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Morbid Obesity in Children 12-18 Years and Bariatric and Nonpharmacologic Influence and Interaction

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This is to certify that the doctoral dissertation by

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Abstract

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MBA, Kennesaw State University, 2009

MS, The University of Texas at Dallas, 2000

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health

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Abstract

The prevalence of obesity, particularly morbid obesity in children and adolescents, continues to rise in the United States despite existing studies and intervention programs. Reports have shown that the obesity rate is more than 18% among 12 to 18-year-olds. Children who are morbidly obese are 5 times more likely to carry the condition into adulthood and are more likely to have shorter life expectancies of up to 14 years than their normal-weight peers. The purpose of this study was to investigate the influence of bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age living in the U.S. and who have metabolic syndrome. This study was guided by the social ecological model. The research questions focused on whether bariatric surgery, diet, physical activity, age, gender, race, and their interactions influenced morbid obesity. A quantitative retrospective study design was employed with a sample size of 242. Logistic regression statistical analyses were conducted. Diet ($p < .05$) was a statistically significant predictor of morbid obesity; bariatric surgery ($p > .05$) and physical activity ($p > .05$) were not. The positive social change implication of this study is that it can lead to finding more effective obesity prevention or intervention programs to address the rising morbid obesity in children and adolescents and it can lead to future studies that seek to inform better obesity intervention programs.

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Dedication

I dedicate this dissertation to my mom, Lolo Florence A. Osuoha, in honor of her memory and the inspiration she instilled in me that it is rewarding to always make a positive social change by lifting individuals and communities needing better health and life. I also dedicate my work to my dad, Chief Bernard E. Osuoha, whose relentless efforts in helping people are the source of my passion for public health.

Acknowledgments

First, I thank God for His Grace and for giving me the strength to pedal through this arduous but rewarding journey. I sincerely thank my amiable chair, Dr. Shawn Munford, for his guidance and support, without which this journey would not have been possible. I thank my committee member, Dr. Hadi Danawi, whose feedback, and advice challenged and propelled me to reach the finish line. I also thank my URR, Dr. Naoyo Mori for reviewing this dissertation. I will always be indebted to their commitment to seeing that I succeeded.

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Lastly, I thank my friends and my community for their understanding and accommodation of the many times I missed meetings and social events that are important to them. Their support and prayers were encouraging.

This dissertation used data from the Teen-LABS study. The Teen-LABS study was conducted by the Teen-LABS Investigators and supported by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). The data from the Teen-LABS study reported here were supplied by the NIDDK Central Repository. This manuscript was not prepared in collaboration with Investigators of the Teen-LABS study and does

not necessarily reflect the opinions or views of the Teen-LABS study, NIDDK Central Repository, or NIDDK.

Table of Contents

List of Tables

Chapter 1: Introduction to the Study

Introduction

The rising prevalence of obesity and its comorbidities, particularly severe or morbid obesity in children and adolescents in the United States, has reached alarming levels despite many studies and progress made on intervention programs. Seventeen percent of United States children are obese (Sanyaolu et al., 2019). Reports have shown that the prevalence of obesity worldwide has continued to increase at a rate that is concerning over the past 4 decades and that the United States and the European regions have the highest obesity rates (Boutari & Mantzoros, 2022) The United States ranks 12^{th} globally in obesity level (36.2%) and first among the Organization for Economic Co-operation and Development (ProCon.org, 2020). Obesity has been linked with many health conditions, including heart disease, stroke, diabetes, high blood pressure, high cholesterol, and some forms of cancer (Murtis, 2019; Sanyaolu et al., 2019). Obesity has also been linked with metabolic syndrome, which can cause Type 2 diabetes and heart and blood vessel disease (Mayo Clinic, n.d.). Murtis (2019) noted that the social effects of obesity include discrimination, lower wages, lower quality of life, vulnerability to depression, and other physical problems.

The rising obesity prevalence in the United States has affected the healthcare system, families, and communities, particularly children. In 2015-2016, obesity prevalence was over 18% among U.S. children and adolescents, nearly 21% among 12 to 19-year-olds, 18% among 6 to 11-year-olds, and 14% among 2 to 5-year-olds (Sanyaolu et al., 2019). Additionally, 2015-2016 data specified that obesity prevalence among children and adolescents 12 to 17 years old was 18% (Wisconsin Health Atlas, n.d.). However, Sanyeolu et al. (2019) and the Wisconsin Health Atlas reports (n.d.) revealed that the average obesity rate among children and adolescents 12 to 18 years old is higher than 18%. Additionally, report has shown that 12- to 18-year-olds who are morbidly obese, have over 13% higher risk of suffering high blood pressure, about 6% suffer impaired glucose, and nearly 9% suffer metabolic syndrome (American College of Obstetricians and Gynecologists, 2017). More than 12.7 million American children and adolescents are obese; children who are obese are five times more likely to carry the disease into adulthood, and obesity costs the United States about $147 billion each year (Healthline, 2022).

In a study that addressed the association of childhood obesity with the risk of early all-cause and cause-specific mortality, Lindberg et al. (2020) found that individuals who had obesity in childhood had a three times higher risk of mortality in early adulthood compared with a population-based comparison group. Several reports have indicated that severe or morbid obesity is associated with a more serious health burden and mortality rate (Abdelaal et al., 2017; Ghanta et al., 2017). Morbidly or severely obese teens and adolescents can carry the disease into adulthood and have shorter life expectancy than their normal-weight peers – 6.5 years shorter life for a body mass index (BMI) of 40 to 44.9 kg/m2 to 13.7 years shorter life for a BMI of 55 to 59.5 kg/m2 (Himelstein, 2017).

In this study, morbid obesity is used synonymously with severe obesity; as such, morbid obesity is used throughout the rest of the document to represent either morbid obesity or severe obesity. Morbid obesity is classified as having a BMI greater than 40 kg/m² or a BMI greater than 35 kg/m² with one or more obesity-related condition or more than 100 pounds over ideal body weight (Welcome, 2019). A BMI at or above 120% of the 95th percentile is deemed morbid obesity in children and adolescents (Burton et al., 2020; Ruiz et al., 2019). Ruiz et al. (2019) noted that data collected by the National Health and Nutrition Examination Survey between 2015-2016 revealed that in the United States, 18.5% of youths aged 2 to 19 years were obese, and 5.6% of those obese were morbidly obese. High morbid obesity prevalence presents a more significant health burden among certain ethnic groups than others. More specifically, among Hispanics and non-Hispanic Black adolescents, morbid obesity prevalence was approximately 12% compared to 7% for non-Hispanic Whites (Ruiz et al., 2019).

In Chapter 1 of this study, I discussed the study background, problem statement, purpose of the study, the research questions and hypotheses, theoretical framework, and variable definitions and other relevant terms.

Background

Although there are studies that have examined the impact of weight-loss surgery or lifestyle modification on morbid obesity in children and adolescents, there is a gap in knowledge about the influence of combined bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Most adolescents and children who underwent bariatric surgery experienced significant and sustained weight loss; however, many still had a BMI in the overweight and obese levels (Greenhill, 2017). A health essentials report noted that people could start gaining weight 12 to 18 months after surgery (Cleveland Clinic, 2019). Additionally, Castelnuovo et al. (2017) described that significant weight regains of lost weight occurs within 1 year of treatment, and treated obese patients can return to baseline weight before treatment within 3 to 5 years after treatment. Castelnuovo et al. and the Cleveland Clinic (2019) agreed that weight regain can occur after weight loss surgery. As such, both Castelnuovo et al. and the Cleveland Clinic justified the need to investigate the combined influence of bariatric surgery and nonpharmacological factors such as diet, physical activity, and their interactive effects on morbid obesity in children and adolescents 3 years postsurgery. Zeratsky (2020) noted that adequate preparation can help surgery be an effective obesity treatment. Furthermore, Zeratsky revealed that it is essential to combine surgery with lifestyle changes to avert weight regain.

Despite the controversy and safety concerns surrounding surgery procedure for children and adolescents with obesity, reports have shown that the benefit of bariatric surgery outweighs the negative consequences (Burton et al., 2020). Burton et al. (2020) noted that if morbid obesity is left untreated, it can cause severe medical and psychological health problems in children and adolescents. Burton et al. described that an early intervention that includes bariatric surgery, diet, and physical activity is needed to reverse the deadly effects of a more serious case of obesity. Despite the reluctance to allow weight loss surgery on children due to safety concerns, multiple reports described that bariatric surgery is safe, effective, and long-lasting for morbidly obese children and adolescents when the procedure is performed by experienced experts and under strict conditions (Halloun & Weiss, 2022; Khattab & Sperling, 2019; Penn Medicine, 2019;

Pratt et al., 2018). Children and adolescents who are morbidly obese are at significant risk of developing severe health problems, including heart disease, hypertension, stroke, diabetes, and cancer (Halloun & Weiss, 2022; Khattab & Sperling, 2019; Penn Medicine, 2019; Pratt et al., 2018). Halloun and Weiss (2022) described that the conditions for recommending bariatric surgery include a BMI > 35 kg/m2 or > 120% of the 95th percentile and a comorbidity such as Type 2 diabetes, obstructive sleep apnea, or hypertension or and a BMI > 40 kg/m2 or > 140% of the 95th percentile.

By investigating the influence of combined bariatric surgery and nonpharmacologic factors (diet, physical activity) and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States, I examined the main and the interaction effects of bariatric surgery and nonpharmacologic factors (diet, physical activity) on the dependent variable (morbid obesity) 3-years postsurgery. The goal was to determine whether the influence of surgery and the nonpharmacological factors and their interactive effects held down morbid obesity 3 years postsurgery in the study population.

Based on the current literature, there is a more focused need on intensive lifestyle modification such as diet and physical activity or administration of bariatric surgery individually to control obesity but less on integrated bariatric surgery and nonpharmacologic factors including lifestyle modification and their interactive effects (Srivastava et al., 2019). Lindberg et al. (2020) supported continued efforts to find improved treatment for obesity in children and adolescents. For moderate to morbid obesity and the associated comorbidities, weight loss surgery has shown to be the most effective treatment to create sustainable changes in metabolic imbalances (Campoverde Reyes et al., 2018). However, Campoverde Reyes et al. recommended that further studies are needed to ensure that weight loss surgery is used for those patients who stand to gain the most benefit. Further supporting the need for future studies, Burton et al. (2020) described that 7% of adolescents who qualified for bariatric surgery had binge eating disorder, which is a psychological disorder, thus further supporting the need for this study.

The American Society for Metabolic and Bariatric Surgery asserted that adolescents with Class II obesity (BMI > 120% of the 95th percentile) and a diagnosed comorbidity or with Class III obesity (BMI ≥ 140% of the 95th percentile) require bariatric surgery (as cited in Pratt et al., 2018). Moreover, Ottley et al. (2018) stressed the need for testing a hypothesized synergy of strategies, which suggested a need for more investigation of combined health strategies or programs and policies to combat obesity prevalence. Additionally, Campoverde Reyes et al. (2018) noted that weight loss surgery is underused despite being the most effective treatment to create sustainable changes in metabolic imbalances. The rising prevalence of obesity over the past 3 decades, particularly with the high rate of morbid obesity in children, requires more aggressive combination therapies that include behavioral modification and surgical interventions (Czepiel et al., 2020).

Bariatric surgery is a tool for losing weight but using it alone cannot address obesity long-term; bariatric surgery is needed along with diet and exercise to maintain weight loss (Cleveland Clinic, 2019). Based on the literature, a combined influence of the surgical and nonpharmacologic factors and the interaction effects can lead to a potential intervention program that can help maintain a downward trend of morbid obesity prevalence. Therefore, more research is needed to address the existing gap by examining not only the individual influence of the factors but an examination of the combined influence and interactive effects of bariatric surgery and nonpharmacologic factors on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Multiple studies have noted that the rising obesity prevalence has necessitated the search for a more efficient pharmacological intervention to manage obesity (Higuera-Hernández et al., 2018; Joshi & Adhikari, 2018). However, pharmacological approaches have faced challenges or, in some cases, have failed to sustain obesity management partly due to the multiple-factor interactive nature of obesity (Higuera-Hernández et al., 2018; Joshi & Adhikari, 2018). Higuera-Hernández et al. (2018) argued that considering that the pharmacological approach is faced with somber challenges in developing effective obesity management, the nonpharmacological method, which includes diet and physical activity, can be used to achieve efficient obesity management. By noting the challenge, the pharmacological approach has posed in finding proper and efficient management of obesity. Joshi and Adhikari (2018) supported Higuera-Hernández et al.'s (2018) argument that nonpharmacological interventions can be used to effectively manage obesity. The nonpharmacological factors examined in this study included diet and physical activity.

Reports have highlighted that it is essential to establish healthy diets and health-related behavior and healthier food choices in early childhood. Unhealthy food choices such as energy-dense foods like high-fat foods, sugar, and sweetened beverages, excess food consumption, and unbalanced food intake among adolescents exacerbate obesity development (Kim & Lim, 2019; National Collaborative on Childhood Obesity Research [NCCOR], n.d.). Making a progressive effort in advancing the prevention of childhood obesity requires understanding how dietary behaviors are associated with other factors that affect obesity, and how these factors influence obesity intervention (NCCOR, n.d.). Changing problematic dietary influences require modification of dietary risk stemming from nutrients, foods, dietary patterns, and dietary behaviors (Kim & Lim, 2019). The Centers for Disease Control and Prevention (CDC) provided information that a healthy eating plan should stress fruits, vegetables, whole grains, and low-fat milk; include protein foods such as seafood, lean meat, and soy products; and be low in sugar, sodium, and saturated fats (CDC, 2022b).

Physical activity, though sometimes used interchangeably with exercise, is different from exercise. Physical activity involves any body movement that burns calories, for example, walking, biking, or daily commute, whereas exercise is a subset of physical activity, and it is planned, structured, and repetitive to improve physical fitness and health (Harvard School of Public Health, 2012). Multiple studies have agreed that physical activity improves health, helps people stay at a healthy weight, and reduces the burden of chronic diseases, including obesity, Type 2 diabetes, and some cancers (CDC, 2022c; Harvard School of Public Health, 2012). Physical activity is a crucial factor in preventing excessive weight in children and reports have shown that children with a higher level of physical activity have lower body fat than those with a lower level of physical activity (Wyszyńska et al., 2020). Additionally, Wyszyńska et al. (2020) noted that a decline in energy expenditure is a major determinant of excessive body weight, and lack of intervention could result in excess weight from birth through childhood and adolescence to adulthood. Wyszyńska et al. suggested that a public health intervention is needed to maintain an increased physical activity level in the pediatric population. The Physical Activity Guidelines for Americans 2nd edition recommends 60 minutes or more of moderate-to-vigorous physical activity daily for children and adolescents aged 6 through 17 (as cited in Piercy et al., 2018).

