

The influence of county-level gender inequality on gender differences in bariatric surgery

A thesis submitted by

Claire Ardell Pernat

in partial fulfillment of the requirements for the degree of

Degree of Bachelor of Arts in Community Health

May 2020

Dr. Andrea Acevedo and Dr. Shalini Tendulkar

## Contents

<b>Acknowledgments</b> .....	<b>4</b>
<b>Abstract</b> .....	<b>5</b>
<b>Introduction</b> .....	<b>6</b>
<b>Background</b> .....	<b>6</b>
Obesity .....	6
Obesity Prevalence in the United States .....	9
Obesity-related Comorbidities .....	10
Non-Surgical Obesity Treatments .....	11
Surgical Obesity Treatment .....	12
Types of Bariatric Surgery .....	13
Bariatric Surgery Benefits and Limitations .....	14
Bariatric Surgery Underutilization .....	16
Gender Difference in Bariatric Surgery .....	17
Gender Inequality and Women’s Empowerment .....	21
Measuring Gender Equality and Women’s Empowerment .....	22
<b>Research Aims</b> .....	<b>25</b>
<b>Methods</b> .....	<b>26</b>
Research Design .....	26
Data Sources.....	26
<b>Figure 1: Data Merging and Data Set Creation Process</b> .....	28
Inclusion and Exclusion Criteria .....	28
<b>Figure 2</b> .....	30
<b>Research Question 1: Is there an association between county gender inequality and sex of the bariatric surgery patient?</b> .....	<b>30</b>
Unit of analyses .....	30
Dependent Variable .....	31
Primary Independent Variable .....	31
<b>Table 1. Gender Inequality Index Dimensions, Indicators, Data Sources, Calculation, and Description</b> .....	32
<b>Gender Inequality Index Indicator Explanations</b> .....	33

Parliamentary Rates .....	35
<b>Gender Inequality Index (GII) .....</b>	<b>36</b>
Covariates .....	38
Statistical Analysis for Research Question 1 .....	38
<b>Research Question 2: Is there an association between county gender inequality and the percent female bariatric surgeries at a county-level? .....</b>	<b>39</b>
Unit of analyses .....	39
Dependent Variable .....	39
Primary Independent Variable .....	39
Covariates .....	39
Statistical Analysis for Research Question 2 .....	40
<b>Results .....</b>	<b>41</b>
Population .....	41
<b>Table 2: Bariatric Surgery Population Demographics (n= 71,364).....</b>	<b>42</b>
Counties .....	42
<b>Table 3: Primary Independent Variable and Covariates by County (n=62) .....</b>	<b>43</b>
<b>Table 4: Total Population and Percent Females of Counties and Number of Bariatric Surgeries and Surgery Percent Females of Counties (n=62).....</b>	<b>44</b>
<b>Research Question 1: Is there an association between county gender inequality and sex of the bariatric surgery patient? .....</b>	<b>45</b>
Unadjusted analysis .....	45
Adjusted Multivariate Analysis.....	46
<b>Table 5: Results of Multivariate Logistic Regression Analysis for Predicting Sex of Bariatric Surgery Patient (n= 71,364) .....</b>	<b>47</b>
<b>Research Question 2: Is there an association between county gender inequality and the percent female bariatric surgeries at a county-level? .....</b>	<b>48</b>
Normality and Linearity Tests .....	48
Pearson Correlation .....	48
<b>Table 6: Pearson Correlation Matrix of Variables .....</b>	<b>49</b>
Linear Regression .....	49
<b>Table 7: Results of Linear Regression Analysis Predicting the Percent Female of Bariatric Surgery at a County-Level.....</b>	<b>51</b>
<b>Discussion .....</b>	<b>52</b>

Major Findings .....	52
Implications of Finding #1: Gender Inequality can Affect Treatment Choices at a Patient-Level .....	53
Implications of Finding #2: The Effect of Gender Inequality is Influenced by Income .....	57
Implications of Finding #3: The Need for Multi-level Gender Inequality Measures .....	58
Study Limitations .....	59
Potential Future Research .....	60
<b>Conclusion .....</b>	<b>62</b>
<b>Ethical Considerations .....</b>	<b>63</b>
<b>References.....</b>	<b>64</b>

## **Acknowledgments**

It has truly been a privilege and honor to complete my Community Health senior honors thesis this year. I owe so much gratitude to all my incredibly supportive mentors, colleagues, and professors at Tufts University and the Codman Center for Clinical Effectiveness in Surgery at Massachusetts General Hospital.

I would like to express my greatest appreciation and gratitude to my thesis committee comprising of Drs. Andrea Acevedo and Shalini Tendulkar. Thank you both for your profound encouragement and belief in my capabilities. Your unwavering support was essential throughout this year through many medical ups and downs, as well as the COVID-19 pandemic. I would like to express the greatest appreciation to my thesis chair, Dr. Acevedo, who continued to push me to achieve the highest standards in my work. My success in this thesis would not have been possible without her valuable insights, constructive advice, and unparalleled guidance.

I would like to extend my sincere thanks to the members of the Codman Center at Massachusetts General Hospital, including Dr. David C. Chang and Dr. Ya-Wen Chen. I am truly honored to have had the opportunity to work with you all. I cannot begin to express my thanks to Dr. Chang, who allowed me to work on independent projects and who was instrumental in the creation and implementation of this thesis. Without his mentorship and guidance, there is no way I could have produced this thesis.

I wish to acknowledge the continued support, encouragement, and love from my family, Sally, Frank, and Reed Pernat; my partner, Badr Bouhou; and my many friends. All of these individuals kept me going through the ups and downs. This work would not be possible without their continued support. Finally, I would like to recognize the assistance of the many medical professionals who helped keep me in good health and physically able to complete this thesis.

