Appalachian Bariatric Surgery Population Descriptive Analysis, Surgical Outcomes, and Food Accessibility

Makenzie Leanne Barr

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Appalachian Bariatric Surgery Population Descriptive Analysis, Surgical Outcomes, and Food Accessibility

Makenzie Leanne Barr

Dissertation submitted
To the Davis College of Agriculture, Natural Resources, and Design
at West Virginia University

In Partial Fulfillment of the requirements for the degree of
Doctor of Philosophy in Animal and Food Science

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Morgantown, West Virginia
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Keywords: Obesity, Bariatric Surgery, Appalachia, West Virginia, Food Access

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Abstract

Describing an Appalachian bariatric patient population through surgical outcomes and food access
Makenzie L. Barr

Introduction. Overweight and obesity, diabetes, mental health issues, and lack of access to healthcare resources are frequent burdens among the Appalachian region of the United States. With morbid obesity, conventional behavioral interventions tend to fail. Bariatric surgery has been deemed the most successful treatment for morbid obesity and is performed regularly worldwide, however, the Appalachian population with the highest proportions of obesity and related co-morbidities has been poorly studied.

Aims. This dissertation aims to (1) provide a systematic review of the literature surrounding obesity and food access among Appalachian residents, (2) address the void in research of characterizing Appalachian bariatric surgery patients through descriptive statistics of demographic, co-morbidities, psychological scores, nutritional habits, baseline physical measures, and surgical outcomes, and (3) determine Food Access Ranking Scores of an Appalachian bariatric surgery population through Geographical Information Systems (GIS) locating patient addresses and its relationship to descriptive variables.

Methods. A retrospective chart review was performed on bariatric surgery patients who had been enrolled in a bariatric surgery program and completed gastric bypass or sleeve gastrectomy surgery between March 2013 and April 2017. Twenty-four research assistants were trained to retrieve data from over 540 bariatric patients Electronic Medical Record. Data collected from initial visit clinic questionnaires included demographics, socioeconomic status, past and current health status, family history, baseline dietary behaviors and anthropometrics. Repeated anthropometric data was recorded from patients attending one-year follow-up visits. Additional mapping of patient geographical location was conducted to identify rural locality of the population.

Results. In a systematic review, minimal research was found regarding obesity and food access within the Appalachian region were found. Within the limited findings, although conflicting, most work suggests increasing obesity is correlated with low food access. Our bariatric population was largely defined in the categories of low and moderate-low food access. Access food scores were significantly related to depression and ethnicity. Specifically, bariatric patients with lower food access scores were diagnosed with depression and were mostly non-Caucasian. Lower values of excess weight loss at one-year follow-up were found in patients receiving sleeve surgery type, diagnosed with diabetes, depression, or having a higher Hemoglobin A1c percentage at baseline compared to those receiving bypass surgery and without co-morbidities.

Conclusion. Minimal research has been explored among bariatric surgery patients who live in an area with the largest rates of obesity, co-morbidities and rural locality. This work aimed to fill the void in describing the Appalachian bariatric surgery patient population along with their lifestyle behaviors and health history prior to surgery and how it correlates to their food access and impact surgical outcomes. Findings suggest weight loss surgery in residents of the Appalachian region is successful but, lessen in the conjunction with co-morbidities. Consideration and additional education and support should be given to those diagnosed with diabetes or depression. This research intends to inform future interventions in an Appalachian bariatric population.
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To my family. You are the greatest gift God has ever given me. I know that you’ve always thought I was just going to go to school for the rest of my life, good thing I’ve finally proved you wrong. Thank you for standing beside me through all these years and supporting this goal.
List of Definitions

Appalachia. An area of the United States relating to the Appalachian Mountains region, its population, or cultural aspects.

Body Mass Index (BMI). Body Mass Index categorized as a standard measure of health that utilized weight in kilograms divided by the height in meters squared. BMI categories include: underweight <18.5 kg/m²; normal = 18.5-24.9 kg/m²; Overweight = 25.0-29.9 kg/m²; Obese = 30.0-39.9 kg/m²; Morbid Obesity ≥40 kg/m².

Bariatric Surgery (BS). Surgical procedures that reduce stomach size, thus reducing caloric intake, in individuals with obesity to aid in weight loss. Criteria for receiving bariatric surgery include a BMI of ≥40 kg/m² or ≥35 kg/m² with other obesity-related morbidities.

Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) [1-3]. A restrictive-malabsorptive procedure where a small stomach pouch, approximately one ounce or 30 milliliters in volume, is created by dividing the top of the stomach from the rest of the stomach. Next, the first portion of the small intestine is divided, and the bottom end of the divided small intestine is brought up and connected to the newly created small stomach pouch. The procedure is completed by connecting the top portion of the divided small intestine to the small intestine further down so that the stomach acids and digestive enzymes from the bypassed stomach and first portion of small intestine will eventually mix with the food.

Laparoscopic Sleeve Gastrectomy (LSG) [1-3]. A restrictive procedure performed by removing approximately 80 percent of the stomach. The remaining stomach is a tubular pouch that resembles a banana. The new stomach pouch holds a considerably smaller volume than the normal stomach and helps to significantly reduce the amount of food (and thus calories) that can be consumed.

Percent Excess Weight Loss (%EWL). Percent excess weight loss determined by excess body weight loss one-year post bariatric surgery. Literature loosely defines “success” of surgery by a 50% EWL.

Food Access. Residing in an area with limited quality and quantity supermarkets, supercenters, grocery stores, or other sources of healthy and affordable food further exacerbated by low-income and lack of vehicle access.

United States Department of Agriculture (USDA). The USDA is a government agency that strives to support food, agriculture, natural resources, rural development, nutrition, and related issues based on public policy, the best available science, and effective management.

Census Tracts. As defined by USDA, census tracts are relatively permanent subdivisions of a county typically with between 2,500 and 8,000 people. Spatial size of census tracts varies widely depending on population density. Census tracts do not cross county lines and are designed to be
homogeneous with respect to population characteristics, economic status, and living conditions. Census tract boundaries are established to be relatively stable to allow for comparison.
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Chapter I: Introduction to the Study
Introduction

“The U.S. can’t be healthy as a whole if we are leaving whole regions behind”, a quote from Hillary Heishman, senior program officer of the Robert Wood Johnson Foundation in a recent Appalachian Regional Commission press release entitled, Appalachian Region Endures Dramatic Health Challenges Compared with the Nation, New Research Shows [4]. Health among the Appalachian region (New York, Pennsylvania, Ohio, West Virginia, Kentucky, North Carolina, South Carolina, Maryland, Virginia, Tennessee, Georgia, Alabama, and Mississippi) has trailed behind the health of the nation as a whole. This underrepresented, and health disparate population not only lacks resources and access to a vast array of healthcare, but specific areas of research supporting the understanding of this population is lagging as well. The foci of this dissertation will delve into the bariatric surgery patient population in centralized Appalachia. This document aims to provide background and insight into the literature surrounding obesity, Appalachia, and food access to describe this population and their metabolic outcomes of surgery as it relates to healthy dietary patterns. Across the following chapters, a summation of the literature behind Appalachia, bariatric surgery, and food access will be explained.

Background of the Problem

Overweight is classified as having a body mass index (BMI) between 25.0 and 30.0 kg/m² and obese classification is having a BMI of 30 kg/m² or higher [5]. Specifically, within the obesity classification, there are three subgroups: Class I Obesity is a BMI of 30-35 kg/m², Class II Obesity is a BMI of 35-40 kg/m², and Class III Obesity is a BMI of 40 kg/m² or higher [5]. Within the United States, more than one third of adults are considered obese [6]. Class 3 obesity, or morbid obesity, is found to be present among 7.7% of the U.S. population [6]. When examining the health of the nation, the Appalachian region is often scrutinized for various health
conditions including leading the nation in diabetes and cardiovascular disease as well as claiming
the highest rates of overweight and obesity. Contained by the Appalachian area, West Virginia is
the only state that is entirely encompassed in the region. Per the State of Obesity, 35.6% of West
Virginia adults were considered obese in 2015, increasing to 37.7% of adults in 2016 placing the
state first in the nation for percentage of adults with obesity [7, 8]. Common obesity related co-
morbidities are not surprisingly, also elevated among this population. West Virginia adults
specifically placed highest among rates of diabetes (15%), depression (23.8%) and hypertension
(42.7%) [7, 9]. Due to these multi-morbidities that accompany each other, along with the hefty
economic burden that obesity causes [10-12], nationwide calls for research and interventions in
the realm of obesity have had a long standing in the literature among all ages and regions.
However, in the upper classes of obesity, dietary and physical activity interventions tend to fail
at disarming the burden excess weight brings.

The current, most effective solution for alleviating extreme weight and consequent health
issues is through metabolic surgeries [13]. Between 2011 and 2016 bariatric surgery procedures
in the United States have risen from 158,000 to 216,000 annually [3, 14-16]. Surgical options
have become less invasive over the years to typically being performed laparoscopically. The
most common types of surgeries in the United States include laparoscopic roux-en-y gastric
bypass (LRYGB), laparoscopic sleeve gastrectomy (LSG), laparoscopic adjustable banding
(LAB), and biliopancreatic diversion with duodenal switch (BPD-DS). Surgical procedures are
typically determined through careful consideration of health history and specific patient need by
the surgical team and patient. To achieve significant, and expectantly, long-term weight loss
these surgical interventions are comprised of procedures that cause malabsorption and/or
restriction of food intake [2]. Most insurance companies, for coverage of bariatric surgeries,
require candidates to have a BMI of $\geq 35$ kg/m$^2$ with at least one or more co-morbidities (type II diabetes, hypertension, sleep apnea or other respiratory disorders, non-alcoholic fatty liver disease, osteoarthritis, lipid abnormalities, gastrointestinal disorders, or heart disease) or a BMI of $\geq 40$ kg/m$^2$ or 100 pounds overweight without co-morbidities [3]. However, not only do co-morbidities impact a patients’ eligibility for surgery, these conditions can impact surgical outcomes post-operatively. Because behavioral health, including nutritional and mental health, is vital to optimal outcomes after bariatric surgery, the research included in this dissertation is of value. Conditions that often accompanies extreme weight are mental health issues [17]. Patients with morbid obesity tend to have lower self-esteem and body dissatisfaction from carrying extra weight. A model proposed by Marks et al. depicts the reciprocal relationships among weight/obesity, body dissatisfaction, energy-dense consumption and their negative affect that becomes a cyclic process and downwards spiral of health [18, 19]. Specifically, having a BMI over 40 increases chances of having depression. When examining the relationship among depressive disorders and obesity, some large cohort studies have identified over 40% of patients who undergo a bariatric program have a depressive disorder [20, 21]. Consideration of these multi-factorial conditions play a role in individualized treatment both pre-operatively and post-operatively. To provide a holistic approach encompassing all health conditions, it is important to involve a multi-disciplinary team of professionals in each bariatric patient’s program. As recommended by the American Society of Metabolic and Bariatric Surgery (ASMBS), nursing, surgery, nutrition, and psychology, all play an important role in each patient’s trajectory and clearance for surgery in a typical bariatric program. For a health disparate population that has large percentages of unhealthy dietary patterns and related co-morbidities such as mental health conditions and type II diabetes, a multi-disciplinary team can be vital to success in a central
Appalachia and West Virginia population. Nonetheless, it is unknown how this population responds to surgery and how their personal health and habits at baseline are playing a role in their surgical weight loss.

In conjunction with the Appalachian region leading in chronic diseases, residents also tend to have lower income, limited resources and poorer educational attainment [22] that only exacerbate the impact obesity and its co-morbidities produce [23-25]. When specifically examining the Appalachian region, rural areas, or West Virginia as centralized Appalachia, bariatric surgery is minimally utilized compared to the quantity of individuals who are eligible. Consideration of health history, insurance availability, support from family, or even health literacy can effect utilization of bariatric surgery as a tool for weight loss. In a 2017 study examining rural bariatric patients, Bergmann et al. finds that rural status was a significant predictor of surgery completion with rural patients being less likely to undergo surgery than their urban counterparts, though when placed in a model controlling for insurance type, rural status was no longer a significant predictor [26]. However, rural dwellers were more likely to be unemployed or disabled, have co-morbidities, and have West Virginia Medicaid. Furthermore, those completing the surgery program were more educated and employed full time. When predicting outcomes in relation to rural status, authors found that rural status did not significantly predict BMI at 6 months follow up or with follow up attendance [27]. In the understanding of the literature, this is the first study analyzing a rural Appalachian population, however, contains only minimal focus on the surgical outcomes. This initial study provides minimal baseline analysis to place grounds for approaching further research examining this population and designing future prospective interventions.
In order to better equip Appalachian patients with the best care during their pre and post-operative bariatric program, investigation of an Appalachian centered surgical program is warranted. Likewise, the examination of the environment is important when changing or intervening on health of a population. An aspect of the environment that this document will focus on will be food access of the residents within West Virginia. Access to affordable, nutritious food is a difficult feat for many residents in this area due to their rurality, limited income, or even vehicle access. Access to healthy foods is vital for changing dietary behavior, specifically, in a post-operative bariatric patient who should be following a specific dietary regimen.

Currently, there is a large void in the research identifying bariatric surgery outcome status of Appalachian and rural bariatric patients. Likewise, literature is lagging among food access and bariatric surgery and further, bariatric surgery and obesity within the Appalachian region. Of the population of patients who receive weight loss surgery in West Virginia, there may prove to be aspects of rural locality that hinder their process toward a healthier lifestyle as well as their clinical and weight outcomes post-surgery.

Of the previously mentioned disparities among the Appalachian region, specific issues to be focused on throughout this dissertation are the areas lack of resources and influence of co-morbidities that are among the highest. Due to the large rurality and low income of the area, the population faces a lack of health care resources, and even adequate, affordable, nutritious foods that would aid in a healthier lifestyle pattern. Research surrounding food access and obesity identify significant correlations within United States populations. Within the Appalachian region, research is lacking. This dissertation aims to provide insight and add to the limited existing literature in into this research void among the Appalachian population and begin formative investigation in the area.
Theoretical Foundation

Although a prospective study is not included in the current dissertation, the research proposed will be grounded in the foundation of the Social Cognitive Theory and the Social Ecological Model [28-31]. The Social Cognitive Theory (SCT), previously the Social Learning Theory, employs the idea that human behavior, cognition, and other personal factors have a reciprocal relationship with the environment around them, which allows them to continuously influence each other [28-31]. Further, it identifies that behavior is also influenced by reinforcement and observing others, such as family members influencing health and dietary behaviors. Specifically, the SCT is made up of 9 concepts based on the reciprocity of individual, behavior, and environment: reciprocal determinism, outcome expectancies, self-efficacy, collective efficacy, observational learning, incentive motivation, facilitation, self-regulation, and moral disengagement [30, 31]. Overall, the SCT is based upon the idea that individuals can shape their environment to suit the purpose they frame for themselves [30, 31]. This idea specifically, “reciprocal determinism”, explains human action, motivation, and emotion by the person, their behavior, and their environment all working equally on each other [31]. In this intervention, individuals have already invested in receiving bariatric surgery and, the belief is that they will also be invested in changing their current routine to fit the new lifestyle required after surgery. Specific research in the field of behavior change in obesity or dietary change has employed the SCT constructs of goal setting, self-efficacy, and social support. These constructs, as well as observational learning, incentive motivation, and facilitation, will be in the forefront of thought during this retrospective study to aid in forming a thoughtful, future intervention.

The Social Ecological Model (SEM) will also be kept in mind to understand the impact the environment plays on an individual and their health outcomes. Specifically, when utilizing
SEM in this retrospective study, our focus will be on the environment of the patients through food access. The SEM describes how each system impacts a certain aspect, such as obesity or surgical outcomes [30, 32]. Nested systems in place in the SEM include (1) Individual, (2) Interpersonal, (3) Institutions/Organizations, (4) Community, and (5) Structure, Policies, and Systems [30, 32]. This model will provide the framework to look beyond individual level factors influencing health by acknowledging the interactions of the environment, relationships, and economic factors that play a role in individuals’ lifestyle and health decision making. Food environments play a significant role in the decisions individuals make pertaining to their diet [33, 34]. Populations living in an area with poor access to food can lead to inadequate dietary choices or further exacerbate other co-morbid conditions. We aim to examine the food environment of patients to inform if future prospective studies considering food access knowledge and resources are warranted.

**Statement of the Problem**

Despite the deteriorated health status in much of the Appalachian region of the United States, examining the impact of a successful weight loss treatment such as bariatric surgery outcomes have yet to be fully explored. Although different patients see diverse results after metabolic surgery there is limited understanding overall outcomes among an Appalachian population. As Appalachian individuals are exposed to a variety of factors influencing their health, such as access to healthcare, greater frequency of co-morbidities, and inadequate food access, understanding the effectiveness of surgery and variables impacting these outcomes in this region is important. This dissertation aims to provide insight and formative examination into Appalachian health, surgical outcomes, and environmental factors to inform and begin the understanding of this population in the literature.
Purpose of the Study

The objectives of the current dissertation are to (1) provide a systematic review of the literature surrounding obesity and food access among Appalachian residents, (2) address the void in research of characterizing Appalachian bariatric surgery patients through descriptive statistics of demographic, co-morbidities, psychological scores, nutritional habits, baseline physical measures, and surgical outcomes, and (3) determine Food Access Ranking Scores of an Appalachian bariatric surgery population through a novel Geographical Information Systems (GIS) approach to assessing food access in the region by locating patient addresses. The overarching goal will be to describe this overlooked population and inform future research on factors to consider when planning prospective interventions.

Significance

Understanding regions of the United States that are lagging in health is essential to improving health nationwide. The Appalachian region is one of these health disparate regions. An array of literature has examined obesity, rural or Appalachian regions, and food access singularly or in minimal combinations. However, examining all of these important topics together in bariatric surgery patients is a novel and unique approach. This dissertation delves into uncharted territory combining these topics to shed light on the impact Appalachian living makes on individuals who seek and complete bariatric surgery. We hope to fill a gap in knowledge regarding this population and the considerations needing to be taken to further aid in developing future interventions for this underrepresented population during their bariatric program.

Summary

Obesity among the nation is not only a public health concern but has stemmed into an economic concern as well. Furthermore, when in higher classes of obesity, these resulting factors
are intensified. Among a health disparate and underserved Appalachian region of the United States, obesity exacerbates its related co-morbidities due to inadequate income, education, and access to healthy foods when compared to the nation. The treatment intervention was selected naturally occurred for this dissertation is bariatric surgery. Within this document Chapter 2 delivers a literature review that will provide a thorough background to support the subsequent studies. The research design and statistical analyses is described in Chapter 3 to provide insight to the processes involved in the approval and data collection of this project. These chapters are followed by three manuscripts that aim to respond to the lack of research in the areas of Appalachian bariatric surgery patients, their surgical outcomes, and food environments. Chapters 4-6 include: A Systematic Review of Food Access and Obesity in the Appalachian Region (Ch. 4), Population and Surgical Outcome Description of an Appalachian Bariatric Patient Population (Ch. 5), and A Novel approach to classifying Food Access among West Virginia Bariatric Surgery Patients (Ch. 6). These manuscripts taken together provide formative research to shed light on underrepresented Appalachia, bariatric surgery patients. Through the vast amount of research separately capturing bariatric surgery outcomes, the Appalachian region and food access, this dissertation aims to merge the three in a methodical arena. This document is concluded by a discussion and suggestions for future research.
Chapter II: Additional Background
Literature Review
Introduction

The current chapter provides background for the studies through a literature review based not only on bariatric surgery among the nation and Appalachian region specifically, but also the health of this disparate area and the barriers to healthy living that may be present. Further literature review is provided in each manuscript background and introduction (Chapters 4-6). These reviews together provide comprehensive understanding of the literature, identify the gaps, and bring about awareness as to support the significance of this effort.

Literature provided in this review was obtained through various databases provided through West Virginia University Libraries. No year restrictions were placed on literature review however, obesity, diabetes and mental health prevalence statistics were restricted to the most recent years for comparison. Databases utilized included PubMed, Google Scholar, CINAHL, ScienceDirect, and WorldCat.org. Search terms included: Appalachia, rural, obesity, diabetes, bariatric surgery, bariatric, psychology, mental health, food access, food systems, behavioral health, perioperative care, and surgery outcomes.

Health of the Nation: Obesity

Health, United States, 2016: At a Glance provides an overlay of the morbidity and risk factors at present day in the nation [35]. Heart disease leads the 2015 mortality list with 168.5 deaths per 100,000 age-adjusted population, followed by cancer (158.5), chronic lower respiratory disease (41.6), unintentional injuries (43.2), stroke (37.6), Alzheimer’s disease (29.4), diabetes (21.3), influenza and pneumonia (15.2), nephritis, nephrotic syndrome, and nephrosis (13.4), and suicide (13.3) [35].