Thus, based on the existing literature, I examined whether the combined influence of bariatric surgery and the nonpharmacological factors and their interactive effects can lead to more effective intervention or prevention programs that can decrease morbid obesity rates among children and adolescents in the United States.

Problem Statement

The social effects of obesity include discrimination, lower wages, lower quality of life, vulnerability to depression, and other physical problems. Based on reports, obesity has been on the rise in the United States, affecting the healthcare system, families, and communities, particularly children (Murtis, 2019). More than 12.7 million American children and adolescents are obese; children who are obese are five times more likely to carry the disease into adulthood, and obesity costs the United States about $147 billion each year (Healthline, 2022).

Obesity rates continue to rise among children and adolescents despite existing studies and intervention efforts. The specific research problem that was addressed through this study is the rising prevalence of obesity, particularly morbid obesity, in children and adolescents in the United States. Obesity has been linked with many health conditions, including heart disease, stroke, diabetes, high blood pressure, high cholesterol, and some forms of cancer (Murtis, 2019). Obesity has also been linked with metabolic syndrome, which can cause Type 2 diabetes and heart and blood vessel disease (Mayo Clinic, n.d.). Data from 2015-2016 collected by the National Health and Nutrition Examination Survey showed that over 18% of U.S. children and adolescents were obese, nearly 6% of those obese were morbidly obese, and nearly 21% obesity prevalence among 12 to 19-year-olds, 18% among 6 to 11-year-olds, and 14% among 2 to 5-year-olds (as cited in Ruiz et al., 2019; Sanyaolu et al., 2019); Furthermore, the average obesity prevalence is more than 18% amongchildren and adolescents 12 to 18 years old (Sanyeolu et al. 2019; Wisconsin Health Atlas reports, n.d.). Report has shown that morbidly obese children, 12 to 18 years of age have over 13% higher risk of suffering high blood pressure, about 6% suffer impaired glucose, and nearly 9% suffer metabolic syndrome (American College of Obstetricians and Gynecologists, 2017). Additionally, obese children and adolescents have fatty liver rate of about 38% (American College of Obstetricians and Gynecologists, 2017).

Multiple studies have indicated that morbid obesity is associated with a more serious health burden and mortality rate (Abdelaal et al., 2017; Ghanta et al., 2017). Reports have shown that teens and adolescents who are morbidly obese are 5 times more likely to carry the disease into adulthood and are more likely to have shorter life expectancy than their normal weight peers; for instance, teens and adolescents can have up to a 6.5-year shorter life for a BMI of 40 to 44.9 kg/m2 and a 13.7-year shorter life for a BMI of 55 to 59.5 kg/m2 (Himelstein, 2017). In a study that investigated the association of childhood obesity with the risk of early all-cause and cause-specific mortality, Lindberg et al. (2020) found that individuals who had obesity in childhood had a three times higher risk of mortality in early adulthood compared with a population-based comparison group. Additionally, high morbid obesity prevalence presents more of a health burden among certain ethnic groups than others. More specifically, among Hispanics and non-Hispanic Black adolescents, morbid obesity prevalence was approximately 12% compared to 7% for non-Hispanic Whites (Ruiz et al., 2019).

Although studies have examined the impact of weight-loss surgery or lifestyle modification on morbid obesity in children and adolescents, there is limited research that has addressed the influence of combined bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. Reports have shown that adolescents and children who underwent bariatric surgery experienced significant and sustained weight loss, but many still had a BMI in the overweight and obese levels (Greenhill, 2017). A health essentials report noted that people can start gaining weight 12 to 18 months after surgery (Cleveland Clinic, 2019). Zeratsky (2020) noted that adequate preparation can help surgery be an effective obesity treatment and that to avert weight regain, it is important to combine lifestyle changes with surgery. By examining combined bariatric surgery and nonpharmacologic influence and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents with metabolic syndrome, this study can lead to finding more effective and long sustainable obesity and morbid obesity management and intervention programs.

Purpose of the Study

The purpose of this retrospective quantitative study was to investigate the influence of bariatric surgery and nonpharmacologic factors (diet and physical activity) and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. The expectation is that addressing this research problem can lead to a more effective intervention approach that can lead to reduced morbid obesity prevalence and a sustained downward trend of the persistent rising prevalence of morbid obesity among children and adolescents.

The independent variables were bariatric surgery and nonpharmacologic factors (diet and physical activity). The dependent variable was morbid obesity 3-years postsurgery. The covariates used in this study were age, gender, and race/ethnicity. Metabolic syndrome was used as a biomarker or a matching variable to identify study participants with abdominal obesity, dyslipidemia, hyperglycemia, and hypertension. The research problem drew from the gap to investigate the combined influence of bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Research Questions and Hypotheses

In this study, I investigated combined bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3-years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. In this study, the independent variables were bariatric surgery and nonpharmacologic factors. The nonpharmacologic factors consisted of the variables diet and physical activity. The dependent variable was morbid obesity 3-years postsurgery. The covariates in this study were age, gender, and race. Four quantitative research questions (RQs) were appropriate to help guide this study:

RQ1: Is there an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$1: There is no association between bariatric surgery and morbid obesity (using Year3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a1: There is an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ2: Is there an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$2: There is no association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a2: There is an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ3: Is there an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$3: There is no association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a3: There is an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic who underwent bariatric surgery syndrome in the United States.

RQ4: Is there an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$4: There is no association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a4: There is an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

Theoretical Framework for the Study

The theories and/or concepts that helped ground this study included social-ecological model (SEM). Bronfenbrenner introduced the SEM in the1970s as a conceptual model for understanding human development (Bronfenbrenner, 1979), but the model was formalized as a theory in the 1980s (Kilanowski, 2017). As defined by McLeroy et al. (1988), the SEM postulates that health is not only determined by biological factors but is influenced by a group of subsystems that happen at various levels that include individual, interpersonal, institutional, community, and public policy levels (Shaffer, 2019). The SEM framework is a fitting model for obesity research and prevention undertakings in children (Ohri-Vachaspati et al., 2015).

At the intrapersonal or individual level, the focus includes how an individual influences behavior change and self-efficacy; the interpersonal level focuses on social networks and social support systems like families and caregivers that can influence individual behavior; the organizational level focuses on institutions like schools to operate under rules and regulations that provide the right amount of physical activity; the community level is concerned with the built environment, for example, parks for physical activities and groceries for healthy diets; and the policy/enabling environment level is concerned with the local, state, national and global laws and policies, for example, policies that can guide bariatric surgery and dieting (Ohri-Vachaspati et al., 2015).

The SEM is beneficial in describing the etiology of childhood obesity and the development of an obesity prevention framework (Ohri-Vachaspati et al., 2015). The model is a multilevel framework with multilayers of influence that looks at the individual and their affiliations or interrelations to people, organizations, communities, and environments as well as the influence these entities exert on the individual's behaviors and lifestyle (Kilanowski, 2017; Ohri-Vachaspati et al., 2015). The logical connections between the SEM framework and the nature of this study include providing the framework for understanding the multifaceted and interactive effects of personal and environmental factors that affect health (see Kilanowski, 2017). The SEM is a theoretical framework for understanding the interactive effects of personal and environmental factors that determine behavior; for example, the SEM can be used in examining obesity interventions in children and to identify factors at each level of the SEM that impact the behaviors (Jernigan et al., 2018). The SEM is focused on the interaction between individuals, relationships, their communities, institutions, and government as it relates to health behaviors, helping researchers to understand the risk factors that cause individuals to have a higher risk of obesity (Kilanowski, 2017; Ohri-Vachaspati et al., 2015). Table 1 shows the match of the theoretical framework constructs and the study variables.

Table 1

Theoretical Framework Constructs and Study Variables

Constructs of the social-ecological model (SEM)	Theoretical framework title: social-ecological model	Proposed study title: Morbid Obesity in Children 12-18 Years: Bariatric and Nonpharmacologic Influence and Interaction	Variable nature/coding scheme
The social-ecological model levels	List of constructs of the theoretical framework you plan to use in your study below: Influence of policy; promote attitudes, beliefs, and behavior; Interactions and relationships of the immediate surroundings; Multilevel approaches to public health promotion.	List all the study variables you plan to include starting with all independent variables and ending up with your dependent variable (outcome). You can use only and only one dependent variable.	How is your study variable coded? (nature of the variable: nominal, categorical, ordinal, etc.). Include the nature of the variable and coding scheme
5- Public policy/government	1- Influence of policy and enabling environment	1- Bariatric surgery	Independent variable - measured as a categorical variable
2- Individual	2- Promote behavior	2- Diet	Independent variable - measured as a categorical variable
2- Individual	3- Promote attitudes	3- Physical activity	Independent variable - measured as a categorical variable
1- Intrapersonal	4- Biological and personal or developmental history	4- Age	Covariate - measured as a Continuous variable
1- Intrapersonal	5- Biological and personal or developmental history	5- Gender	Covariate) - measured as a categorical variable
1- Intrapersonal	6- Biological and personal or developmental history	6- Race	Covariate - measured as a categorical variable
4- Community	7- Multilevel approaches to public health promotion	7- Morbid Obesity	Dependent variable - coded as a categorical dichotomous variable (yes or no).

The constructs of the SEM the study used were as follows:

1. Influence of policy and enabling environment. This was used for the independent variable (bariatric surgery).
2. Promotion of attitudes, beliefs, and behavior. This was used for the independent variables (nonpharmacologic factors) such as diet and physical activity.
3. Biological and personal or developmental history. This was used for the covariates (age, gender, and race).
4. Multilevel approaches to public health promotion. This was used for the dependent variable (morbid obesity).

Nature of the Study

A quantitative retrospective design was appropriate for this study. The quantitative analysis helped me establish whether combined bariatric surgery and nonpharmacologic factors and their interactive effects predicted morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. In addressing the RQs in this quantitative study, the specific research design included a retrospective cohort study design (see LaMorte, 2021) with bariatric surgery and nonpharmacologic factors and their interactive effects. A retrospective cohort study design is appropriate in cases where patients have already developed the outcome of interest, and researchers look back on the cohort at a point in time before the patients developed the outcome of interest to compare the outcome of interest after a specified period of follow up (LaMorte, 2021). Researchers use retrospective cohort studies to establish a cohort of individual's exposure status at a point in time and to determine whether the cohorts subsequently developed the outcome of interest after a specified follow-up period based on the collected cohort data (LaMorte, 2021).

Definitions

Bariatric surgery: Bariatric surgery, also referred to as weight loss surgery or metabolic and bariatric surgery, may include any of the following procedures: aleeve gastrectomy, roux-en-Y gastric bypass, adjustable gastric band, biliopancreatic diversion with duodenal switch, single anastomosis duodeno-ileal bypass with sleeve gastrectomy (American Society for Metabolic and Bariatric Surgery [ASMBS], n.d.).

Diet: Dietary modifications generally target reducing the consumption of high-fat/high-calorie foods and increasing the consumption of fruits and vegetables, as well as dietary monitoring through classification systems such as the stoplight diet (e Silva et al., 2018). Diet implies healthy food that children and adolescents are required to eat to maintain proper growth and development as well as prevent chronic health conditions such as obesity (CDC, 2021b). The expected healthy eating pattern, as described in the Dietary Guidelines for Americans 2020 to 2025, may include a variety of fruits and vegetables, whole grains, fat-free and low-fat dairy products, a variety of protein foods, and oil (CDC, 2021b). The Dietary Guidelines for Americans 2020 to 2025 recommended dietary reference intakes (DRI) to include macronutrients, vitamins and minerals, and food components (United States Department of Agriculture, n.d.).

Metabolic syndrome: Metabolic syndrome is the clustering of abdominal obesity, dyslipidemia, hyperglycemia, and hypertension (Engin, 2017). The modified Adult Treatment Panel III criteria for the pediatric age group describes metabolic syndrome as having at least three of the following: TAG ≥ 150 mg/dL; HDL ≤ 40 mg/dL; FPG ≥ 100 mg/dL; abdominal obesity by the waist to height ratio > 0.5; and either SBP or DBP > 90th percentile for age, sex, and height (Fulgoni et al., 2020).

Obesity and severe/morbid obesity: The CDC recommended using relative BMI measures when describing obesity and severely or morbidly obese youths. Obesity in children and adolescents is defined as a BMI percentile ≥ 95th for age and sex; severe/morbid obesity is defined as obesity Class II (≥ 120% to 140% of the 95th percentile) or a BMI ≥ 35 to ≤ 39 kg/m2, whichever is lower, plus one comorbidity; or obesity Class III (≥ 140% of the 95th percentile) or BMI ≥ 40 kg/m2, whichever is lower (Burton et al., 2020; Pratt et al., 2018; Skinner et al., 2018). In this study, severe obesity and morbid obesity have the same meaning; therefore, morbid obesity is used in place of severe or morbid obesity to maintain consistency.

Physical activity: Regular physical activity in children and adolescence fosters lasting health and well-being and averts numerous health situations. Physical exercise activity targets commonly include increasing the intensity and duration of physical activity (i.e., play, family activities, organized sports, or structured exercise programs) and reducing time spent in sedentary activities (e.g., television viewing). For example, the CDC's (2021b) physical activity guidelines for children and adolescents is to do at least 60 minutes moderate-to-vigorous physical activity daily that includes aerobic, muscle-strengthening, and bone-strengthening.

Socioeconomic status: Socioeconomic status measures the education, income, and occupational level and social standings of people or group of people; it reveals inequalities in resources access, privileges, and affluence (American Psychological Association, n.d.).

Assumptions

In this study, I assumed that the secondary data provided accurate information about obesity, bariatric surgery, diet, physical activity, factors used in determining metabolic syndrome, and demographics, including ethnicity, gender, age, and race. Additionally, I assumed that the Dietary Guidelines for Americans 2020 to 2025, which recommended applying the DRI (United States Department of Agriculture, n.d.), and the CDC (2021a) physical activity guidelines, which recommended 60 minutes moderate-to-vigorous physical activity daily, were applied in collecting the data for the primary study. The DRI includes macronutrients, vitamins and minerals, and food components (United States Department of Agriculture, n.d.); physical activity guidelines include 60 minutes of moderate-to-vigorous physical activity daily, including aerobic, muscle-strengthening, and bone-strengthening for children and adolescents (CDC, 2021a).

Scope and Delimitations

In this study, I examined morbid obesity 3 years postsurgery among U.S. children and adolescents. Children and adolescents 12 to 18 years of age with metabolic syndrome and living in the United States were included in this study. Children and adolescents under 12 years or over 18 years of age, children and adolescents who did not live in the United States, or children and adolescents without metabolic syndrome were excluded from this study. The study findings can be generalized to the U.S. population of the studied cohort.

