497 (84-710)	336 (130-660)	149 (123-320)	280 (90-630)
Other	325 (175-375)	398 (70-570)	56 (35-275)	239 (77-492)	321 (56-450)
p-value	0.1922	0.6551	0.1325	0.7029	0.0924

Results are presented as median (interquartile range)

3.5 CLINICAL MEASUREMENTS ACROSS WEIGHT CATEGORIES BY RACE/ETHNICITY

For all patients, there were significant differences in the number of BMI measurements ($p<0.0001$), BMI at index ($p<0.0001$), BMI at end of follow-up ($p<0.0001$), percent change in BMI from index to end of follow-up ($p=0.0022$), and percent change in weight from index to end of follow-up ($p=0.0002$) between race/ethnicity groups. When narrowing down to obesity class, significant differences between race/ethnicity groups were still seen in overweight ($p=0.0003$), obese class I ($p<0.0001$), and obese class II ($p=0.0107$). However, no significant differences were seen in number of BMI measurements for obese class III ($p=0.7111$). No significant differences for BMI at index between race/ethnicity groups for BMI at index for overweight ($p=0.1620$), obese class I ($p=0.4776$), obese class II ($p=0.6124$), and obese class III ($p=0.3991$) were present. For BMI at the end of follow-up, there were significant differences by race/ethnicity group present for overweight (0.0117) and obese class II ($p=0.0184$) but no significant differences for patients that were obese class I ($p=0.3163$) and obese class III ($p=0.0956$). Patients in the Other group had the highest mean BMI at end of follow-up for both obese class II and obese class III, but Black patients had the highest BMI at the end of follow-up for all patients. For percent change in BMI from index to end of follow-up, there were also significant differences by race/ethnicity group present for obese class II ($p=0.0172$) and obese class III ($p=0.0456$) but not for overweight ($p=0.0859$) and obese class I ($p=0.4274$). For the overall patients, Other patients had the highest percent change in BMI, followed by Hispanic, Black, and White patients. Lastly, for percent change in weight from index to end of follow-up and race/ethnicity group, there was a significant difference for obese class II ($p=0.0149$) but not for overweight ($p=0.0508$), obese class I ($p=0.1098$), and obese class III ($p=0.0858$). All race/ethnicity groups demonstrated at least a 0.50% increase in BMI from index to end of follow-up. Full results for obesity-related measurements of BMI and weight are presented in Table 3.5.1.

For HbA1c, all patients that were overweight and obesity class I-III, there were significant differences in number of HbA1c measurements (p=0.0325), HbA1c at index (p=0.0031), and HbA1c at end of follow-up (p<0.0001) between race/ethnicity groups. However, there were no significant differences between race/ethnicity groups for the percent change in HbA1c from index to end of follow-up for all patients (p=0.7716). For HbA1c at index, there were significant differences between race/ethnicity groups for overweight patients (p=0.0019) but not for obese class I (p=0.2380), obese class II (p=0.1271), and obese class III (p=0.8446). HbA1c at the end of follow-up yielded more significant results between race/ethnicity groups among obesity classifications, demonstrating significant differences in overweight (p=0.0005), obese class I (p=0.0063), and obese class II (p=0.0430). For percent change in HbA1c from index to end of follow-up, there was no significant difference between race/ethnicity groups for all obesity classifications. White patients demonstrated the lowest mean HbA1c at index and at the end of follow-up. Conversely, Other patients had the highest HbA1c at index and end of follow-up. Additionally, White and Other patients demonstrated increases in percent change in HbA1c from index to end of follow in all patients, which was consistent across all obesity classifications. However, Hispanic patients demonstrated decreases in percent change in HbA1c across each weight classification, except for obese class III. Black patients demonstrated decreases in HbA1c for obese class I and higher. Full results are presented in Table 3.5.2.

Results for blood pressure measurements are separated by DBP (Table 3.5.3) and SBP (Table 3.5.4). All patients demonstrated significant differences between race/ethnicity groups for number of DBP measurements (p<0.0001) and SBP measurements (p<0.0001), with higher median number of SBP for all race/ethnicity groups compared to DBP measurements. There were also significant differences between race/ethnicity groups for both DBP and SBP at index (p<0.0001; p=0.0032) and DBP and SBP at follow-up (p<0.0001; p=0.0067). However, there were no significant differences in percent change in DBP or SBP from index to end of follow-up (p=0.8009; p=0.5988) between race/ethnicity groups. No significant differences were demonstrated between race/ethnicity groups for overweight (p=0.6439), obese class I (p=0.5820),

obese class II (p=0.1672), and obese class III (p=0.1103) for percent change in DBP from index to end of follow-up. The same trend was seen for percent change in SBP for overweight (p=0.8324), obese class I (p=0.6983), and obese class II patients (p=0.8280). However, there were significant differences in percent change in SBP for obese class III patients (p=0.0139). Full results of both DBP and SBP are presented in Table 3.5.3 and Table 3.5.4, respectively.