Modifiable risk factors targeting these diseases consist of high blood cholesterol, poor dietary habits, physical inactivity, smoking, non-familial hypertension, and obesity [36-38].
Obesity, as a major factor in associated co-morbidities has been a major public health concern for years [39]. Overweight is classified as having a body mass index (BMI) between 25.0 and 30.0 kg/m² and obese classification is having a BMI of 30 kg/m² or higher [5]. Within the obesity classification, there are three subgroups:

Class I Obesity is a BMI of 30-35 kg/m², Class II Obesity is a BMI of 35-40 kg/m², and Class III BMI of ≥40 kg/m². Centers for Disease Control and Prevention (CDC) state that within the United States more than one-third, or 36.5%, of adults are classified as obese [6, 40]. Further, rates of ‘extreme’ or ‘severe obesity’ (Class III) are found among 6.4 percent of the adult population in 2011-2012, and increased to 7.7% among 2017 State of Obesity data [41, 42]. In Figure 1, National Health and Nutrition Examination Survey rates of extreme obesity in women and men have been increasing specifically around 1980 [43, 44]. The steep obesity trajectory has softened over the last few years, however, it still poses a threat to the nation and the risk of acquiring additional co-morbidities. Individuals more likely to be overweight or obese include women, racial or ethnic minorities, and persons of lower income or educational attainment [6].

The Department of Defense estimates that $1.5 billion annually is spent on obesity-related health care costs with billions also being lost in work productivity [45]. Furthermore, $1,429/year are spent in additional costs for individuals who are obese compared to their normal weight counterparts [45]. This leads to a demand in further funding of epidemiological studies to combat obesity. When targeting high risk areas, regions of the United States that are low income or rural

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Figure 1: Trends in United States Overweight, Obesity, and Extreme Obesity among men and women aged 20-74: 1960-1962 through 2013-2014
are found to have higher rates of health disparities. Due to their lack of resources, vehicles, and environmental structure, health among residents tends to be inferior compared to other regions [23]. These areas are densely found among the Appalachian region of the United States [23].

**Appalachian Health: West Virginia**

The Appalachia region (Figure 2) ranges across portions of thirteen states, encompassing 420 counties, and 205,000 square miles from southern New York down to northeastern Mississippi [46]. Within this cluster of counties, there is total encompassment of only one entire state, West Virginia. The regions well-known history has strong family ties, coal mining, agriculture, and a large rural population [23, 47]. Compared the national average of 20% of the population being classified as rural, 42% in the Appalachian region are considered rural [46]. This rural region, unfortunately, is also known for its vast amount of health and economic disparities. The formation of the Appalachian Regional Commission has aided in improving economic opportunities, workforce readiness, critical infrastructure, natural and cultural assets, and leadership and community capacity among the region [48]. Although the region has made strides over the past five years, challenges still remain. Educational attainment [22], poverty [22, 23], access to healthful foods and quality healthcare [22], as well as lower health literacy [49] are
exponentially greater than that of the United States. Of the region, the most health disparate areas are found within central and north central Appalachia, which specifically includes the entire state of West Virginia [22]. 2017 reports show all-cause mortality rates in the Appalachian U.S. are increasing at a greater rate than those non-Appalachian regions (1999 to 2014) [50] with West Virginia and Kentucky leading those mortality rates for Appalachia [50].

Likewise, it is recognized that the Appalachian region leads the United States in a variety of modifiable health risk factors, which could be alleviated by a healthful diet and physical activity [51-55]. The region in general leads with higher amounts of physically and mentally unhealthy days than that of the nation as a whole, and those in rural areas are among the highest [56]. Health concerns more prevalent in the area compared to the nation include higher risk of mortality from heart disease, cancer, COPD, injury, stroke, diabetes, drug overdose, and others [4, 56-58]. Particularly, West Virginia has been at the forefront of those lists for over the last decade for conditions including obesity, hypertension, depression and diabetes [7, 9].

According to ‘The State of Obesity: Better Policies for a Healthier America’, West Virginia’s adult obesity rate has increased to 37.7% as of 2016, making the state number one in obesity rates [8]. This rate is compared to 35.7% obesity in 2015, 32.3% in 2010, and 23.9% in 2000 [42]. Among West Virginia rates of Class II obesity, 2013 data place 17.6% of adults in this classification [59] while 2008 data place 4.9% of adults in Class III obesity [9]. With this outdated data and the pronounced increase in obesity within the last decade, updated obesity data within the state specifically is merited.

**Obesity Related Co-morbidities: Nationwide, Appalachia, and West Virginia**

Obesity is taxing on the body and can extend to many other aspects of an individual’s life including, general quality of life, health, self-esteem, and even the addition of other co-
morbidities [60]. Individuals with obesity are at an elevated risk for developing insulin resistance and type 2 diabetes, sleep apnea, cardiovascular disease, hypertension, certain cancers, and many other conditions [60]. These co-morbidities are of higher proportions in the Appalachian region, with its total state of West Virginia leading the statistics. Other co-morbidities positioning West Virginia as the top state in the nation include 15% of adults with diabetes compared to the nation’s 12.7% (2013-2014 data), and 42.7% adults with hypertension compared to the nation’s 33.5% (2016 data) [4, 9, 56]. Along with related co-morbidities such as diabetes and hypertension, those with excess weight can be found to have additional related psychological complications [61-63]. West Virginia Behavioral Risk Factor Surveillance Survey (BRFSS) examines depression rates within the state. A 2016 report places the state second for percentage of adults diagnosed with depression (23.8%) [9]. Clinically diagnosed depression has found to be related to increasing obesity [64-66] and is another avenue demanding consideration when treating obesity.

Reviewing the long standing relationship of obesity to these common co-morbidities, it is unsurprising that these conditions are higher among West Virginia residents as well. These disparities found in the Appalachian region, specifically West Virginia, can be factors in the further exacerbating decline of health in the region. When explaining reasoning behind the unhealthfulness of the area, consideration of multi-factorial diseases and rural locality of the state can be influential [67].

**Access to Resources: Appalachia**

Among the population who reside in the Appalachian region, location has impacted its health, economy, and resources. Poverty has declined since 1960 (295 counties above 1.5 times the U.S. poverty rate) to currently 87 counties in high poverty regions (although remaining 1.5
times the U.S. poverty rate) [56]. It is estimated that 700,261 people living in rural areas in West Virginia [68], have a poverty rate of 17.9% [69], annual per-capita income of $24,002 [69], and 17.6% have not completed high school. A similar 2017 Appalachian Regional Commission report comparing the region to the nation averages places the Appalachian region 19% lower median household income, nearly 2% higher poverty rate, over 6% less post-secondary education, and nearly 2% more receiving disability benefits [56].

Coincidentally, while health among Appalachian populations is markedly poorer than that of the nation, health care resources are also scarce. According to Health, United States, 2016: At a Glance, adults in the South (including West Virginia), had the greatest difficulty accessing medical care due to cost in 2015 [35]. A mixed methods study by Gutschall et al. found the number one barrier to good health expressed by Appalachian residents was access and resources [70]. A similar examination of Appalachian individuals with multi-morbidities found that these participants were concerned that they were concerned with their ability to meet dietary and medication requirements for their conditions [71]. Participants were further concerned on missing work days or be fired due to their health, expressing that this can eventually leads to loss of benefits, income, or even onset of depression [71]. Furthermore, this subsequent increase in cost associated with medications or travel to clinics tend to deter individuals from receiving proper care or primary prevention measures to ensure adequate health [25, 57]. In addition to these concerns, the Appalachian Regional Commission reports the region preforms lower than the nation in number of available primary care physicians, mental health professionals, specialty physicians, and dentists overall [4, 46, 57, 68].

Equally, access to affordable, nutritious food is a difficult feat for many residents. Food insecurity, defined as inadequate access at all times to sufficient amounts of food for a
sustainable, active life, is a contributing factor to health disparities in the region [72]. Food insecurity rates in American adults were over 14% in 1995-2012 data and has been labeled as a public health concern (Pheley, et al. 2002). USDA data on food insecurity in West Virginia found 14.9% of households to be food insecure and 6.2% very food insecure [46]. The Appalachian Regional Commission report on health disparities and resources in Appalachia identified the region has 14% fewer grocery stores per 100,000 population than the nations average [56]. The burden of limited income to purchase necessities can be alleviated by programs such as Women, Infants and Children (WIC) or Supplemental Nutrition Assistance Program (SNAP). In West Virginia, WIC clinics serve approximately 42,000 people each month, or 80% of eligible individuals including 3 of 5 infants born in the state [73]. Likewise, SNAP provides food benefits to over 367,000 West Virginians monthly [73]. In a 2016 study by Andress and Fitch, low income WIC participants took part in focus groups to identify feelings regarding food access in their communities of rural West Virginia [74]. Themes that emerged from focus groups included concerns regarding (1) structural environment including distance to retailers and transportation, (2) personal and household determinants of food including purchasing healthy options that are available and affordable, and (3) social and cultural aspects of the environment including stores meeting needs and products that were unacceptable [74].

While food security takes into account the ability to acquire enough food predominately, by terms on monetary value, the environment surrounding these individuals in access to food is of another question. The USDA defines a food desert as “areas of the country void of fresh fruit, vegetables, and other healthful whole foods” [75, 76]. This definition specifically uses lack of grocery stores, farmers’ markets, and healthy food providers as evidence of these food deserts [75, 76]. These data are combined with US Census data to define areas of food deserts in the
United States. Criteria for these measured areas of food deserts include low income areas (median household income <80% of state median income or poverty rate of ≥20%) and low access areas (proximity to a grocery store such as 1 mile in urban areas and 10 miles in rural areas) [75-79]. The USDA defines a grocery store with the minimal criteria as one that sells a wide variety of products [75-79]. Additionally, low access communities are areas also defined by at least 500 persons or 33% of a census tract’s population live more than one mile from a supermarket (10 miles if nonmetropolitan tract) [75-79]. All of these criteria are used to create binary sets for each census tract to determine if an area is deemed a food desert or non-food desert. Among West Virginia residents, it is estimated that 42% of census block groups have low or very low access to a grocery store that carries sufficient amounts of fresh or healthy foods [80].

In 2017, Andress and Hallie used a community-based participatory research approach to photovoice narratives with elderly rural dwellers in West Virginia [81]. Although Appalachia is noted to have 14% fewer grocery stores per 1,000 population than the national average [56], residents indicate that they have grown accustomed to the distance required to obtain food. Yet, when traveling to food stores, options available usually fall short to buyers standards [81].

When investigating both obesity and food access among Appalachian areas, there is a miniscule body of research. Previous literature among other rural regions of the United States have seen correlations of poorer health with lack of quality, affordable, nutritious foods [72, 82]. In conclusion of the limited studies in Appalachia surrounding obesity and food access, the majority of studies found higher rates of obesity with limited food access in the region [83-87]. Most data reviewed were cross-sectional studies or observational data with only correlational
analyses. This limited data does not allow for a meta-analysis but supports future research endeavors in examining obesity and food access relationship in Appalachia.

**Bariatric Surgery as an Intervention**

To date, the most effective treatment for decreasing morbid obesity efficiently and long-term, is bariatric surgery [13, 88, 89]. Between 2011 and 2015 bariatric surgery procedures in the United States have risen from 158,000 to 196,000 [16]. With up to 196,000 bariatric surgeries performed annually, typical surgical procedures include laparoscopic Roux-en-Y gastric bypass (LRYGB), laparoscopic sleeve gastrectomy (LSG), biliopancreatic diversion with duodenal switch, and adjustable gastric bands [2]. These surgeries are comprised of procedures that aid in malabsorption and/or restriction of food intake to achieve weight loss [3, 90]. Most physicians providing surgery or insurance companies paying for bariatric surgeries typically have criteria including patient BMI of \( \geq 35 \text{ kg/m}^2 \) with at least one of its associated co-morbidities (type II diabetes, hypertension, sleep apnea or other respiratory disorders, non-alcoholic fatty liver disease, osteoarthritis, lipid abnormalities, gastrointestinal disorders, or heart disease) or a BMI of \( \geq 40 \text{ kg/m}^2 \) or 100 pounds overweight without co-morbidities [1, 3]. Surgeries performed largely in the United States include LRYGB (18.7%) and LSG (58.1%). The LRYGB has well established effectiveness in patients within the literature however, LSG is noted to be a less demanding operation than LRYGB, and an effective alternative [91]. Research comparing the two surgeries has been found to be conflicting by outcomes of weight loss [92-94]. These results typically show LRYGB achieving significantly higher amounts of excess weight loss. Recent studies by Peterli et al. (2017, 2018) and Salminen et al. (2018) showed similar loss in LRYGB and LSG up to 5-year post-operatively [95-97]. LSG and LRYGB displayed percent excess
weight loss (%EWL) outcomes of >49% and >57% respectively [95-98]. This places both surgical procedures near the loose definition of >50% excess body weight loss as success.

Commonly associated with, and frequently exacerbated among upper classifications of BMI, are obesity related co-morbidities [88]. Conventional dietary, lifestyle and behavior change interventions for significant weight reductions, likely fail in comparison to surgical weight loss interventions [99]. Not only effective in significant weight reduction, bariatric surgeries have been found to reduce severity or appearance of co-morbidities entirely after surgery [100, 101]. Literature supports remission of type 2 diabetes or reduction in blood glucose after surgery [102]. Brethauer et al. found remission of type 2 diabetes after bariatric surgery in nearly 30% of patients after 5-years [102]. Those more likely to achieve remission included patients with a shorter lifetime duration of diabetes and higher long-term excess weight loss [102]. Individuals likely to have reoccurrence of diabetes after remission, were those having a longer lifetime duration of type 2 diabetes, less excess weight loss, and regain of weight after largest loss post-surgery [102]. Likewise, among psychological conditions, increasing weight is found to be correlated with co-morbid. In bariatric patients, literature has found that patients have an array of mental health issues with depression as a main condition [103-106]. Of these individuals receiving surgery, preoperative depression scores and diagnoses predict lesser weight loss outcomes compared to non-diagnosed, lower depressive scoring individuals [107, 108]. Although conflicting results remain in the literature, mental health issues such as depression have seen to be lessened with bariatric surgery [109-111]. In a study by Booth et al., authors found that an average reduction of 4% of clinical depression in patients was seen at 2-years post-operation, however at the seventh year post-operation, depression had increased to 1% greater than baseline [110, 112].
Among the Appalachian region, the question arises of ‘success’ among bariatric surgery patients who reside in the Appalachian region. When analyzing literature regarding health disparities in the Appalachian region, many previously mentioned factors among the population can be antagonistic toward weight loss such as environmental influences, health literacy, access to resources, and co-morbid conditions.

To date, minimal number of studies have examined Appalachian populations of bariatric surgery patients. Although there are nearly 200,000 bariatric surgeries performed annually, this is noted to be a mere 1% of the eligible United States population who actually take advantage of this intervention [113]. In Figure 3, rates of diabetes, obesity, and surgeries performed in 2012 per 100,000 population are depicted [114]. Specifically, when examining West Virginia, both diabetes and obesity are of the highest rates, while bariatric surgery is among the lowest rates, similar to those of Colorado (lowest rates of diabetes and obesity). However, patient understanding of the need for lifestyle change remains the precursor for true health behavior change and utilization of interventions such as metabolic surgery. In a study examining self-reported and perceived health in Appalachian residents, participants reported themselves as being “healthy” while simultaneously reporting themselves as sedentary, hypertensive, overweight, or hyperlipidemic [115]. Over half of the individuals reporting being healthy, also had at least two disease conditions or poor health.

![Figure 3: 2012 Rate of Obesity, Diabetes, and Bariatric Surgeries per 100,000 population in 15 United States](image)
behaviors [115]. This examination of perceived health in Appalachia may lend interesting insight into the inferior health of the region. Equally, if Appalachian individuals have inadequate awareness of their poor health and limited understanding of the impact an unhealthy lifestyle can make, an increased number of residents approaching procedures like bariatric surgery may be unlikely. However; of those individuals who do reach out for bariatric surgery interventions residing in the Appalachian region, there is a large void in the literature describing the population, their journey, surgical outcomes and factors influencing those outcomes.
Chapter III: Research Design and Statistical Analyses
Introduction

The following chapter provides a description of the study methodology used to address research questions for this retrospective medical record review of bariatric surgery patients at West Virginia University Hospital. Data collection methods are described in further detail along with associated hypothesis. Study design, data gathering, instruments, variables measured, and data analyses is explained.

Setting and Sample

Retrospective data consisted of individuals who took part in the bariatric surgery program at West Virginia University Hospitals. Inclusion criteria for analyses included individuals 18 years or older who completed a surgery program and received LSG or LRYGB surgery between 2013-2017. Candidates for surgery were cleared by surgeon, dietitian, psychologist, cardiologist, and pulmonologist. Weight criteria for surgery included a BMI of $\geq 40$ kg/m$^2$ or BMI $\geq 35$kg/m$^2$ with at least one co-morbidity (type II diabetes, hypertension, sleep apnea or other respiratory disorders, non-alcoholic fatty liver disease, osteoarthritis, lipid abnormalities, gastrointestinal disorders, or heart disease).

WVU Medicine Bariatric program has collected data on bariatric patients at initial clinic visit and at each attended follow-up visit. A query was completed on patients who have finished surgery between 2013-2017 (n=599). Patients who received gastric banding surgery or had a revision of a previous bariatric surgery were removed from data set as they were a limited sample and metabolic outcomes may differ. Baseline descriptive statistics were available on a total of 547 patients. Sample sizes differ among analyses due to incomplete/missing data in patient charts. Qualitative and quantitative data were collected via Electronic Medical Record
(EMR) and are described below. Baseline measures were collected from initial visits at bariatric and psychology clinics.

**Data Collection Procedures**

Approval to conduct research was obtained via West Virginia University Institutional Review Board (1611355277) in March 2017. All researchers completed HIPAA training, contracts, and Collaborative Institution Training Initiation course certificates. Research assistants on the project were trained to retrieve information from patient charts for the study. Assistants included graduate students (n=7), medical students (n=13), and undergraduate students (n=4). Students were trained over April and May of 2017. Data was retrieved April through September 2017 via WVU Hospitals secure server, Citrix, and entered into a secure, HIPAA compliant, RedCap survey. Trained students viewed patient EMR and collected information from clinician notes, uploaded PDF documents, and laboratory values that were available.

Data was downloaded onto a secure server on university hard drives for cleaning and analyses. Data was cleaned and outliers were removed prior to analyses in Chapters 5.

**Measures**

A baseline Bariatric Program Questionnaire was completed by each surgical patient prior to their initial bariatric visit. This questionnaire includes demographics, behavioral variables, health history, and a nutritional questionnaire. Follow-up anthropometrics were captured at each follow-up appointment patients attended (3 month, 6 month, 9 month, 1 year, 18 month, and 3 year possible). Lastly, Geographical Information Systems (GIS) were used to locate patient address through WV GIS Technical Centers’ WV Address Locator Services [116]. Measures specifically used in this dissertation are as follows:
**Bariatric Program Questionnaire.** This comprehensive 168 item questionnaire designed by the WVUH bariatric program identified variables including demographic information including age, gender, race, relationship status, education attainment, occupation, and insurance type. Social history questions include drug and alcohol use or any rehab or additions. Family health history and well as personal health history (endocrine, pulmonology, cardiology, neurological, gastrointestinal, bladder/kidney, psychological, and females were given fertility and PCOS) was included. Form was scanned and uploaded as a PDF into patient chart.

**Nutrition Questionnaire.** Baseline dietary behaviors captured in an 86 item self-reported survey completed by patients for their initial bariatric visit. Variables included weight history, dietary patterns, sleep, stress, physical activity, vitamin and mineral use, and a self-reported 24-hour dietary recall. Form was scanned and uploaded as a PDF into patient chart.

**Follow-up Anthropometrics.** Repeated anthropometrics used for major outcome measures were retrieved at each attended follow-up visit. Measures included weight, BMI, and excess body weight (EBW). Percent excess weight loss (%EWL) was calculated as \((\text{initial weight – 1-year follow-up weight}) / (\text{initial weight – weight at BMI of 25}) \times 100\).

**Geographical Information Systems (GIS).** WV address Locator Service used is in collaboration with WV Statewide Addressing and Mapping Board (WVSAMB) and the WV Division of Homeland Security and Emergency Management (WVDHSEM). Patient address was located, and mapped by WV FOODLINK experts’ Food Accessibility Map [117, 118]. This Food Accessibility Map uses four weighted variables to illustrate the barriers that households face in accessing food and calculates food accessibility. The factors used to calculate food accessibility included, (a) the quality of retailers, (b) the quantity of retailers, (c) income, and (d) vehicle access.
**Food Accessibility.** The current study utilizes a novel food access ranking score (FARS) developed by WV FOODLINK GIS experts [117, 118]. Utilizing both USDA census-data and unique indicators of food access (quality of food retailers), this approach provides a more refined understanding of food deserts in West Virginia. Due to the exclusiveness of the map to the state of West Virginia, only patients residing in the state were included. FARS is based on four weighted variables to illustrate the complexity of food access. This map utilizes census block group scales to calculate food access as compared to the USDA census tract usage. The four variables included in the Food Access Ranking Score (FARS) are (1) Quantity of Retailers, (2) Quality of Retailers, (3) Income, and (4) Vehicle Access.