Limitations

This quantitative study was limited to the population of American children and adolescents ages 12 to 18 years of age. As such, generalization of the results to a larger population outside the United States or a wider age range may require additional studies. Additional or future studies may need to use standardized obesity definitions derived from national and international standards to generalize results to a larger population. The National Institute of Health (NIH; n.d.) defined obesity in children 2 to 19 years old as a BMI at or above the 95th percentile on the CDC growth charts and morbid obesity as a BMI at or above 120% of the 95th percentile on the CDC growth charts (National Institute of Diabetes, and Digestive and Kidney Disease [NIDDK], 2021); whereas the World Health Organization (WHO) defined obesity for persons 5 to 19 years old as a BMI-for-age greater than two standard deviations above the WHO Growth Reference median, and for children under 5 years old, obesity is defined as weight-for-height greater than three standard deviations above the WHO Child Growth Standards median (WHO, 2021).

Additionally, because retrospective study data are not usually predesigned for the specific requirement of the study, there is the probability of missing data and the possibility that critical variables that could affect the outcome of the study may not have been recorded (Talari & Goyal, 2020). An example of such a case is the use of the United States Renal Data Systems, which is a robust database, where reports showed that in a retrospective analysis of the same data, different researchers arrived at conflicting conclusions regarding the reuse of dialysers and patient mortality (Talari & Goyal, 2020).

Also, unknown, and unnoticed biases through baseline characteristics, selection of subjects, and reliance on recall can affect retrospective studies (Talari & Goyal, 2020). Talari & Goyal (2020) noted that the bias limitations can be minimized by taking necessary steps, including choosing an appropriate comparator and validating subject selection criteria.

Significance

Multiple studies have focused on pediatric obesity prevalence interventions and the impact the interventions had on the health and quality of life of obese children and adolescents. One such study is the Childhood Obesity Project conducted by Ottley et al. (2018) among children in a school setting. The researchers explored the strategies identified in four communities (Anchorage, Alaska; Granville County, North Carolina; New York City, New York; and Philadelphia, Pennsylvania) reporting obesity declines. Ottley et al. described that the strategies contained a mix of programs, policies, and campaigns that targeted improving healthy food access and nutritious food, increased physical activity, and healthy built environments. Ottley et al. reported that obesity decreased by 0.4% among grades K, 1, and 3 in Anchorage, Alaska; 6.2% among children 2 to 4 years in Granville County, North Carolina; 2.2% among grades K-8 in New York, New York; and 1.0% among grades K-8 in Philadelphia, and among these school age group, the morbid obesity relative decrease was 7.7%.

In another study focused on effective strategies for childhood obesity prevention, Lambrinou et al. (2020) reviewed the development of the Feel4Diabetes-study school-based program designed for diabetes prevention. The researchers aimed to assemble and evaluate existing school-based intervention studies that focused on dietary, physical activity, and sedentary behaviors among primary school children and their families to find a more effective strategy for obesity intervention. Lambrinou et al. noted that the reviewed programs contained several effective strategies that factored into the development of the Feel4Diabetes-intervention and served as a vehicle for a recommendation for designing similar childhood obesity prevention initiatives by other researchers.

This study is significant in that obesity is on the rise in the United States, particularly among children (see Ruiz et al., 2019; Sanyaolu et al., 2019; Tyson & Frank, 2018), and there are treatment and knowledge gaps relating to examining the combined influence and interactive effects of bariatric surgery and nonpharmacologic factors. Additionally, there is an urgent need for more effective treatment strategies for childhood and adolescent obesity (Ottley et al., 2018). The findings from this research can provide vital insights into the combination of healthy behaviors like exercise, healthy food choices, and bariatric surgery to combat the prevalence of morbid obesity in children and adolescents, particularly those unresponsive to behavioral management. The research can also impact positive social change as it can lead to implementing more effective obesity prevention and intervention programs that can reverse the upward trend of obesity prevalence. The conclusions drawn from this study can help establish whether the combination of bariatric surgery and nonpharmacologic factors such as diet and physical activity can lead to finding an effective long sustainable treatment for morbidly obese children and adolescents. Additionally, this research may lead to future studies that provide insights into more effective obesity prevention and intervention programs to combat the rising morbid obesity health burden.

Summary

Despite many existing studies and progress on intervention programs to reduce the obesity rate, the prevalence of obesity and associated comorbidities is rising at an alarming level in the United States. Obesity has been linked with heart disease, stroke, diabetes, high blood pressure, high cholesterol, and some forms of cancer (Murtis, 2019; Sanyaolu et al., 2019) and metabolic syndrome, including Type 2 diabetes and heart and blood vessel disease (Mayo Clinic, n.d.). A 2016-2018 dataset showed that over 18% of U.S. children are obese, and the obesity rate is nearly 21% among children and adolescents 12 to 19 years of age (Sanyaolu et al., 2019). Obesity rate for children and adolescents12 to 18 years of age is over 18% (Sanyeolu et al. 2019; Wisconsin Health Atlas reports, n.d.), over 13% higher risk of suffering high blood pressure, about 6% suffer impaired glucose, and nearly 9% suffer metabolic syndrome (American College of Obstetricians and Gynecologists, 2017). Morbid obesity has been associated with a more severe health burden and mortality rate (Abdelaal et al., 2017; Ghanta et al., 2017). Children and adolescents who are morbidly obese carry the disease into adulthood and have shorter life expectancy than their normal-weight peers – a 6.5-year shorter life for a BMI of 40 to 44.9 kg/m2 to a 13.7-year shorter life for a BMI of 55 to 59.5 kg/m2 (Himelstein, 2017).

Morbid obesity in children requires more aggressive combination therapies that include behavioral modification, and surgical interventions (Czepiel et al., 2020). In this study, I employed a retrospective quantitative design to investigate the influence of bariatric surgery and nonpharmacologic factors, such as diet and physical activity, and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. The SEM and its constructs were used to ground this study. In the next chapter (literature review), the literature search strategy, theoretical foundation, and literature review related to key variables in the study are described in detail.

Chapter 2: Literature Review

Introduction

Obesity is a global health problem in epidemic proportion, with a quadruple rising prevalence from 4% in 1975 to 18% in 2016 among children 5 to 19 years of age (WHO, 2021). In 2016, more than 340 million children and adolescents 5 to 19 years of age were overweight or obese, and 39 million children less than 5 were overweight or obese in 2020 (WHO, 2021). In the United States, children and adolescents affected by obesity and morbid obesity are on the rise, and this trend continues to increase at a debilitating or alarming rate (Abdelaal et al., 2017; Ghanta et al., 2017; Himelstein, 2017; Khattab & Sperling, 2019; Pratt et al., 2020; Sanyaolu et al., 2019). In 2017-2018, over 19% of the United States children and adolescents were obese, and over 6% were morbidly obese. (CDC, 2021b; NIDDK, 2021). Among 12 to 19-year-old children and adolescents in the United States, the morbid obesity rate is 9% (Himelstein, 2017).

Morbid obesity is a BMI at 35 kg/m^2 or greater, a BMI at or above 120% of the 95th percentile with at least one comorbidity (Type 2 diabetes, cardiovascular disease, moderate to severe apnea), a BMI at 40 kg/m^2 or greater, or a BMI at or above 140% of the 95th percentile (Abdelaal et al., 2017; Burton et al., 2020; CDC, 2021b; Himelstein, 2017; Kelly et al., 2018; Khattab & Sperling, 2019; Pratt et al., 2020). Morbid obesity is associated with many chronic diseases and comorbidities, such as hypertension, dyslipidemia, cardiovascular disease, Type 2 diabetes mellitus, and cancer (Abdelaal et al., 2017; NIDDK, 2021). For morbid obesity, bariatric surgery or weight-loss surgery is often an effective treatment for obtaining significant and sustained long-term weight loss and reducing comorbidities such as Type 2 diabetes and high blood pressure (Himelstein, 2017; Khattab & Sperling, 2019; The University of California San Francisco [UCSF], n.d.). Also, bariatric surgery effectively reduces mortality rates associated with obesity comorbidities or improves quality-adjusted life-years, particularly when combined with healthy eating behaviors and regular physical activity (Himelstein, 2017; Khattab & Sperling, 2019; UCSF, n.d.). However, based on reports, weight gain can reoccur 12 to 18 months after surgery; thus, healthy dieting and exercise following bariatric surgery are needed to keep the weight off and to prevent morbid obesity and its comorbidities from reoccurring (Castelnuovo et al., 2017; Cleveland Clinic, 2019).

The CDC 2017-2018 data showed that obesity prevalence was more in children and adolescents 12 to 19 years of age (over 21%) compared to 20.3% for children and adolescents 2 to 19 years of age (CDC, 2021b). Although studies showing the relationship between bariatric surgery and weight loss exist, studies that examined the influence of bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States are scarce or do not exist. Thus, the purpose of this retrospective quantitative study was to investigate the influence of bariatric surgery and nonpharmacologic factors (diet and physical activity) and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Chapter 2 consists of a high-level description of the literature search strategy, a description of the SEM constructs used to ground this study, and the literature review related to the key variables (morbid obesity, bariatric surgery, diet, physical activity), and the resultant interactive variables and other factors examined in this study that affect morbid obesity.

Literature Search Strategy

I conducted this literature review by searching the following databases: Medline, Academic Search Complete, Complementary Index, APA PsycInfo, and ScienceDirect using the following search strings: *adolescent obesity* OR *childhood obesity* OR *morbid obesity in children* OR *severe obesity in children* AND *bariatric surgery* OR *physical activity* OR *diet* AND *metabolic syndrome* OR *metabolic* AND *America* OR *United States* OR *US* OR *USA* OR *U.S* for peer-reviewed articles published between 2016 and 2022. This search yielded 175 peer-reviewed articles, and after removing the duplicates, 130 articles were produced. Further review of the articles' titles and abstracts resulted in the removal of articles that did not mainly discuss obesity or severe/morbid obesity or obesity/severe obesity and metabolic syndrome, which yielded 46 articles. In addition to the databases searched, multiple websites were searched, including Google Scholar, the CDC, and NIH for *obesity/severe obesity*, for additional references and foundational information such as theoretical framework articles and metabolic syndrome-related information.

Peer-reviewed articles were included in this literature review based on their discussion of obesity/severe or morbid obesity and the related key variables such as metabolic and bariatric surgery, diet, and physical activity. The studies retained comprised mainly of work published between 2017 and 2022 and older works that described the foundation and theoretical framework for obesity intervention and prevention, such as the SEM. More than 90% of the works included were quantitative, with less than 10% being qualitative or mixed.

Theoretical Foundation

The multifaceted nature of the obesity and morbid obesity epidemic and its determinant factors in children and adolescents triggered the need to examine the social concepts and influences that contribute to childhood and adolescent morbid obesity from the individual, interpersonal, organization, community/physical environment, and policy levels of the SEM. McLeroy (1988) described that the SEM postulates that health is not only determined by biological factors but is influenced by a group of subsystems that happen at various levels that include individual, interpersonal, institutional, community, and public policy levels (as cited in Shaffer, 2019). The SEM not only examines the interaction between these levels and how it affects behaviors but also aids researchers in understanding the factors that cause a higher risk of obesity and eating disorders (Goines, 2020); thus, the SEM is an appropriate theoretical framework for disease prevention, including obesity.

The CDC (2022d) used the SEM to examine the factors that influence violence and to understand violence and the effect of likely prevention approaches. The CDC violence prevention program documented that by considering the relationship between the individual, relationships, community, and societal factors, the SEM allows for an understanding of the risk factors for violence that people face or that protect people from committing violence. Additionally, the CDC noted that preventing violence requires acting across multiple levels of the SEM at the same time to produce sustained prevention efforts that can yield population-level influence. Similarly, the SEM is useful in understanding obesity and morbid obesity as a chronic disease with multiple levels of influence and in examining the multiple interacting factors that influence obesity to understand the effect of likely prevention approaches.

Other studies that supported the use of the SEM as an appropriate theoretical framework for this study included research by Jernigan et al. (2018) and Onhri-Vachaspati et al. (2014). Jernigan et al. (2018) study used the SEM to retrospectively examine programs, policies, and campaigns that targeted improvement of healthy food access and nutritious food; increased physical activity; and healthy built environments that occurred in Anchorage, Alaska; Granville, North Carolina; Philadelphia, Pennsylvania; and New York City, New York and to examine related factors that may have influenced the programs and policies. They examined how each location implemented the programs and policies across the SEM levels to address obesity while investigating how interactions occurred across and within the model levels. They also examined the effect of the school setting, from a healthy diet program perspective, the augmentation of policies and programs at the community level, and the impact on the school setting, including interaction within the city government agencies.

Onhri-Vachaspati et al. (2014) used the SEM to describe the etiology of childhood obesity and to develop a framework for prevention. Onhri-Vachaspati et al. used multiple regression to determine how much each layer of the SEM contributed individually and jointly to the children's weight condition.

Theoretical Constructs: SEM Components

Intrapersonal Level

At the intrapersonal or individual level, the focus includes how an individual influences behavior changes and self-efficacy. Studies have documented that the social-ecological components influence individual traits and characteristics such as behavior, attitudes, and self-efficacy (Goines, 2020; Kaplan et al., 2000). The characteristics and behaviors exhibited by an individual and the barriers that exist at this level are associated with the development of chronic diseases such as obesity; therefore, the behaviors and characteristics should be taken into consideration when implementing public health intervention programs (Goines, 2020; Kaplan et al., 2000).

Interpersonal Level

The interpersonal level is focused on social networks and social support systems such as families, friends, caregivers, peers, coworkers, and religious networks that can influence individual behaviors. At this level, social and environmental cues can affect an individual's behavior; thus, promoting healthy relationships is vital in generating a positive impact on health behaviors that can result in healthy metabolic control (Goines, 2020; McLeroy et al., 1988).

Organizational Level

The organizational level is focused on institutions like schools to operate under rules and regulations that provide the right amount of physical activity and diet. At this level, the social institutions have organizational characteristics and rules and regulations for operation (McLeroy et al., 1988). For example, information about safety health practices among children is shared, and restrictions and regulations about certain behaviors such as dieting and physical activity are enforced (Goines, 2020).

Community Level

The community level is concerned with relationships among organizations, institutions, and casual networks operating within defined operating boundaries. This level focuses on the built environment, for example, parks for physical activities, grocery stores for healthy diets, and the barriers that make the built environment unavailable or unsafe (Goines, 2020).

Public Policy

The public policy level of the SEM is focused on the national, state, and local policies that can foster effective prevention interventions for weight loss and obesity programs (Goines, 2020). Major characteristics of public health include emphasizing population health and using regulatory policies, procedures, and laws to protect community health (McLeroy et al., 1988). Between 1900 and 1973, reports showed a significant reduction in mortality rates in the United States due to policies that improved water supply, sanitation, housing, and food quality (Pawluch, 1986). In order to achieve a reduction in childhood obesity, policy makers are charged to prioritize investment treatment and prevention programs that can yield cost-effectiveness in obesity policy programs, including sugar-sweetened beverage excise tax, nutrition standards for school meals, improved early care and education, and more access to teen-age bariatric surgery (Gortmaker et al., 2015).