## **Abstract**

In the United States, around 80% of bariatric surgery patients are female, while obesity rates between genders are similar. This study aims to understand (1) if there is an association between county-level gender inequality and bariatric surgery patient sex and (2) if there is an association between county-level gender inequality and percent female bariatric surgeries.

A retrospective analysis of New York's Statewide Planning and Research Cooperative System between 2010 and 2015 was performed. Our study included New York State adult patients with obesity who underwent bariatric surgery. County-level gender inequality, defined by the United Nation's Gender Inequality Index, was created with data from Area Health Resources Files, New York State, American Community Survey, and CDC. The dependent variable for the multivariate logistic regression was the sex of the patient, and the dependent variable for the multivariate linear regression was percent female bariatric surgical procedures by county. We adjusted for gender inequality and relevant covariates for both analyses.

From 2010 to 2015, 71,364 bariatric surgical procedures were performed in New York's 62 counties. Females made up 79.15% of the patient population. Bariatric surgery patients residing in counties with high levels of gender inequality were significantly more likely to be female than male ( $p < 0.01$ ). Increased levels of county-level gender inequality were associated with a predicted increase in the percentages of county-level female bariatric surgeries ( $p < 0.05$ ).

The gender difference in bariatric surgery patients is influenced by county-level gender inequality. This demonstrates that gender inequality can affect treatment choices and that clinical decisions may be made because of non-clinical reasons. To promote equality in healthcare, isolating clinical and societal influences in the bariatric decision-making process may be beneficial in decreasing gender differences in surgery.

## **Introduction**

In the United States, even though obesity rates are similar between men and women, the proportion of patients who seek bariatric surgery is disproportionately women (Flegal, Kruszon-Moran, Carroll, Fryar, & Ogden, 2016; Fuchs et al., 2015; Kochkodan, Telem, & Ghaferi, 2018). The overarching aim of this study is to understand the association between county-level gender inequality and gender differences in bariatric surgery.

## **Background**

### *Obesity*

Obesity, or the condition of having excess body fat, is a well-documented problem among adults in the United States (US) (Jiang, Lu, Zong, Ruan, & Liu, 2016). In the late 1970s, the prevalence of obesity began to increase across the entire U.S. population. There was, and still is, some variation in obesity prevalence by age, sex, race, and ethnicity; however, all of these groups' weights increased at the same time (Reither, Hauser, & Yang, 2009; Rodgers, Woodward, Swinburn, & Dietz, 2018). The drastic increase in weight across the entire U.S. population demonstrates the increase was likely due to population-level or societal factors rather than being only influenced individual-level factors, such as age, sex, and socioeconomic status (Rodgers et al., 2018). The substantial increase in obesity rates concerns health officials because obesity is significantly associated with severe, potentially life-threatening health consequences (Jiang et al., 2016; Preston, Vierboom, & Stokes, 2018). Furthermore, the increasing rates of obesity and obesity-related health conditions, such as type II diabetes, hypertension, coronary heart disease, and heart failure, has led to a population-level increase in mortality, or death, and a reduced life expectancy of U.S. adults (Preston et al., 2018).

Obesity is the result of an imbalance in energy intake, or caloric consumption, and energy expenditure where excess calories not burned by the body are stored as fat (Jiang et al., 2016). An individual's body mass index (BMI) quantitatively defines obesity. Calculation of BMI is completed by taking a person's weight in kilograms and dividing the weight by the person's height in meters squared. According to standards set by the National Heart, Lung, and Blood Institute, adults with a BMI between 18.5 kg/m<sup>2</sup> to 24.9 kg/m<sup>2</sup> are at a normal or healthy weight, adults with a BMI between 25 kg/m<sup>2</sup> and 29.9 kg/m<sup>2</sup> are overweight, and adults who have a BMI of greater than or equal to 30 kg/m<sup>2</sup> are considered obese.

Within the obese category, there are three different classes of obesity that differentiate the significance and impact of that individual's weight on his or her health. First, there is class 1 obesity, which includes individuals with a BMI between 30 kg/m<sup>2</sup> and 34.9 kg/m<sup>2</sup>. Individuals with class 1 obesity are at a lower risk of developing obesity-related health problems compared to more obese individuals. However, individuals with class 1 obesity are at a higher risk of developing obesity-related health problems such as type II diabetes, hypertension, cardiovascular disease, and stroke compared to individuals who are at a healthy weight. Second, there is class 2 obesity, which includes individuals with a BMI between 35 kg/m<sup>2</sup> and 39.5 kg/m<sup>2</sup>. Individuals with class 2 obesity are at moderate risk of developing obesity-related health problems. Finally, there is class 3 obesity, which includes individuals who have a BMI of 40 kg/m<sup>2</sup> or higher. Class 3 obesity is also known as extreme obesity and/or morbid obesity. Individuals with class 3 obesity are at a high risk of developing obesity-related health problems. Overall, as the BMI and the obesity class increases, the risk of developing obesity-related becomes higher (Wadden, Pories, Blair, & Hubbard, 2000).

Overall, eating habits and physical activity patterns are responsible for weight management and the role of weight gain leading to obesity. However, other factors, such as a sedentary lifestyle, low self-esteem, depression, and decreased sleep, play a role in excess weight gain (Jiang et al., 2016). Beyond individual-level factors, population-level environmental and social factors are associated with the increasing prevalence of obesity, and these social determinants can help to explain the drastic increase of obesity rates since the late 1970s (Reidpath, Burns, Garrard, Mahoney, & Townsend, 2002; Rodgers et al., 2018; Rossner, 2002). One potential reason for the drastic rise of obesity across the entire U.S. population is due to the changes in the U.S. farm and agricultural bills in the 1970s and beyond, which have promoted the production of products such as corn, soybeans, and wheat through subsidies. These subsidies started with corn farmers and have now expanded to include milk, meat, sorghum, rice, soybeans, and wheat in addition to corn. These changes led to increased agricultural and food production, which, in turn, led to a greater availability of food, more inexpensive food, and larger food portions. Additionally, these agricultural changes introduced sweetening agents derived from corn, such as high fructose-corn syrup, and other energy dense foods to the population. Not only were these foods introduced to the population, they were marketed heavily and the availability and affordability of these foods made them popular among Americans (Rodgers et al., 2018).