- The **quantity variable** calculated a score for each census block group based upon the presence of absence of retailer types and was also normalized to create a weighted variable between 0 and 1.

- The **quality variable** was calculated by multiplying the number of retailers in each category by the quality of the foods available, normalized statewide via a weighted variable between 0 and 1.

- The **income variable** was calculated based upon the median national household income to more accurately reflect household purchasing power in relationship to other parts of the country. Census block groups were given a score of 0 or 1 based upon whether they were above or below 80% of the national income median.

- Finally, the **vehicle variable** was drawn from the USDA data and disaggregated from the census tract to the census block group scale. Tracts that had high vehicle access were given a 1 and tracts with low vehicle access were given a 0.
The FARS was then calculated by summing the weighted variables into a final access score between 0 and 4. Block groups that scored a zero have little to no food access (do not have access to a quality store of any kind, they have low incomes and low vehicle access), areas in moderate range of 1 to 2, and groups that scored between a 3 and 4 (have each type of quality store, more than one of some of them have household incomes above the national median, and have access to a vehicle).

Study Assumptions

The current bariatric program in which study participants participated, required prospective patients to complete a written questionnaire and return it back to the clinic at their initial bariatric program visit. These questionnaires were predominately self-reported measures. It is assumed throughout these studies that patients had completed questionnaires honestly and to the best of their ability.

Dissertation Aims and Objectives/Hypotheses

Specific Aim 1: Systematically review literature regarding food access and obesity among the Appalachian region of the United States. Minimal literature examines the Appalachian regions food access and relationship to obesity.

Objective: Summarize available literature on an populations with obesity and their food access among the Appalachian region to inform future studies and potential prospective interventions.

Specific Aim 2: Provide insight into formative research characterizing Appalachian bariatric surgery patients through descriptive statistics of demographic, co-morbidities, nutritional habits, and baseline physical measures. Describe bariatric surgery success outcomes of Appalachian patients through body weight loss percentage, BMI, and their
relationship to patient demographics, health conditions, and dietary behaviors. The
environment within the Appalachian region is less than conducive to maintaining a healthy
lifestyle. This can impact the outcomes or success a bariatric surgery has on those residing in this
area. The work proposed in Aim 2 provides informative data on the success after bariatric
surgery in a health disparate population. Analysis will lead to discussion and interpretation to
implement qualitative research designs to identify barriers in place with these individuals and
thus, future interventions to overcome them.

**Research Hypothesis:** Those patients with less successful surgical outcomes at 1-year
follow-up (<50% EBWL) will have higher initial weight/BMI/EBW, multiple
morbidities, poorer nutritional behaviors, and poorer family history. Further, patients
within our population will have lower %EWL than described in the literature among
other bariatric surgery cohorts.

**Specific Aim 3:** Determining Food Access Ranking Scores of an Appalachian bariatric
surgery population through Geographical Information Systems (GIS) locating patient
addresses and its relationship to descriptive variables. Specifically, with bariatric surgery
patients and food access, little work has been completed to examine the relationship or impact
they have on each other. The approach taken here, defining this bariatric population and utilizing
a GIS location to identify food access scores, will provide valuable insight for future research
interventions to ensure better understanding how conducive residents’ food environments will be
prior to or after surgery.

**Research Hypothesis:** It is hypothesized that the largest proportion of food access
ranking among a West Virginia bariatric population is in the low and moderate-low food
access score. Further, those patients with lower food access would have poorer surgical outcomes (i.e. lower %EWL).

Analysis

In Aim 1 a systematic review of the literature was performed regarding obesity and food access in the Appalachian region. No specific statistical analyses were utilized due to the lack of comparability of study measures. Study locations, and a general population demographics are combined from studies original data.

General descriptive statistics to define the population are described in Chapter 5. Differences among LRYGB and LSG baseline descriptors was utilized in Chapter 5, Table 1. Examining outcome measure of %EWL to identify characteristics differences among those patients achieving more or less success was initiated with a priori selection of variables. Initial variables included for relational screening included gender, age, ethnicity, surgery type, marital status, baseline diabetes, hypertension, high cholesterol, diagnosed depression, and cooking responsibilities.

Independent t-test was used for assessing association between %EWL and variables with two groups (Surgery type, Gender, Ethnicity, Education level, State, Marital Status, Diabetic, Diagnosed Hypertension, Diagnosed Depression). ANOVA was used testing for testing hypothesis of equality among more than two groups of categorical variables (education and marital status), and Spearman’s Rho was used for examining correlation of %EWL with continuous variables (age, % Attended follow-up, Systolic Blood Pressure, Diastolic Blood Pressure, HbA1c and BDI). Fisher’s Exact test was used for cell sizes < five. Significant correlations of p<.05 were included in next step of building ANOVA and ANCOVA models to test relationship between %EWL and categorical and continuous predictor variables. Model
assumptions of homoscedasticity, normality, and lack of multicollinearity were assessed. Cook’s D influence was set at 0.0227 (4/n). Data with an influence greater than Cook’s D were removed from analysis (n=7). Effect size in models were assessed by change in adjusted $R^2$ values to calculate variance of each variable when placed in the model.

Aim 3 targeted understanding food access among West Virginia cohort of patients. Hypothesis stated that those with lower food access scores would display less successful %EWL. Wilcoxon Rank Sum test was used to examine relationship between continuous FARS scores and binary variables and Kruskal-Wallis test was used for examining if FARS depended on continuous variables. Fisher’s Exact test was used for categorical variables when cell sizes were less than five. FARS shown in categories of 1 through 4 for visualization, utilized on a continuous scale for initial analyses and adapted into quartiles for further analyses to compare differences in the extreme low and high food access areas. Pearson’s Chi-Square test was used for testing association of FARS categories (quartile 1: low and quartile 4: high) with binary categorical variables and Kruskal-Wallis was used for comparing the continuous variables between the two FARS quartile categories.

**Limitations of the Study**

Utilizing a retrospective cohort study design brings about potential issues in the data collection phase. Within each bariatric patient chart across time, there were changes with surgeons and style of written notes and communication regarding patients. Most of the data collected on each patient were provided in the form of scanned PDF documents into their chart. This may have led to questionnaires not entirely completed by the patient, illegible writing, or patient was seen previously by another physician and documentation wasn’t required (i.e. some
patients were cleared by other behavioral medicine physicians and psychological questionnaire scores weren’t available). Further limitations of the overall studies are described in Chapter 7.
Chapter IV: Food Access and Obesity in the Appalachian Region: A Systematic Review
Submitted Manuscript for Review:

Food Access in the Appalachian Region and Obesity: A Systematic Review

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Abstract

Studies examining food access and food deserts among United States populations are widely found within the literature in both rural and urban areas. Research focusing on health disparate, high obesity, and low access areas such as Appalachia, however, are limited. The objective of the current study was to complete a systematic review of food access and obesity among Appalachian regions of the United States. Search terms used were Appalachia, rural, obesity, food access, food systems, and food deserts. 487 articles were searchable through peer-reviewed databases. Seven remaining articles were found to meet all inclusion criteria. Five of the seven studies identified that residing in a rural or food desert area had positive associations with obesity prevalence. The remaining two studies had examined urban neighborhoods and all United States counties to find no changes in dietary quality or BMI and no association of obesity prevalence with residing in a food desert. Food access and obesity among a health disparate region such as Appalachia is poorly understood. However, with limited studies and conflicting results, a clear comparability of studies was unobtainable. Future research and examination of intervention effectiveness is warranted in this underrepresented Appalachian region.

Keywords: food access, obesity, Appalachia, rural, food desert
INTRODUCTION

Appalachia, consisting of portions of 12 states, and the entirety of West Virginia contain the Appalachian Mountain Range along with a long standing reputation of health disparities [23, 119-123]. The area is consistently among the highest rates of hypertension, diabetes, obesity, mental health issues, and lack of access to care [23, 124, 125]. Among the highest conditions in this region, overweight and obesity rates have spiked and remained elevated among these individuals [4, 6, 40, 46, 126-132]. Various research has been employed examining the relationship of overweight and obesity among the Appalachian region and culture [132, 133]. The rural nature among the region lends a hand to the continued health disparities among the area: [4, 46, 134] distance to higher resource areas increases travel time or time off of work, low income and inadequate insurance coverage discourages seeking of preventative care, infrastructure barriers, lower educational attainment, poor health literacy and lower confidence lower the ability to acquire and utilize new health knowledge for their personal care [135, 136]. Because of these barriers, encouraging a population to improve their health and dietary habits is impacted by how affordable and available these healthy, nutritious foods are [137, 138]. Interestingly, current literature identifies a lack of access to affordable, healthy, nutritious foods has been found with correlate to obesity rates in rural settings throughout the United States [137, 138]. Food access is typically determined through various avenues including the United States Department of Agriculture’s (USDA) Food Access, USDA Census-tract data (smaller areas than county data) [75, 76], county-level data, participant self-reporting and Geographical Information Systems (GIS) locations [137, 139, 140]. Likewise, overweight and obesity is determined through variations of measurements such as county-level data, self-reported measures, anthropometrics and body mass index [6, 40, 43]. These techniques of determining access and
obesity have been used nationwide for various purposes, however utilizing them together in a streamline fashion is warranted. This work is specifically necessary in regions that are rural and have high rates of obesity. In our target population of Appalachia, there has been minimal work focusing on this specific health disparate population, food access, and obesity, simultaneously.

The objective of the current study was to systematically review both peer-reviewed and gray literature to synthesize and capture understanding of obesity and food access in a health disparate region such as Appalachia. To our knowledge, this is the first review to obtain an examination of both obesity and food access (FA), specifically in the Appalachia region.

METHODS

To provide a complete picture of FA and obesity in Appalachia, a systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [141]. Databases utilized included PubMed, CINAHL, ScienceDirect, and WorldCat.org. Google Scholar was utilized outside the normal databases to capture any overlooked or gray literature including dissertations and conference proceedings. Search terms included: Appalachia, rural, obesity, food access, food systems, and food deserts. Date restrictions weren’t used as all articles were 2006 and later. Language restrictions of English were used. Excel spreadsheets and citation managers were used to extract and assess articles.

Selection Criteria

Citation manager was used to identify duplicates. Articles were extracted into an excel spreadsheet and were independently screened for eligibility. Titles, abstracts, and full text portions were reviewed to determine final articles for analysis. Food access variables were determined by inclusion criteria of studies to use measurable Geographic Information System
(GIS) locations of individuals in proximity to nearest food stores or determined through personal accounting of community access. Obesity related criteria for study variables were determined through census data, physical measurements, county data, or self-report. Appalachian region was determined from the study or from current authors examining study location.

**Data Extraction**

Authors MLB and RLH reviewed all full-text for final inclusion. MDO reviewed final decisions for tie breakers. All relevant peer-review literature to extract the following: objective, data collection time frame, study design and approach (eg. obesity and food access measurements), results and conclusions. Results were compiled and assigned into the following categories: prevalence of access, impact of demographic factors, obesity factors, and other influential factors.

**RESULTS**

From selected search terms, a total of 487 articles were searchable through peer-reviewed databases (n=377) and Google Scholar searches (n=110). All citations were compiled into EndNote citation manager and duplicates (n=18) were removed. Titles were reviewed to remove a further 227 citations that did not meet the inclusion criteria (not measuring food access, not measuring obesity, not in the Appalachian region, or a combination) for this review. The remaining 242 abstracts were assessed removing 197 articles

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<td>2 (28.6)</td>
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<tr>
<td>West Virginia</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Kentucky</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Alabama</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>United States</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td><strong>Demographic</strong></td>
<td></td>
</tr>
<tr>
<td>Predominately White</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Predominately Black</td>
<td>2 (25.0)</td>
</tr>
<tr>
<td>Mixed</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Unknown</td>
<td>4 (57.1)</td>
</tr>
<tr>
<td><strong>Locale</strong></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>5 (71.4)</td>
</tr>
<tr>
<td>Urban</td>
<td>1 (14.3)</td>
</tr>
<tr>
<td>Mixed</td>
<td>1 (14.3)</td>
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</table>
for failure to meet inclusion criteria of study completion in the Appalachian region or measuring food access and obesity. The remaining 45 articles were full-text reviewed. PRISMA flowchart of article selection in Figure 1. After full text review, 38 articles were removed for incomplete inclusion criteria of either not measuring obesity (n=8), not measuring food access (n=16), not within the Appalachian region (n=9), or not meeting a combination of the three (n=5). The remaining 7 articles were found to meet all inclusion criteria (measuring food access, obesity and in the Appalachian region) to be included in qualitative analysis. One article as gray literature, the remaining 6 were peer-reviewed.

**Description of Study Locations**

Of the 7 articles reviewed, all were included in portions of the Appalachian region with one including the entire state of West Virginia (n=1) [83], Pennsylvania counties (n=2) [86, 142], one including Pennsylvania and New York counties (n=1) [143], Kentucky counties (n=1) [84], Alabama counties (n=1) [85], and all United States counties (stating disparities among Appalachia described in Table 1) (n=1) [87] (Table 2).

**Study Samples**

Average sample size across all articles utilizing individual participants was n=909. Studies with individual participants ranged from 613 participants in an Alabama county school [85] to 1,372 in two Pennsylvania neighborhoods [86]. Studies focusing on county data ranged from 55 in West Virginia counties [83] to 3,109 counties in 48 United States [87]. Age ranges of the studies typically ranged within adults 18 years or higher [83-85, 87, 142, 143], however, some varied including school district data of individuals 2-20 years old [86].
Figure 1: Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of food access and obesity within the Appalachian region
### Table 2: Reviewed articles examining food access and obesity among an Appalachian population

<table>
<thead>
<tr>
<th>Authors</th>
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<th>Study design and approach</th>
<th>Food access measures</th>
<th>Results</th>
<th>Demographic factors</th>
<th>Obesity factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amarasingshe A, et al. 2006</td>
<td>1992 and 1997</td>
<td>West Virginia counties</td>
<td>N=55 counties; 94.66 people per square mile (rural); Obese: 18.92±4.2%; Below poverty line: 20.32±6.36%; Completed college: 11.1±4.57%; Percent unemployment: 7.57±3.03%; Annual wages: $20,915.87±4076.85; % population who smoked: 26.01±5.60%</td>
<td>Cross-sectional; Secondary county data; Inclusion criteria: All counties with available data; Panel Data Structure, random and fixed effect regression models, Lagrange</td>
<td>County-level total number of establishments per 1000 people, total number of food stores per 1000 people, eating and drinking places per 1000 people, average travel time to work</td>
<td>Total establishments: 20.48±5.84; Total food stores: 0.88±0.27; Eating and drinking places: 1.38±0.64; Travel time: 26.12±5.77min</td>
<td>1% increase in college education completion significantly decreases obesity rates by about 0.3%; County annual per capita wage positively and significantly contribute to obesity; $1,000 significantly increases obesity by 0.3%</td>
<td>Total number of food stores per thousand population (one unit increase in number of food stores significantly decreases obesity by 2.6%); business establishments (1 unit increase significantly raises obesity by 0.2%) and mean travel time to work (one minute increase raise obesity by 0.2%) are significant built environment contributors of county-level obesity</td>
</tr>
<tr>
<td>Dubowitz T, et al. 2015</td>
<td>2011;2014</td>
<td>Pittsburgh, PA</td>
<td>Two demographic and geographic matched neighborhoods; N=1,372 baseline participant’s Full-service supermarket opened in 2013, N=831 follow-up: 75% female, 95.2% African American, 82.3% not married or living with a partner, low-income of $13,608, 53.3 years old, BMI of 30.5kg/m², 77.4% met criteria for being overweight;</td>
<td>Quasi-experimental longitudinal; Two neighborhoods where a new full-service supermarket was opening in one; surveys, ASA 24-hour recalls</td>
<td>Perceived access, choice, quality, and cost of healthy foods</td>
<td>For nearly all variables regarding access, significant increases were seen after introduction of new store in those residing in the natural intervention neighborhood. Those who frequently used the store compared to those non-users increased 8 of 10 perceived access variables</td>
<td>Intervention neighborhood saw decreases in total kilocalories, added sugars, and percent of solid fats, alcohol, and added sugars (SoFAAS). These variables increased or remained the same in the comparison neighborhood.</td>
<td>After new supermarket arrived consumption of fruits and vegetables and whole grains declined in both neighborhoods and overall diet quality. Weight and BMI remained relatively stable in both groups across time. No significant factors on food purchasing places and diet were seen except for increase in total fat in diet when shopping at a discount grocery store.</td>
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<tr>
<td>Gustafson A, et al. 2017</td>
<td>2015</td>
<td>Rural Kentucky</td>
<td>6 rural Kentucky counties. Random dials to registered telephone landline or cellular numbers. N=741 completed surveys. 76% female, 59 years, 97% white.</td>
<td>Cross-sectional. Multiple Logistic Regression</td>
<td>Qualitative data: participants self-report</td>
<td>Participants self-reported communities as 'food-deserts' where their accessible options are fast-food chains, a limited number of grocery stores that struggle to keep fresh items, and costs being higher for those fresh items. 6 counties participating have poverty rates of 11-19% and educational attainment of 10-20% for associate's degree or higher. All counties participating have obesity rates &gt;40%. 40% participants had serious concern with obesity and 59% believed it was easy to obtain information about obesity; 66% were unaware of any community resources to address obesity. 36% had a serious concern with healthy eating and 68% believed it would be easy to access information; 54% were unaware of any community resources for healthy eating; 67% and 65% of participants consumed 2 or less servings of fruits and vegetables per day, respectively.</td>
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<tr>
<td>Li Y, et al. 2015</td>
<td>2013</td>
<td>Alabama county</td>
<td>N=613 African American children, ages 4-13. 50.9% male, 42.1% overweight or obese</td>
<td>Cross-sectional. Multi-level regression to examine relation between food environments and children weight status.</td>
<td>Food Environment Score (FES): summed score of four composite z-scores (probability that student patronizes type of store): convenience stores, fast food, supermarket, and restaurant.</td>
<td>Census blocks with &gt;50% African Americans, (scale -5.35 to 5.3; higher number as healthier food environment) only 7.28% had FES &gt;1 Blocks with &lt;50% African Americans, 26% has FES over 1. Total census blocks with &gt;50% African Americans had 11.37% in FES &lt; -1, while the &lt;50% African American blocks had 0% in FES &lt; -1 Blocks with median household incomes of &gt;$30,000 had 11.16% with FES &gt;1 Blocks with &lt;$30,000 median income had 7.18% with FES &gt;1 Greater median income also had 16.73% FES &lt; -1 and lower median income had 6.36% in this category. Regression model 1: convenience store and restaurants had a significant, positive effect on weight status, supercenters had a negative impact and fast food had no significant impact. Model 2 including % of African Americas, median household income, and school distance: fast food remained insignificant while convenience, restaurant, supercenter, and median household income had a significant, negative impact on weight and % African American and school distance had a significant positive association with weight.</td>
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### Table 2: Reviewed articles examining food access and obesity among an Appalachian population

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<td>Slack T, et al., 2014</td>
<td>2000-2009</td>
<td>United States</td>
<td>N=3109 U.S. counties in 48 states; 30.3% adults with obesity, 17.1% less than high school education, 4.1% unemployed, 15.4% poor, 9.6% families headed by single mother, 59.8% rural</td>
<td>Cross-sectional; spatial statistical methods</td>
<td>USDA defined food-desert census tracts and number of fast food restaurants per 1000 people (2000 and 2006 data for food-desert, 2009 data for fast food restaurants)</td>
<td>17.3% living in a food desert; 0.6 fast food restaurants per 1000 population. Neither showed a significant association with obesity prevalence. Areas with higher African Americans, unemployment, female-headed families, and less than high school education had significant positive correlations with county obesity while areas with a larger number of available physicians, natural amenities, Hispanic population, population size, population age of 65 and older, and fitness centers had negative correlations with county obesity.</td>
</tr>
<tr>
<td>Flynt A, et al., 2015</td>
<td>2010-2013</td>
<td>PA and NY</td>
<td>N=67 PA counties, 62 NY counties; 28.9% obesity and 10.13% diabetes, 8.68% unemployment, median Household income $49,367</td>
<td>Cross-sectional, observational; Model-based cluster analyses</td>
<td>USDA Food Environment Atlas percent of each county's population in 2010 living in a 'food desert'; without supermarkets or large grocers</td>
<td>16.4% defined as low-access. Large proportion lacking access to supermarkets were generally medium or large fringe metropolitan areas. Large fringe and large central metropolitan counties with significantly lower rates of obesity than those in more rural or suburban clusters.</td>
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<tr>
<td>Schafft, K. A., et al., 2009</td>
<td>1999-2000</td>
<td>Rural PA school districts</td>
<td>N=243 rural school districts, 34% of students within, data including 2-20 year olds</td>
<td>Longitudinal; Inclusion: rural school districts with BMI data; following fifth graders in 1999 to 7th grade in 2001</td>
<td>GIS 10-mile buffer zone around each zip code with one or more large grocery store Missouri Census Data Center's Geographic Correspondence Engine with Census 2000 Geography to calculate food-desert zip codes inside school districts. School districts defined a ‘food desert’ if &gt;50% of population lived in food-desert zip codes.</td>
<td>45 (18.5%) school districts labeled as food-desert. Food-desert school districts had smaller populations, lower per capita income, median family income, income-to-poverty ratios, high school or less education, and more unemployed individuals, students receiving reduced or free lunch, at risk or overweight or overweight students in 1999, and students overweight in 2001. Regression model identifies median family income, percent mobile home residence, and percent incomplete kitchen as significant predictors of food-desert residence. In 1999 data each 1-point increase in % of population residing in food-desert is associated with .06% increase in student at risk or overweight. Median family income and percent food-desert residence are strongest predictors of student risk of overweight. 2001 data, percent residence in food-desert is the only predictor of student risk of overweight, although weaker than 1999.</td>
</tr>
</tbody>
</table>
Locations of studies ranged across the Appalachian region and a United States general study referencing the Appalachian region (Table 1). Most studies did not represent ethnicity/racial breakdown however two were predominately black [85, 142] and one predominately white [84]. For locale of the studies, five were defined as rural [83-86, 143], one urban [142], and one a combination [87].