Literature Review Related to Key Variables and/or Concepts

Childhood Obesity

The health problems posed by childhood obesity in the United States are severe and of great concern to public health. Obesity prevalence among children and adolescents is very high, and children and adolescents are at great risk of poor health due to obesity (CDC, 2022a). In the United States, from 2017 to 2020, obesity prevalence among children and adolescents 2 to 19 years of age was nearly 20%, that is, nearly 15 million children and adolescents were obese: 26.2% among Hispanic children, 24.8% among non-Hispanic Black children, 16.6% among non-Hispanic White children, and 9.0% among non-Hispanic Asian children (CDC, 2022a). Childhood obesity has been associated with many chronic diseases, including hypertension, dyslipidemia, cardiovascular disease, Type 2 diabetes mellitus, psycho-social dimensions of poor self-esteem, discrimination, and lower quality of life measures (Khattab & Sperling, 2019). Moreover, morbidly obese teens and adolescents have a shorter life expectancy than their normal-weight peers (Himelstein, 2017; Messiah et al., 2019). Lambrinou et al. (2020) noted that despite the many existing interventions targeting childhood obesity, very few had shown positive results; hence, more studies are needed to find the most effective strategy and programs to sustain significantly reduced childhood obesity.

Morbid or Severe Obesity

Obesity is defined as a BMI at or above age and sex-specific 95^{th} percentile, while morbid obesity or severe obesity is defined as a BMI at or above 35 kg/m2 or BMI at or above 120% of the 95^{th} percentile with at least one diagnosed comorbidity or a BMI at or above 140% of the 95th percentile (Burton et al., 2020; Hoeltzel et al., 2021; Kelly et al., 2018; Pratt et al., 2020; Ruiz et al., 2019; Sanyaolu et al., 2019).

Obesity has become a public health epidemic, and it has been associated with many comorbidities, including Type 2 diabetes, cardiovascular disease, psychological disorders, high blood pressure, and cancer (Hoeltzel et al., 2021; Pratt et al., 2020; Tyson & Frank, 2018). Morbid obesity has been linked to reduced quality of life and increased morbidity and death (Burton et al., 2020; Kelly et al., 2018; Pratt et al., 2020; Ruiz al., 2019; Sanyaolu et al., 2019). Morbidly obese teens and adolescents are 5 times more likely to carry the condition into adulthood, and teens and adolescents with morbid obesity have a shorter life expectancy than their normal-weight peers (Himelstein, 2017; Messiah et al., 2019). Morbid obesity can result in a 6.5-year shorter life for a BMI of 40 to 44.9 kg/m2 to a 13.7-year shorter life for a BMI of 55 to 59.5 kg/m2 (Himelstein, 2017). Additionally, morbid obesity in children and adolescents has been associated with many cardiometabolic comorbidities and liver and kidney problems, and more concerning is that preventable diseases can cause death in children and adolescents with obesity more often than in those with a healthy weight (Messiah et al., 2019; Ryder et al., 2020; Tyson & Frank, 2018).

In North America, 30% of children and adolescents are estimated to be overweight or obese, and in the United States, in particular, though the rising obesity rate has slowed down among children 2 to 5 years of age, the morbid obesity rate in children is on the rise (Tyson & Frank, 2018). The obesity rate in children 2 to 19 years of age in the United States increased from 13.9% in 2000 to 18.5% in 2017, with many studies confirming that youths with morbid obesity had an adult BMI at or above 35kg/m2, and with severe adverse health and lifespan impact (Lopez et al., 2020; Ryder et al., 2019).

Studies have shown that obesity is a multifaceted chronic disease with contributing factors that include biological risk factors, socioeconomic status, health literacy, and numerous environmental influences, with the United States youths from disadvantaged backgrounds experiencing higher obesity rates, and more so, adolescents 12 to 19 years of age are disproportionately affected with obesity and severe health issues (Fletcher et al., 2017; Lopez et al., 2020; Pratt et al., 2020; Ruiz et al., 2019). For example, morbid obesity is more prevalent among Hispanics and non-Hispanic Black adolescents (12%) compared to 7% for non-Hispanic Whites (Ruiz et al., 2019). Additionally, Ruiz et al. (2019) noted that obesity prevalence is highest for children 12 to 19 years of age (~21%) compared to 6 to 11 years (18.4%) and 2 to 5 years (~14%). As existing studies have focused more on individual factor outcomes and less on the combined and interactive effects, in this study, I examined the combined influence of bariatric surgery, diet, and physical activity and the interactive effects on controlling morbid obesity with age, gender, and race as covariates.

In a study that reviewed psychopathology and adolescent bariatric surgery, Burton et al. (2020) noted that a more intensive weight management program is needed among morbidly obese children and adolescents in the United States. Burton et al. (2020) described that weight loss surgery is necessary to support behavioral life modifications for morbid obesity. In extreme cases, interventions may include medications, meal replacements, and surgical management (Burton et al., 2020). Thus, Burton et al. (2020)

study supports the need for future research. In turn, this current study focused on examining the combined influence of bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity.

Bariatric Surgery and Morbid Obesity

Due to fear and the concern about risks associated with surgical options to treat morbid obesity in children and adolescents, parents, caregivers, and pediatric surgeons were not willing or at least were reluctant to refer adolescent patients with morbid obesity for appropriate surgical care (Inge et al., 2019; Kang et al., 2020; Olbers et al., 2017). Supporting this claim, Inge et al. and Olbers et al. (2017) noted that adolescents who underwent weight-loss surgery had an increased risk of vitamin D and iron deficiencies. In contrast, the AMBSreleased pediatric metabolic and bariatric surgery guidelines in 2018 recommending surgery for morbidly obese patients, that is, individuals/adolescents with a BMI ≥ 35 kg/m2 or BMI ≥ 120% of the 95th percentile and with a diagnosis of severe comorbidity or BMI ≥ 40 kg/m2 or BMI ≥ 140% of the 95th percentile (Pratt et al., 2018).

Describing the enormity of obesity as a chronic disease worldwide, and in the United States, where one-third of adults are obese, with obesity accounting for one-third of mortality, Kang et al. (2020) noted that children are increasingly affected. Kang et al. (2020) revealed that patients who complete behavioral and dietary weight-loss programs later regain most of the lost weight and that effective options for long-term weight reduction are lacking. Kang et al. (2020) referenced multiple reports which have shown that lifestyle changes alone do not effectively address morbid obesity and that surgical treatment is effective and safe (; Childerhose et al., 2017; Durkin & Desai, 2017; Janicke et al., 2014; Oude Luttikhuis et al., 2009).

Additionally, Burton et al. (2020) documented that several reports have revealed that using bariatric surgery in children and adolescents who are morbidly obsessed has shown strong efficacy in attaining long-term weight loss and resolution of comorbidities, including psychological health issues (Ahn, 2020; Griggs et al., 2018; Inge et al., 2019; Kang et al., 2020; Zeller et al., 2009). The American Society for Metabolic and Bariatric Surgery Pediatric Committee performed an extensive literature search/review and supporting evidence that included 1387 articles and used reviewed data to update their evidence-based guideline for metabolic and bariatric surgery published in 2012 (Pratt et al., 2018). In the updated evidence-based guideline for metabolic and bariatric surgery, Pratt et al. (2018) recognized that morbid obesity requires a long-life multidisciplinary intervention method that utilizes combinations of lifestyle changes, nutrition, medications, and metabolic and bariatric surgery. By recognizing the need for a long-lasting morbid obesity multidisciplinary intervention approach, the Pratt et al. (2018) report, in essence, supported this current study to examine the influence of combined bariatric surgery and nonpharmacologic factors (diet, physical activity) and their interactive effects on morbid obesity in children, and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Diet and Morbid Obesity

There is substantial documentation that adolescents who fail to meet recommended dietary intake for certain food groups are at great risk of being obese.

Children and adolescents 12-19 years of age are disproportionally affected as unhealthy effects of excess adiposity are more prevalent at this critical development stage (Pratt et al., 2018; Ruiz et al., 2019;). Many reports have documented that diet is a contributing factor to childhood and adolescent obesity, and studies have revealed that the control and prevention of obesity require the combination of multiple approaches that include diet, physical activity, psychological factors, in addition to bariatric surgery, particularly, in morbid obesity cases (Ahn, 2020; Burton et al., 2020; Kang et al., 2020; Pratt et al., 2018; Pratt et al., 2020; Ruiz et al., 2019; Sanyaolu et al., 2019).

A good understanding of eating patterns requires measuring the quality of diet. The Healthy Eating Index (HEI) is one method for assessing the quality of diet through the generation of HEI scores from food frequency questionnaires or 24 h recall which makes dietary information available (Ruiz et al., 2019, USDA, n.d.). In their study, Ruiz et al. (2019) reported that reducing and preventing adolescent obesity would require theory-driven multicomponent school- and community-based intervention programs that yield healthy practices by promoting knowledge and self-efficacy. Ruiz et al. (2019) noted that the United States Burden of Disease Collaborators are of the view that suboptimal diet is a major risk factor that exacerbates or contributes to disease burden (McGuire, 2016) and that a theoretical framework such as the social cognitive theory is commonly utilized in nutrition interventions geared at improving self-efficacy, knowledge, and environmental factors (Bandura, 1986).

Physical Activity and Morbid Obesity

Physical activity combined with a healthy diet or components that restrict calories can reduce obesity and associated cardiometabolic risks (Andela et al., 2019; Stoner et al., 2016). Controlling obesity prevalence will require a multifaceted approach (Ruiz et al., 2019; Ryder et al., 201; Tyson & Frank, 20188). A risk factors report showed that physical activity is vital in reducing obesity prevalence (Ruiz et al., 2019). For morbid obesity, combining physical activity with other nonpharmacological factors such as diet may be required to attain an effective and more desirable result in reducing morbid obesity in children and adolescents (Ruiz et al., 2019; Ryder et al., 2018; Tyson & Frank, 2018). However, in morbid obesity cases, to lose excess weight, resolve comorbidities, and increase the odds of reduced long-term mortalities in children and adolescents, metabolic and bariatric surgery is needed in combination with diet, exercise, and behavioral therapy (Hoeltzel et al., 2021; Kang et al., 2020; Kelly et al., 2018; Lopez et al., 2020; Moore et al., 2020;).

Other Factors Affecting Morbid Obesity

Other factors such as Cognitive Behavioral Intervention, medication, metabolic syndrome, social-economic status, race/ethnicity, gender, and age are also believed to influence obesity in children and adolescents.

Cognitive Behavioral Intervention and Morbid Obesity

Based on studies, obesity is born out of the interaction of multiple events and as such, there is a need to find an extensive choice of obesity management procedures that include cognitive behavioral intervention (Higuera-Hernández et al., 2018; Pratt et al., 2018). Cognitive behavioral intervention is a psychological factor used to measure binge eating disorder (Burton et al., 2020; Pratt et al., 2018). Combating obesity disease, particularly morbid obesity in children and adolescents, will require a lifelong multidisciplinary morbid obesity treatment approach that will combine cognitive behavioral intervention, diet, and physical activity (Higuera-Hernández et al., 2018; Pratt et al., 2018), including medications and weight loss surgery (Czepiel et al., 2020; Pratt et al., 2018).

In order to have success in designing obesity or morbid obesity interventions, it is beneficial to develop the intervention using social cognitive theory framework (Ruiz et al., 2019). In a previously released study, Ruiz et al. (2019) noted that the social cognitive theory is utilized in diet intervention to improve self-efficacy and environmental factors (Bandura, 1986). Cognitive behavioral intervention or therapy is designed to treat obese patients and employs a traditional behavioral change approach to influence weight loss and weight loss management (Dalle Grave et al., 2018). Cognitive behavioral therapy, a technique that can help address obesity-associated psychological disorders such as eating disorders, has been adapted to treat binge eating disorders associated with obesity (Dalle Grave et al., 2018). Dalle Grave et al. (2018) described that cognitive factor associated with weight loss include increased dietary restraint. Dietary restraint could imply intentional self-regulation of eating or dieting; for example, overheating and binge eating among children and adolescents should be avoided (Bauer & Chuisano, 2018). Thus, cognitive effort or cognitive intervention, or cognitive intention in this context, implies a psychological technique to restrain overeating and binge eating (Bauer & Chuisano, 2018; Castelnuovo et al., 2017). Castelnuovo et al. (2017) revealed that cognitive-behavioral intervention is the gold standard for binge eating.

Medication

In a retrospective quantitative study that used a centralized data registry, Czepiel et al. (2020) described that notwithstanding that several anti-obesity drugs have been approved by the Food and Drug Administration (FDA) for adult use, only two FDA-approved medications (orlistat for > 12 years of age and phentermine for > 16 years of age) exists for use for children and adolescents, and the limited option has resulted in frequent off-label use of adult anti-obesity medication among children and adolescents. Although, a multivariate analysis showed that the drug, Metformin was the most effective among the off-label medications examined with statistically significant weight loss (p = .005) and a 0.12 decrease in BMI *z*-score, the small magnitude of the effect prompts the need for medications or pharmacotherapy to be combined with lifestyle modification and metabolic and bariatric surgery (Czepiel et al., 2020). Czepiel et al. (2020) suggested that adolescents who are not morbidly obese, that is, who do not meet the requirement for bariatric surgery or weight loss surgery and who are unable to achieve a healthy weight with lifestyle modification, should use pharmacotherapy (anti-obesity medication) treatment option.

Metabolic Syndrome

In western countries, particularly in the United States, 12–19-year-olds experience obesity and metabolic syndrome at a disproportionately high rate (Fletcher et al., 2017; Pratt et al., 2020). More than 20% of the U.S. adolescents 12 to 19 years of age are obese, nearly 10% of those obese suffer from metabolic syndrome, and since children and adolescents who are obese carry it into adulthood, those who suffer from metabolic syndrome have a higher risk to develop Type 2 diabetes and cardiovascular disease in their adulthood (Fletcher et al., 2017). Studies revealed that obese or morbidly obese adolescents are at high metabolic risk, including insulin resistance and hyperglycemia which they likely carry into adulthood (Lopez et al., 2020; Ruiz et al., 2019; Weigensberg et al., 2018). Ruiz et al. (2019) documented that there is an association between adolescent obesity and an ensuing cluster of metabolic syndromes into adulthood. The analysis result of a systematic review and meta-analysis to examine the impact of a combined diet and exercise programs on reducing metabolic risks revealed that combined exercise and dieting intervention improved the levels of high-density lipoprotein cholesterol substantially (3.86 mg/dL; 95% confidence interval [CI] = 2.70 to 4.63), fasting glucose (−2.16 mg/dL; 95% CI = −3.78 to −0.72), and fasting insulin (−2.75 μIU/mL; 95% CI = −4.50 to −1.00) over six months (Sanyaolu et al., 2019).