Furthermore, there are issues with food deserts, or geographic areas that have limited access to affordable and nutritious foods, as well as increased density of fast-food outlets in areas often with a lower overall socioeconomic status (SES). These factors give economically disadvantaged areas increased exposure to unhealthy, energy-dense foods that contribute to obesity in individuals with a low SES (Reidpath et al., 2002). These environmental and social factors, in

addition to individual-level factors, all contribute to the rising rates of obesity in the U.S. (Rodgers et al., 2018).

### ***Obesity Prevalence in the United States***

According to the 2013-2014 National Health and Nutritional Examination Survey, more than 1 in 3 American adults are obese, and approximately 1 in 13 American adults are morbidly obese (Hales, Carroll, Fryar, & Ogden, 2017; Hales, Fryar, Carroll, Freedman, & Ogden, 2018). In the U.S., the prevalence of obesity between 2015 and 2016 in adults was 39.8% (Ogden et al., 2018). There has been an increase in the prevalence of obesity, with 30.5% of U.S. adults being obese in 1999 to 34.3% of U.S. adults being obese in 2015 (Hales et al., 2017).

With increasing trends of adult obesity, it is essential to look at the breakdown of the population that is obese to understand if there are specific populations that are disproportionately affected by the obesity epidemic (Hales et al., 2017). Age, race/ethnicity, and educational attainment have all been significantly associated with obesity (Halpern et al., 2017). Obesity is slightly more prevalent among women (40%) than men (35%) (Flegal et al., 2016). Within each sex category, the prevalence of obesity differs based on age and race. For example, the obesity prevalence of both men and women aged 40 to 59 years (approximately 45% for women and 41% for men) was higher than those aged 20 to 39 years (approximately 37% for women and 35% for men) (Hales et al., 2017). Overall, for both sexes, as age increases, the odds of being obese increase for each additional decade until the age of 65 years old (Halpern et al., 2017). Additionally, the obesity prevalence of Hispanic women (51%) and men (43%) and non-Hispanic black women (55%) and men (37%) was higher in comparison to non-Hispanic white women (38%) and men (37%) and non-Hispanic Asian women (14%) and men (10%). There is a much more significant obesity gender gap for Hispanics and non-Hispanic blacks in comparison

to non-Hispanic whites (Hales et al., 2017). The prevalence of obesity additionally changes based on educational attainment. Overall, individuals with a high school diploma or less have a significantly higher odds of being obese in comparison to college graduates (Halpern et al., 2017).

### ***Obesity-related Comorbidities***

The high and increasing prevalence of obesity concerns health professionals due to the adverse nature of obesity-related comorbidities and the association with serious health risks such as hypertension, type II diabetes, stroke, cancer, and coronary heart disease (Khaodhiar, McCowen, & Blackburn, 1999). The positive association between BMI and hypertension, also known as high blood pressure, is well documented. A 10 kg increase of body weight is associated with a systolic blood pressure increase of 3 mmHg. Another serious comorbidity related to obesity is type II diabetes. A higher BMI increases the risk of having type II diabetes (Khaodhiar et al., 1999). This association is due to abdominal obesity causing insulin resistance with hyperinsulinemia. Obesity is also a strong risk factor for coronary heart disease development since obesity is associated with type II diabetes, hypertension, and high cholesterol, which are all cardiovascular health markers (Khaodhiar et al., 1999).

The impact of obesity-related comorbidities ties directly into increased mortality's association with obesity (Jarolimova, Tagoni, & Stern, 2013). Class 2 and class 3 obesity are both associated with higher mortality, or death, in comparison to normal weight. In contrast, class 1 obesity is not associated with higher mortality, which suggests that there may be a correlation with increased BMI and increased risk of mortality (Flegal, Kit, Orpana, & Graubard, 2013). Furthermore, the Framingham Heart Study demonstrated that in comparison to individuals with normal body weight (BMI between 18.5 kg/m<sup>2</sup> to 24.9 kg/m<sup>2</sup>), individuals with

a BMI of 30 kg/m<sup>2</sup> at the age of 40 years had a 6 to 7-year decrease in lifespan for both men and women (Peeters et al., 2003). Due to the association of obesity with many comorbidities and increased mortality, there have been significant public health and medical efforts to reduce the rates of obesity in the U.S.—especially because many of the obesity-related comorbidities are potentially reversible (Khaodhjar et al., 1999; Wolfe, Kvach, & Eckel, 2016).

### ***Non-Surgical Obesity Treatments***

When the weight of an obese or morbidly obese person is reduced, the comorbidities associated with obesity often decrease (Khaodhjar et al., 1999; Wolfe et al., 2016). For example, weight loss has been shown to lower the risk of hypertension (Khaodhjar et al., 1999). As such, there is a strong focus on decreasing the prevalence of obesity among adults in the U.S. (Wolfe et al., 2016). In a healthcare setting, physicians follow clinical guidelines to help them manage patients with obesity more effectively. The initial objective of the guidelines is to identify patients, based on BMI, who need to lose weight. Within this assessment, a physician can make a tailored plan for each patient based on the overweight or obesity class of the patient. Following the identification of patients, physicians focus on recommending modest weight loss through lifestyle modification such as dietary changes and an increase in exercise and activity. Sustained weight loss as small as 3% to 5% helps to decrease the impact of obesity-related comorbidities, including type II diabetes, hypertension, and coronary heart disease. If those lifestyle changes do not result in weight loss, a doctor may prescribe a reduced-calorie diet tailored to the patient's needs and may suggest that the patient seek nutritional and/or psychological therapy depending on the patient's needs. If a strict diet and therapy do not work for the patient, the physician may prescribe prescription weight-loss medication. Finally, if the non-surgical weight loss options do

not work, then bariatric or weight loss surgery is considered as a potential treatment option for individuals with class 2 or class 3 obesity (a BMI of 35 kg/m<sup>2</sup> or higher) (Jensen & Ryan, 2014).