**Study Measures**

Four of the selected studies used a cross-sectional design [84-86, 142, 143] while the remaining two used a longitudinal design [87] and data with two time points of county-level data [83]. Minimal articles clearly defined their sample as being within the Appalachian region. Utilizing ‘rural’ in search terms opened up to articles in the Appalachian region that weren’t clearly defined in the article. Reviewers determined Appalachian status of the study through Appalachian Regional Commission list of Appalachian counties in comparison to study location [144]. Food access measures included two studies using USDA defined food-desert census tracts [87, 143] and others using participant self-reported perceived food-desert communities [84, 86, 142], county-level number of business, grocery stores, convenience stores, food stores, average travel time to work [83], or an access score using probability of individuals using four types of restaurants [85]. Excess weight was determined by overweight and obesity or high BMI determined through county available, census, or self-reported data.

**Study Analyses**

The included studies were largely cross-sectional [84, 85, 87, 142, 143] with one longitudinal study [142] and one county-level study at two time points [83, 86]. Due to the cross-sectional nature of the majority of studies included, descriptive and bivariate analyses were predominately used for demographic data, food access, and obesity measures. Regression models
were used to identify confounding factors that may predict obesity in various studies [83-85]. This included percentage increases of obesity with changes such as a decrease in food access or increases with increasing number of food stores. One article utilized cluster analyses to cluster counties based on socioeconomic, demographic, and environmental variables to then use ANOVA to compare rates of obesity among their clusters [143]. Longitudinal studies used pre-post changes in diet, access, behaviors via t test, correlations, and regression [83-87, 142, 143].

**Food Access**

Articles used in this review chose various routes of describing access prevalence due to studies utilizing county-wide data with a range of access. Slack et al, utilized USDA census-tract data and number of fast food restaurants per 1000 population to identify 17.3% of United States counties were defined as living in a food-desert [87]. Flynt et al. used USDA Food Environment Atlas to determine that 16.4% of counties within New York and Pennsylvania were low access [143]. For Schafft et al., authors used zip-code business patterns and GIS buffer zone of ten miles to determine that 45 school districts (18.5%) were food-deserts [86]. All participants, in the study by Gufstafson et al., were stated to have labelled themselves as living in a food-desert, where their most accessible foods are from fast food chains [84]. Li et al. describes access in terms of a score including probabilities of students visiting a certain type (convenience, fast food, restaurant, supermarket) and those with a higher score are deemed healthier environments and thus, greater food access [85]. The average scores were found within the -1 to +1 range (total range -5.35 to 5.35), however authors recognized that areas with lower income and higher percentage of African Americans had a larger proportion in the -1 and lower scores [85]. Amarasinghe et al. utilized averages of county data to deem low access, built environments by showing the average total establishments (20.48±5.84 per 1000 population), food stores
(0.88±0.27 per 1000 population), eating and drinking places (1.38±0.64 per 1000 population), and travel time to work (26.12±5.77 minutes) as access variables [83]. Lastly, in the only longitudinal intervention type of study, Dubotiwz et al. identified that from baseline to one-year post supermarket addition in a neighborhood, variables included in ‘perceived access to health foods %’ (easy accessibility, choice, quality and cost to fruits and vegetables, whole grain products, and low fat products), all significantly improved in the intervention group [142]. Within a group of store ‘users’ most perceptions of access improved as compared to those non-users. Improvements in dietary quality weren’t improved in ‘users’ compared to ‘non-users’ [142].

**Obesity and Food Access**

As criteria for the review, each study included obesity measurements among their population with food access issues. Two similar studies showed that their population resided in a food-desert and/or rural area that also had high rates of obesity [84, 85]. Flynt et al. identified that large fringe or large central metropolitan counties had significantly lower rates of obesity as compared to suburban or rural clusters [143]. Likewise, Li et al. acknowledged that in a county with >40% rates of obesity, there was a positive effect of using convenience stores and restaurants with weight status [85]. These results shifted when percentage of African American residents, median household income, and school distance to stores were included. Percent of African Americans and school distance were the only variables with a positive effect on weight status.

Two similar studies identified that with decreasing levels of food access among a population, obesity levels would increase [83, 85]. Amarasinghe et al. identified a one-unit increase in total number of food stores per thousand populations would decrease obesity by 2.6%
[83]. Similarly, Schafft et al. found in both 1999 and 2001 data, residing a food-desert was a strong predictor of risk for overweight [86]. In the 1999 data each 1-point increase in percentage of population residing in a food-desert, there was an associated .06% increase in student’s risk of overweight [86]. Among Alabama students, Li et al. found convenience stores and restaurants had a significant positive association with weight status while supermarkets had a negative effect [85]. However, when controlling for demographic variables, these food places all had a negative association with weight status. In Dubowitz et al., with the introduction of a new supermarket, no significant change was seen with overall diet quality or weight status [142]. However, Gustafson et al. studied a county with obesity rates >40% where although they were concerned with healthy eating, 67% and 65% of participants consumed 2 or less servings of fruits and vegetables per day, respectively [84]. Similarly, to Dubowitz et al. findings, although 15.8% of counties in the United States were found to be high-obesity regions, Slack et al. found that the food environment had no significant association with local obesity prevalence among all U.S. counties, which encompassed those regions with in Appalachia [87].

**DISCUSSION**

Food deserts, and thus food access, has been understudied in the health disparate region of Appalachia. With previous research identifying that this area has the highest prevalence of individuals overweight and obese, food access research plays a prominent role. This study aimed to understand the body of literature behind food access and obesity in the Appalachian region of the United States. Over 480 articles were reviewed and assessed for inclusion into this review. Ultimately, 6 peer-reviewed and 1 gray literature article met inclusion criteria, which demonstrates the minimal amount of research on food access/deserts and obesity across the Appalachian region. A large body of work focuses on urban sprawl and food deserts, food
deserts across the United States, and the use of federal funding agencies within these communities (eg, SNAP-ed) [129, 145-148]. However, this is a disconnect in the research regarding rural, health disparate Appalachia. Within the current studies examined in this review, the majority conclude with statistical associations of increasing obesity levels among rural, food-desert areas that have limited access. Those studies examining food access at a county or state wide level show increasing prevalence of obesity in these areas [83-86, 143] however in studies including all United States counties and urban Pennsylvania, those results were conflicting [87, 142]. Slack et al. found that within all United States counties, food access was not associated with obesity rates. Of the same background, in the urban Pennsylvania neighborhoods who received a new supermarket, BMI remained relatively stable and dietary quality didn’t improve as one would expect [142]. However, this was the only intervention study that met the criteria for the review and results should be taken with caution.

The limited number of studies within this review highlights the need for further exploration of these disparities among this population. An updated study in 2010 from the USDA examining poverty and low access to foods identified that there had been very little change from 2006 to 2010 in distance to a supermarket [75]. Individuals with limited access to a vehicle improved over the years. Contrastingly, individuals in low-income areas with a distance more than 1-mile to a supermarket increased. Noteworthy that rural areas distance to supermarkets and income differ to urban areas: lower income individuals live closer to supermarkets than their moderate-to-high counterparts while this is found to be the opposite in rural locations. Authors follow this summary up by indicating that this study time frame was before policy makers began initiatives to improve food access in 2011 [75].
Strengths and Limitations

Due to variability amongst study measures for food access, conclusive comparisons between studies were unmanageable, and likewise impossible to complete a meta-analysis. A systematic review of food deserts and obesity across United States populations also saw a lack of connection in measurements of food access and obesity that rendered an incomplete conclusion to be drawn [149]. Minimal data and studies available on the topic renders it difficult to capture a full comprehensive look at food access and obesity among Appalachian residents. However, utilizing county and nationwide data allows for a broad picture of the issue in larger populations while smaller scale studies provided support to the understanding of personal an individual needs and perceptions of the populations being examined. Capturing more data in this capacity is important to the lifestyle and quality of life improvements in areas such as Appalachia. Further, the consideration of the populations beliefs and behaviors are vital when directing future interventions.

CONCLUSION

Our comprehensive systematic review provides support for the need of understanding and addressing the gap in food access literature and the impact on chronic disease such as obesity in the Appalachian region specifically. The reviewed articles here provide the support for delving into studying this specific rural population and move toward prospective interventions with a community-based participatory research approach. Future study recommendations to examine food access specifically in the heart of the Appalachian region of West Virginia along with access impacts within a population with obesity.
Declarations

Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable

Availability of data and materials: Not applicable

Competing interests: The authors declare that they have no competing interests.

Funding: This work was supported by West Virginia University Experimental Station Hatch WVA00627 and WVA00641. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of the data; in the writing of the manuscript; or in the decision to publish the results.

Authors’ contributions: Article search was completed by MLB. Inclusion review of articles completed by MLB and RLH. Final review of articles and tie breaking competed by MDO. Manuscript written by MLB, RLH, and MDO. All authors read and approved the final manuscript.
Chapter V: Bariatric Surgery Outcomes in Appalachia influenced by Surgery Type, Diabetes and Depression
Abstract

**Bariatric Surgery Outcomes in Appalachia influenced by Surgery Type, Diabetes and Depression**

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The most effective treatment for morbid obesity and its co-morbidities is bariatric surgery. However, in an area with the highest rates of these health disparities, there is no research examining a population of surgical patients and their weight loss success. Our objective was to examine demographics and surgical outcomes of the population including: weight, body mass index (BMI kg/m²), excess body weight (EBW), percent excess weight loss (%EWL), Beck’s Depression Inventory (BDI) and laboratory values (i.e., hemoglobin A1c (HbA1c), systolic and diastolic blood pressure). A retrospective electronic medical record (EMR) data extraction was performed on patients receiving bariatric surgery at a large tertiary academic medical center within Appalachia between 2013-2017. Descriptive statistics shown in means and standard deviations. Independent t-test, Wilcoxon Rank Sum and Spearman’s Rho used for identifying significant relationships on %EWL. Variables significantly related to %EWL were used in ANOVA and ACOVA model building for examining relationship with %EWL. Average patient population was 92.5% Caucasian, 79.3% female, 62.8% married, 45+11.1 years old, and 75.8% receiving bypass surgery. Average %EWL from baseline to one year follow up was 68.5±18.4% (n=224). In final descriptive models, surgery type, diagnosed diabetes, HbA1c and clinical depression were significant co-variates associated with %EWL. Findings suggest patients completing surgery within an Appalachian region have successful surgical outcomes, as indicated by significant reductions of >50%EWL regardless of other covariates. However, outcomes suggest consideration during bariatric programs for those with diagnosed diabetes and depression. Results will inform future prospective studies, along with specific interventions tailored to address unique needs of this population.

**Keywords:** obesity, bariatric surgery, Appalachia, outcomes

**Abstract Word Count:** 237

**Manuscript Word Count:** 2,144
INTRODUCTION

The Appalachian region has had a well-established reputation of health disparities [133, 134]. The area has been among the highest rates of diabetes, obesity, mental health issues along with economic and infrastructure disparities [23, 133, 150]. Among the highest of these disparities, overweight and obesity rates have remained elevated among Appalachian residents. When combating obesity, behavior, dietary, or lifestyle, interventions are employed on a community-based level. However, for those suffering from morbid obesity (BMI $> 40$kg/m$^2$), which is over 6% of the United States population, behavioral interventions tend to fall short in combating the issue long-term or with only marginal weight improvements [6, 151-153]. Furthermore, in a region such as Appalachia, access to participants to implement interventions can be difficult due to their rural locality. Distances to health care facilities [68], lack of access to a vehicle, lack of support from family and providers, low educational attainment, perceptions of health [115] and specific cultural and family ties that can all impact lifestyle habits and impede health improvements. Solutions to contest these issues may be alleviated with a clinical intervention such as metabolic surgery.

Metabolic, or bariatric surgery, although poorly utilized by individuals meeting the criteria in the United States, has been deemed the most effective treatment for morbid obesity [3, 90, 113, 154, 155]. Primary bariatric procedures performed in the United States include laparoscopic gastric bypass and sleeve gastrectomy [3, 14, 15, 154, 156]. Between 2014 and 2016, total amount of surgeries in the United States increased from 193,000 to 216,000 with gastric bypass currently making up 18.7% and sleeve gastrectomy making up 58.1% [14, 15]. Noteworthy, across the same years, gastric bypass surgeries have declined (-8.1%) while sleeve gastrectomy’s increased (+6.4%) [14, 15]. Influential outcomes of bariatric surgeries such as
significant reductions in excess body weight and declines or remission of co-morbidities (type 2 diabetes, improved quality of life, hypertension, gastrointestinal reflux disease, depression, and others), make bariatric surgery the most effective treatment for individuals with morbid obesity. However, in Appalachia, a region with peak obesity rates and related health disparities, there is a gap in the research regarding bariatric surgery patient populations, their surgical and related outcomes. An article by Bergmann et al. examined how rurality of surgery patients impacted their access to and outcomes of surgery [26]. Authors found that rural status, based on Rural-Urban Commuting Areas, did not have a relationship with surgical weight outcomes or compliance with follow-up appointments [26]. A similar study by Mock et al. examined limited food budgets among bariatric patients to find a significant reduction in weight loss outcomes when on a limited budget at 3-months post-bariatric surgery, however that significance was not found at 12-months post-bariatric surgery [157]. These minimal studies bring about the question of other underlying correlations with baseline patient health, demographics, and behaviors that may be influencing outcomes. Understanding the impact health disparities make on the outcomes of metabolic surgery are poorly understood but vital to recognize.

The objective of the current study was to expand the research and knowledge base supporting bariatric surgery patients located in a health disparate region of Appalachia, and their surgical outcomes of bariatric surgery. To our knowledge, this is the first study to comprehensively describe a large Appalachian bariatric surgery patient population and their surgical outcomes.

METHODS

Approval to conduct research was obtained via West Virginia University Institutional Review Board (#1611355277) in March 2017. Data capturing through a retrospective chart
review of bariatric surgery patients was conducted. A patient query was completed on all patients (n=672), 18 years and older, who had completed all required clearance and received gastric bypass or sleeve gastrectomy surgery between 2013-2017. Researchers completed required HIPAA training for clearance into patient electronic medical records (EMR). Upon EMR clearance, researchers were trained on patient chart navigation and reliability of data capturing. Data collection took place between March-September 2017. Retrieval of information was found in forms of both electronically entered data as well as scanned and uploaded PDF files. All data were entered into a HIPAA compliant RedCap survey and downloaded onto secure hard drive for further data analyses. A second data pass was completed on 2% of charts to ensure data reliability of 85%.

**Study Measures**

Patient EMR data were captured at patient’s initial visit to the bariatric clinic. Baseline demographics, anthropometrics, labs, health history, family history, nutrition habits, and psychological testing scores were recorded. Changes in anthropometrics obtained through follow-up visits logged in patient EMR. Main outcome measure was percent excess weight loss (%EWL) from baseline to one-year follow up. %EWL was calculated as (initial weight – 1-year follow-up weight) / (initial weight – weight at BMI of 25) x 100. Within previous bariatric literature, and a criteria utilized in this study, a %EWL of 50% is loosely considered successful loss after one-year post bariatric surgery. Predictor variables used include surgery type, age, gender, ethnicity, education, marital status, type 2 diabetes, percent follow-up attendance (number of follow-ups attended/determined by amount of follow-ups possible multiplied by 100), diagnosed high blood pressure, diagnosed depression, and cooking responsibilities. In addition, co-morbidities included in analyses were EMR reported diabetes, hypertension and
depression included as they typically are found simultaneously with obesity. Additionally, to the subjective chart declared diabetes, hypertension, and depression, HbA1c lab values, blood pressure values, and BDI scores taken from patient EMR data were used for objective measures of the co-morbidities.

**Statistical Analyses**

All analyses were performed using SAS (SAS®, Version 9.3) [158] and JMP (JMP®, Version Pro 13) [159]. Data were examined for variable specific outliers greater than 3 standard deviations above the mean, which were removed prior to analyses (n=10 outliers). Differences were tested between baseline measures of surgery groups (gastric bypass vs. sleeve gastrectomy). Independent t-test was used for assessing association between %EWL and variables with two groups (Surgery type, Gender, Ethnicity, Education level, State, Marital Status, Diabetic, Diagnosed Hypertension, Diagnosed Depression). ANOVA was used testing for testing hypothesis of equality among more than two groups of categorical variables (education and marital status), and Spearman’s Rho was used for examining correlation of %EWL with continuous variables (age, % Attended follow-up, Systolic Blood Pressure, Diastolic Blood Pressure, HbA1c and BDI). Fisher’s Exact test was used for cell sizes < five. Significant correlations of p<.05 were included in next step of building ANOVA and ANCOVA models to test relationship between %EWL and categorical and continuous predictor variables. Model assumptions of homoscedasticity, normality, and lack of multicolinearity were assessed. Cook’s D influence was set at 0.0227 (4/n). Data with an influence greater than Cook’s D were removed from analysis (n=7). Effect size in models were assessed by change in adjusted $R^2$ values to calculate variance of each variable when placed in the model. ANOVA models computed using PROC MIXED procedure Type III Sum of Squares (SS) in SAS (partial) and ANCOVA models
computed using PROC GLM procedure Type I SS (sequential). In partial SS, the hypothesis to be tested are invariant to the ordering of effects in the model. In sequential SS, order of effects matters and latter effects are being adjusted to previous variable effects in the model. For examples, effect of surgery type on %EWL is adjusted to HbA1c on %EWL. Effect size in final models were assessed by change in adjusted R^2 values to calculate variance of each variable when placed in the model.

**RESULTS**

A total of 582 patient charts were reviewed for data extraction. Thirty-five charts and corresponding data were removed due to type of surgery being a gastric band or revision of previous surgery leaving a sample of n=547. Bariatric surgery patients receiving surgery between 2013-2017, in an Appalachian centered clinic, were predominately 92.5% Caucasian, 79.3% female, 62.8% married, 45±11.1 years old, and 75.8% receiving bypass surgery. When stratifying the population by surgery type, similar demographic breakdowns were seen. No significant demographic differences were found among between two surgery type groups (Table 1). Bypass patients had average baseline weight of 299.9±64.0 pounds, BMI of 48.5±8.1 kg/m^2, and EBW of 146.3±55.5 pounds. Sleeve patients had average baseline weight of 305.0±59.1 pounds, BMI of 49.2±8.0 kg/m^2, and EBW of 150.1±52.7 pounds. Among population EMR reported baseline co-morbidities, diagnosed diabetic (n=174), diagnosed depressed (n=259), and diagnosed hypertensive patients (n=304) were examined. Among these co-morbidities, no significant differences were found among groups at baseline (Table 1; all p>.05). Likewise, no significant differences between surgery groups were found among objective measures of HbA1c, blood pressure, and BDI scores (all p-values >.05). Percent follow up at 1-year appointment was 47% for bypass (n=196) and 30% for sleeve patients (n=40) (p<.001). Average %EWL among
whole sample was 68.80±18.92% and percent body weight loss was 33±8.68% (n=224) with bypass patients achieving higher %EWL than their sleeve counterparts (p<.0001).