Social Economic Status

Children and adolescents living in underserved or economically disadvantaged populations are at a higher risk of experiencing food insecurity and obesity (Kelly et al., 2018; Pratt et al., 2020). Additionally, those with morbid obesity are less likely to be evaluated for weight loss surgery (Kelly et al., 2018; Pratt et al., 2020). Multiple studies have shown that managing obesity and related disorders and comorbidities in children and adolescents poses a severe socioconomic burden and carries major health policy issues and health care implications (Ahn, 2020; Khattab & Sperling, 2019; Ruiz et al., 2019;). Reports showed that the healthcare expenditures associated with overweight and obesity management in adolescents are over 14 billion dollars a year (Khattab & Sperling, 2019). The CDC described that in 2011-2014, obesity prevalence among children and adolescents in the lower income group was about 19%, about 20% for those in the middle-income group, and 11% for those in the highest income group (CDC, 2022a).

Race/Ethnicity

Minority ethnic or racial groups in the United States experience higher childhood obesity prevalence compared with Whites, for example, obesity is more prevalent among American Indians or Native Alaskans (31.2%), non-Hispanic black (20.8%), and Hispanics (22.0%) children compared with their White (15.9%) and Asian (12.8%) counterparts (Isong et al., 2018). Additionally, morbid obesity prevalence presents a more significant health burden among Hispanics and non-Hispanic black adolescents (12%) compared to the 7% for non-Hispanic Whites (Ruiz et al., 2019).

Gender

According to multiple reports, gender is a significant risk factor for developing obesity. The NIDDK (2021) noted that a 2017-2018 National Health and Nutrition Examination Survey data showed that among non-Hispanic whites, more than 1 in 6 boys have obesity, and more than 1in 7 girls have obesity; among non-Hispanic Blacks, about 1 in 5 boys have obesity, and more than 2 in 7 girls have obesity; among Hispanic Asians, 1 in 8 boys have obesity, and about 1 in 20 girls have obesity; and among Hispanics, 2 in 7 boys have obesity, and 1 in 4 girls have obesity. Also, Sanyaolu et al.

(2019) noted that among adolescents 12 to 19 years of age, obesity prevalence in boys was slightly lower than those of girls, but among school-aged (6 to 11) years of age, the disparity in obesity prevalence was significantly higher in boys (20%) compared to girls (15.4%). Shah et al. (2020) noted that obesity disparity between boys and girls might be caused by sociocultural influences due in part that girls, especially ones in higher income countries, may prefer foods that are lower in energy and nutrient-dense, such as fruits and vegetables, but in contrast, boys are inclined to consume more meat and calorie-dense foods.

Age

Multiple studies revealed that obesity and morbid obesity rates are more prevalent among certain age groups. For example, morbid obesity is disproportionately higher in children and adolescents12 to 19 years of age (Pratt et al., 2020; Ruiz et al., 2019; Sanyaolu et al., 2019). Multiple studies described that the National Health and Nutrition Examination Survey (NHANES) data collected from 2015-2016 revealed that adolescents 12 to 19 years of age had the highest obesity prevalence among youths (20.6%) compared to children 6 to 11 years of age (18.6%), and children 2 to 5 years of age (13.9%) (Ruiz et al., 2019; Sanyaolu et al., 2019). Additionally, the NHANES data showed that school-aged boys had a higher prevalence of obesity (20.4%) than preschool-aged boys [14.3%], and adolescent girls had a higher prevalence of obesity (20.9%) than preschool-aged girls (13.5%) (Sanyaolu et al., 2019).

Summary and Conclusion

Globally, obesity is considered an epidemic with quadruple rising prevalence - over 14% increase from 1975 to 2016 and serious health implications, affecting over 340 million children and adolescents 5-19 years of age (WHO, 2021). Obesity is associated with many comorbidities, including Type 2 diabetes, cardiovascular disease, psychological disorders, high blood pressure, and cancer (Hoeltzel et al., 2021; Pratt et al., 2020; Tyson & Frank, 2018). Additionally, morbid obesity is associated with reduced quality of life and increased morbidity and mortality (Pratt et al., 2020; Ruiz al., 2019). Furthermore, morbidly obese teens and adolescents carry the disease into adulthood and have a shorter life expectancy than their normal-weight peers (Himelstein, 2017). Studies described obesity as multifaceted with multiple levels of influence; as such, it was beneficial for this study to use the SEM in understanding the factors that cause a higher risk of obesity and eating disorders (see Goines, 2020).

In the United States, children and adolescents are affected by obesity and morbid obesity at an alarming rate. In 2017-1018, over 19% of the United States children and adolescents were obese, and over 6% were morbidly obese. (CDC, 2021b; NIDDK, 2021). More disturbing is that, among the 12–19-year-old children and adolescents in the United States, the morbid obesity rate is 9% (Himelstein, 2017). Multiple studies revealed that parents, caregivers, and pediatric surgeons are not willing or at least are reluctant to refer adolescent patients with morbid obesity for appropriate surgical care due to fear and the concern about risks associated with surgical options to treat morbid obesity in children and adolescents (Inge et al., 2019; Kang et al., 2020; Olbers et al., 2017). Nonetheless, literature has indicated that bariatric surgery or weight loss surgery combined with diet, and physical activity is an effective treatment for morbid obesity (Czepiel et al., 2020; Higuera-Hernández et al., 2018; Pratt et al., 2018).

By releasing the pediatric metabolic and bariatric surgery guidelines in 2018 recommending surgery for morbidly obese patients, the ASMBS supports the use of weight loss surgery to treat morbid obesity [BMI ≥ 35 kg/m2 or 120% of the 95th percentile with a diagnosis of severe comorbidity or BMI ≥ 40 kg/m2 or 140% of the 95th percentile] (Pratt et al., 2018).

The research design, methodology, data analysis plan, and threat to validity are discussed in chapter three (Research Methodology).

Chapter 3: Research Method

Introduction

The purpose of this retrospective quantitative study was to investigate the influence of bariatric surgery and nonpharmacologic factors (diet and physical activity) and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. In this study, I examined the influence of bariatric surgery and nonpharmacologic factors (diet and physical activity) on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Adolescents and children who undergo bariatric surgery often experience significant and sustained weight loss; however, many still have a BMI in the overweight and obese levels (Greenhill, 2017). A health essentials report noted that people could start gaining weight 12 to 18 months after surgery (Cleveland Clinic, 2019). Zeratsky (2020) indicated that adequate preparation can help surgery be an effective obesity treatment and that it is essential to combine surgery with lifestyle changes to avert weight regain.

In this study, I examined the main effects of bariatric surgery and nonpharmacologic factors (diet, physical activity) on the response variable (morbid obesity) and the interaction effect of bariatric surgery and the nonpharmacologic factors. The research method section convers the research design and rationale, the methodology, the data analysis plan, and threats to validity.

Research Design and Rationale

Variables

The dependent variable was morbid obesity. The independent variables were bariatric surgery, diet, and physical activity. The covariates considered in this study were age, gender, and race. Metabolic syndrome was used as a biomarker or matching variable to identify study participants with abdominal obesity, dyslipidemia, hyperglycemia, and hypertension.

Research Design

The specific research design in this study was a quantitative retrospective cohort study design. A retrospective cohort study design is appropriate in cases where patients have already developed the outcome of interest, and researchers look back on the cohort at a point in time before the patients developed the outcome of interest to compare the outcome of interest after a specified period of follow up (LaMorte, 2021). LaMorte’s (2021) report supported this study design approach in that the patients had already developed morbid obesity, and I focused on investigating the influence of bariatric surgery and nonpharmacologic factors, such as diet and physical activity, and their interactive effects on morbid obesity 3 years postsurgery. Researchers use retrospective cohort studies to establish a cohort of an individual’s exposure status at a point in time and to determine whether the cohorts subsequently developed the outcome of interest after a specified follow-up period based on the collected cohort data (LaMorte, 2021).

Additionally, other studies that have used a quantitative retrospective study, thus justifying the use of quantitative retrospective design for this study as appropriate, include the following: Hoeltzel et al. (2021) used the quantitative retrospective study to investigate how safe adolescent bariatric surgery is by analyzing the short-term outcomes; Ryder et al. (2019) used the quantitative retrospective study to investigate heterogeneity in response to treatment of morbidly obese adolescents; and Lopez et al (2020) employed comparative retrospective study to examine morbidity and mortality after bariatric surgery in adults versus.

The quantitative analysis helped establish whether combined bariatric surgery and nonpharmacologic factors and their interactive effects predict morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. The outcome of interest in this study was morbid obesity 3 years postsurgery. A retrospective cohort quantitative analysis method was chosen over survival analysis as a better fit for this dissertation because the quantitative approach is associated with finding evidence to either support or reject hypotheses, where the outcome of interest is the disease (see LaMorte, 2020), whereas in survival analysis, though the method is used to analyze prospective data, the outcome of interest is time to an event or disease (Kartsonaki, 2016; Schober & Vetter, 2018).

Methodology

Population

The study population was children and adolescents who lived in the United States. The target study cohort was children and adolescents 12 to 18 years of age with metabolic syndrome. Multiple studies have described that adolescents 12 to 19 years of age are disproportionately affected by obesity and severe health issues (Fletcher et al., 2017; Lopez et al., 2020; Pratt et al., 2020; Ruiz et al., 2019). Furthermore, Ruiz et al. (2019) noted that obesity prevalence is highest for children 12 to 19 years of age (20.6%) compared to 6 to 11 years (18.4%) and 2 to 5 years (13.9%). In the United States, nearly 10% of the obese 12 to 19 years of age suffer from metabolic syndrome (Fletcher et al., 2017). Like obesity or morbid obesity, children and adolescents who suffer from metabolic syndrome have a higher risk of developing Type 2 diabetes and cardiovascular disease in their adulthood (Fletcher et al., 2017).

Sampling and Sampling Procedures

In this study, I used secondary data from the NIDDK funded Teen-LABS (Longitudinal Assessment of Bariatric Surgery) study, which examined the short- and long-term risks and benefits of bariatric surgery in teens. The NIDDK is an institute within the NIH. The NIH's main data come from surveys in which health data are collected through population surveys and provider surveys; medical records with data automatically collected from diagnosis, procedures, and lab tests, and the data collected are usually accurate; claims data; vital records that are collected through the National Vital Statistics System; and from surveillance collected through the CDC, and WHO (NIH, n.d.).

The NIDDK centralized repository makes organized, well-integrated, and standardized secondary data available for addressing new RQs (NIDDK, n.d.-a). The NIDDK collects data through clinical trials of all ages and stores the data in the NIDDK central repository for future secondary data research and other uses. In this study, I used data from NIDDK-funded clinical research - Teen-LABS (Longitudinal Assessment of

Bariatric Surgery) study that looked at the short- and long-term risks and benefits of bariatric (weight-loss) surgery in teens. The Teen-Labs study recruiting criteria were patients 12 to 18 years of age and approved for bariatric surgery.

Reports revealed that common programs are not feasible for use in calculating sample size and conducting power analysis, but G*Power software avoids or alleviates the burden of extensive knowledge of statistical or software programming (Kang, 2021). Thus, G*Power (version3.1) was used to calculate the sample size. Using G*Power software to calculate a minimum sample size, using a two-tailed test, at least 81 participants were required for this study to achieve an effect size = 0.25, alpha = 0.05, and statistical power = 0.80.

The effect size reveals the magnitude of difference between groups or the strength of the relationship (Kang, 2021). Effect size represents clinically meaningful differences in the focused factors (Sullivan & Feinn, 2012). The Cohen's term *d* provides an effect size index and classifies effect size $d = 0.2$ as small, $d = 0.5$ as medium, and $d = 0.8$ as large (Sullivan & Feinn, 2012). Reports have described that effect size can vary based on discipline and that it is normal for medical or health research to be associated with small effect sizes in the range of 0.005 to 0.2 range; for example, Kang (2021) described that a small effect of 0.2 is smaller than medium (0.5) but not trivial, thus justifying the choice of an effect size of 0.25 to calculate the minimum sample size required for the study.

Accessing Secondary Data

I used data from the NIH clinical research - Teen-LABS (Longitudinal Assessment of Bariatric Surgery) study data stored in the NIDDK central repository. The

Teen-Labs study recruited patients 12 to 18 years of age approved for bariatric surgery. The Teen-Labs study enrolled 242 teens between the ages of 12 to 18 years from 2007 to 2012. Two hundred forty-two teens had bariatric surgery at five medical centers: Cincinnati Children's Hospital Medical Center, Ohio; Texas Children's Hospital, Texas; Children's Hospital of Alabama, Alabama; University of Pittsburgh Medical Center, Pennsylvania; and Nationwide Children's Hospital, Ohio.

In order to gain access to the NIDDK central repository, I made a formal request through the website, as required by NIH, and a completed form was submitted. A written authorization for data use was obtained from the NIH/NIDDK. The approval for data access and use is documented in Appendix A. The secondary data from NIDDK were extracted electronically from the NIDDK central repository. The Internal Review Board (IRB) of Walden University policies and prerequisites for the use of human subjects was followed by this study. Approval to conduct this study was secured from Walden University IRB.

Instrumentation and Operationalization of Constructs

NIDDK Instrument

The NIDDK Central Repository was created in 2003, and with expanded selection, it makes available valuable data resources for researchers to use in validating clinical hypotheses and processes, including medical/health research (NIDDK, n.d.-a). The NIDDK Central Repository is web-based, and it acquires, stores, and distributes data generated from multicenter studies that the NIDDK supports, thus promoting secondary research, maximizing contributions from research participants, and increasing the scientific impact the originating studies provided (NIDDK, n.d.-a).

Operationalization

Table 2 shows the matching of the theoretical framework constructs and the study variables.

Table 2

Theoretical Framework Constructs and Study Variables

Constructs of the social-ecological model (SEM)	Theoretical framework title: social-ecological model	Proposed study title: Morbid Obesity in Children 12-18 Years: Bariatric and Nonpharmacologic Influence and Interaction	Variable nature/coding scheme
The SEM levels	List of constructs of the theoretical framework you plan to use in your study below: Influence of policy; promote attitudes, beliefs, and behavior; Interactions and relationships of the immediate surroundings; Multilevel approaches to public health promotion.	List all the study variables you plan to include starting with all independent variables and ending up with your dependent variable (outcome). You can use only and only one dependent variable.	How is your study variable coded? (nature of the variable: nominal, categorical, ordinal, etc.). Include the nature of the variable and coding scheme
5- Public policy/government	1- Influence of policy and enabling environment	1- Bariatric Surgery	Independent variable - measured as a categorical variable
2- Individual	2- Promote behavior	2- Diet	Independent variable - measured as a categorical variable
2- Individual	3- Promote attitudes	3- Physical Activity	Independent variable - measured as a categorical variable
1- Intrapersonal	4- Biological and personal or developmental history	4- Age	Covariate - measured as a continuous variable
1- Intrapersonal	5- Biological and personal or developmental history	5- Gender	Covariate - measured as a categorical variable
1- Intrapersonal	6- Biological and personal or developmental history	6- Race	Covariate - measured as a categorical variable
4- Community	7- Multilevel approaches to public health promotion	7- Morbid Obesity	Dependent variable - coded as a categorical dichotomous variable (yes or no).