### ***Surgical Obesity Treatment***

For long-term weight loss, bariatric surgery is proven to work (Wee et al., 2013).

Bariatric surgery significantly decreases weight and, thus, BMI, which assists in improving the severity of obesity-related comorbidities, such as type II diabetes and hypertension, and reducing mortality (Kochkodan, Telem, Amir, Ghaferi, & Ghaferi, 2018). The main benefit of bariatric surgery is the reduction of weight. As mentioned previously, a decrease in the weight of obese individuals is associated with a decrease in the comorbidities associated with obesity.

Hypertension has been shown to decrease following bariatric surgery while weight loss occurs post-operatively, and hypertension typically remains at the reduced level following surgery as long as the individual does not gain the weight back (Wolfe et al., 2016). Following bariatric surgery, patients with type II diabetes often have a full remission of type II diabetes. No other medical diabetes interventions such as pharmaceuticals can achieve type II diabetes remission that is seen following bariatric surgery (Pories, 2008).

According to the American Society for Metabolic and Bariatric Surgery, there are only certain times an adult patient would medically qualify for bariatric surgery. The patient must have exhausted non-operative weight loss measures, such as dieting, increased exercise, nutritional therapy, psychological therapy, and medication, before qualifying for bariatric surgery. Additionally, patients must have an extensive medical evaluation, which includes seeing primary care specialists, and depending on the patients' health condition, subsequent evaluations by specialists such as cardiologists, psychologists, and psychiatrists may be required to assess the

patient to determine if bariatric surgery is the best options for the patient. Typically, the age range is limited to those from 18 years old to 70 years old (Pories, 2008).

Beyond those initial qualifications for surgery, there are typically two groups of individuals who have bariatric surgery. The first group is patients with a BMI of 35 kg/m<sup>2</sup> or higher with at least one obesity-related comorbidity. The other group is patients who have a BMI of 40 kg/m<sup>2</sup> or higher, and those patients can qualify regardless of the presence of obesity-related comorbidities (Sljivic & Gusenoff, 2019). Additional inclusion criteria that are similar for other surgical procedures include the patient's ability to comprehend the surgery and its consequences and agreeing to comply with the follow-up that is often long-term. Some exclusion criteria include unmanaged mental health disorders, alcohol or drug abuse, and a lack of support from family members or caretakers (Pories, 2008).

### ***Types of Bariatric Surgery***

The American Society for Metabolic and Bariatric Surgery estimates that each year, over 200,000 bariatric surgical procedures are performed (Sljivic & Gusenoff, 2019). There are several specific types of surgical procedures that qualify as bariatric surgery, such as sleeve gastrectomy, Roux-en-Y gastric bypass, and laparoscopic adjustable gastric banding (Wolfe et al., 2016). The surgical procedure chosen for each patient is often based on the surgeon's preference rather than patient factors (Pories, 2008). Sleeve gastrectomy comprises 71% of bariatric surgery in the U.S., making sleeve gastrectomy the most common bariatric procedure (Udelsman, Jin, Chang, Hutter, & Witkowski, 2019). Sleeve gastrectomy involves resecting approximately 80% of the stomach. This resection results in smaller stomach size, and the stomach becomes more tubular. As such, the stomach expels digested food, known as gastric

emptying, at a higher rate. Additionally, with a smaller stomach, food consumption often decreases. All of these factors contribute to weight loss (Wolfe et al., 2016).

The second most common bariatric surgical procedure is Roux-en-Y gastric bypass. The procedure is much more involved in comparison to sleeve gastrectomy, and as such, it is starting to be used less by surgeons (Udelsman et al., 2019). In the Roux-en-Y gastric bypass, the surgeon reduces the upper stomach size to approximately one ounce. Additionally, this gastric pouch is then attached to the Roux limb, which is part of the small intestine. This connection allows food to bypass most of the stomach and upper small intestine. With a smaller stomach, the amount of food consumed reduces. Additionally, the consumed food bypasses a large portion of the digestive tract, which decreases the amount of calories and fat absorbed by the body. This decrease in calorie and fat absorption, in turn, leads to weight loss (Wolfe et al., 2016).

Finally, the least common type of bariatric surgery is laparoscopic adjustable gastric banding (Udelsman et al., 2019). With laparoscopic adjustable gastric banding, an adjustable gastric band is placed around the stomach to decrease the size of the stomach. The adjustable band also contains an adjustable balloon that controls the gastric emptying rate (Wolfe et al., 2016). Sleeve gastrectomy, Roux-en-Y gastric bypass, and laparoscopic adjustable gastric banding have been proven to be effective in increasing weight-loss and decreasing an individual's weight (Kochkodan, Telem, & Ghaferi, 2018; Udelsman et al., 2019; Wee et al., 2013; Wolfe et al., 2016).

### ***Bariatric Surgery Benefits and Limitations***

In bariatric surgery, the primary objective is weight loss. Weight loss post-bariatric surgery is followed and monitored both short- and long-term. Laparoscopic adjustable gastric banding, which is the least invasive of the three most common bariatric surgical procedures,

accomplishes less weight loss in comparison to sleeve gastrectomy or Roux-en-Y gastric bypass. Three years post-bariatric surgery, laparoscopic adjustable gastric banding provided approximately 16% total body weight reduction. In contrast, the overall body weight reduction of Roux-en-Y gastric bypass and sleeve gastrectomy at three years post-surgery was around 30-35%. With the lower total body weight reduction in laparoscopic adjustable gastric banding, the other types of bariatric surgery have become more dominant in the treatment of severe obesity. However, laparoscopic adjustable gastric banding is still performed due to the decreased risk of the procedure (Wolfe et al., 2016). While the benefits of reducing BMI and obesity-related comorbidities are substantial, both the surgeon and the patient must consider surgical complications and risks.