For total cholesterol, there were no significant differences between race/ethnicity groups for number of total cholesterol measurements (p=0.8297), total cholesterol at index (p=0.2876), and percent change in total cholesterol from index to end of follow-up (p=0.5113) for all patients. For total cholesterol at index, Other patients had the highest average total cholesterol across all weight categories. Significant differences were seen for the total cholesterol at end of follow-up between race/ethnicity groups (p=0.0447). No significant differences were also seen across race/ethnicity groups for total cholesterol at index and total cholesterol at end of follow-up, with the exception for obese class II for total cholesterol measurement at end of follow-up (p=0.0050). Patients in the other group had the highest total cholesterol at the end of follow-up for the overall patients, followed by Black patients. The percent change in TC from index to end of follow-up was also not significantly different between race/ethnicity groups for overweight (p=0.9725), obese class I (p=0.4442), obese class II (p=0.0857), and obese class III patients (p=0.1127). However, all groups demonstrated decreases in percent change in total cholesterol, with White patients having the highest decrease. Full results of the total cholesterol results are presented in Table 3.5.5.

Table 3.5.1: Obesity-Related (BMI and Weight) Clinical Measurements Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,368)	Obese Class I (N=1,903)	Obese Class II (N=921)	Obese Class III (N=821)	All Patients (N=6,013)
Number of BMI Measurements 5 years, (Median [IQR])					
White	23.0 (13.0-37.0)	25.0 (15.0-41.0)	25.0 (14.0-43.0)	27.0 (17.0-44.5)	25.0 (12.0-39.0)
Black	23.0 (13.0-39.0)	25.0 (13.0-38.0)	28.5 (16.0-47.5)	28.0 (18.0-44.0)	25.0 (15.0-41.0)
Hispanic	23.0 (13.0-39.0)	23.0 (13.0-38.5)	34.0 (21.0-48.0)	28.0 (21.0-37.0)	25.0 (14.0-40.0)
Other	16.5 (9.0-27.0)	15.5 (8.0-29.0)	23.0 (10.0-34.0)	25.0 (12.0-39.0)	18.0 (9.0-33.0)
p-value	0.0003	<0.0001	0.0107	0.7111	<0.0001
BMI at index (Median [IQR])					
White	27.4 (26.1-28.6)	32.2 (31-33.3)	37.0 (36.0-38.3)	44.3 (41.9-48.2)	31.0 (27.9-35.5)
Black	27.3 (26-28.7)	32.4 (31.1-33.5)	37.0 (35.9-38.4)	43.6 (41.2-47.9)	33.1 (29.3-38.1)
Hispanic	27.8 (26.5-28.9)	32.2 (30.9-33.6)	37.6 (36.3-38.4)	44.6 (41.6-49.1)	31.5 (28.5-35.9)
Other	27.4 (26.2-28.7)	32.1 (30.9-33.5)	37.2 (36.4-38.6)	44.9 (42.4-48.2)	30.9 (27.9-35.0)
p-value	0.1620	0.4776	0.6124	0.3991	<0.0001
BMI at end of follow-up (Median [IQR])					
White	27.7 (25.8-29.6)	32.2 (30.4-34.6)	36.9 (34.5-39.2)	43.6 (40.3-48.2)	31.3 (27.9-36.2)
Black	28.0 (26.3-29.6)	32.7 (30.7-34.7)	37.2 (35.0-40.0)	44.0 (40.8-47.8)	33.6 (29.5-38.6)
Hispanic	28.3 (26.76-30.3)	32.2 (30.4-34.9)	37.7 (34.6-40.9)	43.2 (40.2-52.2)	31.5 (28.4-36.8)
Other	27.8 (26.4-29.4)	32.7 (30.8-34.4)	38.1 (35.6-40.3)	45.8 (42.7-50.0)	31.6 (28.0-35.9)
p-value	0.0117	0.3163	0.0184	0.0956	<0.0001
Percent change in BMI from index to end of follow-up (Median [IQR])					
White	1.7 (-4.4-7.0)	0.6 (-5.3-6.7)	-0.7 (-6.8-4.7)	-1.7 (-9.0-4.4)	0.50 (-3.0-6.3)
Black	2.1 (-3.0-7.4)	1.2 (-3.4-5.9)	1.2 (-5.8-6.8)	-0.2 (-5.6-4.0)	0.89 (-4.4-6.0)
Hispanic	2.1 (-3.1-8.3)	0.3 (-5.2-5.8)	2.3 (-6.9-9.8)	-0.5 (-6.7-3.7)	1.11 (-4.5-7.0)
Other	2.9 (-2.6-6.8)	1.0 (-3.2-5.6)	1.7 (-3.1-7.2)	0.5 (-3.0-6.3)	1.7 (-2.9-6.5)
p-value	0.0859	0.4274	0.0172	0.0456	0.0022
Percent change in weight (kg) from index to end of follow-up (Median [IQR])					
White	0.7 (-4.5-6.1)	0.4 (-5.3-6.1)	-1.1 (-6.7-4.4)	-1.9 (-8.8-4.1)	0.15 (-3.5-5.9)
Black	1.5 (-3.2-6.7)	1.2 (-3.2-5.9)	1.1 (-5.7-6.9)	-1.2 (-5.6-3.9)	0.75 (-4.2-6.0)

Hispanic	1.8 (-2.8-7.8)	0.0 (4.8-5.7)	1.3 (-5.0-7.8)	-1.2 (-5.6-3.7)	0.99 (-4.5-6.6)
Other	1.7 (-2.9-5.8)	0.8 (-3.1-5.8)	1.6 (-3.4-4.4)	0.2 (-3.5-5.9)	1.27 (-3.1-5.8)
p-value	0.0508	0.1098	0.0149	0.0858	0.0002