Table 1: Descriptive Statistics, by Surgery Type, of Appalachian Bariatric Surgery Patients between 2013-2017 Receiving Surgery in West Virginia

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Bypass</th>
<th>n</th>
<th>Sleeve</th>
<th>p-value</th>
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<td></td>
<td></td>
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<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>407</td>
<td>81 (20)</td>
<td>128</td>
<td>29 (22.7)</td>
<td>0.5012</td>
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<tr>
<td>Female</td>
<td></td>
<td>326 (80)</td>
<td></td>
<td>99 (77.3)</td>
<td></td>
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<tr>
<td>State</td>
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<td></td>
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<td></td>
<td></td>
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<tr>
<td>West Virginia</td>
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<td>128</td>
<td>104 (81.3)</td>
<td>0.8121</td>
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<td>127</td>
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<td>Single</td>
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<tr>
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<td>5 (4.3)</td>
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<td>77</td>
<td>68.1</td>
<td>0.5226</td>
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<tr>
<td>Depression</td>
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<td>53.0</td>
<td>67</td>
<td>59.8</td>
<td>0.2091</td>
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<tr>
<td>Baseline Measures</td>
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<td></td>
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<td>Height (in)</td>
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<td>127</td>
<td>66.0 (3.7)</td>
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<td>Weight (pounds)</td>
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<td>300.3 (64.2)</td>
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<td>306.8 (58.3)</td>
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<tr>
<td>BMI (kg/m²)</td>
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<td>48.5 (8.1)</td>
<td>127</td>
<td>49.4 (7.9)</td>
<td>0.2443</td>
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<tr>
<td>EBW (pounds)</td>
<td>407</td>
<td>146.7 (55.6)</td>
<td>127</td>
<td>151.7 (52.3)</td>
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<tr>
<td>HbA1c</td>
<td>195</td>
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<td>64</td>
<td>6.1 (1.1)</td>
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<td>126.7 (13.7)</td>
<td>123</td>
<td>128.7 (13.7)</td>
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<tr>
<td>Diastolic Blood Pressure</td>
<td>407</td>
<td>78.0 (8.3)</td>
<td>123</td>
<td>77.5 (7.8)</td>
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<td>303</td>
<td>10.4 (9.0)</td>
<td>105</td>
<td>9.4 (10.5)</td>
<td>0.5659</td>
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<td>Year-One Measures</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>188</td>
<td>199.2 (45.3)</td>
<td>36</td>
<td>227.0 (51.0)</td>
<td>0.0006*</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>188</td>
<td>32.8 (5.9)</td>
<td>36</td>
<td>37.4 (7.6)</td>
<td>0.0004*</td>
</tr>
<tr>
<td>EBW (pounds)</td>
<td>188</td>
<td>47.1 (37.5)</td>
<td>36</td>
<td>74.2 (46.3)</td>
<td>0.0003*</td>
</tr>
<tr>
<td>%EWL</td>
<td>188</td>
<td>71.8 (16.8)</td>
<td>36</td>
<td>51.1 (16.6)</td>
<td>&lt;.0001*</td>
</tr>
</tbody>
</table>

Independent t-test was used for assessing association between %EWL and variables with two groups (Surgery type, Gender, Ethnicity, Education level, State, Marital Status, Diabetic, Diagnosed Hypertension, Diagnosed Depression). ANOVA was used testing for testing hypothesis of equality among more than two groups of categorical variables (education and marital status), and Spearman’s Rho was used for examining correlation of %EWL with continuous variables (age, % Attended follow-up, Systolic Blood Pressure, Diastolic Blood Pressure, HbA1c and BDI). Fisher’s Exact test used for cell sizes < 5
*Significant at <0.05 level
Bivariate analyses identified 6 of 15 dependent variables of interest had significant associations (p<.05) with %EWL (Table 2). Surgery type, age, diagnosed diabetes, diagnosed depression, and HbA1c values all found to have a significant association with %EWL (Table 2; all p<.05). As HbA1c and EMR declared diabetes were both significantly related to %EWL, separate models were used to display their effect as they both describe abnormal glucose control. Variables were utilized in further model building to test the influence of each significant identified variable on predicting %EWL at one-year post-bariatric surgery. In a preliminary full screening model, surgery type, EMR reported diagnosed diabetes, depression, and hypertension, and HbA1c value remained significant (Table 2). To further analyze variance of %EWL caused by remaining significant variables. To show variance via changes in adjusted R\(^2\) across significantly correlated variables, five models listed below were developed (Table 3). Both HbA1c and Diagnosed Diabetes measured blood glucose control status and thus, separate models were designed for both:

**Model 1:** \(\%\text{EWL} = \text{surgery type}\)
**Model 2:** \(\%\text{EWL} = \text{surgery type} + \text{Diagnosed Diabetes}\)
**Model 3:** \(\%\text{EWL} = \text{surgery type} + \text{HbA1c}\)
**Model 4:** \(\%\text{EWL} = \text{surgery type} + \text{Diagnosed Diabetes} + \text{Diagnosed Depression}\)
**Model 5:** \(\%\text{EWL} = \text{surgery type} + \text{HbA1c} + \text{Diagnosed Depression}\)

Model 1 examines the main effect of surgery alone on %EWL (F (1,222) = 45.72, p<.0001). Figure 1 shows significantly higher %EWL in bypass patients (72.16±17.44 %EWL) compared to sleeve (51.15±16.62 %EWL) at one-year follow-up (p<.001). Effect of EMR diagnosed diabetes, surgery and interaction between diabetes and surgery on %EWL is depicted in Model 2. Type 3 fixed effects for both surgery (F (1,199) = 44.95, p<.0001) and EMR diagnosed diabetes were significant (F (1,199) = 15.49, p=.0001). Figure 2 represents the main effect of surgery type although interaction between the two were not significant (F (1,199) = 0.38, p=0.5368). Model 3 examines surgery type, EMR diagnosed diabetes, and EMR diagnosed
depression and their interactions. Type 3 fixed effects identify significance among surgery type (F (1,170) = 15.88, p<.0001), diagnosed diabetes (F (1,170) = 5.59, p=.0192), as well as diagnosed depression (F (1,170) = 8.37, p=.0043). All interaction terms between each combination of surgery, diabetes, and depression were found as non-significant (p>.05).

Table 2: Values between percent excess weight loss and other possible associated variables for entry into ANOVA and ANCOVA models

<table>
<thead>
<tr>
<th>Success Variable</th>
<th>Covariates</th>
<th>Test Effect</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>%EWL</td>
<td>Categorical</td>
<td>Surgery type</td>
<td>-6.900</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gender</td>
<td>1.274</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ethnicity</td>
<td>0.397</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Education level</td>
<td>0.455</td>
</tr>
<tr>
<td></td>
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<td>State</td>
<td>-0.106</td>
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<tr>
<td></td>
<td></td>
<td>Marital Status</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Diabetic</td>
<td>-4.015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diagnosed Hypertension</td>
<td>-2.235</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diagnosed Depression</td>
<td>-2.913</td>
</tr>
<tr>
<td></td>
<td>Continuous</td>
<td>Age</td>
<td>-0.258</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Attended follow-up</td>
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<tr>
<td></td>
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<td>Systolic Blood Pressure</td>
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<tr>
<td></td>
<td></td>
<td>Diastolic Blood Pressure</td>
<td>-0.012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HbA1c</td>
<td>-0.313</td>
</tr>
<tr>
<td></td>
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<td>BDI</td>
<td>-0.005</td>
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</table>

Independent t-test was used for assessing association between %EWL and variables with two groups (Surgery type, Gender, Ethnicity, Education level, State, Marital Status, Diabetic, Diagnosed Hypertension, Diagnosed Depression). ANOVA was used testing for testing hypothesis of equality among more than two groups of categorical variables (education and marital status), and Spearman’s Rho was used for examining correlation of %EWL with continuous variables (age, % Attended follow-up, Systolic Blood Pressure, Diastolic Blood Pressure, HbA1c and BDI). *Significant at <0.05 level **Significant at <0.01 level

Among models 4 and 5 (Table 4), EMR diagnosed diabetes was replaced with objective measure of HbA1c blood glucose control. Model 4 (F (3,133) = 9.46, p<.0001), examined main effect of surgery on %EWL while controlling for HbA1c. Model 4 had an R-squared value of 0.31 and found both surgery type and HbA1c had significant relationship with %EWL (p’s<.0001), however, interaction term between surgery and HbA1c was not significant (p=.07). Model 5 (F (7, 110) = 9.46, p<.0001) with an R-squared value of 0.39, examined main effect of surgery type on %EWL while controlling for HbA1c and EMR diagnosed depression. Variables
of surgery type (p<.0001), HbA1c (p<.0001), and diagnosed depression (p=.0229) were all significant, however all interaction combinations were not statistically significant (p>.05).

DISCUSSION

In our study population of Appalachian bypass and sleeve bariatric surgery patients, when examining excess weight loss one-year post-surgery, outcomes were impressive by reaching and exceeding those of current literature. Within each ANOVA and ANCOVA model, figures depicted sleeve patients typically having less %EWL than bypass patients. However, when looking at both diabetes and depression, depiction of %EWL were lower when having a diagnosed of these co-morbidities. However, as we didn’t find significant interactions between our variables in models, which limits the ability to specify that those with co-morbidities had lower amount of %EWL. However, we were able to identify that each variable separately (surgery type, diagnosed diabetes, HbA1c, and diagnosed depression) impact %EWL. Generally, those receiving sleeve surgery, or being diagnosed with diabetes or depression, or having a higher HbA1c test at baseline had lower %EWL. Contrastingly, those receiving bypass, or non-diagnosed with diabetes or depression, or having a lower HbA1c value at baseline had greater %EWL at one-year follow-up. Our data seems to be both similar and contrasting to those of nationwide numbers. Various studies and reviews identify bariatric surgery as aiding in the success of 40-71% EWL post-surgery [156]. Specifically, with diabetic patient receiving sleeve gastrectomy, patients had a 47% EWL which is similar to our findings [160]. The well-known Swedish Obese Subject (SOS) study examined longitudinal weight loss at 20-30% in 2 years [161, 162]. This population had a larger cohort of bypass patients while similarly to a 2003-2015 registry report by the International Federation for Surgery for Obesity and Metabolic Disorders, 49.4% received gastric bypass followed by 40.7% receiving sleeve gastrectomy. Weight loss at
one-year follow-up in this population was 30%. A similar study by Shah et al. examined retrospective data of bypass and sleeve patients. Outcomes of >50% EWL was seen more frequently in those patients who had lower initial BMI, absence of type 2 diabetes, and underwent bypass surgery [163]. Our population data shows similar and exceeding results as compared to these listed studies and national averages for percent excess body weight loss one year after surgery. With this study being the first to our knowledge to examine an Appalachian centered population, more work is warranted on solidifying these results.

**Limitations**

Due to the retrospective nature of data retrieval, some data could not be captured through patient EMR. A significant amount of data was in forms of hand written copies of PDF documents scanned into patient charts. Consequently, illegibility of writing led to areas of incomplete data. Further, our patient population was largely Caucasian females who received bypass surgery. Of these patients a significantly higher amount of bypass patients returned for one-year follow up as compared to sleeve patients. However, this population demographic is largely representative and similar to that of the nation’s bariatric surgery demographic breakdown.

**CONCLUSION**

In summary, this study found that although patients may reside in a health disparate location such as Appalachia, metabolic surgeries are still successful for achieving significant weight loss after one-year follow-up. Although, consideration needs to be taken when supporting individuals with obesity related co-morbidities such as diabetes and depression. Therefore, it is recommended that health practitioners/public health experts endorse metabolic surgery for populations who are morbidly obese, specifically in Appalachian regions, as well as support
individuals with co-morbidities with additional resources for success. However, due to limited longitudinal data regarding this population, future research examining success of behavioral and dietary patterns changes as well as co-morbidity resolution are warranted.
Table 3: Models and Figures 1-3: ANOVA model building and figures of surgery, diabetes, and depression relationship with %EWL outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1 (n=224)</th>
<th></th>
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<th>Model 2 (n=203)</th>
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<th>Model 3 (n=178)</th>
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<tr>
<td></td>
<td>Df</td>
<td>F</td>
<td>p</td>
<td>Df</td>
<td>F</td>
<td>p</td>
<td>Df</td>
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<td>p</td>
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<td>&lt;.0001**</td>
<td>1</td>
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<td>1</td>
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</tbody>
</table>

Model building through ANOVA analyses examining main effect of surgery type (Model 1; Figure 1). Model 2 and Figure 2 depict main effect of surgery type with diagnosed diabetes as well as the interaction term. Model 3 and Figure 3 includes variables of Model 2 with the additional effect of diagnosed depression and interaction terms between surgery type, diabetes, and depression.

*Significance level of <.05
**Significance level of <.01
Table 4: Models and Figures 4 and 5: ANCOVA model building and figures of surgery, HbA1c, and depression relationship with %EWL outcome

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 4 (n=134)</th>
<th></th>
<th></th>
<th>Model 5 (n=111)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Df</td>
<td>SS</td>
<td>F value</td>
<td>p</td>
<td>Df</td>
<td>SS</td>
</tr>
<tr>
<td>Model</td>
<td>3</td>
<td>13248</td>
<td>19.76</td>
<td>&lt;.0001**</td>
<td>7</td>
<td>13672</td>
</tr>
<tr>
<td>HbA1c</td>
<td>1</td>
<td>4285.1</td>
<td>19.17</td>
<td>&lt;.0001**</td>
<td>1</td>
<td>3691.3</td>
</tr>
<tr>
<td>Surgery Type</td>
<td>1</td>
<td>8231.3</td>
<td>36.83</td>
<td>&lt;.0001**</td>
<td>1</td>
<td>7960.8</td>
</tr>
<tr>
<td>Surgery Type*HbA1c</td>
<td>1</td>
<td>732.0</td>
<td>3.28</td>
<td>0.0726</td>
<td>1</td>
<td>732.0</td>
</tr>
<tr>
<td>Diagnosed Depression</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1102.1</td>
</tr>
<tr>
<td>Surgery Type*Diagnosed Depression</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>111.2</td>
</tr>
<tr>
<td>HbA1c*Diagnosed Depression</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>28.5</td>
</tr>
<tr>
<td>Surgery<em>HbA1c</em>Depression</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>46.2</td>
</tr>
<tr>
<td>Error</td>
<td>130</td>
<td>29053</td>
<td>-</td>
<td>-</td>
<td>103</td>
<td>21263</td>
</tr>
<tr>
<td>Corrected Total</td>
<td>133</td>
<td>42301</td>
<td>-</td>
<td>-</td>
<td>110</td>
<td>34935</td>
</tr>
<tr>
<td>Adj R²</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>F-Value</td>
<td>19.76</td>
<td></td>
<td></td>
<td></td>
<td>9.46</td>
<td></td>
</tr>
</tbody>
</table>

In sequential SS, order of effects matters and latter effects are being adjusted to previous variable effects in the model. For examples, effect of surgery type on %EWL is adjusted to HbA1c on %EWL. Model 4 and Figure 4 depict main effect of surgery type with covariate HbA1c (Hemoglobin A1c) values as well as their interaction. Model 5 and Figure 5 includes co-variates of Model 4 with the additional co-variate effect of diagnosed depression and interaction terms between surgery type, HbA1c, and depression.

*Significance level of <.05
**Significance level of <.01
Chapter VI: Food Access Ranking Score among West Virginia Bariatric Surgery Patients
Abstract

Successful Weight Loss after Bariatric Surgery Regardless of Food Access Ranking Score in West Virginia

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In addition to having highest rates of obesity, diabetes, and hypertension, West Virginia Appalachian population has limited food access that may contribute to the prevalence of obesity and potentially mitigate treatments of obesity. This research aimed to identify food access within a cohort of metabolic surgery patients in an Appalachian area, specifically West Virginia. A retrospective data extraction of patients receiving bariatric surgery between 2013-2017 was performed. Variables collected included preoperative weight, demographics, lifestyle and dietary behaviors, and geographical location information. Patient geographical location was identified for West Virginia residing patients through Geographic Information Systems (GIS) to calculate food accessibility. Patients were given a food access ranking score (FARS) between 0 (low food access) and 4 (high food access) based on four criteria of quantity, quality, income, and vehicle access. We examined significant relationships of FARS with patient anthropometrics, demographics, and dietary and lifestyle factors. Patients were predominately 45-year-old, married (60.5%), Caucasian (92.4%), females (77.8%), who received bypass surgery (75.9%). Average FARS for subjects was 1.67±0.73. The highest proportion of patients were located within FARS between low and moderate-low (72.6%). Significant correlations were found among those that were in the minority ethnicity, had a family history of obesity, and were clinically depressed. Due to the homogenous nature of our population, levels of FARS saw similar initial weight before surgery and weight loss after surgery. Those that were non-Caucasian, had diagnosed depression, and those without a family history of obesity were found to be in the lower FARS categories. Future studies examining mixed-method approaches to identify patient perceptions of food access in this population are warranted to understanding the impact that food access is making bariatric surgery outcomes in this health disparate population.

Keywords: food access, obesity, Appalachia, bariatric surgery, health disparate, rural

Abstract Word Count: 284

Manuscript Word Count: 3,224
INTRODUCTION

West Virginia has the highest prevalence of obesity (37.7%) and weight related comorbidities, including diabetes (14.5%), and hypertension (42.7%) in the United States [6-8, 23, 46, 69, 164, 165]. In addition, the locality of the state, within central Appalachian, has unique influences on the food environment and thus, access [23, 46, 83, 117, 166]. The United States Department of Agriculture’s (USDA) definition of a food desert is areas of the country void of fresh fruit, vegetables, and other healthful whole foods [12, 13]. Lack of grocery stores, farmers’ markets, and healthy food providers are evidence of these food deserts [12, 13]. In addition, the USDA employs the criteria of (1) low income and (2) low access to determine United States areas of food deserts. Collaborative work nationwide has shown a significant association between increased rates of obesity with low food access [83-87, 142, 143]. These results are prevalent largely in rural areas and those with a larger amount of minority populations [85]. Specifically, within rural areas such as Appalachia, obesity and food access have been minimally investigated. One study of West Virginia census data found that total number of food stores, business establishments, and mean travel time to work increased rates of obesity among the population [83]. The limited food access in these areas are in part due to rural locality, lower income in the state and lack of vehicle access [74, 83, 145, 167-169]. As dietary change is a common recommendation for weight loss, for those in a health disparate population with limited access to food, following a prescribed or suggested dietary pattern for health purposes may be difficult to achieve and near impossible to sustain [170]. These factors may contribute to the prevalence of obesity and potentially mitigate the treatments for obesity.

A target population needing to follow a specific dietary regimen are post-bariatric surgery patients residing in these food-desert areas. As bariatric surgery is the most effective treatment
for morbid obesity (Body Mass Index of >40kg/m$^2$ or >35kg/m$^2$ with comorbidities) [3, 90, 113, 154, 155], those receiving the surgery in the top ranking state of obesity, West Virginia, are underrepresented within the literature [27]. Lifestyle adjustments after bariatric surgery should change to following a lifelong, healthful, nutritious diet. Therefore, to sustain lifestyle change, access to fresh, healthy, nutritious foods at affordable prices is vital.

The USDA defines a food desert as “areas of the country void of fresh fruit, vegetables, and other healthful whole foods” [75, 76]. This definition specifically uses lack of grocery stores, farmers’ markets, and healthy food providers as evidence of these food deserts [75, 76]. These data are combined with US Census data to create a food desert map in the United States. Criteria for these measured areas of food deserts include low income areas (median household income <80% of state median income or poverty rate of ≥20%) and low access areas (proximity to a grocery store such as > 1 mile in urban areas and > 10 miles in rural) [75-79]. The USDA defines a grocery store with the minimal criteria as one that sells a wide variety of products [75-79]. Further, low access communities are areas also defined by at least 500 persons or 33% of a census tract’s population live more than one mile from a supermarket (10 miles if nonmetropolitan tract) [75-79]. All of these criteria are used to create binary sets for each census tract. However, the USDA definition is void of an important component of understanding the ‘quality’ of food retailers.

The objective of the current study was to examine food access among West Virginia bariatric surgery patients and its correlation with demographic, health history, dietary behaviors, and excess body weight loss percentage one-year after surgery. To our knowledge, this is the first published work looking at this novel approach to capturing a more comprehensive look at food access by incorporating quantity, quality, income, and vehicle transportation access.
METHODS

Approval to conduct research was obtained via West Virginia University Institutional Review Board (#1611355277) in March 2017. Data collection was achieved through a retrospective chart review of bariatric surgery patients. A comprehensive inclusion patient identification was done by a patient query of all bariatric surgery patients (n=672), 18 years and older, who had completed all required clearance and received gastric bypass or sleeve gastrectomy surgery between 2013-2017. All researchers completed required HIPAA training for clearance into patient electronic medical records (EMR). Upon EMR clearance, researchers were trained on patient chart navigation and reliability of data capturing. Data collection took place between March-September 2017. Retrieval of information was in found in forms of both electronically entered data as well as scanned and uploaded PDF files. All data was entered into a HIPAA compliant RedCap survey and downloaded onto secure hard drive for further data analyses. A second data pass was completed on 2% of charts to ensure data reliability of 85% or higher.