Being obese or morbidly obese with comorbidities immediately puts an individual at a higher risk of surgical complications. There are acute and long-term complications that can occur following bariatric surgery. Acute complications such as obstruction, hemorrhage, infection, and pulmonary emboli typically occur in 5% to 10% of patients (Pories, 2008). The varying risk is based on the patient's age, comorbidities, weight, and health status (Pories, 2008). These acute complications are general to most surgical procedures. Long-term complications, which are less common than acute complications, include internal hernias, emotional disorders, and nutritional deficits that can lead to neuropathy. Due to the standardization of bariatric surgical care in the U.S., the mortality rate is low (less than 1%) (Pories, 2008). With some of these risks, bariatric surgery is often not an option for every obese person. However, those who undergo bariatric surgery tend to benefit significantly from the procedure (Kochkodan, Telem, & Ghaferi, 2018; Udelsman et al., 2019; Wee et al., 2013; Wolfe et al., 2016).

### ***Bariatric Surgery Underutilization***

In general, bariatric surgery is often underutilized by the obese population, and many studies have analyzed this underutilization to try to understand why it exists and to see if the underutilization disproportionately affects one group over another. A study demonstrated that only 45.2% of patients who were referred to a bariatric surgeon and evaluated proceeded to undergo bariatric surgery (Ju et al., 2019). Some of the groups that are disproportionately affected by underutilization of bariatric surgery when comparing the demographics of patients who undergo bariatric surgery in comparison to the demographics of the obese population are men, African-Americans, publicly insured patients, patients with lower SES, and patients with lower levels of education (Santry et al., 2007). Physician referral of a patient to a bariatric surgeon, or lack thereof, and the choice of the bariatric surgeon of whether to perform the surgery have been noted as clinical reasons for the disproportionate underutilization (Ju et al., 2019; Santry et al., 2007).

Male sex, older age, and positive smoking status were associated with not proceeding with the bariatric surgery procedure. Smoking regulations for specific bariatric centers (i.e., cessation before surgery or surgeons not operating on smokers) were excluded—the patient's decision not to go through with the surgery. Patients who continue with non-surgical weight-loss management guided by a dietician and have success with weight-loss also tend to not go through with bariatric surgery. Medicaid and Medicare can cover bariatric surgery procedures; however, not all states have bariatric surgery as an essential health benefit. Insurance requirements to have surgery such as extended dieting time requirements, advanced laboratory testing, and pulmonologist and cardiologist evaluations and the costs associated with these additional requirements also contribute to a decreased utilization of bariatric surgery (Ju et al., 2019).

Another source of underutilization of bariatric surgery is geographic location. When comparing the Northeast, South, Midwest, and West regions, the South has the highest overweight population in the U.S., with 39.7% of the South's population being overweight. In contrast, the Northeast has the second-highest overweight population, with 24.1% of the Northeast's population being overweight, followed by the West with 21.4%, and then the Midwest with 17.1%. Bariatric surgery is not performed in a manner that is proportional to the eligible population, however. The Northeast performed the most bariatric surgeries (24.4%); whereas, the South only performed 13.9% of the U.S.'s bariatric surgeries. This difference in the South of the percent of the U.S.'s overweight population and the percent of U.S.'s bariatric surgery indicates that there is an unequal distribution of bariatric surgery based on the region in the U.S. (Hennings et al., 2017). Beyond the region of the U.S., it has been shown that individuals in more rural communities are 23% less likely to undergo bariatric surgery compared to their urban counterparts. Part of the rural-urban difference is that public insurance, such as Medicare and Medicaid, only reimburse high-volume centers for bariatric surgery, which leaves rural residents with less access to bariatric surgical care because there are fewer high-volume centers in rural areas (Wallace, Young-Xu, Hartley, & Weeks, 2010).

### ***Gender Difference in Bariatric Surgery***

Analyzing the patient population undergoing bariatric surgery reveals a significant gender gap. Of those who undergo bariatric surgery, women comprise approximately 80% of patients, and men comprise of approximately 20% (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Martin, Beekley, Kjorstad, & Sebesta, 2010; Young, Phelan, & Nguyen, 2016). The gender gap in bariatric surgery is significantly larger than the gender gap seen in the obese population where the obesity prevalence for women is 40% and for men is 35% (Flegal et al.,

2016). This uneven distribution of bariatric surgery between men and women when rates of obesity—a qualifier for bariatric surgery—are much closer indicates that there is a gender gap in use of bariatric surgery for weight loss (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Young et al., 2016). For over two decades, this gender gap has been present and tracked, and no significant change in the gender gap has been observed over those past two decades. It is unclear why there is such a significant gender gap in rates of bariatric surgery (Wee et al., 2013; Young et al., 2016; Zizza, Herring, Stevens, & Carey, 2003).

Many studies have looked examined the gender gap in bariatric surgery through demographic factors and both a physiological and psychological lenses (Farinholt, Carr, Chang, & Ali, 2013; Fuchs et al., 2015; Santry et al., 2007; Young et al., 2016). Some reasons may include differences in access to healthcare, cultural differences, and patient preferences to undergo surgery (Fuchs et al., 2015; Wee et al., 2013; Zizza et al., 2003).