IQR: interquartile range

Table 3.5.2: HbA1c Measurements Results by Obesity Class and Race/Ethnicity

	Overweight (N=263)	Obese Class I (N=244)	Obese Class II (N=148)	Obese Class III (N=147)	All Patients (N=802)
Number of HbA1c Measurements 5 years, (Median [IQR])					
White	3.0 (1.0-8.0)	4.0 (1.0-9.5)	4.0 (1.0-9.5)	6.0 (2.0-10.0)	4.0 (1.0-9.0)
Black	4.0 (1.0-10.0)	4.0 (2.0-10.0)	4.0 (2.0-10.0)	4.5 (2.0-10.0)	4.0 (2.0-10.0)
Hispanic	4.0 (1.0-10.0)	6.0 (2.0-11.5)	6.0 (2.0-11.5)	5.0 (2.0-9.0)	5.0 (2.0-10.5)
Other	5.0 (2.0-9.0)	6.0 (2.0-10.0)	6.0 (2.0-10.0)	4.0 (1.0-11.0)	6.0 (2.0-10.0)
p-value	0.0269	0.1126	0.2201	0.4914	0.0325
HbA1c at index (Median [IQR])					
White	6.3 (5.6-7.0)	6.5 (5.8-7.5)	6.5 (5.8-7.5)	7.0 (5.9-8.0)	6.5 (5.7-7.4)
Black	7.1 (5.9-8.4)	7.0 (6.2-8.1)	7.0 (6.2-8.1)	6.4 (5.9-7.2)	6.9 (6.1-8.0)
Hispanic	7.6 (6.0-9.2)	6.4 (5.8-8.1)	6.4 (5.8-8.1)	6.7 (6.2-8.1)	6.6 (5.9-8.5)
Other	6.6 (6.0-7.8)	6.8 (5.9-7.7)	6.8 (5.9-7.7)	7.5 (6.5-8.5)	7.2 (6.0-8.1)
p-value	0.0019	0.2380	0.1271	0.8446	0.0031
HbA1c at end of follow-up (Median [IQR])					
White	5.7 (5.3-6.4)	5.9 (5.5-6.8)	5.9 (5.5-6.8)	6.0 (5.5-7.1)	5.8 (5.4-6.7)
Black	5.9 (5.5-6.7)	6.2 (5.6-6.9)	6.2 (5.6-6.9)	6.1 (5.6-7.0)	6.1 (5.5-6.9)
Hispanic	5.9 (5.5-7.3)	5.9 (5.5-7.8)	5.9 (5.5-7.8)	6.3 (5.6-7.7)	6.0 (5.5-7.7)
Other	5.9 (5.5-7.1)	6.3 (5.7-7.5)	6.3 (5.7-7.5)	6.3 (5.7-6.9)	6.2 (5.6-7.2)
p-value	0.0005	0.0063	0.0430	0.3740	<0.0001
Percent change in HbA1c from index to end of follow-up (Median [IQR])					
White	2.0 (-4.4-10.2)	1.9 (-7.4-10.3)	1.9 (-7.4-10.3)	0.0 (-12.5-7.1)	1.8 (-6.9-9.6)
Black	3.3 (-7.3-11.3)	-1.6 (-12.8-9.5)	-1.6 (-12.8-9.5)	-0.7 (-5.7-7.8)	0.0 (-7.8-10.3)
Hispanic	-1.8 (-11.4-7.1)	-1.5 (-15.9-8.3)	-1.5 (-15.9-8.3)	5.8 (-9.8-33.3)	0.0 (-11.4-10.9)
Other	3.3 (-4.6-13.3)	4.4 (-4.1-17.9)	4.4 (-4.1-17.9)	3.7 (-3.1-10.9)	3.3 (-8.2-11.2)
p-value	0.3803	0.2379	0.1097	0.4805	0.7716