Dependent Variable. The dependent variable was morbid obesity. Based on the CDC recommendation to use a relative BMI measure when describing morbidly obese youths, morbid obesity is defined as obesity Class II (≥ 120% to 140% of the 95th percentile) or a BMI ≥ 35 to ≤ 39 kg/m2, whichever was lower, plus at least one comorbidity like diabetes, hypertension, obstructive sleep apnea, or congestive heart failure (Pratt et al., 2018; Skinner et al., 2018). Morbid obesity is also defined as obesity Class III (≥ 140% of the 95th percentile) or BMI ≥ 40 kg/m2, whichever was lower (Pratt et al., 2018; Skinner et al., 2018). In this study, morbid obesity was measured as a categorical dichotomous variable and coded (morbidly obese/not morbidly obese).

Independent Variables. The independent variables in this study included the following:

1. Bariatric surgery: Bariatric surgery may include any of the following procedures – sleeve gastrectomy, roux-en-Y gastric bypass, adjustable gastric band, biliopancreatic diversion with duodenal switch, or single anastomosis duodeno-ileal bypass with sleeve gastrectomy (ASMBS, n.d.). In this study, bariatric surgery was recoded as categorical variable with two categories: bariatric surgery (1 = *gastric bypass*, 2 = *others*).
2. Diet: Diet comprises of healthy eating patterns described in the Dietary Guidelines for Americans 2020 to 2025, which includes a variety of fruits and vegetables, whole grains, fat-free and low-fat dairy products, and a variety of protein foods (CDC, 2021b). Driven by the demand of the United States and Canadian governments, the National Academies of Sciences, Engineering, and Medicine sets the DRI to include macronutrients, vitamins and minerals, and food components (United States Department of Agriculture, n.d.). In this

study, I assumed “diet” as contained in the NIDDK dataset used for this study followed the recommended DRI healthy eating pattern described in the Dietary Guidelines for Americans 2020 to 2025. The TeenLABs study data dictionary defined diet used in this study to include high protein/low carbohydrate and low calorie. A high protein diet, which includes lean meats, seafood, beans, soy, and low-fat dairy, can be helpful in reducing weight (Casarella, 2019). Low carbohydrate diets include fatty fish, egg, nuts and seeds, avocados, and nonstarchy vegetables, which can help lower high blood pressure, promote good cholesterol, and reduce triglyceride levels, thereby reducing obesity (Ajmera, 2020). Low calorie diets can help weight loss and include oats, Greek yogurt, and skim milk (Ajmera, 2020). Diet was recoded as a categorical variable: diet (0 = *did not follow diet*, 1 = *followed diet*).

3. Physical activity– this study assumed that the CDC physical activity guidelines for children and adolescents to do at least 60minutes of moderate-to-vigorous physical activity daily, which includes aerobic, muscle-strengthening, and bone-strengthening is met by the dataset used by this study. The NIDDK collection of the physical activity data used in this study was based on the International Physical Activity Questionnaire. The physical activity I defined for this study is moderate physical activity that include walking, bicycling, swimming, and double tennis; one to seven times per week and at least 10 minutes at a time. Physical activity is recoded as a

categorical variable: physical activity (0 = no physical activity, 1 = 1-3 times/wk/10 minutes each time, 2 = 4-7 times/wk/10 minutes each time).

Covariates. The descriptive statistics of the following covariates were discussed in this study:

1. Age – this is the age of the study participants at the time of surgery, and it is measured as a continuous variable.
2. Gender – this is the gender of the study participants, and it has a categorical scale of measure with two categories [1 = male, 2 = female].
3. Race/Ethnicity – this is the race/ethnicity of the study participants, and it has a categorical scale of measure with the following categories [1 = White, 2 = Black or African Americans 3 = others].

Biomarkers. Metabolic syndrome is a biomarker or matching variable included in this study as a categorical covariate. Fulgoni et al. (2020) noted that children and adolescents are presumed to have metabolic syndrome if at least three of the following are present: Triglyceride [TAG] $\geq$ 150 mg/dL]; high-density lipoprotein-cholesterol [HDL $\leq$ 40 mg/dL]; fasting plasma glucose [FPG $\geq$ 100 mg/dL]; abdominal obesity by the waist to height ratio > 0.5; and either systolic blood pressure [SBP] or diastolic blood pressure [DBP] > 90th percentile for age, sex, and height. Thus, metabolic syndrome is calculated using the presence of at least three of any of the listed factors and coded as a categorical variable with two categories: Metabolic Syndrome (0 = has no metabolic syndrome, 1 = has metabolic syndrome). The codebook for the variables I examined in this study are documented in Appendix B.

Table 3

Operationalized Variables

Variable name	Variable label	Scales of measurement	Variable type	Source
Morbid obesity		Categorical	Dependent variable	Computed from BMI - NIDDK Repository
Bariatric surgery		Categorical	Independent variable	NIDDK Repository
Diet		Categorical	Independent variable	NIDDK Repository
Physical activity		Categorical	Independent variable	NIDDK Repository
Age		Continuous	Covariate	NIDDK Repository
Gender		Categorical	Covariate	NIDDK Repository
Race/Ethnicity		Categorical	Covariate	NIDDK Repository

Note. BMI - NIDDK = BMI values from NIDDK data file I used in this study

Data Analysis Plan

In this study, I used the Statistical Package for the Social Sciences (SPSS) version 28 to perform descriptive and inferential analysis. I accessed the NIDDK data used for the Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) Adolescent, Bariatrics study from the NIDDK central repository, and I extracted the essential datasets required for this study. Descriptive statistics were used to characterize the examined variables. Simple and multiple logistic regression analyses were performed to examine each of the multiple predictor variables while controlling for covariates like age, gender, and race/ethnicity.

The following RQs and hypotheses were evaluated:

RQ1: Is there an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$1: There is no association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a1: There is an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ2: Is there an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$2: There is no association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a2: There is an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ3: Is there an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$3: There is no association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a3: There is an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ4: Is there an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$4: There is no association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a4: There is an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

Simple logistic regression was conducted to address RQ1 by examining the odds that bariatric surgery is associated with morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States. Simple logistic regression was conducted to address RQ2 by examining the odds that diet is associated with morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States. Simple logistic regression was conducted to address RQ3 by examining the odds that physical activity is associated with morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States. Multiple logistic regression was conducted to address RQ4 by examining the odds that bariatric surgery, diet, physical activity, age, gender, and race are associated with morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

The outcome variable for all four RQs was morbid obesity. The independent variable for question one was bariatric surgery; for question two, the independent variable was diet, and for question three, the independent variable was physical activity. For question four, the predictor variables were bariatric surgery, diet, and physical activity, and the covariates were age, gender, and race.

A simple logistic regression was conducted for RQs 1 through 3, and a multiple logistic regression model was conducted for RQ4 to determine whether to “reject” or to “fail to reject” the null hypothesis for each of the four RQs. The statistically significant level (alpha) was set to (p=.05) with a 95% confidence interval. The test was conducted while controlling for the covariates (age, gender, race/ethnicity). This study reported and interpreted the odds ratio and the 95% confidence interval.

Threats to Validity

The external validity is concerned with the sampling design, the sample, and general population relationship and whether the research outcome can be generalized to a larger population (NIH, n.d.). There were no threats to external validity for this study, as the findings in this study can be generalized to the United States. population of the studied cohort. Internal validity tells whether the observed effects of the investigated variable can be attributed to the hypothesized cause. In this study I used secondary data from the NIH central repository collected from the participants in the NIH Teen-Longitudinal Assessment of Bariatric Surgery (Teen-LABS) Adolescent Bariatrics clinical study; thus, the belief is that the data has no threat to internal validity.

Ethical Procedures

In this study I used secondary data extracted from the NIDDK central repository, which is publicly available for secondary studies; therefore, requesting individual agreement or approval from participants was not necessary. However, in this study I obtained permission from the NIDDK data management and the Walden University IRB to access and or use the datasets. The NIH and NIDDK policies required the Data and Safety Monitoring Board (DSMB) to maintain a data and monitoring plan which provides guidelines in handling study participants, especially when human subjects are involved (NDDIK, n.d. -b). The DSMB role includes reviewing the protocol, informed consent documents, and plans for data and safety monitoring and ensuring data integrity and reliability (NIDDK, n.d. -b).

Summary

In this study I used a quantitative retrospective cohort study design to examine any probable relationship between bariatric surgery, diet, physical activity, their interactions, and morbid obesity. Approval was obtained from NIDDK and the IRB to use the data from the NIDDK central repository. Data from the NIDDK central repository was used to answer the RQs in this study. In this study I used descriptive statistics and binomial logistic regression inferential statistics to describe the study findings. Data collection and the study findings were presented in Chapter 4.

Chapter 4: Results

Introduction

The purpose of this retrospective quantitative study was to investigate the influence of bariatric surgery and nonpharmacologic factors (diet and physical activity) and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. The expectation was that addressing this research problem can lead to finding a more effective intervention approach that can lead to reduced morbid obesity prevalence and a sustained downward trend of the persistent rising prevalence of morbid obesity among children and adolescents. The datasets used for this study indicated that the study participants had undergone bariatric surgery, and, as such, the RQs were adjusted to align with the datasets. Four quantitative RQs were appropriate to help guide this study:

RQ1: Is there an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$1: There is no association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a1: There is an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ2: Is there an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$2: There is no association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a2: There is an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ3: Is there an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$3: There is no association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a3: There is an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

RQ4: Is there an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

$H_0$4: There is no association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

H_a4: There an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

In Chapter 4, I describe the source of the secondary data used in this study, data collection methods, descriptive statistics, hypothesis testing and statistical analyses, and the study results.

Data Collection

In this study, I used secondary data collected from the NIDDK repository, which was used in the Teen-LABS Adolescent Bariatrics study. The Teen-Lab study data used in this study consisted of 242 participants, 12 to 18 years of age who underwent bariatric surgery at five medical centers: Cincinnati Children's Hospital Medical Center, Ohio; Texas Children's Hospital, Texas; Children's Hospital of Alabama, Alabama; University of Pittsburgh Medical Center, Pennsylvania; and Nationwide Children's Hospital, Ohio. For this study, I analyzed 242 cases with participants aged 12 to 18 years of age and with metabolic syndrome. The data represented an adequate sample of the cohort, which required at least 81 participants as revealed by G*Power calculation.

The data files I accessed from the NIDDK repository conformed with the data collection plan described in Chapter 3 of this study, and there were no discrepancies. The independent variables, bariatric surgery, diet, and physical activity were coded as nominal variables, with detailed description documented under operationalization in this paper. Morbid obesity was computed as a dichotomous categorical variable from Year 3 BMI: BMI > = 35 and < = 39 plus at least one comorbidity (hypertension, diabetes, heart disease, sleep apnea, asthma) or BMI > = 40. Metabolic syndrome was computed as having at least three of the following: waist circumference > = 40 inches, waist-height ratio > 0.5, triglyceride > = 150 mg/dL, HDL < = 40 mg/dL, SBP or DBP > 90th percentile for age, sex, and height.

Descriptive and Demographic Characteristics

The sample population used for this study consisted of 242 participants retrieved from the NIDDK repository. The participants were morbidly obese and were approved for bariatric surgery in the Teen-Labs study. The Teen-Labs study data used in this study had age criteria of 12 to 18 years (NIDDK, 2020) The data were independently collected in five medical centers: Cincinnati Children’s Hospital Medical Center, Ohio; Texas Children’s Hospital, Texas; Children’s Hospital of Alabama, Alabama; University of Pittsburgh Medical Center, Pennsylvania; and Nationwide Children’s Hospital, Ohio. As such, the sample population for this study represented children and adolescents 12 to 18 years of age who were approved for bariatric surgery.

Univariate Analysis

Eta statistic was used to examine the measure of association between categorical variable (morbid obesity) and the covariate scale variable (age). Table 4 shows that with morbid obesity as the dependent variable, the Eta value (η = 0.169) is an indication of a weak association (see Lee, 2016).

Table 4

*Eta Statistics Morbid Obesity*Age*

Directional measures			
			Value
Nominal by interval	Eta	Morbid obesity dependent	.169
		AgeAtSurg dependent	.085

Notes: * indicates interaction of morbid obesity and age

Chi-square analyses were used to examine the association between categorical variables (morbid obesity and gender). As shown in Table 5, there was no significant association between morbid obesity and gender at alpha level (p = .05); $\chi 2(1, N = 241)$ = .413, p = .521. In Table 6, Cramer's value showed a negligence or weak association (V = 041, p = .521).

Table 5

*Chi-Square Tests Morbid Obesity * Gender*

	Value	*df*	Asymptotic significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson chi-square	.413[a]	1	.521		
Continuity correction[b]	.236	1	.627		
Likelihood ratio	.417	1	.518		
Fisher's exact test				.639	.316
Linear-by-linear sssociation	.411	1	.522		
N of valid cases	241				

Notes. * = interaction

Table 6

*Cramer's V Result Morbid Obesity * Gender*

Symmetric measures			
		Value	Approximate significance
Nominal by nominal	Phi	-.041	.521
	Cramer's V	.041	.521
N of valid cases		241	

Notes. * = interactionChi-square analyses were used to examine association between categorical variables (morbid obesity and race). Table 7 shows that there was no significant association between morbid obesity and race at alpha level (*p* = .05); *χ2(*2, *N* = 241) = .2.11, *p* =.348). In Table 8, Cramer's value showed a negligence or weak association (*V* = 094, *p* = .348).

Table 7

*Chi-Square Tests Morbid Obesity * Race*

	Value	*df*	Asymptotic significance (2-sided)
Pearson chi-square	2.114[a]	2	.348
Likelihood ratio	2.222	2	.329
Linear-by-linear association	2.072	1	.150
N of valid cases	241		

Note. * = interaction

Table 8

*Cramer's V Result Morbid Obesity * Race*

Symmetric measures			
		Value	Approximate significance
Nominal by nominal	Phi	.094	.348
	Cramer's V	.094	.348
N of valid cases		241	

Note. * = interaction

Additionally, reports noted that most epidemiologists apply a 10% rule in keeping covariates or cofounders in the model if the change in odds ratio between the crude and adjusted measures of association is 10% or more (LaMorte, 2021). A verification of whether to include the covariates age, gender, and race in the model by comparing the crude and adjusted measures of association showed less than 1% change in odds ratio for the dependent variable morbid obesity and the covariates age, gender, and race (see Tables 9 & 10).