Access to healthcare may help to partially explain the gap since more men (9.6% in 2017) are uninsured in comparison to women (8.1% in 2017) (U.S. Census Bureau, 2017). This may indicate that women are more likely to go healthcare professionals than men and, therefore, have better access to medical procedures (Fuchs et al., 2015). Additionally, barriers to care are also more common among men. Some studies suggest that men tend to wait longer to see a doctor for medical conditions and problems (Fuchs et al., 2015; Thompson et al., 2016). As such, men tend to present with a higher burden of disease which includes obesity-related comorbidities such as hypertension, diabetes, congestive heart failure, and pulmonary disorders when they do seek medical care (Kochkodan, Telem, Amir, et al., 2018; Young et al., 2016; Zizza et al., 2003). With men being more reluctant to seek out care, male patients tend to delay bariatric surgery until they experience considerable comorbidities. As such, the rate of complications of male

patients is higher than that of women. This increased risk of complications may deter male patients from getting bariatric surgery (Young et al., 2016).

Another potential reason for the gender gap derives from weight stigma and societal pressure. In 2010, weight stigma was proposed as a public health problem to focus on when addressing the interventions to combat obesity. The population perception and reaction to obesity derive from social constructs regarding the normal or ideal person. In the U.S., the population tends to blame the individual for their own poor health. This comes in a form of blaming individual-level factors such as overeating and laziness. These assumptions create a foundation for weight stigma. Women report being more affected by weight stigma than men, and it was shown that women with higher perceived weight stigma are more willing to take a more substantial mortality risk when deciding to undergo a bariatric surgical procedure (Giardino, Keitel, Patelis, & Takooshian, 2017; Puhl & Heuer, 2010). Additionally, women tend to face more consequences of being obese than men, such as obese women having decreased wages in comparison to women at a normal weight (Baum & Ford, 2004). As such, when studying weight stigma and the role it has in motivating individuals to seek bariatric surgery, it was seen that weight stigma tends to influence the decision of women deciding to proceed with bariatric surgery; whereas, men did not seem to have weight stigma influence their decision of whether to undergo bariatric surgery (Giardino et al., 2017). Additionally, in comparison to men, women tend to desire to lose more weight from bariatric surgery than men, which may arise due to the higher burden of weight stigma women face (Wee et al., 2013).

Furthermore, there is variation in weight stigma and the bariatric surgery gender gap across race/ethnicity. One study demonstrated that in comparison to non-Hispanic whites, African Americans had the largest gender gap, and Asians had the lowest gender gap. Hispanics

had a larger gender gap than non-Hispanic whites but less than African Americans (Fuchs et al., 2015). Beauty-ideal and standards for women may vary across cultures since culture, which is shared by racial and ethnic groups or a society, plays a large part in creating ideals for appearance including body size and body shape (Fallon, 1990; Wiseman, Gray, Mosimann, & Ahrens, 1992). As such, people from varying cultures might have a different understanding and acceptance of body image and societal body-expectations for men and women (Fuchs et al., 2015). Some studies showed that in some non-Western cultures, larger, more curvy bodies are more accepted (Cachelin, Monreal, & Juarez, 2006; Cheney, 2011; Demarest & Allen, 2000; Furnham & Baguma, 1994). Furthermore, studies have shown that in comparison to non-Hispanic white women, Asian women tend to have less dissatisfaction with their bodies (Akan & Grilo, 1995; Cachelin, Rebeck, Chung, & Pelayo, 2002). A study also demonstrated that white women tend more affected by weight stigma than women of other races (Giardino et al., 2017). Moreover, when general body image has been studied, African American and Hispanic women tend to be less concerned about weight and had a more positive self-view of their body than that of non-Hispanic white participants (Altabe, 1998; Rosen et al., 1991).

In relation to varying cultural norms and expectations, many studies state that the gender gap is likely influenced by the differing societal standards and expectations of men and women (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Santry et al., 2007). However, no study has quantified these societal standards. From a psychological perspective on the issue, women tend to have lower psychological well-being and an overall lower self-perception of their bodies. Additionally, women's perceptions of bariatric surgery are typically aimed at losing a significant amount of weight and having a resolution of comorbidities. These psychological factors are likely tied to societal standards and expectations of women (Kochkodan, Telem,

Amir, et al., 2018). Some studies have looked at women's and men's thoughts about bariatric surgery, and some studies show that women tend to have a more negative perception of body image and increased concerns about body shape and figure in comparison to men (Kochkodan, Telem, & Ghaferi, 2018). Furthermore, women tend to struggle more with body image and psychological disorders from adolescence to adult life (Kochkodan, Telem, Amir, et al., 2018).

Moreover, there are two ways to look at the gender gap in bariatric surgery. One can view it as an underutilization by men or overutilization by women. Additionally, there is the possibility that both underutilization and overutilization come into play (Fuchs et al., 2015). One study documented that when comparing men and women who undergo bariatric surgery, men presented with higher BMI, increased comorbidities, and better body image scores, and postoperatively, men experienced higher complications and worse outcomes in comparison to women (Kochkodan, Telem, Amir, et al., 2018). The gender gap in bariatric surgery is of great concern to bariatric surgeons, and such has been a focus of study. However, no studies have looked at the community-level impact of societal standards or expectations relating the inequality of females and males on the bariatric surgery gap (Farinholt et al., 2013; Fuchs et al., 2015; Santry et al., 2007; Wee et al., 2013; Young et al., 2016). Looking at community-level gender equality, which relates to societal standards, may help to understand some of the reasons behind the bariatric surgery gender gap.

### ***Gender Inequality and Women's Empowerment.***

Before delving into the intricacies of gender inequality and equality, it is imperative to understand and differentiate sex and gender. Gender is a concept created by feminist scholars that extend beyond an individual's biological sex (Moghadam & Senftova, 2005). The differences between sex and gender were first distinguished by John Money and colleagues,

1955, in the late 1950s (Muehlenhard & Peterson, 2011). Money et al. 1955 defined sex as an individual's physical and biological characteristics such as chromosomal sex, hormonal sex, and gonadal sex. In contrast, Money et al. 1955 defined gender as referring to an individual's behavior and psychological characteristics (Money, Hampson, & Hampson, 1955). The difference between sex and gender is now often understood as sex can be defined as a biological attribute, whereas gender can be defined as a sociocultural relationship (Moghadam & Senftova, 2005). Furthermore, gender encompasses a social and structural relationship where power and political, economic, and cultural resources are unequally distributed (*Closing the gap*, 2008; Moghadam & Senftova, 2005).