Demographics and baseline anthropometrics and labs, health history, family history, nutrition habits, and psychological testing scores were captured via EMR. Main outcome measure was percent excess body weight loss (%EWL) from baseline to one-year follow up. Food Access determined through Geographic Information Systems (GIS) was used as main predictor.

Food Access Measures

The current study utilizes a novel Food Access Ranking Score (FARS) developed by WV FOODLINK GIS experts [117, 118]. Due to the exclusiveness of the map to the state of West Virginia, only patients residing in the state were included in further analyses (n=369). FARS is based on four weighted variables to illustrate the complexity of food access. This map utilizes census block group scales to calculate food access as compared to the USDA census tract usage.
The four variables included in the Food Access Ranking Score (FARS) are (1) quality of retailers, (2) quantity of retailers, (3) income of resident, and (4) vehicle access for transportation.

### Table 1: Food Access Ranking Score (FARS) Description

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of Retailers</td>
<td>Calculated a score for each census block group based upon the presence of absence of a type of retailer and was normalized to create a weighted variable between 0 and 1.</td>
</tr>
<tr>
<td>Quality of Retailers</td>
<td>Calculated by multiplying the number of retailers in each category (SNAP and WIC) times the quality of the retailer and then divided by the highest score to create a normalized weighted variable between 0 and 1.</td>
</tr>
<tr>
<td>Income of Resident</td>
<td>Census block groups were given a score of 0 or 1 based upon the median household income being above or below 80% of the national household median income as it more accurately reflects purchasing power.</td>
</tr>
<tr>
<td>Vehicle Access</td>
<td>USDA data and disaggregated from the census tract scale to the census block group scale. Tracts that had high vehicle access were given a 1 and tracts with low vehicle access were given a 0.</td>
</tr>
</tbody>
</table>

The state of WV requires stores to meet criteria to be able to participate in federally funded programs such as Supplemental Nutrition Assistance Program (SNAP-P = SNAP plus Produce) and Women, Infants and Children (WIC) which plays a role in our quality and quantity variables. The quantity variable (1) calculated a score for each census block group based upon the presence of absence of a type of retailer and was normalized to create a weighted variable between 0 and 1 (Quantity Score Calculation = (WIC*1) + (SNAP*0.2) + (SNAPP*0.5) / 1.7). The quality variable (2) was calculated by multiplying the number of retailers in each category (SNAP and WIC) times the quality of the retailer and then divided by the highest score to create a normalized weighted variable between 0 and 1 (Quality Ranking (highest score possible=7.2) = ((#WIC*1) + (#SNAP*0.2) + (#SNAP-P*0.5)) / 7.2). The income variable (3) was calculated differently from the USDA calculations as well. Rather than using the state median household income, census block groups were given a score of 0 or 1 based upon the median household income being above or below 80% of the national household median income as it more accurately reflects purchasing power.
accurately reflects purchasing power\(^1\). Finally, the vehicle access variable (4) was taken from USDA data and disaggregated from the census tract scale to the census block group scale. Tracts that had high vehicle access were given a 1 and tracts with low vehicle access were given a 0. The FARS was then calculated by summing the weighted variables into a final access score between 0 and 4. Figure 1 represents FARS by heat map color coding. Block groups that scored a zero are shown in red and have little to no food access (do not have access to a quality store of any kind, they have low incomes and low vehicle access), areas in yellow fall in the moderate range of 1 to 2, and groups that scored between a 3 and 4 are shown in green (have each type of quality store, more than one of some of them have household incomes above the national median, and have access to a vehicle).

**Health History and Behavior Measures**

Variables of interest for correlational analyses with FARS were demographics (gender, age, race, education, marital status), family history of obesity and diabetes, patient’s baseline co-morbidities (diabetes, hypertension, high cholesterol), baseline anthropometrics (weight, EBW,
BMI), and follow-up measures (%EWL and % follow-up appointment attendance determined individually by duration since surgery date).

Statistical Analyses

Baseline descriptive statistics in forms of frequency, percent, mean and standard deviation were used. FARS scores initially utilized on a continuous scale were later adapted into quartiles for further analyses to compare differences in the extreme low and high food access areas. Wilcoxon Rank Sum test was used to examine relationship between continuous FARS scores and binary variables; Kruskal-Wallis test was used for comparing FARS scores among multiple categories of categorical variables. Fisher’s Exact test was used for categorical variables when cell sizes were less than 5. Pearson’s Chi-Square test was used for analyses of contingency tables of FARS quartiles (1 and 4) and categorical variables, while Wilcoxon Rank Sum test was used to test differences in continuous variables between the two FARS quartiles.

RESULTS

Other than marital status (p=.026), no significant differences were found among sociodemographic or baseline anthropometrics by surgery type (Table 2). Patients were predominately 45-year-old, married (60.5%), Caucasian (92.4%), females (77.8%), who received bypass surgery (75.9%). Average patient baseline weight was 301.9±62.8 pounds, they had a BMI of 48.5±8.2 kg/m², and an EBW of 147.2±54.8 pounds (total population average data not shown). No significant differences were found between surgery types for baseline co-morbidities or behaviors (Tables 2 and 3). From the total population 24.4% had a family history of obesity, 62.6% had a family history of diabetes, 38.1% had diagnosed diabetes, 65.2% had diagnosed hypertension, 56.2% had diagnosed high cholesterol, and 56.2% were clinically depressed. Among personal dietary and lifestyle behaviors, 57.5% took vitamin and/or mineral supplements,
51% cooked for themselves, 24.7% had a limited food budget, and 54.7% were moderately stressed. No significant differences were seen among behaviors by surgery group (Table 3).

Percent EWL was significantly higher in the bypass patients, however when analyzing relationship of food access to surgery groups, there was lack of evidence of significant relationship. Further analyses combined surgery types due to similarity of populations in food access.

**Table 2: Descriptive characteristics of bariatric patients residing in West Virginia between 2013-2017**

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Bypass n (%)</th>
<th>n</th>
<th>Sleeve n (%)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>280</td>
<td>61 (21.8)</td>
<td>89</td>
<td>21 (23.6)</td>
<td>0.7700</td>
</tr>
<tr>
<td>Female</td>
<td>219</td>
<td>(78.2)</td>
<td>68</td>
<td>(76.4)</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian only</td>
<td>280</td>
<td>259 (92.5)</td>
<td>89</td>
<td>82 (92.1)</td>
<td>1.0000</td>
</tr>
<tr>
<td>Other</td>
<td>21</td>
<td>(7.5)</td>
<td>9</td>
<td>(7.9)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High School or Less</td>
<td>267</td>
<td>95 (35.6)</td>
<td>86</td>
<td>25 (29.1)</td>
<td>0.4002</td>
</tr>
<tr>
<td>Some College or Associates</td>
<td></td>
<td>89 (33.3)</td>
<td>27</td>
<td>(31.4)</td>
<td></td>
</tr>
<tr>
<td>Bachelors</td>
<td></td>
<td>55 (20.6)</td>
<td>25</td>
<td>(29.1)</td>
<td></td>
</tr>
<tr>
<td>Post Grad, Masters, PhD, Law</td>
<td></td>
<td>28 (10.5)</td>
<td>9</td>
<td>(10.5)</td>
<td></td>
</tr>
<tr>
<td>Marital</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>258</td>
<td>42 (16.3)</td>
<td>79</td>
<td>16 (20.3)</td>
<td>0.0226*</td>
</tr>
<tr>
<td>Married</td>
<td></td>
<td>154 (59.7)</td>
<td>50</td>
<td>(63.3)</td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td></td>
<td>40 (15.5)</td>
<td>13</td>
<td>(16.5)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>22 (8.5)</td>
<td>0</td>
<td>(0)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline Comorbidities</th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Hx of Obesity</td>
<td>66</td>
<td>23.6</td>
<td>24</td>
<td>27.0</td>
<td>0.5159</td>
</tr>
<tr>
<td>Family Hx of Diabetes</td>
<td>181</td>
<td>64.6</td>
<td>50</td>
<td>56.2</td>
<td>0.1672</td>
</tr>
<tr>
<td>Diagnosed Diabetes</td>
<td>103</td>
<td>40.7</td>
<td>25</td>
<td>30.1</td>
<td>0.0916</td>
</tr>
<tr>
<td>Diagnosed High blood pressure</td>
<td>158</td>
<td>65.3</td>
<td>52</td>
<td>65.0</td>
<td>1.0000</td>
</tr>
<tr>
<td>Diagnosed High Cholesterol</td>
<td>121</td>
<td>56.8</td>
<td>38</td>
<td>54.3</td>
<td>0.7816</td>
</tr>
<tr>
<td>Diagnosed Depression</td>
<td>129</td>
<td>54.0</td>
<td>48</td>
<td>63.2</td>
<td>0.1850</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anthropometrics</th>
<th>n</th>
<th>Mean (SD)</th>
<th>n</th>
<th>Mean (SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (in)</td>
<td>280</td>
<td>65.8 (3.7)</td>
<td>89</td>
<td>66.3 (3.7)</td>
<td>0.2642</td>
</tr>
<tr>
<td>Weight (pounds)</td>
<td>280</td>
<td>299.7 (62.7)</td>
<td>89</td>
<td>308.9 (63.3)</td>
<td>0.2330</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>280</td>
<td>48.3 (8.1)</td>
<td>89</td>
<td>49.2 (8.3)</td>
<td>0.3925</td>
</tr>
<tr>
<td>EBW (pounds)</td>
<td>280</td>
<td>145.6 (54.2)</td>
<td>89</td>
<td>152.4 (56.7)</td>
<td>0.3560</td>
</tr>
<tr>
<td>FARS</td>
<td>280</td>
<td>1.6 (0.7)</td>
<td>89</td>
<td>1.8 (0.7)</td>
<td>0.1153</td>
</tr>
<tr>
<td>% Attended Follow-up</td>
<td>280</td>
<td>45.9 (34.1)</td>
<td>89</td>
<td>42.3 (30.7)</td>
<td>0.3078</td>
</tr>
<tr>
<td>%EWL (baseline to one-year)</td>
<td>189</td>
<td>72.2 (17.4)</td>
<td>27</td>
<td>49.4 (18.4)</td>
<td>&lt;.0001*</td>
</tr>
</tbody>
</table>

Independent t-test was used for parametric data tests (%EWL). Wilcoxon Rank Sum test was used for examining demographics, height, weight, BMI, EBW, and Food Access Ranking Score (FARS) by surgery type for nonparametric data. Pearson’s Chi-square analysis was used to test associations among categorical variables. Fisher’s Exact test was used for cell sizes < 5.

*Significance level <.05
Table 3: Nutrition and lifestyle behaviors among surgery patient groups at baseline

<table>
<thead>
<tr>
<th>Behavior Variable</th>
<th>Bypass</th>
<th></th>
<th>Sleeve</th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Cooking responsibilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self</td>
<td>93</td>
<td>52.2</td>
<td>30</td>
<td>47.6</td>
<td></td>
</tr>
<tr>
<td>Shared</td>
<td>56</td>
<td>31.5</td>
<td>19</td>
<td>30.2</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>29</td>
<td>16.3</td>
<td>14</td>
<td>22.2</td>
<td>0.5662</td>
</tr>
<tr>
<td>Limited Food Budget</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>41</td>
<td>24.7</td>
<td>14</td>
<td>23.3</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>125</td>
<td>75.3</td>
<td>46</td>
<td>76.7</td>
<td>0.8327</td>
</tr>
<tr>
<td>Daily Stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all/ somewhat stressed</td>
<td>55</td>
<td>28.8</td>
<td>24</td>
<td>35.8</td>
<td></td>
</tr>
<tr>
<td>Moderately stressed</td>
<td>110</td>
<td>57.6</td>
<td>31</td>
<td>46.3</td>
<td></td>
</tr>
<tr>
<td>Very stressed</td>
<td>26</td>
<td>13.6</td>
<td>12</td>
<td>17.9</td>
<td>0.2746</td>
</tr>
<tr>
<td>Taking Vitamin/Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>88</td>
<td>59.5</td>
<td>28</td>
<td>47.5</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>60</td>
<td>40.5</td>
<td>31</td>
<td>52.5</td>
<td>0.4364</td>
</tr>
</tbody>
</table>

Pearson Chi-Square contingency tables were used to find differences among categorical variables
*significance level of <.05

Table 4: Categorical FARS by Surgery Type

<table>
<thead>
<tr>
<th>Food Access</th>
<th>Total n (%)</th>
<th>Bypass n (%)</th>
<th>Sleeve n (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td></td>
</tr>
<tr>
<td>1 (Low)</td>
<td>97 (26.3)</td>
<td>76 (27.1)</td>
<td>21 (23.6)</td>
<td>0.2123</td>
</tr>
<tr>
<td>2 (Moderate-Low)</td>
<td>171 (46.3)</td>
<td>135 (48.2)</td>
<td>36 (40.4)</td>
<td></td>
</tr>
<tr>
<td>3 (Moderate-High)</td>
<td>80 (21.7)</td>
<td>54 (19.3)</td>
<td>26 (29.2)</td>
<td></td>
</tr>
<tr>
<td>4 (High)</td>
<td>21 (5.7)</td>
<td>15 (5.4)</td>
<td>6 (6.7)</td>
<td></td>
</tr>
</tbody>
</table>

Pearson’s Chi-square analysis was used to test food access by surgery type.
*Significance level <.05

Food access was given whole categorical scoring of 1, 2, 3, or 4 with 1 being low access and 4 being high access (Table 4). Within the current population, 72.6% fell in the lesser two categories of low (26.3%) and moderate-low (46.3%) (Table 4).

Significant associations with food access were found among patient ethnicity (Z=-2.16, p<.01), family history of obesity (Z=2.06, p<.05), and diagnosed depression (Z= -2.11, p<.05) (Table 5). Interestingly, although income is playing a role as a variable within the calculation of FARS, a significant correlation with self-reported limited food budget and FARS was not found (Z= -1.05, p=0.29).
Table 5: Correlation Table of Continuous FARS

<table>
<thead>
<tr>
<th>Food Access</th>
<th>Test Effect</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categorical Gender</td>
<td>-0.047</td>
<td>0.9624</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>-2.614</td>
<td>0.0090**</td>
</tr>
<tr>
<td>Education level</td>
<td>0.325</td>
<td>0.9553</td>
</tr>
<tr>
<td>Marital Status</td>
<td>4.109</td>
<td>0.2499</td>
</tr>
<tr>
<td>Family Hx of Obesity</td>
<td>2.065</td>
<td>0.0389*</td>
</tr>
<tr>
<td>Family Hx of Diabetes</td>
<td>-1.585</td>
<td>0.1129</td>
</tr>
<tr>
<td>Diabetic</td>
<td>0.444</td>
<td>0.6564</td>
</tr>
<tr>
<td>Diagnosed High blood pressure</td>
<td>0.332</td>
<td>0.7299</td>
</tr>
<tr>
<td>Diagnosed High Cholesterol</td>
<td>-1.851</td>
<td>0.0642</td>
</tr>
<tr>
<td>Diagnosed Depression</td>
<td>2.109</td>
<td>0.0350*</td>
</tr>
<tr>
<td>Limited Food Budget</td>
<td>-1.047</td>
<td>0.2949</td>
</tr>
<tr>
<td>Taking Vitamin/Minerals</td>
<td>-1.330</td>
<td>0.1834</td>
</tr>
<tr>
<td>Continuous Age</td>
<td>-0.016</td>
<td>0.7553</td>
</tr>
<tr>
<td>Initial Weight</td>
<td>-0.038</td>
<td>0.4696</td>
</tr>
<tr>
<td>Initial EBW</td>
<td>-0.061</td>
<td>0.2458</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.085</td>
<td>0.1029</td>
</tr>
<tr>
<td>Cooking responsibilities</td>
<td>-0.002</td>
<td>0.9809</td>
</tr>
<tr>
<td>Daily Stress</td>
<td>-0.052</td>
<td>0.4039</td>
</tr>
<tr>
<td>% Attended follow-up</td>
<td>-0.009</td>
<td>0.8664</td>
</tr>
<tr>
<td>%EWL</td>
<td>-0.009</td>
<td>0.9096</td>
</tr>
</tbody>
</table>

Wilcoxon Rank Sum test was used for binary variables and Kruskal-Wallis test was used for categorical variables with >2 groups. Spearman rho correlations of food access and continuous variables.

*Significance level <.05
**Significance level <.01

FARS was placed into quartiles to examine differences among lowest and highest quartiles (Table 5). Similarly, to total FARS, significant associations were found among ethnicity Chi-square (1, N=189) = 4.73, p=.03; family history of obesity Chi-square (1, N=189) = 6.52, p=.01; and diagnosed depression Chi-square (1, N=161) = 5.84, p=.02.

Table 6: Categorical FARS by Quartiles

<table>
<thead>
<tr>
<th>FARS</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
</tr>
<tr>
<td>Quartile 1: Low Access</td>
<td>97 (26.3)</td>
</tr>
<tr>
<td>Quartile 4: High Access</td>
<td>92 (24.9)</td>
</tr>
</tbody>
</table>

Figures 2a-c depict relationships of lowest and highest food access with ethnicity/race, history of obesity and depression. Specifically, percentage of patients in the ‘other’ category (African American, Asian, Hispanic, bi-racial) of ethnicity/race was higher in the lower food access as compared to higher food access having higher percentage of White/Caucasian
individuals (Figure 1a; p<.05). Those with a higher family history of obesity were found in larger frequency in highest food access (Figure 2b; p<.05). Those in low food access had higher rates of diagnosed depression as compared to high food access (Figure 2c; p<.05).

Table 7: Correlation Table of low vs high FARS

<table>
<thead>
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<th>FARS</th>
<th>Variables</th>
<th>Test Effect</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categorical</td>
<td>Gender</td>
<td>0.001</td>
<td>0.9810</td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>4.729</td>
<td>0.0297*</td>
</tr>
<tr>
<td></td>
<td>Education level</td>
<td>0.837</td>
<td>0.8406</td>
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<tr>
<td></td>
<td>Marital Status</td>
<td>2.117</td>
<td>0.5485</td>
</tr>
<tr>
<td></td>
<td>Family Hx of Obesity</td>
<td>6.516</td>
<td>0.0107*</td>
</tr>
<tr>
<td></td>
<td>Family Hx of Diabetes</td>
<td>1.471</td>
<td>0.2251</td>
</tr>
<tr>
<td></td>
<td>Diabetic</td>
<td>0.080</td>
<td>0.7777</td>
</tr>
<tr>
<td></td>
<td>Diagnosed Hypertension</td>
<td>0.070</td>
<td>0.7910</td>
</tr>
<tr>
<td></td>
<td>Diagnosed High Cholesterol</td>
<td>3.617</td>
<td>0.0572</td>
</tr>
<tr>
<td></td>
<td>Diagnosed Depression</td>
<td>5.839</td>
<td>0.0157*</td>
</tr>
<tr>
<td></td>
<td>Limited Food Budget</td>
<td>0.054</td>
<td>0.8168</td>
</tr>
<tr>
<td></td>
<td>Taking Vitamin/Minerals</td>
<td>0.910</td>
<td>0.3400</td>
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<tr>
<td></td>
<td>Cooking responsibilities</td>
<td>0.724</td>
<td>0.6962</td>
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<tr>
<td></td>
<td>Daily Stress</td>
<td>2.339</td>
<td>0.3106</td>
</tr>
<tr>
<td>Continuous</td>
<td>Age</td>
<td>-1.099</td>
<td>0.3142</td>
</tr>
<tr>
<td></td>
<td>Initial Weight</td>
<td>0.155</td>
<td>0.8773</td>
</tr>
<tr>
<td></td>
<td>Initial EBW</td>
<td>-0.691</td>
<td>0.9450</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
<td>-0.567</td>
<td>0.5715</td>
</tr>
<tr>
<td></td>
<td>% Attended follow-up</td>
<td>-0.374</td>
<td>0.7090</td>
</tr>
<tr>
<td></td>
<td>%EWL</td>
<td>-0.151</td>
<td>0.8803</td>
</tr>
</tbody>
</table>

Associations (Chi-square test) and correlations (Spearman’s rho) of food access (FARS) with demographics, dietary behaviors, and health history variables of categorical and continuous classification, respectively.

*Significance level <.05

DISCUSSION

Within literature among food access and obesity among Appalachian residents, low food access is correlated with increased obesity rates although some results conflicting [83-87, 142, 143]. The vast majority of studies in this area take place across the United States, with minimal studies in the Appalachian region specifically.

When examining food access among bariatric patients who need access to adequate and nutritious food we utilized a novel approach within the state of West Virginia. Low access ranking score among our population was over 26% while USDA labeled low-income, low-access tracts in West Virginia were a total of 13.2% [77-79]. The difference among our results and
others could be attributed to the WV FOODLINK including quality of stores into scoring food access, not just quantity as USDA defines [117, 118]. This warranted examination of further cohorts to identify the extent of this quality variable among general populations of West Virginians.