IQR: interquartile range

Table 3.5.3: Diastolic Blood Pressure (DBP) Measurements Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,342)	Obese Class I (N=1,886)	Obese Class II (N=909)	Obese Class III (N=811)	All Patients (N=5,948)
Number of DBP Measurements 5 years, (Median [IQR])					
White	23.0 (13.0-37.0)	25.0 (15.0-41.0)	25.0 (14.0-43.0)	27.0 (17.0-44.5)	25.0 (14.0-40.0)
Black	23.0 (13.0-39.0)	25.0 (13.0-38.0)	28.5 (16.0-47.5)	28.0 (18.0-44.0)	25.0 (15.0-41.0)
Hispanic	23.0 (13.0-39.0)	23.0 (13.0-38.5)	34.0 (21.0-48.0)	28.0 (21.0-37.0)	25.0 (14.0-40.0)
Other	16.5 (9.00-27.0)	15.5 (8.00-29.0)	23.0 (10.0-34.0)	25.0 (12.0-39.0)	18.0 (9.00-33.0)
p-value	0.0003	<0.0001	0.0107	0.7111	<0.0001
DBP at index (Median [IQR])					
White	77.0 (70.0-83.0)	78.0 (70.0-84.0)	80.0 (72.0-85.0)	81.0 (74.0-87.0)	78.0 (71.0-84.0)
Black	80.0 (72.0-85.0)	80.0 (75.0-87.0)	80.0 (74.0-86.0)	80.0 (74.0-88.0)	80.0 (74.0-86.0)
Hispanic	75.0 (68.0-82.0)	78.5 (70.0-85.0)	80.0 (73.0-87.0)	80.0 (72.0-84.5)	78.0 (70.0-85.0)
Other	78.0 (70.0-83.0)	80.0 (73.0-86.0)	79.0 (68.0-87.0)	82.0 (74.0-87.0)	80.0 (72.0-85.0)
p-value	0.0034	<0.0001	0.8011	0.7598	<0.0001
DBP at end of follow-up (Median [IQR])					
White	77.0 (70.0-83.0)	78.0 (71.0-84.0)	80.0 (72.0-84.0)	80.0 (72.0-84.0)	78.0 (70.0-84.0)
Black	78.0 (72.0-84.0)	80.0 (72.0-86.0)	80.0 (72.0-86.0)	81.0 (76.0-87.0)	80.0 (72.0-85.0)
Hispanic	76.0 (70.0-83.0)	77.5 (71.0-84.5)	79.0 (73.0-83.0)	80.0 (73.0-84.0)	78.0 (70.0-84.0)
Other	78.0 (70.0-82.0)	78.0 (74.0-84.0)	82.0 (71.0-86.0)	82.0 (74.0-85.0)	78.0 (72.0-84.0)
p-value	0.1464	0.0197	0.5160	0.0159	<0.0001
Percent change in DBP from index to end of follow-up (Median [IQR])					
White	0.0 (-10.3-11.4)	0.0 (-10.3-9.2)	0.0 (-10.3-8.6)	-2.4 (-12.0-7.4)	-1.1 (-10.5-9.9)
Black	-1.2 (-9.8-8.1)	-2.0 (-10.9-8.4)	-0.7 (-10.7-8.9)	0.0 (-8.6-12.5)	-1.2 (-10.3-8.9)
Hispanic	0.0 (-8.5-12.9)	0.0 (-8.4-9.0)	-3.8 (-12.3-6.8)	-1.3 (-10.1-13.9)	-1.2 (-9.8-11.1)
Other	0.0 (-10.8-8.1)	-1.3 (-11.2-7.5)	2.5 (-5.6-12.8)	0.0 (-7.9-11.0)	0.0 (-10.3-9.46)
p-value	0.6439	0.5820	0.1672	0.1103	0.8009

IQR: interquartile range

Table 3.5.4: Systolic Blood Pressure (SBP) Measurements Results by Obesity Class and Race/Ethnicity

	Overweight (N=2,342)	Obese Class I (N=1,886)	Obese Class II (N=909)	Obese Class III (N=811)	All Patients (N=5,948)
Number of SBP Measurements 5 years, (Median [IQR])					
White	39.0 (19.0-77.0)	44.0 (22.0-85.0)	44.0 (20.0-87.0)	51.0 (25.0-94.5)	42.0 (21.0-83.0)
Black	35.0 (18.0-75.5)	40.0 (19.0-71.0)	47.0 (22.5-95.5)	47.0 (25.0-90.0)	41.0 (21.0-82.0)
Hispanic	37.0 (18.0-85.0)	34.0 (18.0-73.5)	61.0 (31.0-98.0)	50.0 (29.0-89.0)	40.0 (20.0-86.0)
Other	22.0 (11.0-48.0)	22.0 (10.0-40.0)	26.5 (15.0-47.0)	35.0 (19.0-63.0)	24.0 (11.0-48.0)
p-value	<0.0001	<0.0001	0.0007	0.2044	<0.0001
SBP at index (Median [IQR])					
White	129.0 (119.0-140.0)	132.0 (120.0-142.0)	132.0 (122.0-143.0)	13.04 (126.0-146.0)	131.0 (120.0-142.0)
Black	130.5 (120.0-143.0)	132.0 (122.0-143.0)	132.0 (120.0-145.0)	134.5 (125.0-147.0)	132.0 (121.0-144.0)
Hispanic	126.0 (116.0-138.0)	130.0 (122.5-138.0)	134.0 (126.0-146.0)	131.5 (121.0-142.5)	130.0 (120.0-140.0)
Other	126.0 (115.0-140.0)	131.0 (121.0-145.0)	126.0 (120.0-141.0)	135.0 (121.0-151.0)	130.0 (118.0-142.0)
p-value	0.0411	0.2006	0.3482	0.6309	0.0032
SBP at end of follow-up (Median [IQR])					
White	128.0 (120.0-138.0)	130.0 (121.0-140.0)	131.0 (122.0-140.0)	132.0 (122.0-140.0)	130.0 (120.0-139.0)
Black	130.0 (120.0-139.0)	132.0 (122.0-142.0)	132.0 (124.0-142.0)	132.0 (125.0-140.0)	132.0 (122.0-140.5)
Hispanic	128.0 (118.0-138.0)	130.0 (118.5-138.0)	132.0 (122.0-140.0)	134.0 (128.0-147.0)	130.0 (120.0-139.0)
Other	126.0 (118.0-136.0)	130.0 (120-138.0)	132.0 (122.0-140.0)	135.0 (127.0-140.0)	130.0 (120.0-138.0)
p-value	0.1632	0.2645	0.8946	0.0726	0.0067
Percent change in SBP from index to end of follow-up (Median [IQR])					
White	0.0 (-9.3-9.4)	0.0 (-10.2-10.0)	-0.7 (-9.6-9.6)	-3.2 (-11.2-6.8)	-0.8 (-10.0-9.4)
Black	0.0 (-9.5-8.8)	-0.8 (-10.0-7.2)	-1.1 (-10.1-10.0)	0.0 (-8.7-8.9)	0.0 (-9.7-8.6)
Hispanic	0.7 (-9.3-11.5)	-0.4 (-9.7-9.4)	-1.7 (-12.7-7.7)	2.0 (-6.4-13.2)	0.0 (-9.6-10.4)
Other	0.0 (-10.0-8.6)	-1.3 (-10.6-6.4)	2.5 (-9.1-10.0)	2.6 (-9.9-12.9)	0.0 (-10.0-9.1)
p-value	0.8324	0.6983	0.8280	0.0139	0.5988