In the U.S., there have been considerable gains in obtaining gender equality and women's empowerment; however, the U.S. still has a long way to go to achieve full gender equality. There have been advances in the economic gains and employment of women since the late 1970s; however, there is still a significant pay gap where women earn only 72 cents for each dollar earned by a man. Within different regions of the U.S., the pay gap is more extreme (Newman, 2016; O'Neill, 2003). Furthermore, women are still underrepresented in politics and other positions of power (*Closing the gap*, 2008). In 2013, approximately 1 in 5 seats in Congress was held by women (Newman, 2016).

### ***Measuring Gender Equality and Women's Empowerment***

With the goals to decrease gender inequality and attain gender equality, it is imperative that we understand and measure gender equality and women's empowerment. There have been several attempts to quantify empowerment and equality from academic scholars and organizations such as the United Nations (Jbara & Darnton, 2019).

Beginning in 1977, Janet Z. Giele crafted a framework to understand women's status in society. Through a six-fold framework including political expression; work and mobility; family: formation, duration, and size; education; health and sexual control; and cultural expression, she created a way to conceptualize and compare the status of women. Her framework encompasses both quantitative (e.g., age of marriage, educational attainment) and qualitative (e.g., how are women involved in the political process? What laws exist to prevent or punish violence against women?) metrics, and it incorporates more than just the economic status of women. Giele's framework was the start of trying to quantify women's empowerment, and her framework has continued to be developed and expanded upon (Moghadam & Senftova, 2005).

A new framework to understand and measure women's empowerment expanding upon Giele's work was presented in 2006 in response to the 1995 Beijing Platform for Action's call to empower women culturally, economically, and politically and to recognize the human rights of women. This new framework encompasses seven domains that are key in assessing a woman's participation, rights, and capabilities. Social indicators of women's empowerment include sociodemographic indicators; bodily integrity and health; literacy and educational attainment; economic participation and rights; political participation and rights; and cultural participation and rights. The framework ideally includes a mixture of quantitative and qualitative (e.g., right to take part in cultural activities, role and views of women) data; however, due to a lack of available qualitative data, the framework relies primarily on quantitative data. Socio-demographic indicators include life expectancy at birth in comparison to males, sex ratio, average female age at first marriage, adolescent marriage, adolescent birth rate, and total fertility rate. Bodily integrity and health indicators include maternal mortality rate, child mortality rate, contraceptive prevalence, female genital mutilation prevalence, people with HIV, sexual abuse of

women, and domestic assault against women. Literacy and educational attainment indicators include comparing females and males in youth literacy rates, adult literacy rates, school life expectancy, new secondary school enrollment, and tertiary enrollment rates. Economic participation and rights indicators include the comparison of female and male labor force participation rates, unemployment rate, estimated earned income, the female share of the paid labor force, the percentage of female professional and technical workers, and length, amount, and source of payment of maternity leave. Political participation and rights indicators include the percentage of female seats in government and percentage of female legislators, senior officials and managers. Cultural participation and rights indicators include access to computers and the internet, number of existing feminist resources in print and electronic media, number of women's NGOs, the existence of paternity leaves, percentage of female museum staff, and percentage of females who are cultural organization decision-makers. These many factors provide a comprehensive framework for understanding the complex nature of women's empowerment and gender equality (Moghadam & Senftova, 2005). However, many of these indicators are not currently available at an international or national level. This framework aims to advance the data collection of factors that encompass and help researchers to understand and quantify female empowerment.

A more quantitative model for understanding gender inequality was created by the United Nations. The Gender Inequality Index (GII) was created to understand the position of women in a country and to highlight potential areas for human development. The GII uses three dimensions—health, empowerment, and labor market—to measure gender inequalities and to better analyze the differences between women and men. The indicators for health include maternal mortality ratio and adolescent birth rate. The indicators for empowerment include the

female and male population with at least a secondary education and the female and male shares of parliamentary or government seats. Finally, the labor market indicators include the female and male labor force participation rates. The GII results in a continuous variable between 0 and 1 with 0 equating to gender equality and 1 equating to gender inequality (Gaye, Klugman, Kovacevic, Twigg, & Zambrano, 2010). The GII is gender symmetric, which means it treats both women and men the same in the index. Additionally, the calculation of the GII is association sensitive where gender inequality increases when there are increasing value of indicators for one gender over the five indicators (Gaye et al., 2010; Seth, 2009).

The multidimensional nature of each of these proposed measures demonstrates the complexity of understanding and quantifying gender inequality and women's empowerment. There is no clear definition of what constitutes empowerment and how to measure it truly (Beetham & Demetriades, 2007). However, some of the theories and frameworks that attempt to quantify empowerment and equality have common domains such as economic influence, health, political power, and education. Moreover, it is important to note that gender inequality and women's empowerment are typically measured at a country-level rather than a state or county-level, and there are also issues with a lack of data for quantifying inequality and empowerment (Gaye et al., 2010; Moghadam & Senftova, 2005).

## **Research Aims**

Overall, bariatric surgery is disproportionately used by women in comparison to men (approximately 80% women versus 20% men) (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Martin et al., 2010; Young et al., 2016). Furthermore, studies suggest that the gender gap in bariatric surgery is likely influenced by differing societal standards and expectations of women and men, yet these societal expectations have not been quantified and studied relating to

gender differences in bariatric surgery (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Martin et al., 2010; Santry et al., 2007; Young et al., 2016). As such, analyzing the gender differences in bariatric surgery through looking a community-level gender inequality, which relates to societal standards, may help to understand the gender differences in bariatric surgery. Moreover, the aims of this study were:

- 1) To understand if there is an association between county-level gender inequality and sex of the bariatric surgery patient. We hypothesize that counties with higher gender inequality are associated with a higher likelihood of the patient undergoing bariatric surgery being female.
- 2) To understand if there is an association between county-level gender inequality and the county-level percent female bariatric surgeries. We hypothesize that counties with higher gender inequality are associated with a higher female percent of bariatric surgeries.