Our population was largely homogeneous. All individuals considered in this study had met criteria to have bariatric surgery which requires a similar weight and/or BMI. These criteria also influence similar EBW, health history, and health behaviors. Due to this, levels of FARS saw similar initial weight before surgery and weight loss after surgery. Associations with food access were only present among ethnicity/race, family history of obesity, and diagnosed depression. Those that were non-Caucasian, had diagnosed depression, and those without a family history of obesity were found to be in the lower FARS categories. Similar results seen in a study by Li et al. found that census blocks with >50% African American populations had lower food environment scores as compared to their counterparts [85]. These predominately African American locations also showed higher weight status [85]. Further, large bodies of work have examined the relationship among poor physical health, depression or poor mental health with food insecurity [171-174]. These correlations, although largely represented in the literature, warrant attention when treating patients who have multiple morbidities and are seeking a metabolic intervention that requires access to adequate food and resources afterwards.

Limitations

Because this is a non-traditional approach to addressing food access in West Virginia, the cohort in this study is limited to those in residing in the state who are receiving bariatric surgery. This collaboration is within its infancy and is the beginning of further exploration. This limits the generalizability of the results to the entire WV population. This is also true to the body of work
surrounding food access and obesity specifically in Appalachia. Researchers tend to use various tools to define a low access or food-desert area which limits the comparability of the results. However, further expanding our approach to other samples and cohorts may bring to light a variety of findings outside of these as well. This will allow us to begin understanding the expanse of food accessibility in West Virginia and ultimately, other states.

CONCLUSION

Access to healthy nutritious food, defined predominately in a central Appalachian population, was found to be influential in ethnicity, family history of obesity, and diagnosed depression among post bariatric surgery patients. Specifically, due to their homogeneous nature, limited associations were seen outside of these. This initial utilization of our novel food access ranking score is promising for beginning formative work on West Virginia’s food-desert areas. Within bariatric surgery, implementing educational and resource toolkits during pre-operative programs could enhance their comfortability with major dietary changes needed after surgery. These resources can incorporate how and where to access these foods within their area. Future experimental studies investigating how food access resources or counseling could impact minority races or depressed individuals during their pre-operative journey.
Figure 2a: High and Low FARS Quartiles by Ethnicity/Race

Figure 2b: High and Low FARS Quartiles by Family History of Obesity

Figure 2c: High and Low FARS Quartiles by Diagnosed Depression
Chapter VII: Discussion and Conclusion
Discussion

The purpose of the research in this dissertation was to provide formative research and insight into the underrepresented population of Appalachian based individuals who sought bariatric surgery as a weight loss intervention. The research examined in this dissertation had interesting findings regarding the impact of food access on outcomes of bariatric surgery. Several studies regarding food access and obesity or rural locations indicate that there is a correlation between lower food access and higher rates of obesity [175, 176]. In Chapter 5, it was hypothesized that those patients with lower food access would have poorer outcomes (i.e. %EWL). However, findings suggest that regardless of food access, outcomes were still deemed successful (%EWL of >50%). These findings, albeit surprising, indicate that even in food desert regions bariatric surgery is still successful. Nonetheless, these results do not mean that food access is irrelevant in dietary interventions. Because bariatric surgery is a metabolic tool to significantly reduce weight, and patients were a largely homogenous group at baseline, weight changes at one-year may have been too significant and similar to identify any other changes that may have been seen in a general food desert population.

Equally, reiterating these same results when aiming to identify differences among the population regarding food access saw limited associations. This population began at similar weight, BMI, EBW, and health conditions at baseline which may influence those lesser correlations. However, some variables were found to be associated with food access: ethnicity, diagnosed depression, and a family history of obesity. It is well known in the literature that racial minorities are found to have lower food access. Although the population was largely Caucasian, those non-Caucasian individuals were found to have lower access than their Caucasian counterparts. Similarly, with diagnosed depression, individuals who were non-depressed had
higher food access ranking. Among current literature it is expressed that poor access is associated with areas of lower income, higher disparities, and poorer mental health. This falls in line with the disparities among the Appalachian regions, or those of rural locale. In contrast, those with a family history of obesity had higher food access. This is contrary to literature supporting associations between the paradoxical relationship of obesity and food deserts \[176\]. A body of work examines that those residing in an area with lower access, there is a larger frequency of convenience, dollar, or small box store that rarely sell fresh foods and have a surplus of energy dense snack and meal items \[80, 118\]. This influences higher calorie food consumption in these individuals, and thus increases weight. These aspects are also compounded by limited health care resources, vehicle access, or even opportunities to be physically active. All of these aspects in conjunction can lead to greater health disparities and morbidity or mortality. Ironically, in our population, those with a lower family history of obesity fell in the higher food access category. This opposes that paradoxical relationship of low food access and obesity. However, this does not define this relationship as truth. Our population was similar in baseline weight, BMI, EBW, and health histories so finding associations with food access among initial descriptions were scarce.

Interesting findings from Chapter 4 indicate that surgery type, diabetes and depression were the only indicators of %EWL in our population. Those receiving gastric bypass surgery had larger %EWL than those receiving sleeve gastrectomy surgery (nearly 20% more). A study comparing bypass to sleeve results, Peterli et al. identifies very similar results in %EWL between surgeries \[98\]. However, important to take into consideration the proportion of patients within our bariatric population returning for their one-year follow-up appointments, there were 188 bypass patients (83.9% of patients at one-year) compared to 36 sleeve which is similar to the
overall breakdown of bypass to sleeve patients in the entire sample (75.8% receiving bypass surgery).

Education, health literacy, rural status, and co-morbidities impact the health among the region and, on average, our population fell into these criteria. Although being a largely homogeneous group of individuals meeting a certain criterion to receive bariatric surgery, they also display these similar Appalachian characteristics. When using demographic variables to predict %EWL or association with FARS, no significant relationships were seen. This does not discredit the importance of socioeconomic factors in this region and that they should be considered when preparing future interventions. These aspects may play a role in the accessibility of patients in a rural setting as well as the importance of tailoring interventions to the need of the population.

When examining co-morbidities among the cohort and their %EWL outcomes at one-year follow-up (Chapter 4) we found significant relationships. Those patients who were diagnosed in their EMR as a Type 2 Diabetic had lesser %EWL than those non-diagnosed. Similarly, with diagnosed depression in EMR, patients with a diagnoses had lesser outcomes than those non-diagnosed. When we examined both HbA1c and Beck’s Depression Inventory as objective measures of blood glucose control and depression severity, we found that higher HbA1c values was negatively related to %EWL while BDI scores were found to be unrelated to %EWL. However, when examining interactions between variables and their effect on %EWL, no significant interactions were detected. These results, taken together, identify that separately, these variables are impacting patient %EWL at one-year follow-up, although not having a significant relationship together.
Future Research

Future prospective studies based on this preliminary descriptive examination is warranted for Appalachian patients. Consideration of individuals who present with co-morbid conditions before bariatric surgery, such as diabetes and depression, should receive additional resources, counseling, or education throughout their program. Although bariatric surgery has been found to reduce or alleviate co-morbid conditions, our population with these conditions did see lesser weight loss outcomes than their non-co-morbid diagnosed counterparts.

When examining food access, future research that employs both qualitative and quantitative methods, or a mixed-methods approach, along with the perceptions, descriptions, and factors influencing patient food choices needs to be explored. Within the literature regarding Appalachia, food access and obesity, minimal conclusions can be drawn. The vast majority of the work focuses on defining and locating food deserts within each population. Gufstufson et al. was the one of two studies that examined perception work regarding food access where the population self-reported living in a food desert and how they described their surroundings [84]. Individuals expressed living in a food desert and the barriers they feel when trying to find healthful foods [84]. Another study by Dubowitz et al. examined a natural experiment of a new supermarket in one neighborhood compared to a control [142, 177]. Although specific dietary quality didn’t change, individuals perceived their access to healthier foods greater after the new market came [142]. All remaining studies of food access and obesity in the Appalachian region utilized large-scale data (i.e. county-level census data, GIS data) to examine food environments with no qualitative data included. This provides an avenue for future research in the area along with the novelty of including bariatric surgery patients whose food accessibility and dietary quality are important to understand post-operatively.
Limitations

These studies are not without limitations. The non-experimental retrospective design of this study urges results to be taken with caution. Correlational analyses only identify association among outcomes and patient characteristic, and thus, any cause-and-effect relationship cannot be determined. Among demographics, Caucasian, female patients made up the majority of the population as males and other race and ethnicities were underrepresented. Due to the retrospective nature of the studies, limited clarification on data retrieval could be retrieved. A large quantity of data were entered into patient charts in the form of PDF documents that were hand written by the patient at their initial clinic visit. Further, changes in surgeons came with changes in documentation and thus, missing data point. This reduced some of the sample size however, still gave adequate numbers for analyses. Also, this study aimed to be an overview of the population and their outcomes as a starting point for future examination and analyses which makes this formative research limited in specific conclusions.

Outcome data (%EWL), which a large portion of analyses were based upon, were data from those individuals who attended their one-year follow-up appointments. This could impose an extent of bias in the results due to the fact that these individuals may have taken their success more seriously and believed attending follow-up appointments were important to their attainment of significant weight loss.

Lastly, the novelty of our food access scoring limits comparibility to other food access scoring of its type. Our scoring is exclusive to West Virginia residents and could not be compared across the entire sample size. However, utilizing this scoring to use a qualitative approach capturing perceptions of residents food access will be useful when approaching interventions targeting food access among Appalachian West Virginia residents.
Conclusion

This dissertation aimed to provide a systematic review into the literature on food access and obesity within the Appalachian region, examine the overall population and any specific characteristics of individuals with more successful %EWL, and investigate relationships among patient characteristics and outcomes with their food accessibility score. Findings suggest that those with diagnosed diabetes or depression have lower %EWL after bariatric surgery, while LRYBG overall provided higher %EWL. Among food access ranking scores, those of non-Caucasian race and with diagnosed depression had lower food access ranking while those with a family history of obesity had a higher food access ranking. Generally, minimal correlations in this data set may have been observed due to bariatric surgery being successful among those individuals who our data represented. In out Appalachian population, %EWL met and exceeded some weight loss representations in the literature. A follow-up repeated measures survey on behavioral patterns and patient remission of co-morbid conditions can be worthy moving forward. This will inform longer follow-up duration outcomes and inform a prospective study reaching these Appalachian populations seeking bariatric surgery.
References
References:

5. CDC, Defining Adult Overweight and Obesity | Overweight & Obesity | CDC. 2018.


40. Prevention, C.f.D.C.a. *National Center for Chronic Disease Prevention and Health Promotion, Division of Nutrition, Physical Activity, and Obesity*. Data, Trend and Maps. 2017; Available from:


46. ARC. *The Appalachian Region - Appalachian Regional Commission*. 2018; Available from: [https://www.arc.gov/appalachian_region/TheAppalachianRegion.asp](https://www.arc.gov/appalachian_region/TheAppalachianRegion.asp).


80. WV FOODLINK, W., B et al., Nourishing Networks: West Virginia Community Food Security Assessment. 2016, West Virginia University: Morgantown, WV.


148. Mayle, A.W., The Relationship Between Food Insecurity, Produce Intake and Behaviors, Hemoglobin Levels, BMI, and Health Status Among Women Participating in the West Virginia WIC and WIC FMNP Programs. 2015, Ohio University.


Appendix
Institutional Review Board Approval

West Virginia University
Office of Research Integrity and Compliance

Approval Letter Expedited

Action Date: 03/09/2017
To: Melissa Offert
From: WVU Office of Research Integrity and Compliance
Approval Date: 03/09/2017
Expiration Date: 03/09/2018
Subject: Protocol Approval Letter
Protocol Number: 1611355277
Title: Bariatric Surgery Patient Lifestyle Behavior and Clinical Outcomes

The above-referenced research study was reviewed by the West Virginia University Institutional Review Board IRB and was approved in accordance with 46 CFR 46.101b.

It has been determined that this study is of minimal risk and meets the criteria as defined by the expedited categories listed below:

- Category 5. Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).
- Category 7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, or history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies. [NOTE: Some research in this category may be exempt from the DHHS regulations for the protection of human subjects. See Exempt Categories and 45 CFR 46.101(b)(2) and (3). This listing refers only to research that is not exempt.]

Documents reviewed and/or approved as part of this submission:

Overall HIPAA Waiver_3.8.17.docx: 2017-03-06-05:00
Bariatric consent_3.8.17.pdf: 2017-03-06-05:00
FollowUp_BariatricDataEntry (3).pdf: 2017-03-06-05:00
Bariatric Revisions_3.8.17.docx: 2017-03-06-05:00
Documents for use in this study are available in the WVUir system in the Notes and Attachments section of your protocol.

The Office of Research Integrity and Compliance is here to provide assistance to you from the initial submission of an IRB protocol and all subsequent activity. Please feel free to contact us by phone at 304.293.7073 with any question you may have. Thank you.

WVU Office of Research Integrity and Compliance

Date: 03/09/2017

Signed:

Lilo Ast
Senior Program Coordinator

Once you begin your human subject research, the following regulations apply:

1. Unanticipated or serious adverse events/side effects encountered in this research study must be reported to the IRB within five (5) days via the Notify IRB action.

2. Any modifications to the study protocol or informed consent form must be reviewed and approved by the IRB prior to implementation via submission of an amendment.

3. You may not use a modified informed consent form until it has been approved and validated by the IRB.
# Retrospective Data Collection Survey

<table>
<thead>
<tr>
<th>Variable / Field Name</th>
<th>Section Header</th>
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<td>Patient home address (include zip code)</td>
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<td>Provide name of primary Insurance Provider/Easiest way to find i</td>
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<td>what_was_weight_at_surgery</td>
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<td>What was weight AT SURGERY? You can find this in the note from</td>
</tr>
<tr>
<td>preoploss</td>
<td></td>
<td>How much pre-operative weight loss was achieved?</td>
</tr>
<tr>
<td>if_you_can_t_find_previous</td>
<td></td>
<td>If you can't find previous questions -- Did dietitian reduce calorie</td>
</tr>
<tr>
<td>liquiddiet</td>
<td></td>
<td>How many days was the patients pre-operative liquid diet?</td>
</tr>
<tr>
<td>goodmeasures</td>
<td></td>
<td>Did the patient receive a referral to use Good Measures? (this w</td>
</tr>
<tr>
<td>surgeon_rating_of_patient</td>
<td></td>
<td>Surgeon rating of patient candidacy for surgery? Subjective rating</td>
</tr>
<tr>
<td>psychrate</td>
<td></td>
<td>Psychologist rating of patients candidacy for surgery? Subjective</td>
</tr>
<tr>
<td>rbrate</td>
<td></td>
<td>Dietitian rating of patients candidacy for surgery? Dietitians usual</td>
</tr>
<tr>
<td>age</td>
<td></td>
<td>The following in Age at initial visit</td>
</tr>
<tr>
<td>height</td>
<td></td>
<td>Height</td>
</tr>
<tr>
<td>initialwt</td>
<td></td>
<td>Weight at initial visit</td>
</tr>
<tr>
<td>bmi_at_initial_visit</td>
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<td>BMI at initial visit</td>
</tr>
<tr>
<td>agehighestwt</td>
<td></td>
<td>The following in What age was their highest weight?</td>
</tr>
<tr>
<td>wta18</td>
<td></td>
<td>Weight at age 18</td>
</tr>
<tr>
<td>ethnicity</td>
<td></td>
<td>Ethnicity, choose all that apply</td>
</tr>
<tr>
<td>years_of_education</td>
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<td>Years of education?</td>
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<td>occupation</td>
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<td>Occupation</td>
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<tr>
<td>typeoccupation</td>
<td></td>
<td>Nature of occupation</td>
</tr>
<tr>
<td>maritalstat</td>
<td></td>
<td>Marital status</td>
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<tr>
<td>children</td>
<td></td>
<td>Do you have children?</td>
</tr>
<tr>
<td>noofchild</td>
<td></td>
<td>How many children do you have?</td>
</tr>
<tr>
<td>illegal_drugs</td>
<td></td>
<td>Have you ever used illegal or street drugs?</td>
</tr>
<tr>
<td>illegal_frequency</td>
<td></td>
<td>If you've used illegal drugs was it</td>
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<td>have_you_stopped_using_str</td>
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<td>Have you stopped using street drugs?</td>
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<td>do_you_drink_alcohol</td>
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<td>Do you drink alcohol?</td>
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<td>did_you_have_a_previous_al</td>
<td></td>
<td>Did you have a previous alcohol problem?</td>
</tr>
<tr>
<td>how_often_do_you_drink_alc</td>
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<td>How often do you drink alcohol?</td>
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<tr>
<td>addiction_rehab_or_treat</td>
<td></td>
<td>Have you ever had an addiction problem that required treatment</td>
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<td>which_addiction</td>
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<td>If yes to an addiction problem, please check all that apply:</td>
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<tr>
<td>family_history</td>
<td></td>
<td>Family History</td>
</tr>
<tr>
<td>Condition</td>
<td>Medical Specialty</td>
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<td>-----------------------------------</td>
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<td>Endocrine</td>
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<td>father_age_death</td>
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<td>mother_present_age</td>
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<td>mother_age_death</td>
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<td>siblings</td>
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<td>family_history_disease</td>
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<td>diabetes_current</td>
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<td>do_you_have_asthma</td>
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<td>inhaler_daily</td>
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<td>inhaler_need</td>
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<td>nebulizer</td>
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<tr>
<td>use_oxygen</td>
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<tr>
<td>asthma_hospital</td>
<td></td>
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<td>sleep_apnea</td>
<td></td>
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<tr>
<td>snore</td>
<td></td>
<td></td>
</tr>
<tr>
<td>night_catch</td>
<td></td>
<td></td>
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<tr>
<td>chair</td>
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<tr>
<td>copd</td>
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<td>emphysema</td>
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<td>cardiologist</td>
<td>Cardiac</td>
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<td>highbp</td>
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<td>highbp_med</td>
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<td>irreg hb</td>
<td></td>
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<td>irreg_hb_meds</td>
<td></td>
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</tr>
<tr>
<td>heartattack</td>
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<tr>
<td>abnormal_ekg</td>
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</tr>
<tr>
<td>heart_cath</td>
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<tr>
<td>stressetest</td>
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<tr>
<td>chf</td>
<td></td>
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</tr>
<tr>
<td>heartfail_hospital</td>
<td></td>
<td></td>
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<tr>
<td>angio_stent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>bloodthinner</td>
<td></td>
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<tr>
<td>swelling</td>
<td></td>
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<tr>
<td>dvt</td>
<td></td>
<td></td>
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<tr>
<td>dvt_bloodthin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pulm_embolus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pe_bloodthin</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
varicose  Have you been treated for varicose veins?
ivefilter  Have you ever had an IVC filter placed for blood clots?
stroke  Have you ever had a stroke?
highchol  Have you ever been told that your cholesterol levels are high?
highchol_med  Do you have medication for high cholesterol levels?
higtrig  Have you ever been told that you have high triglyceride levels?
higtrig_med  Do you take medication for high triglyceride levels?
gastroenterologist  GI (Stomach/Int) Have you seen a GI specialist (gastroenterologist) in the past 2 yr?
difficulty_chewing  Do you have frequent difficulty chewing or swallowing?
constipation  Do you suffer from difficulty having bowel movements (constipation)?
diarrhea  Do you have frequent loose stools (diarrhea)?
acid_reflux  Do you suffer from heartburn (acid reflux)?
medications_for_heartburn  Do you routinely take over the counter medications for heartburn?
gerd  Do you take prescription medications for heartburn (GERD)?
hiatal_hernia  Have you ever been told that you have a hiatal hernia (hernia in stomach or duodenal ulcer)
stomach_or_duodenal_ulcer  Have you ever had a stomach or duodenal ulcer?
lactose_intolerant  Are you lactose intolerant?
crohn_s_disease  Have you ever been diagnosed with Crohn’s disease?
ulcerative_colitis  Have you ever been diagnosed with ulcerative colitis?
cirrhosis  Have you ever been diagnosed with cirrhosis?
fatty_liver  Have you ever been diagnosed with fatty liver?
hepatitis  Have you ever been diagnosed with hepatitis?
celiac_sprue  Have you ever been diagnosed with celiac sprue?
pancreatitis  Have you ever been treated for pancreatitis?
previous_weight_loss_surgery  Have you ever had a previous weight-loss surgery?
seizure  HEENT/Neuro Have you ever had a seizure?
seizure_meds  Are you currently taking any medications to prevent seizures?
ms  Have you ever been diagnosed with multiple sclerosis (MS)?
ps  Have you ever been diagnosed with psoriasis?
ps_surgery  If yes to psoriasis, have you received surgical treatment?
arthritis  Have you ever been diagnosed with arthritis? If yes, indicate type
hippain  Do you have hip pain that limits your activity level? If yes, indicate type
kneepain  Do you have knee pain that limits your activity level? If yes, indicate type
anklepain  Do you have ankle pain that limits your activity? If yes, indicate type
shoulderpain  Do you have shoulder pain that limits your activity? If yes, indicate type
backpain  Do you have frequent back pain which limits your activity level?
cane_or_walker  Do you use a cane or walker to help you walk?
scooter_wheelchair  Do you use a motorized scooter or wheelchair?
fibromyalgia  Have you ever been diagnosed with fibromyalgia? If YES, how is it?
cancer  Have you ever been diagnosed with a cancer other than skin cancer?
type_cancer  If YES to being diagnosed with cancer, indicate type
proteinuria  Bladder/kidney Have you ever been told that you have protein in your urine?
kidney_stone  Have you ever had a kidney stone?
urine_leak  Do you have leakage of urine with laughing/coughing/sneezing?
stool_leak  Do you have leaking of stool (feces) with laughing/coughing/sneezing?
uti  Have you ever had a bladder infection (UTI)?
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depression</strong></td>
<td>Have you ever been diagnosed with depression?</td>
</tr>
<tr>
<td><strong>Does your depression</strong></td>
<td>Do you require medications for your depression?</td>
</tr>
<tr>
<td><strong>Is your depression</strong></td>
<td>occasional or episodic?</td>
</tr>
<tr>
<td><strong>Does your depression</strong></td>
<td>prevent you from caring for yourself?</td>
</tr>
<tr>
<td><strong>Does your depression</strong></td>
<td>prevent you from keeping a job?</td>
</tr>
<tr>
<td><strong>Have you ever required</strong></td>
<td>hospitalization for depression?</td>
</tr>
<tr>
<td><strong>Are you currently receiving</strong></td>
<td>care by a psychologist, psychiatrist, or nurse?</td>
</tr>
<tr>
<td><strong>Is your depression</strong></td>
<td>being treated by your family doctor?</td>
</tr>
<tr>
<td><strong>Have you ever been diagnosed with</strong></td>
<td>panic/panic attacks?</td>
</tr>
<tr>
<td><strong>Panic/Anxiety</strong></td>
<td>Do you require medications for anxiety?</td>
</tr>
<tr>
<td><strong>Is your depression</strong></td>
<td>only occasional or episodic?</td>
</tr>
<tr>
<td><strong>Does your anxiety</strong></td>
<td>prevent you from maintaining employment?</td>
</tr>
<tr>
<td><strong>Have you ever required</strong></td>
<td>care by a psychologist, psychiatrist, or nurse?</td>
</tr>
<tr>
<td><strong>Is your anxiety</strong></td>
<td>being treated by your family doctor?</td>
</tr>
<tr>
<td><strong>Have you ever been diagnosed with</strong></td>
<td>having a bipolar disorder?</td>
</tr>
<tr>
<td><strong>Bipolar Disorder</strong></td>
<td>Do you require medications for your bipolar disorder?</td>
</tr>
<tr>
<td><strong>Does your bipolar disorder</strong></td>
<td>prevent you from caring for yourself?</td>
</tr>
<tr>
<td><strong>Does your bipolar disorder</strong></td>
<td>prevent you from keeping a job?</td>
</tr>
<tr>
<td><strong>Have you ever required hospitalization</strong></td>
<td>for bipolar disorder?</td>
</tr>
<tr>
<td><strong>Are you currently receiving</strong></td>
<td>care by a psychologist, psychiatrist, or nurse?</td>
</tr>
<tr>
<td><strong>Is your bipolar disorder</strong></td>
<td>being treated by your family doctor?</td>
</tr>
<tr>
<td><strong>Have you ever been diagnosed with</strong></td>
<td>schizophrenia or any other psychiatric illness?</td>
</tr>
<tr>
<td><strong>Fertility</strong></td>
<td>Have you ever had a fertility workup?</td>
</tr>
<tr>
<td><strong>Are you currently pregnant?</strong></td>
<td>Have you been hospitalized for any form of mental illness or bereavement?</td>
</tr>
<tr>
<td><strong>Are your periods irregular?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Do you have abnormally heavy or prolonged</strong></td>
<td>menstrual periods?</td>
</tr>
<tr>
<td><strong>Have you ever been pregnant?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td>Low iron levels</td>
</tr>
<tr>
<td><strong>High blood pressure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pre-eclampsia</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Are you currently going through</strong></td>
<td>in menopause?</td>
</tr>
<tr>
<td><strong>Are you currently oral contraceptives?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Are you currently using any other</strong></td>
<td>form of contraception?</td>
</tr>
<tr>
<td><strong>Have you ever been diagnosed with</strong></td>
<td>polycystic ovarian disease?</td>
</tr>
<tr>
<td><strong>PCOS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>For your PCOS.</strong></td>
<td>Are you being treated with oral contraceptives?</td>
</tr>
<tr>
<td><strong>Are you being treated with metformin?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Are you being treated with any other</strong></td>
<td>medication(s)?</td>
</tr>
<tr>
<td>**Have you been told that you are infertile?</td>
<td></td>
</tr>
<tr>
<td><strong>Have you ever had any of the following</strong></td>
<td>types of surgery:</td>
</tr>
<tr>
<td><strong>Type medications patient is taking from</strong></td>
<td>surgeries:</td>
</tr>
<tr>
<td><strong>Type in any allergies patient has from</strong></td>
<td>surgeries note</td>
</tr>
<tr>
<td><strong>EPIC</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sitting and reading</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Watching TV</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sitting inactive in a public place</strong></td>
<td></td>
</tr>
<tr>
<td><strong>As a passenger in a car for an hour without</strong></td>
<td></td>
</tr>
</tbody>
</table>
Lying down to rest in the afternoon when circumstances permit
Sitting and talking to someone
Sitting quietly after a lunch without alcohol
In a car, while stopped for a few minutes in traffic
Sleep apnea score