IQR: interquartile range

Table 3.5.5: Total Cholesterol (TC) Measurements Results by Obesity Class and Race/Ethnicity

	Overweight (N=244)	Obese Class I (N=263)	Obese Class II (N=148)	Obese Class III (N=147)	All Patients (N=802)
Number of TC Measurements 5 years, (Median [IQR])					
White	4.0 (3.0-6.0)	5.0 (3.0-6.0)	4.0 (3.0-6.0)	5.0 (3.0-7.0)	4.0 (3.0-6.0)
Black	5.0 (3.0-6.0)	4.0 (3.0-7.0)	4.0 (3.0-7.0)	5.0 (3.0-7.0)	4.0 (3.0-7.0)
Hispanic	4.0 (2.0-6.0)	4.0 (3.0-7.0)	5.0 (4.0-8.0)	5.0 (3.0-7.0)	5.0 (3.0-6.0)
Other	5.0 (3.0-6.0)	4.0 (2.0-8.0)	5.0 (2.0-7.0)	4.0 (2.0-6.0)	5.0 (2.0-7.0)
p-value	0.3442	0.7248	0.2026	0.7042	0.8297
TC at index (Median [IQR])					
White	187.0 (161.0-214.0)	183.0 (159.0-209.0)	177.5 (153.0-207.0)	180.0 (153.0-202.0)	183.0 (158.0-209.0)
Black	190.0 (161.0-221.0)	182.5 (156.0-203.0)	187.0 (162.0-219.0)	167.5 (146.0-207.0)	185.5 (156.0-216.0)
Hispanic	188.0 (160.0-210.0)	185.0 (150.0-216.0)	191.5 (167.0-208.0)	165.0 (161.0-186.0)	186.0 (157.0-213.0)
Other	195.0 (168.0-212.0)	190.0 (173.0-218.0)	180.0 (174.0-201.0)	196.0 (175.0-211.0)	192.0 (173.0-208.0)
p-value	0.4895	0.5576	0.3015	0.1848	0.2876
TC at end of follow-up (Median [IQR])					
White	179.0 (152.0-207.0)	173.0 (145.0-202.0)	169.0 (143.0-196.0)	170.0 (147.0-193.0)	174.0 (148.0-202.0)
Black	182.5 (159.0-204.0)	177.0 (154.0-200.0)	180.5 (154.0-206.0)	168.0 (147.0-198.0)	178.0 (154.0-203.0)
Hispanic	183.0 (157.0-211.0)	171.0 (152.0-206.0)	170.0 (142.0-193.0)	163.0 (147.0-179.0)	174.0 (151.0-203.0)
Other	181.5 (157.0-204.0)	178.0 (157.0-202.0)	180.0 (145.0-197.0)	184.0 (162.0-205.0)	180.0 (156.0-203.0)
p-value	0.5055	0.1825	0.0050	0.2231	0.0447
Percent change in TC from index to end of follow-up (Median [IQR])					
White	-4.2 (-16.6-6.6)	-4.9 (-16.1-6.0)	-6.1 (-15.7-5.8)	-4.2 (-17.0-7.5)	-4.6 (-16.5-6.3)
Black	-5.8 (-20.8-6.8)	-1.5 (-17.8-6.6)	-2.8 (-14.7-10.7)	2.7 (-10.5-11.4)	-1.6 (-17.4-8.1)
Hispanic	-5.4 (-12.1-3.6)	-0.5 (-13.1-10.9)	-13.4 (-25.4-(-1.2))	-0.6 (-4.9-9.7)	-3.1 (-14.0-8.3)
Other	-4.5 (-12.6-4.4)	-2.9 (-19.3-5.4)	5.3 (-12.4-12.0)	-7.5 (-13.4-(-2.4))	-3.7 (-14.6-5.4)
p-value	0.9725	0.4442	0.0857	0.1127	0.5113

IQR: interquartile range

3.6 EXPLORATORY OUTCOME: BARIATRIC SURGERY UTILIZATION ACROSS WEIGHT CATEGORIES BY RACE/ETHNICITY

A total of 773 patients (12.1%) had a history of bariatric surgery. Significant differences between the race/ethnicity groups for all patients were present in all patients [X^2 (3, N =733) = 140.4, p<0.0001], obese class I [X^2 (3, N =172) =184.9, p= p<0.0001], obese class II [X^2 (3, N =136) =12.65, p= p=0.0012], and obese class III [X^2 (3, N =262) = 16.27, p= p=0.0006]. For overweight and obese class I, Black patients had the highest proportion of utilization (30.7% and 28.2%, respectively). However, for obese class II and class III, White patients had the highest utilization of bariatric surgery (17.3% and 36.9%, respectively). Pairwise Chi-square analyses were done to compare group differences for bariatric surgery rates and tested against a Bonferroni-adjusted alpha level of 0.008 (0.05/6). In the overall group, Black patients had significantly higher utilization of bariatric surgery than White, Hispanic, and Other patients (p<0.0001). Additionally, both White and Hispanic patients had higher bariatric surgery utilization compared to Other patients (p<0.00010. Full results for the Chi-square analysis and Pairwise Chi-square comparisons are presented in Table 3.6.1 and Table 3.6.2, respectively.