Table 9

Model Before Adjusting for Covariates Age, Gender, and Race

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B) Lower	Upper
Bariatric surgery	-.193	.298	.421	1	.517	.825	.460	1.477
Diet	.615	.284	4.673	1	.031	1.849	1.059	3.228
Physical activity			2.111	2	.348			
Physical activity(1)	-.457	.316	2.084	1	.149	.633	.341	1.177
Physical activity(2)	-.225	.372	.367	1	.545	.798	.385	1.654
Constant	.658	.433	2.313	1	.128	1.931		

Table 10

Model After Adjusting for Covariates Age, Gender, and Race

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B) Lower	Upper
Bariatric surgery	-.248	.304	.664	1	.415	.780	.430	1.416
Diet	.635	.288	4.874	1	.027	1.888	1.074	3.318
Physical activity			2.593	2	.273			
Physical activity(1)	-.518	.322	2.593	1	.107	.596	.317	1.119
Physical activity(2)	-.190	.379	.251	1	.616	.827	.393	1.739
Age	-.106	.088	1.451	1	.228	.899	.757	1.069
Gender	-.255	.331	.594	1	.441	.775	.405	1.483
Race			2.435	2	.296			
Race(1)	.338	.342	.976	1	.323	1.402	.717	2.742
Race(2)	.924	.697	1.756	1	.185	2.519	.642	9.877
Constant	2.825	1.655	2.912	1	.088	16.863		

Therefore, with no statistical significance, and with negligeable or weak associations as reported, backed by the failure to meet the 10% rule, these covariates age, gender, and race were found not to influence the outcome of the model.

Results

Descriptive Statistics

The study participants disproportionately consisted of 183 females (75.6%) of the sample population compared to 59 males (24.4%). The number of females who were morbidly obese were 103, and 65 were not. The number of males who were morbidly obese were 36, and 19 were not morbidly obese. The 18-year-olds who participated in the study were higher in number (26.9%), followed by 16-year-olds (20.7%), 17-year-olds (16.9%), and 15-year-olds (15.7%). Whites in the sample data were 161 (71.6%), Blacks or African Americans were 50 (22.2%), and other races were 14 (6.2%) Table 11 provides a detail characteristics and demographics of the studied sample.

Table 11

Descriptive Statistics of the Sample Population Studied

Category	Frequency	Percentage (%)
Morbid obesity		
Not morbidly obese	86	35.5%
Morbidly obese	155	64.0%
Missing system	1	0.4%
Bariatric surgery		
Gastric bypass	161	66.5%
Others	81	33.5%
Diet		
Did not follow diet	93	38.4%
Followed diet	149	61.6%
Physical activity		
No physical activity	131	54.1%
1-3 Times/WK/10 mins each time	67	27.7%
4-7 Times/WK/10 mins each time	44	18.2%
Age		
13	9	3.7%
14	15	6.2%
15	38	15.7%
16	50	20.7%
17	41	16.9%
18	65	26.9%
19	23	9.5%
20	1	0.4%

Category	Frequency	Percentage (%)
Gender		
Male	59	24.4%
Female	183	75.6
Race		
White	174	71.9%
Black or African-American	54	22.3%
Others	14	5.8%
Metabolic syndrome		
Has no metabolic syndrome	2	0.8%
Has metabolic syndrome	240	99.2%

Note. *N* = 242. WK = week

A crosstabulation of morbid obesity into gender and race (see Table 12), shows that, of the 174 Whites who participated in the study, 66 were not morbidly obese, and 107 were morbidly obese. Among the White population who participated in the study, females made up slightly over 77% of those not morbidly obese, and approximately 74% of those who were morbidly obese while 23% of males were not morbidly obese and 26% of male were morbidly obese. On the other hand, of the 54 Blacks or African Americans who participated in the study, 17 were not morbidly obese, and 37 were morbidly obese. Among the Black or African American population who participated in the study, females made up 77% of those who were not morbidly obese, and 73% of those who were morbidly obese while 24% of males were not morbidly obese and 25% of male were morbidly obese (see Table 12)

Table 12

*Morbid Obesity * Gender * Race Crosstabulation*

Race				Gender Male	Female	Total
White	Morbid obesity	Not morbidly obese	Count	15	51	66
			% within morbid obesity	22.7%	77.3%	100.0%
		Morbidly obese	Count	28	79	107
			% within morbid obesity	26.2%	73.8%	100.0%
	Total		Count	43	130	173
			% within morbid obesity	24.9%	75.1%	100.0%
Black or African-American	Morbid obesity	Not morbidly obese	Count	4	13	17
			% within morbid obesity	23.5%	76.5%	100.0%
		Morbidly obese	Count	10	27	37
			% within morbid obesity	27.0%	73.0%	100.0%
	Total		Count	14	40	54
			% within morbid obesity	25.9%	74.1%	100.0%
Others	Morbid obesity	Not morbidly obese	Count	0	3	3
			% within morbid obesity	0.0%	100.0%	100.0%
		Morbidly obese	Count	2	9	11
			% within morbid obesity	18.2%	81.8%	100.0%
	Total		Count	2	12	14
			% within morbid obesity	14.3%	85.7%	100.0%
Total	Morbid obesity	Not morbidly obese	Count	19	67	86
			% within morbid obesity	22.1%	77.9%	100.0%
			Count	40	115	155

Race				Gender		
				Male	Female	Total
		Morbidly obese	% within morbid obesity	25.8%	74.2%	100.0%
	Total		Count	59	182	241
			% within morbid obesity	24.5%	75.5%	100.0%

Note. *N* = 242, * = interaction

Statistical Assumptions

Simple binary logistic regression was conducted to address RQs 1 to 3, and multiple binary logistic regression was conducted to address RQ4. The assumptions of binary logistic regression were tested and determined to be met. First, the dependent variable for a binary logistic regression must be a dichotomous categorical variable (present or not present). The dependent variable in this study, morbid obesity is dichotomous categorical variable with categories (morbid obesity: morbidly obese or not morbidly obese). Thus, the assumption of a dichotomous categorical variable was met. Second, the assumption of independent observation assumption was met since the data was collected in five separate independent locations. Third, the assumption of no linearity between the independent continuous variables. was met as the assumption did not apply to this study since all the independent variables were categorical variables. Fourth, the assumption that the data should not be highly correlated was tested using Pearson's Chi-square with Cramer's V using SPSS version 28. For bariatric surgery*diet matrix, Cramer's V value was (.249), which indicated the relationship is moderate, for bariatric surgery*physical activity, Cramer's V value was (.092), for physical activity*diet matrix, Cramer's V value was .053. A value greater than or equal to .40 indicates a large relationship (Lee, 2016), and since the association between any two of the three independent variables fell below .30, the assumption of no multicollinearity was met. Finally, the assumption of no outlier which applies to continuous independent variables was checked for age using box plot, and the result showed no outlier, thus the assumption of no outlier was met.

Statistical Analysis Findings

RQ1

A simple logistic regression analysis to investigate, Is there an association between Bariatric Surgery and Morbid Obesity (using Year3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States? was conducted. The predictor variable, bariatric surgery was tested a priori to verify there was no violation of the independence of errors, no violation of the assumption of linearity of logit, and no violation of the assumption of no strongly influential outliers. The predictor variable, bariatric surgery in the simple logistic regression analysis was found to have no statistically significant contribution to the model, p = .717. The unstandardized beta weight for the constant; B = 0.733, SE = 0.405, *wald* = 3.265, p = .071. The unstandardized beta weight for the predictor variable, bariatric surgery; B = (-0.104), SE = 0.287, *wald* = 0.132, p = .717. Therefore, I failed to reject the null hypothesis, p = .717, and concluded that there was no statistically significant association between bariatric surgery and morbid obesity 3-years post-bariatric surgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States (see Table 13).

Table 13

Simple Logistic Regression Analysis: Bariatric Surgery and Morbid Obesity

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B)	
							Lower	Upper
Bariatric surgery	-.104	.287	.132	1	.717	.901	.514	1.581
Constant	.733	.405	3.265	1	.071	2.081		

RQ2

A simple logistic regression analysis to investigate, Is there an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States? was conducted. The predictor variable, diet was tested a priori to verify there was no violation of the independence of errors, no violation of the assumption of linearity of logit, and no violation of the assumption of no strongly influential outliers. The predictor variable, diet in the simple logistic regression analysis was found to contribute to the model, $p = .044$. The unstandardized beta weight for the constant; $B = 0.262$, $SE = 0.210$, $Wald = 1.556$, $p = .212$. The unstandardized beta weight for the predictor variable, diet; $B = 0.556$, $SE = 0.276$, $wald = 4.053$, $p < .05$. The estimated odds ratio favored a 74% [Exp (B) = 1.744, 95% CI (1.015, 2.996)] likely chance that diet would influence or lower morbid obesity in those who followed diet than in those who did not follow diet. Therefore, I rejected the null hypothesis, $p <.05$, and concluded that there was a statistically significant association between diet and morbid obesity 3-years post-bariatric surgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States (see Table 14).

A simple logistic regression was conducted to generate the predicted probability of morbidly obese participants as a function of diet. A correlation result between morbid obesity and the predicted probability of morbidly obese showed a Pearson correlation value of 0.19. This indicated a small effect size. An effect size of 0.2 is small, 0.5 is medium, and 0.8 is large effect size (McLeod, 2019).

Table 14

Simple Logistic Regression Analysis: Diet and Morbid Obesity

							95% CI for EXP(B)	
	B	*SE*	Wald	*df*	Sig.	Exp(B)	Lower	Upper
Diet	.556	.276	4.053	1	.044	1.744	1.015	2.996
Constant	.262	.210	1.556	1	.212	1.300		

RQ3

A simple logistic regression analysis to investigate, Is there an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States? was conducted. The predictor variable, physical activity was tested a priori to verify there was no violation of the independence of errors, no violation of the assumption of linearity of logit, and no violation of the assumption of no strongly influential outliers. The predictor variable, physical activity in the simple logistic regression analysis was found to have no contribution to the model, $p = .372$. The unstandardized beta weight for the constant; *B* = 0.764, *SE* = 0.189, *wald* = 16.315, $p <$ .001. The unstandardized beta weight for the predictor variable, (physical activity: 1-3 times/WK/10 mins each time); *B* = (-0.432), *SE* = 0.312, *Wald* = 1.925, *p* = .165. The unstandardized beta weight for the predictor variable, (physical activity: 4-7 times/WK/10 mins each time); *B* = (-0.241), *SE* = 0.368, *wald* = 0.428, *p* = .513. Therefore, I failed to reject the null hypothesis, *p* = .372, and concluded that there was no statistically significant association between physical activity and morbid obesity 3-years post-bariatric surgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States (see Table 15).

Table 15

Simple Logistic Regression Analysis: Physical Activity and Morbid Obesity

							95% CI for (Exp(B)	
	B	*SE*	Wald	*df*	Sig.	Exp(B)	Lower	Upper
Physical activity (Reference: no physical activity)			1.980	2	.372			
Physical activity (1-3 times/WK/10 mins each time)	-.432	.312	1.925	1	.165	.649	.352	1.195
Physical activity (4-7 times/WK/10 mins each time	-.241	.368	.428	1	.513	.786	.382	1.617
Constant	.764	.189	16.315	1	<.001	2.146		

Note. WK = week

RQ4

A multiple logistic regression analysis to investigate, Is there an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States? was conducted. The predictor variables: bariatric surgery, diet, physical activity, age, gender, and race were tested a priori to verify there was no violation of the independence of errors, no violation of the assumption of linearity of logit, no violation of multicollinearity, and no violation of the assumption of no strongly influential outliers. Morbid obesity was the outcome of interest. The model resulted the IVs (bariatric surgery, physical activity, age, gender, race) in the multiple logistic regression analysis not significant ($p > 0.05$), however, the IV (diet) was found to be significant (see Table 16). Controlling for bariatric surgery, physical activity, age, gender, and race, the predictor variable, diet was found to contribute to the model. The unstandardized beta weight for the constant; *B* = (2.825), *SE* = (1.655), *wald* = (2.912), $p = .088$. The unstandardized beta weight for the predictor variable, diet; *B* = (0.625), *SE* = (0.288), *wald* = (4.874), $p <.05$. In the multiple logistic regression model (see Table 16), not all predictor variables were significant: the predictor variables (bariatric surgery, physical activity, age, gender, race) were not significant ($p >$ 0.05), and the predictor variable (diet) was significant ($p < 0.05$) Therefore, I failed to reject the null hypothesis, and concluded that in the multiple logistic regression model, the predictor variable (diet) is associated with morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States.

A multiple logistic regression was conducted to generate the predicted probability of morbidly obese participants as a function of the predictor variables (bariatric surgery, diet, physical activity, age, gender, race). A correlation result between morbid obesity and the predicted probability of morbidly obese showed a Pearson correlation value of 0.22. This indicated a small effect size. An effect size of 0.2 is small, 0.5 is medium, and 0.8 is large effect size (McLeod, 2019).

Table 16

Multiple Logistic Regression Analysis: Variables in the Equation

	B	*SE*	Wald	*df*	Sig.	Exp(B)	95% CI for EXP(B) Lower	Upper
Bariatric surgery	-.248	.304	.664	1	.415	.780	.430	1.416
Diet	.635	.288	4.874	1	.027	1.888	1.074	3.318
Physical activity			2.593	2	.273			
Physical activity(1)	-.518	.322	2.593	1	.107	.596	.317	1.119
Physical activity(2)	-.190	.379	.251	1	.616	.827	.393	1.739
Age	-.106	.088	1.451	1	.228	.899	.757	1.069
Gender	-.255	.331	.594	1	.441	.775	.405	1.483
Race			2.435	2	.296			
Race(1)	.338	.342	.976	1	.323	1.402	.717	2.742
Race(2)	.924	.697	1.756	1	.185	2.519	.642	9.877
Constant	2.825	1.655	2.912	1	.088	16.863		

Note. Variables included bariatric surgery, diet, physical activity, age, gender, and race.

Summary

In RQ1, the result of a simple logistic regression model showed that there was no statistically significant association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States (p = 717), thus, I failed to reject the null hypothesis. The result of a simple logistic regression model for RQ2 showed a statistically significant association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States (p <.05), as result, I rejected the null hypothesis. In RQ3, the result of a simple logistic regression model showed that there was no statistically significant association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States (p = 372), thus, I failed to reject the null hypothesis. In RQ4, the result of a multiple logistic regression showed that the association between bariatric surgery, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States was not statistically significant (p > .05), however, controlling for (bariatric surgery, physical activity, age, gender, race), the association between diet, and morbid obesity was statistically significant (p < .05, and as such, the predictor variable diet was found to contribute to the multiple logistic analysis model.