For women: Are you... Are you currently at your highest weight?
If you’re not at your highest weight now, what has been your hi?
Weight one year ago

Age at lowest adult weight
Amount of weight loss you hope to see with surgery?
Your ideal weight following surgery?
Young child
Grade School
High School

18-35 years old
35+ years old

Briefly describe your weight history; has weight gain/loss been g
Briefly describe why you’re seeking bariatric surgery at this time;
Are you currently on a diet for a medical reason?
If yes, please describe
Are you currently or have you in the past worked with a Dietitian
If you are currently or in the past used prescription or over the c
Please list all previous weight loss attempts not already listed (nu
Any food intolerances? Please identify
Do you have any food allergies? Please identify
List any personal, cultural, religious, ethnic practices, or re
Are you a picky eater?
Do you enjoy a variety of foods/trying new things?
What foods do you especially dislike?
List your favorite foods (rank is not important
Any problems with the following (check all that apply)?
Do you currently take any vitamin or mineral supplements?
Please list the name and amount of any vitamin or mineral suppl
Do you use any other Dietary or Herbal Supplements on a regula
Do you use Meal Replacement Products (liquids, bars, etc)?Bst b
Who does your grocery shopping? (yourself, or please indicate o
Who does your cooking (yourself or other, please indicate who)
Are you on a limited food budget or rely on food stamps, food p:
If you do have a limited budget or rely on food stamps, food pan
Do you feel you have a support system in place as you go throu
What is your average hours of sleep per night?
Is your sleep restful?
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you rate your daily stress level</td>
<td>How would you rate your daily stress level</td>
</tr>
<tr>
<td>What things/techniques do you use to manage or reduce stress?</td>
<td>What things/techniques do you use to manage or reduce stress?</td>
</tr>
<tr>
<td>How often do you find yourself eating in response to stress, emotions</td>
<td>How often do you find yourself eating in response to stress, emotions</td>
</tr>
<tr>
<td>List any specific foods you have during those times of stress</td>
<td>List any specific foods you have during those times of stress</td>
</tr>
<tr>
<td>Do you participate in regular exercise (walking, biking, swimming)</td>
<td>Do you participate in regular exercise (walking, biking, swimming)</td>
</tr>
<tr>
<td>What types of activity do you do? List type, frequency/duration</td>
<td>What types of activity do you do? List type, frequency/duration</td>
</tr>
<tr>
<td>If you have any activity limitations, please describe</td>
<td>If you have any activity limitations, please describe</td>
</tr>
<tr>
<td>How would you describe your activity during a typical day at work?</td>
<td>How would you describe your activity during a typical day at work?</td>
</tr>
<tr>
<td>What plans do you have to increase physical activity after surgery</td>
<td>What plans do you have to increase physical activity after surgery</td>
</tr>
<tr>
<td>How many times do you eat a day (on average)?</td>
<td>How many times do you eat a day (on average)?</td>
</tr>
<tr>
<td>Does your meal routine change greatly from weekdays to weekends?</td>
<td>Does your meal routine change greatly from weekdays to weekends?</td>
</tr>
<tr>
<td>How often do you skip meals?</td>
<td>How often do you skip meals?</td>
</tr>
<tr>
<td>Do you often snack, nibble or graze throughout the day?</td>
<td>Do you often snack, nibble or graze throughout the day?</td>
</tr>
<tr>
<td>If you often snack, nibble or graze, please describe snack</td>
<td>If you often snack, nibble or graze, please describe snack</td>
</tr>
<tr>
<td>How long do your meals typically last?</td>
<td>How long do your meals typically last?</td>
</tr>
<tr>
<td>How often do you feel uncomfortably full after eating?</td>
<td>How often do you feel uncomfortably full after eating?</td>
</tr>
<tr>
<td>Where do you typically eat?</td>
<td>Where do you typically eat?</td>
</tr>
<tr>
<td>With whom do you typically eat?</td>
<td>With whom do you typically eat?</td>
</tr>
<tr>
<td>Meals consumed or prepared away from home (including fast food)</td>
<td>Meals consumed or prepared away from home (including fast food)</td>
</tr>
<tr>
<td>How often do you consume convenient foods such as: ready-made meals</td>
<td>How often do you consume convenient foods such as: ready-made meals</td>
</tr>
<tr>
<td>How many servings of fruits or vegetables combined per day are</td>
<td>How many servings of fruits or vegetables combined per day are</td>
</tr>
<tr>
<td>List common fruits/vegetable choices</td>
<td>List common fruits/vegetable choices</td>
</tr>
<tr>
<td>How often do you consume sweets (candy, cookies, cake, etc.)?</td>
<td>How often do you consume sweets (candy, cookies, cake, etc.)?</td>
</tr>
<tr>
<td>How much of the Juice</td>
<td>How much of the Juice</td>
</tr>
<tr>
<td>Regular Soda</td>
<td>Regular Soda</td>
</tr>
<tr>
<td>Diet soda</td>
<td>Diet soda</td>
</tr>
<tr>
<td>Unsweet tea</td>
<td>Unsweet tea</td>
</tr>
<tr>
<td>Sweet Tea</td>
<td>Sweet Tea</td>
</tr>
<tr>
<td>Sweet/unsweet, not specified</td>
<td>Sweet/unsweet, not specified</td>
</tr>
<tr>
<td>Coffee</td>
<td>Coffee</td>
</tr>
<tr>
<td>Decaf coffee</td>
<td>Decaf coffee</td>
</tr>
<tr>
<td>Milk</td>
<td>Milk</td>
</tr>
<tr>
<td>Water</td>
<td>Water</td>
</tr>
<tr>
<td>How often do you have a drink containing alcohol?</td>
<td>How often do you have a drink containing alcohol?</td>
</tr>
<tr>
<td>How many drinks containing alcohol do you have on a typical day?</td>
<td>How many drinks containing alcohol do you have on a typical day?</td>
</tr>
<tr>
<td>Do you currently use tobacco products</td>
<td>Do you currently use tobacco products</td>
</tr>
<tr>
<td>Did you use tobacco products in the past?</td>
<td>Did you use tobacco products in the past?</td>
</tr>
<tr>
<td>Which tobacco products do you currently use. Check all that apply</td>
<td>Which tobacco products do you currently use. Check all that apply</td>
</tr>
<tr>
<td>Of your preferred use of tobacco, indicate the amount you use</td>
<td>Of your preferred use of tobacco, indicate the amount you use</td>
</tr>
<tr>
<td>Have you previously quit using tobacco? (If yes, when?)</td>
<td>Have you previously quit using tobacco? (If yes, when?)</td>
</tr>
<tr>
<td>List which of your current eating and lifestyle habits will be the t</td>
<td>List which of your current eating and lifestyle habits will be the t</td>
</tr>
<tr>
<td>List which of your current eating and lifestyle habits are going to be</td>
<td>List which of your current eating and lifestyle habits are going to be</td>
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<tr>
<td>List any changes you have made in the past 3-6 months to be healthy</td>
<td>List any changes you have made in the past 3-6 months to be healthy</td>
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<tr>
<td>List something you are planning to start working on this month if you</td>
<td>List something you are planning to start working on this month if you</td>
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<td>Type 24-hour food recall from dietitian note</td>
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<td>The following is Gromally Binge Eating Score</td>
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mdl_health_locus_chance
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threefactor_dishinhibition
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brief_cope_score_least
becks_depression_inventory
becks_anxiety_inventory
audit_c_score
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systolic_blood_pressure
diastolic_blood_pressure
blood_o2_saturation
pulse
baseline_blood_glucose_meas
hemoglobin_a1c
calcium
albumin
total_protein
sodium
potassium
co2
chloride
bun
creatine
alp
alt
ast
bilirubin
total_cholesterol
triglycerides
hdl
ldl
vldl
rbc
hemoglobin
hematocrit
wbc
platelet
ferritin
total_iron_binding_capacity
iron
folate
thyroid_stimulating_hormone
vitamin_b12

The following question was asked:

Date of baseline (initial visit lab)?

Systolic Blood Pressure - baseline
Diastolic Blood Pressure - baseline
Blood O2 saturation - baseline
Pulse - baseline
Baseline Blood Glucose Measure - baseline
Hemoglobin A1C (%) - baseline
Calcium - baseline
Albumin - baseline
Total Protein - baseline
Sodium - baseline
Potassium - baseline
CO2 - baseline
Chloride - baseline
BUN - baseline
Creatinine - baseline
ALP - baseline
ALT - baseline
AST - baseline
Bilirubin - baseline
Total Cholesterol - baseline
Triglycerides - baseline
HDL - baseline
LDL - baseline
VLDL - baseline
RBC - baseline
Hemoglobin - baseline
Hematocrit - baseline
WBC - baseline
Platelet - baseline
Ferritin - baseline
Total Iron Binding Capacity - baseline
Iron - baseline
Folate - baseline
Thyroid Stimulating Hormone (TSH) - baseline
Vitamin B12 - baseline
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hemoglobin2_cd2
hematocrit2_4f6
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ferritin2_715
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vitamin_d2_305
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diastolic_blood_press2_2fa
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calcium2_b2f
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creatine2_78f
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alt2_301
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BUN - 9 month
Creatinine - 9 month
ALP - 9 month
ALT - 9 month
AST - 9 month
Bilirubin - 9 month
Total Cholesterol - 9 month
Triglycerides - 9 month
HDL - 9 month
LDL - 9 month
VLDL - 9 month
RBC - 9 month
Hemoglobin - 9 month
Hematocrit - 9 month
WBC - 9 month
Platelet - 9 month
Ferritin - 9 month
Total Iron Binding Capacity - 9 month
Iron - 9 month
Folate - 9 month
Thyroid Stimulating Hormone (TSH) - 9 month
Vitamin B12 - 9 month
Vitamin D3, total - 9 month
Weight at 1 year post
BMI - 1 year
Systolic Blood Pressure - 1 year
Diastolic Blood Pressure - 1 year
Blood O2 saturation - 1 year
Pulse - 1 year
Blood Glucose Measure - 1 year
Hemoglobin A1C (%) - 1 year
Calcium - 1 year
Albumin - 1 year
Total Protein - 1 year
Sodium - 1 year
Potassium - 1 year
CO2 - 1 year
Chloride - 1 year
BUN - 1 year
Creatinine - 1 year
ALP - 1 year
ALT - 1 year
AST - 1 year
Bilirubin - 1 year
Total Cholesterol - 1 year
Triglycerides - 1 year
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pulse_2_9f0
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ast_2_7e5
bilirubin_2_0b7
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vldl_2_2b1
rbc_2_499
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hematocrit_2_3cc
wbc_2_de9
platelet_2_42d
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hematocrit_2_3cc
wbc_2_de9
platelet_2_42d
ferritin_2_d01
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iron_2_067
folate_2_8ce
thyroid_stimulating_h2_ab8
vitamin_b12_2_6d1
vitamin_d2_5f5
weight_at_2_year_post
bmi_2_year
systolic_blood_pressure_2_9fa
diastolic_blood_pressure_2_c98
blood_o2_saturation_2_9f6
pulse_2_9f0
baseline_blood_glucose_2_1d5
hemoglobin_a1c_2_5a9
calcium_2_b2b
albumin_2_aeb
total_protein_2_277
sodium_2_0cf
potassium_2_4c8
c02_2_60b
chloride_2_3d8
bun_2_5c9
creatinine_2_568
alp_2_869
alt_2_c53
ast_2_7e5
bilirubin_2_0b7
total_cholesterol_2_346
triglycerides_2_59a
hdl_2_0cc
ldl_2_8cb
vldl_2_2b1
rbc_2_499
hemoglobin_2_d34
hematocrit_2_3cc
wbc_2_de9
platelet_2_42d
ferritin_2_d01

Ferritin - 18 month
Total Iron Binding Capacity - 18 month
Iron - 18 month
Folate - 18 month
Thyroid Stimulating Hormone (TSH) - 18 month
Vitamin B12 - 18 month
Vitamin D3, total - 18 month

Date of 2 year assessment/notes/labs?

Date of 3 year assessment/notes/labs?
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<th>Variable</th>
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Makenzie L. Barr, BS, RDN, LD
mbarr6@mix.wvu.edu
Updated 3/24/2018

Education

Ph.D. Student in Animal and Nutritional Sciences  
Faculty Advisor: Dr. Melissa D. Olfert  
*West Virginia University, Morgantown, WV*

Registered Dietitian  
Individual Supervised Practice Pathway  
*University of Arizona, Tucson, AZ*

B.S. Degree in Human Nutrition and Foods  
Minor: Food Science and Technology  
*West Virginia University, Morgantown, WV*

Honors & Awards

E.J. Van Liere Oral Presentation  
Graduate Student Enhancement Grant  
Davis College PhD Travel Grant  
Rural Health Conference Scholarship  
Graduate Student Enhancement Grant  
WVCTSI/ATRN Annual Conference Travel Award  
Dean’s List  
Undergraduate Research Day Presenter  
President’s List

Memberships and Affiliations

Healthy Campus Research Consortium  
• Information, Data, and Outputs Committee  

*Society for Nutrition Education and Behavior (SNEB)*  
• Student Committee Member – Social Media Committee  
• Student volunteer

American Society for Nutrition (ASN)  

Academy of Nutrition and Dietetics (AND)  

Phi Sigma Pi National Honors Fraternity  
• Social Committee Co-chair

Student Academy of Nutrition and Dietetics (SAND)  
• Volunteered and attended local nutrition related activities

2017-current

2014-current

2015-current

2012-current

2012-2013
Work Experience

Graduate Research Assistant 2014-current
- Self-driven student with capabilities to learn new skills and concepts quickly
- Thrives under pressure, balancing Ph.D. course work and research endeavors
- Work under Assistant Professor on multiple nutrition related research projects
- Constantly working in group settings
- Campus Coordinator on large USDA funded multi-state grant: Get Fruved
- Skills in various computer programs. Analyze and present data

Graduate Teaching Assistant 2015-2018
- Worked, interacted, and led nutrition courses with undergraduate students of all ages and ethnicities
- Graded and kept track of student’s grades and assignments
- Formed professional and working relationships with students
- Lectured and mentored graduate students in Maternal and Child Nutrition

Dietetic Internship 2016-2017
- Completed 1200 hours of supervised practice within the realms of community, foodservice, and clinical nutrition
- Personalized all rotations individually
## Presentations and Publications


8. Hagedorn RL, **Barr ML**, Olfert MD. WISH4CAMPUS: Initial Investigation of Food Insecurity Prevalence and Outcomes at West Virginia University. Annual Adolescent and Young Adult Research Symposium. Pittsburgh, PA. May 2017

9. Morris AM, **Barr ML**, Hagedorn RL, Clark RL, Horacek T, Olfert MD. Characteristics of the Built Environment at West Virginia University. Annual Adolescent and Young Adult Research Symposium. Pittsburgh, PA. May 2017


37. Bowyer D, **Barr ML**, Olfert MD. Identifying Effectiveness of Twitter at West Virginia University when Targeting a Large Audience. Undergraduate Research Day at the Capitol (URDC), Charleston, WV. Feb. 25, 2016.


39. **Barr ML**, White JA, Famodu OA, Olfert MD. 'Get Fruved': Overview, recruitment and training in West Virginia for a peer-led, social marketing campaign aimed at increasing healthier lifestyles on college campuses. Appalachian Translational Research Network (ATRN), Charleston, WV. October 14-16, 2015. (Travel award $200)