Table 3.6.1: Bariatric Surgery Utilization by Obesity Class and Race/Ethnicity

	Overweight (N=2,386)	**Obese Class I (N=1,914)**	**Obese Class II (N=928)**	**Obese Class III (N=823)**	**All Patients (N=6,051)**
White	75 (4.1%)	78 (5.7%)	109 (17.3%)	209 (36.9%)	471 (10.7%)
Black	79 (30.7%)	81 (28.2%)	21 (11.6%)	41 (24.6%)	222 (24.9%)
Hispanic	18 (10.3%)	1 (0.7%)	6 (9.2%)	10 (17.5%)	35 (8.0%)
Other	0 (0.0%)	3 (2.7%)	0 (0.0%)	2 (6.1%)	5 (1.5%)
Total	172 (7.26%)	163 (7.97%)	136 (13.2%)	262 (25.7%)	733 (12.1%)
p-value (X^2)	<0.0001 (184.9)	<0.0001 (130.6)	0.0012 (12.65)	0.0006 (16.27)	<0.0001 (140.4)

Table 3.6.2: Bariatric Surgery Utilization Pairwise Chi-square Comparisons Results by Obesity Class and Race/Ethnicity

	Overweight (N=172)	**Obese Class I (N=163)**	**Obese Class II (N=136)**	**Obese Class III (N=262)**	**All Patients (N=733)**
White vs Black	<0.0001 (168.0)*	<0.0001 (103.4)*	0.1084 (2.635)	0.0297 (4.836)	<0.0001 (92.93)*
White vs Hispanic	0.0027 (11.70)*	0.0078 (6.101)*	0.2067 (1.921)	0.0204 (5.353)	0.1008 (2.815)
White vs Other	0.0085 (5.778)	0.2721 (1.647)	0.0006 (9.226)*	0.0025 (8.123)*	<0.0001 (26.40)*
Black vs Hispanic	<0.0001 (16.40)*	<0.0001 (35.40)*	0.8178 (0.1582)	0.3717 (0.9507)	<0.0001 (39.30)*
Black vs Other	<0.0001 (39.33)*	<0.0001 (23.19)*	0.0096 (6.054)	0.0523 (4.088)	<0.0001 (68.78)*
Hispanic vs Other	<0.0001 (13.78)*	0.3250 (1.551)	0.0346 (4.904)	0.3276 (1.771)	<0.0001 (15.01)*

Results presented as p-value (X^2)

*Significant results (adjusted p-value following Bonferroni correction is 0.008).

Chapter 4: Discussion and Conclusion

4.1 DISCUSSION

This is the first study evaluating the differences in a real-world employee-insured commercial population of overweight and obese patients with an extended follow-up period of five years. In regard to baseline characteristics at index, a median age range of 51-56 years was present, with White patients having the highest age at index date. All race/ethnicity groups had a higher proportion of female patients compared to male patients. The BMI at index was significantly different across race/ethnicity groups but remained within a median BMI range of 31-33. The distribution of BMI classification groups was significantly different across race/ethnicity group, with most patients falling in the overweight classification, followed by obese class I, obese class II, and obese class III. Lastly, there was a relatively low number of patients with obesity-related comorbidities at index.

For healthcare utilization measured through emergency department, outpatient, and inpatient visits, there were significant differences in all visits for all patients, overweight, obese class I, and obese class II patients between race/ethnicity. Furthermore, the rates of visits for all visits for Other were much lower than other racial/ethnic groups within the study. However, there were no significant differences between race/ethnicity groups for obese class III patients. This may be attributed to obese class III patients having a higher disease burden and thus seeking care more frequency regardless of race. Study findings contrast previous literature that demonstrated Black patients were more likely to have lower healthcare utilization as represented through having the highest likelihood of having delayed or forgone care among White, Latino, and other racial and ethnic groups. However, these patients were done specifically in the nonelderly population and did not specify patients on commercial insurance.[81]

Medication utilization for all patients was low, representing only 227 (3.75%) patients in the entire cohort. All minorities had relatively higher rates of medication utilization across the obesity classifications. All groups demonstrated higher rates of medication utilization with

worsening obesity classification. However, there were no significant differences between race/ethnicity categories for overweight, obese class II, and obese class III patients. Additionally, there were no significant differences in median medication length of therapy between race/ethnicity categories among obesity classes. The results of this study support previous evidence in younger, obese patients that there was no significant race/ethnic differences in anti-obesity medication prescriptions.[82] The lack of statistical significance between race/ethnicity groups demonstrates that underutilization of weight loss medications related to race/ethnicity, especially since AACE/ACE guidelines recommend pharmacotherapy for patients in obesity class I and above.[66]