In Chapter 5, the study findings are interpreted, and limitations of the study, recommendations, and social change implications are discussed.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to investigate the influence of bariatric surgery and nonpharmacologic factors and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome. I aimed to answer whether the influence of bariatric surgery and nonpharmacological factors and their interactive effects are factors that predict morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age. The study was needed to address the existing gap of not only the individual influence of the factors but an examination of the combined influence and interactive effects of bariatric surgery and nonpharmacologic factors on morbid obesity 3 years postsurgery.

Previous studies have noted that bariatric surgery significantly reduced obesity prevalence and that diet and physical activity also influenced obesity (Burton et al., 2020; Greenhill, 2017). Additionally, reports have shown that weight regain can occur after weight loss surgery, and, in many cases, patients can return to baseline weight before treatment within 3 to 5 years after treatment (Castelnuovo, 2017; Cleveland Clinic, 2019). The current literature on obesity is limited in examining whether combined bariatric surgery and nonpharmacologic factors including lifestyle modification and their interactive effects influence morbid obesity 3 years postsurgery. Four RQs were developed to address the existing gap in the literature:

RQ1: Is there an association between bariatric surgery and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

RQ2: Is there an association between diet and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

RQ3: Is there an association between physical activity and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

RQ4: Is there an association between bariatric surgery, diet, physical activity, age, gender, race, and morbid obesity (using Year 3 BMI) in children and adolescents 12 to 18 years of age with metabolic syndrome who underwent bariatric surgery in the United States?

The results of the simple logistic regression showed a statistically significant association between diet and morbid obesity 3 years postsurgery. However, similar simple logistic regression test results between bariatric surgery and morbid obesity and between physical activity and morbid obesity 3 years postsurgery showed no statistically significant association. In a multiple logistic regression analysis, the test results showed that there was no statistically significant association between the predictor variables (bariatric surgery, physical activity, age, gender, race), and morbid obesity 3 years postsurgery; however, the predictor variable (diet) was statistically significant.

Interpretation of the Findings

In the simple logistic regression model, the study was performed to determine the level of association between bariatric surgery and morbid obesity 3 years postsurgery, the level of association between diet and morbid obesity 3 years postsurgery, and the level of association between physical activity and morbid obesity 3 years postsurgery. In the multiple logistic regression model, I examined whether there was statistically significant association between any of the predictor variables (bariatric surgery, diet, physical activity, age, gender, race), and morbid obesity while controlling for the rest of the predictor variables.

In either the simple or multiple logistic regression results, bariatric surgery showed no statistically significant association with morbid obesity. However, the outcome of the multiple logistic regression (see Table 16) showed a 12% improved likelihood of association over the simple logistic model (see Table 13). The outcome of this model that examined the association between bariatric surgery and morbid obesity suggests that morbid obesity is affected more by multiple factors and their interactive effects than bariatric surgery alone. This suggestion is in line with Pratt et al. (2018), who recognized that morbid obesity requires a multidisciplinary intervention method that uses combinations of lifestyle changes and metabolic and bariatric surgery.

Diet yielded a statistically significant association with morbid obesity for study participants who followed a prescribed diet, with 1.7 times likelihood in the simple logistic regression model (see Table 14) compared to those who did not follow diet. The multiple logistic regression model (see Table 16) showed an improved outcome of nearly

2 times the likelihood that diet is associated with morbid obesity compared to the 1.7 times likelihood in the simple logistic regression (see Table 14).

In both the simple logistic regression and multiple logistic regression, physical activity showed no statistically significant association with morbid obesity. However, the result of the multiple logistic regression analysis (see Table 16) showed a wider variance of 23% improved likelihood of association compared to the 14% recorded in the simple logistic regression model (see Table 15).

The findings of this study agreed with the major findings of previous studies, which noted that bariatric surgery alone cannot address obesity long term and that bariatric surgery is needed along with diet and exercise to maintain weight loss (Cleveland Clinic, 2019; Zeratsky, 2020). Additionally, the findings agreed with the major finding of past studies that reported that unhealthy food choices such as energy-dense foods like high-fat foods, sugar, sweetened beverages, excess food consumption, and unbalanced food intake among adolescents exacerbate obesity (Kim & Lim, 2019; NCCOR, n.d.). Also, the findings of this study with respect to physical activity, although not showing a statistically significant association with morbid obesity or the prediction of morbid obesity when interacting with bariatric surgery, revealed that the exposed improved likelihood is an indication that the findings are in line with previous studies that noted that after surgery, healthy dieting and exercise following bariatric surgery are needed to keep the weight off and to prevent morbid obesity and its comorbidities from reoccurring (Castelnuovo et al., 2017; Cleveland Clinic, 2019). Furthermore, this study agreed with core findings of previous studies (Ahn, 2020; Burton et al., 2020; Kang et al., 2020; Pratt et al., 2018; Pratt et al., 2020; Ruiz et al., 2019; Sanyaolu et al., 2019) that recommended the combination of multiple approaches that include diet, physical activity, and psychological factors, along with bariatric surgery for morbid obesity cases.

The current literature revealed that adolescents and children who underwent bariatric surgery experienced significant weight loss (Greenhill, 2017), and bariatric surgery can yield long term sustained weight loss (Himelstein, 2017; Khattab & Sperling, 2019; UCSF, n.d.). Other studies recommended examining the combined influence of bariatric surgery and nonpharmacologic factors such as diet and physical activities and their interactive effects on morbid obesity (Campoverde Reyes et al., 2018; Castelnuovo, 2017; Cleveland Clinic, 2019; Zeratsky, 2020). In contrast, I found that neither bariatric surgery as a single factor or the combined influence of bariatric surgery, physical activity, age, gender, and race and their interactive effects had statistically significant influence on morbid obesity 3 years postsurgery. However, the study revealed an improved likelihood of association when multiple factors and their interactive effects were examined. This study outcome suggests that future studies are needed to understand better the influence of combined factors and their interactive effects on morbid obesity 3 years postweight-loss surgery.

This study was guided by the SEM. The SEM postulates that health is not only determined by biological factors but is influenced by a group of subsystems that happen at various levels that include individual, interpersonal, institutional, community, and public policy levels (Shaffer, 2019). The study findings are aligned with the SEM constructs. The findings revealed that the construct influence of policy and enabling environment at the policy/government level demanded adherence to the eligibility criteria of 12 to 18 years of age and morbidly obese for participants to qualify for bariatric surgery. Also, the study findings suggest that following the SEM constructs that promote behavior and attitude, the participants' choice to follow diet or not and the participants' choice to participate in physical activity or not contributed to the association or lack of association between the independent variables and morbid obesity 3 years postsurgery. Furthermore, the study findings suggest that factors that interact at the community level of the SEM can influence or not influence morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States.

Limitations of the Study

The use of a quantitative retrospective cohort study design in this study was appropriate to examine the factors that are associated with morbid obesity 3 years postsurgery or factors that predict morbid obesity 3 years postsurgery; however, this type of test lacked the ability to conclude a causal effect. Additionally, while I used reliable and trusted secondary data from the NIDDK repository, which can be generalized to the population of American children and adolescents ages 12 to 18 years of age, generalization of the results to a larger population outside the United States or to a wider age range may require additional studies that include collected data from outside the United States.

Recommendations

The current study showed that diet interactively with bariatric surgery had a statistically significant association with morbid obesity 3 years postsurgery both in the simple logistic regression model and multiple logistic regression model. This result is backed by previous studies, which documented that more studies that combined bariatric surgery and nonpharmacologic factors like diet and physical activity are needed to formulate effective program to combat morbid obesity. Developing obesity intervention programs that build on dietary modifications which target reducing the consumption of high-fat/high-calorie foods and increasing the consumption of fruits and vegetables, as well as dietary monitoring and adherence to prescribed diet can yield significant positive social change benefit in reducing obesity in children and adolescents.

Though I found physical activity interactively with bariatric surgery to be nonstatistically significant in both the simple and multiple logistic regression models, the result of the multiple logistic regression model revealed an improved likelihood of potential association or influence on morbid obesity compared to the simple logistic regression model, suggesting that future studies and an examination of the mix of potential affecting variables in a multiple regression model that evaluates combined and/or interactive effects are needed.

This study can serve as a springboard for future studies, with the suggestion that more studies are needed to examine additional independent variables and cofounders, such as psychological factors, eating disorders, and cognitive behavioral interventions that could potentially influence morbid obesity. I also recommend more studies that examines a broader sample population that includes outside of the United States and a broader age range, which can be valuable in attaining results that can be generalized globally. Furthermore, the United States and the European regions have the highest obesity rates (Boutari & Mantzoros, 2022) The United States in particular ranks 12th globally in obesity level (36.2%) and is first among the Organization for Economic Cooperation and Development (ProCon.org, 2020). Future studies need to include investigations that examine the influence of geographical and environmental factors on morbid obesity and what aspects of these factors are unique to developed countries such as the United States and Europe. Additionally, because diet, physical activity, environmental factors, and socioeconomic determinants directly poses obesity risks (Chiolero, 2018), future studies should examine how the interaction of these factors affect obesity, particularly morbid obesity in children and adolescents.

Social Change Implications

Morbid obesity is associated with reduced quality of life and increased morbidity and mortality (Pratt et al., 2020; Ruiz al., 2019). Children and adolescents who are morbidly obese carry the disease into adulthood and have a shorter life expectancy than their normal-weight peers – a 6.5-year shorter life for a BMI of 40 to 44.9 kg/m2 to a 13.7-year shorter life for a BMI of 55 to 59.5 kg/m2 (Himelstein, 2017). This study can lead to programs that reduce morbid obesity in children and adolescents, thus improving life expectancy of morbid obesity patients by up to 14 years (Himelstein, 2017).

By examining the influence of bariatric surgery and nonpharmacologic factors like diet and physical activities and their interaction effects, the current study has social change implications at the intrapersonal, interpersonal, community and policy/government levels of the SEM that is rooted in the study's importance to create effective morbid obesity prevention and intervention programs that can reduce the persistent rising prevalence of morbid obesity, and, in turn, improve the life expectancy of children and adolescents. The study result revealed that diet was statistically significant. Using the SEM multilevel approach in creating a dieting program with focus on administration and adherence to dieting at the intrapersonal, personal and community levels of the SEM can reduce obesity rate of the obsessed individuals, and the community or population at large.

Childhood obesity has been associated with chronic diseases such as hypertension, dyslipidemia, cardiovascular disease, and Type 2 diabetes mellitus (Khattab & Sperling, 2019). By providing findings that can be vital in informing an effective prevention program, this study can be useful in reducing the prevalence of these chronic diseases in individuals as well as in the communities or population. Also, obesity in children has been associated with psycho-social dimensions of poor self-esteem and discrimination (Khattab & Sperling, 2019). By providing information that can lead to designing effective preventive measures or to future studies that can offer better treatment programs, this study can aid measures intended to reduce prevalence of poor self-esteem and discrimination in children and adolescence and perhaps in the larger population. Additionally, the results of the current study can be generalized for children and adolescents 12 to 18 years of age in the United States who are morbidly obese and have metabolic syndrome.

Conclusion

In this retrospective quantitative study, I examined the influence of bariatric surgery and nonpharmacologic factors (diet, physical activity, age, gender, race) and their interactive effects on morbid obesity 3 years postsurgery in children and adolescents 12 to 18 years of age with metabolic syndrome in the United States. To examine the influence of bariatric surgery, diet, and physical activity individually, a simple logistic regression was used to analyze the data. The results of the simple logistic regression showed that diet had a statistically significant association with morbid obesity 3 years postsurgery while bariatric surgery and physical activity showed no statistically significant association. To examine the interactive effects of the factors, a multiple logistic regression was used to analyze the data that included the predictor variables (bariatric surgery, diet, physical activity) and the covariates (age, gender, race). The result of the multiple logistic regression showed that diet was statistically significant. Also, the result of the multiple logistic regression showed that both the physical activity and bariatric surgery were not statistically significant; however, the result revealed that the likelihood of influence improved in the multiple logistic regression model over the simple logistic regression model.

The results of the current study can be generalized for children and adolescents 12 to 18 years of age in the United States who are morbidly obese and have metabolic syndrome. The study can serve as a springboard for informing intervention programs that consider the effect of diet and bariatric surgery interaction. The study can also lead to future studies that examine combined effects of additional independent variables and cofounders, including psychological impacts and cognitive behavioral intervention that could potentially influence morbid obesity. These efforts can lead to finding a more effective prevention or intervention programs to address the rising morbid obesity in children and adolescents.

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Appendix A: Data Access Approval - Full Datasets and Data Dictionary and Codebook

NIDDK Request ID: 23789
Request Type: Data Request
Request Status: Fulfilled
Requestor (Institution): Sam Osuoha (Walden University)
Requested Studies: Teen-LABS
Repositories: None
Approval Date: 11/28/2022
Material Sent: 12/21/2022
Modified: 01/12/2023 12:29p.m. • Submitted: 11/16/2022 12:00a.m…

Appendix B: Codebook for the Variables in the Study

Morbid_Obesity

		Value	Count	Percent
Standard Attributes	Position	85		
	Label	Morbid Obesity		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	0	Not Morbidly Obese	86	35.5%
	1	Morbidly Obese	155	64.0%
Missing Values	System		1	0.4%

SURG_Recode

		Value	Count	Percent
Standard Attributes	Position	79		
	Label	Bariatric Surgery		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	1	Gastric Bypass	161	66.5%
	2	All Others	81	33.5%

SDIETF_1_Recode

		Value	Count	Percent
Standard Attributes	Position	93		
	Label	Diet		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	0	Did Not Follow Diet	93	38.4%
	1	Followed Diet	149	61.6%

PHYACT_1

		Value	Count	Percent
Standard Attributes	Position	89		
	Label	Physical Activity		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	0	No Physical Activity	131	54.1%
	1	1-3 Times/WK/10 Mins each time	67	27.7%
	2	4-7 Times/WK/10 Mins each time	44	18.2%

MetS

		Value	Count	Percent
Standard Attributes	Position	86		
	Label	Metabolic Syndrome		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	0	Has No Metabolic Syndrome	2	0.8%
	1	Has Metabolic Syndrome	240	99.2%

AgeAtSurg

		Value
Standard Attributes	Position	6
	Label	Age
	Type	Numeric
	Format	F2
	Measurement	Scale
	Role	Input

N	Valid	242
	Missing	0
Central Tendency and Dispersion	Mean	16.62
	Standard Deviation	1.593
	Percentile 25	15.00
	Percentile 50	17.00
	Percentile 75	18.00

Gender

		Value	Count	Percent
Standard Attributes	Position	92		
	Label	Gender		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	1	Male	59	24.4%
	2	Female	183	75.6%

Race_recode

		Value	Count	Percent
Standard Attributes	Position	91		
	Label	Race		
	Type	Numeric		
	Format	F8		
	Measurement	Nominal		
	Role	Input		
Valid Values	1	White	174	71.9%
	2	Black or African-American	54	22.3%
	3	Others	14	5.8%