In regard to weight-related clinical measurements, there were overall differences between race/ethnicity categories for all overweight and obese patients. However, results began to vary drastically when analyzing specific weight classifications. The number of BMI measurements were significantly different for overweight, obese class I, and obese class II between race/ethnicity categories but not for obese class III. Contrastingly, percent changes in BMI for obese class III were significantly different across race/ethnicity groups, as well as obese class II. Results from percent change in weight were different from change in BMI, with no significant differences in race/ethnicity groups for overweight, obese class I, and obese class III patients. Additionally, most results for percent change in BMI and weight were positive, indicating an increase in the respective measurement from index. However, White, Black, and Hispanic patients in obese class III demonstrated decreases in percent change in BMI and weight. These results are likely attributed to the increased healthcare utilization seen in these patients, demonstrating a potential association between increased healthcare utilization and improved weight management that is not dependent on race/ethnicity. Percent changes in weight and BMI were relatively minimal, likely not demonstrating a clinical difference.

The results for non-weight related obesity measurements of HbA1c, DBP, SBP, and total cholesterol varied. Since percent changes are measured at a specific point and time, it might not be truly representative of a patient's clinical profile across the study follow-up period. However,

the frequency of obesity-related measurements serves as a reasonable proxy to assess the care of patients. Despite previous studies demonstrating strong associations between obesity and diabetes, hypertension, and hyperlipidemia, the current study cohort had a low prevalence of the respective comorbidities, attributing to the low sample size of HbA1c and total cholesterol measurements at index. The low prevalence of comorbidities likely attributed to the varied trends in percent change and similar medians for number of total measurements for both HbA1c and total cholesterol. SBP measurements were significantly different between race/ethnicity categories for overweight, obese class I, and obese class II patients. However, no statistically significant difference was detected for obese class III. The opposite was seen in regard to percent change in SBP from index to end of follow-up, with statistically significant differences demonstrated in obese class III among race/ethnicity groups. Both SBP and DBP measurements during the follow-up period were more frequent compared to both Hb1Ac and total cholesterol measurements, likely due to the more invasive nature of HbA1c and total cholesterol measurements. Additionally, both percent change in SBP and DBP did not demonstrate significant differences between race/ethnicity groups for all patients and a majority of obesity classifications. Similar to percent change in weight and BMI, most of these percent change in measurement were not clinically significant with the exception of total cholesterol, which demonstrated percent reductions up to 13%.

Lastly, an exploratory analysis revealed significant differences between race/ethnicity groups and history of bariatric surgery utilization, with the highest utilization of bariatric surgery occurring in Black patients. Additionally, obese class II and III patients had the highest proportion of patients with a history of bariatric surgery, which is in line with AACE/ACE recommendations of bariatric surgery in patients with a BMI above 35.[66] However, Black patients had the highest proportion of bariatric surgery utilization for overweight and obese class I patients, starkly contrasting the minimal use seen in Other patient groups. These results conflict with previous literature that suggested race and ethnicity were not independently associated with likelihood of proceeding with bariatric surgery, since the data in this study demonstrated significant differences in utilization by race/ethnicity.[83]

4.2 LIMITATIONS

There were several limitations for this study. Due to the retrospective nature of the study, there is a risk of residual unmeasured confounding that may not be entirely accounted for from the information available within the administrative claims and EHR data. First, based on the 2019 U.S. Census Bureau estimates of Texas demographics, Asians, American Indian and Alaskan Native, and Native Hawaiian and Pacific Islanders all make up a total of less than 6% of the population in Texas, likely attributing to the low sample size within the study population. Therefore, these minorities were grouped into "Other" for the analysis and these results may not be generalizable to a population with a higher proportion of these racial groups. Additionally, the concept of race is separate from the concept of Hispanic origin but were grouped together for the purpose of this study. This study had a low proportion of patients with obesity-related commodities, contrasting with previous literature that demonstrated patients within higher BMI categories had a higher prevalence of comorbidities.[24] This study had a look-back period of two years unlike the current study with a 6-month look back period. Additionally, a previous study demonstrated that among employed U.S. adults with a BMI $\geq$ 30 kg/m^2, the prevalence of diabetes was 11.8% among surveyed individuals.[84] The look-back period and the unique nature of the commercially-insured employee population, along with patients not being diagnosed by index date or patients developing comorbidities during the follow-up period, may be why the comorbidity prevalence of this population is much lower. There is a lack of literature regarding an employee, commercially insured population that needs to be explored further. Additionally, clinical measurements were captured at a single time point and may not be completely accurate representations of the patient's management through the 5-year follow-up period. Another limitation of this study is that did not include highest level of education attained as a baseline demographic. Although there is evidence stating there is a relationship between highest level of education and obesity incidence, this data is not consistently reported in a patient's EHR at BSWH. Currently, the highest level of education is labeled under the variable "EDUCATION_YEARS" and can be inputted as free text. If this variable was included in the analysis, there would be no consistent method to categorize a

numerical input into an education category such as Masters, Doctorate, Bachelor's Degree, or Associates Degree. Another limitation for this study will be that it will not be able to assess whether a patient is receiving non-pharmacologic therapy for obesity, such as particular dietary regimens, frequency of exercise, or enrollment in a weight-loss program. These factors can have a strong impact on a patient's overall health status, as well as impact a patient's weight and BMI. Despite limitations in the analysis, the results of this analysis provide useful insights to a unique population of employee commercially insured population with an extended follow-up period of 5 years, providing valuable insights for the management of obese patients.

4.3 CONCLUSION

This study was the first of its kind to analyze an association between race/ethnicity on healthcare and medication utilization, as well as obesity-related clinical measures across weight categories for patients on employee-based commercial insurance plan. This study demonstrated that despite patients being on an employee-based commercial insurance plan with continued coverage for a follow-up period of 5 years, differences in healthcare utilization, medication utilization, obesity-related clinical measures, and bariatric surgery utilization were present. However, patients with class III obesity demonstrated no significant differences in healthcare utilization, medication utilization, and frequency of clinical measures among race/ethnic classifications. Results suggest that worsening obesity severity is associated with increased management of patients despite racial or ethnic classification. This study provides real-world evidence for healthcare decision-makers regarding the management of overweight and obese patients, especially in relation to racial and ethnic minorities who are low utilizers of weight loss therapies such as medications and bariatric surgery, despite being candidates. Future investigation is needed to evaluate the impact on outcomes such as mortality and development of comorbidities, as well as in a more diverse population.

APPENDIX

A.1 SUPPLEMENTARY TABLES

Table A.1: Obesity-Related Comorbidities at Index by Race/Ethnicity Group

	White (N=4,384)	**Black (N=892)**	**Hispanic (N=439)**	**Other (N=336)**	**p-value**	**All Patients (N=6,051)**
T2DM	76 (1.73%)	21 (2.35%)	10 (2.28%)	10 (2.98%)	0.2660	117 (1.93%)
Prediabetes	30 (0.68%)	9 (1.01%)	2 (0.46%)	5 (1.49%)	0.2651	46 (0.76%)
Hypoglycemia	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	-	0 (0.00%)
Hypertension	203 (4.63%)	42 (4.71%)	19 (4.33%)	20 (5.95%)	0.7147	284 (4.69%)
Hyperlipidemia	155 (3.54%)	29 (3.25%)	11 (2.51%)	16 (4.76%)	0.3289	211 (3.49%)
Obstructive sleep apnea	27 (0.62%)	2 (0.22%)	4 (0.91%)	3 (0.89%)	0.3405	36 (0.59%)
Cardiovascular disease	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	-	0 (0.00%)
Congestive heart failure	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	-	0 (0.00%)
Chronic kidney disease	15 (0.34%)	1 (0.11%)	2 (0.46%)	1 (0.30%)	0.6693	19 (0.31%)
Depression	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	-	0 (0.00%)
Psychiatric disease	74 (1.69%)	11 (1.23%)	7 (1.59%)	8 (2.38%)	0.5509	100 (1.65%)
Osteoarthritis	60 (1.37%)	5 (0.56%)	4 (0.91%)	4 (1.19%)	0.2203	73 (1.21%)
Chronic back pain/ Musculoskeletal pain	31 (0.71%)	2 (0.22%)	4 (0.91%)	2 (0.60%)	0.3576	39 (0.64%)
Urinary incontinence	15 (0.34%)	1 (0.11%)	1 (0.23%)	1 (0.30%)	0.7054	18 (0.30%)
Non-alcoholic fatty liver disease/NASH	6 (0.10%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0.5156	6 (0.10%)
Asthma	24 (0.55%)	8 (0.90%)	0 (0.0%)	1 (0.30%)	0.1855	33 (0.55%)
Cirrhosis (obesity- related)	0 (0.00%)	0 (0.00%)	0 (0.00%)	0 (0.00%)	-	0 (0.00%)
Gastro-esophageal reflux disease	63 (1.44%)	8 (0.90%)	3 (0.68%)	5 (1.49%)	0.3690	79 (1.31%)
Psoriasis	10 (0.23%)	2 (0.22%)	0 (0.00%)	0 (0.00%)	0.622	12 (0.20%)

Total obesity-related comorbidities at index (Median [IQR])	0 (0-0)	0 (0-0)	0 (0-0)	0 (0-0)	0.5455	0 (0-0)

IQR: interquartile range, T2DM : type 2 diabetes mellitus, NASH: Nonalcoholic steatohepatitis

Table A.2: Healthcare Utilization Results for Inpatient and Emergency Department Visits by Obesity Class and Race/Ethnicity

	Overweight (N=2,368)	**Obese Class I (N=1,903)**	**Obese Class II (N=921)**	**Obese Class III (N=821)**	**All Patients (N=6,013)**
Inpatient Visits (median [IQR])					
White	0.0 (0.0-0.0)	0.0 (0.0-2.0)	0.0 (0.0-3.0)	0.0 (0.0-3.0)	0.0 (0.0-2.0)
Black	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-3.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
Hispanic	0.0 (0.0-1.0)	0.0 (0.0-0.0)	0.0 (0.0-2.0)	0.0 (0.0-3.0)	0.0 (0.0-2.0)
Other	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)
p-value	0.0223	<0.0001	0.0111	0.0428	<0.0001
Emergency Department Visits (median [IQR])					
White	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-2.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)
Black	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-3.0)	0.0 (0.0-2.0)	0.0 (0.0-1.0)
Hispanic	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-0.0)	0.0 (0.0-2.0)	0.0 (0.0-2.0)
Other	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)	0.0 (0.0-1.0)
p-value	0.0917	0.0058	0.0033	0.1556	<0.0001

IQR: interquartile range

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