## **Methods**

### ***Research Design***

The intentions of this research are two-fold. The first aim is to understand if there is an association between county-level gender inequality and sex of the bariatric surgery patient, and the second aim is to understand if there is an association between county-level gender inequality and the county-level percent female bariatric surgeries. To fulfill these aims, we performed a retrospective analysis using individual-level health services data linked with county-level data.

### ***Data Sources***

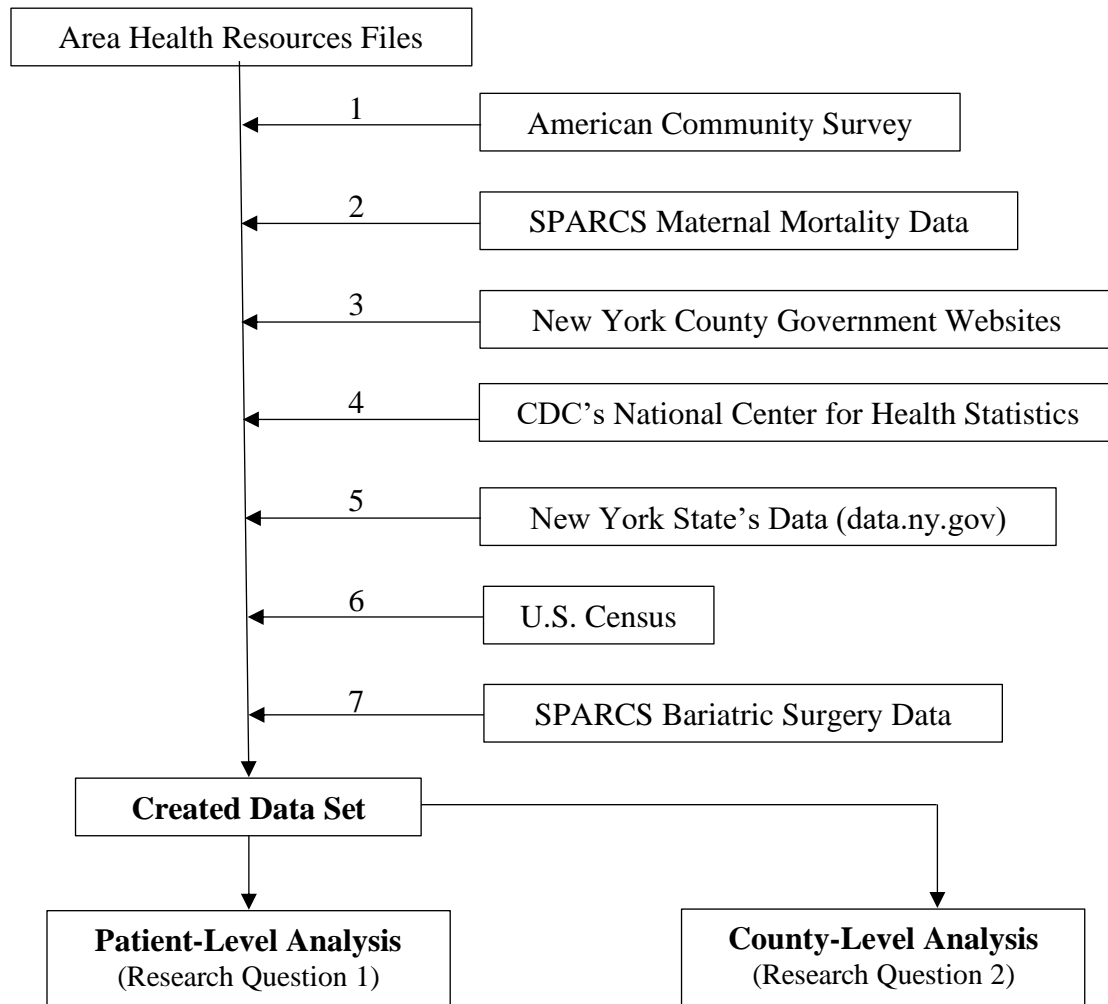
Existing health services data obtained from New York state and county-level publicly available data were used for this study. Health records were obtained from New York's

Statewide Planning and Research Cooperative System (SPARCS), which contains inpatient and outpatient data from all of New York's hospitals. The state of New York was chosen because New York is one of only two states in the U.S. (California is the other state) that have surgical patient data and patient zip codes that is available to researchers. Data used for this study included data from 2010 to 2015.

County-level publicly available data used in this study include the Area Health Resources Files (AHRF), New York State's population data (data.ny.gov), American Community Survey (ACS), the Center for Disease Control's National Center for Health Statistics, and the U.S. Census. AHRF includes data on health care professionals, health facilities, population characteristics, economics, health professions training, hospital utilization, hospital expenditures, and environment at different geographic levels. New York State's data (data.ny.gov) provides open access to detailed population data at different geographic levels in the state of New York. The ACS includes detailed population and housing information at different geographic levels on a yearly basis. The Center for Disease Control's National Center for Health Statistics provides statistics on health, such as population health, health care experience, and trends in healthcare.

The datasets were linked with records from SPARCS that met the inclusion criteria using patients' county code of residence. SPARCS county codes were converted to the Federal Information Processing Standards (FIPS) county codes. All of the other datasets had county variables in the standard FIPS version. As such, all datasets were able to be linked (see Figure 1) by FIPS county codes.

**Figure 1: Data Merging and Data Set Creation Process**



***Inclusion and Exclusion Criteria***

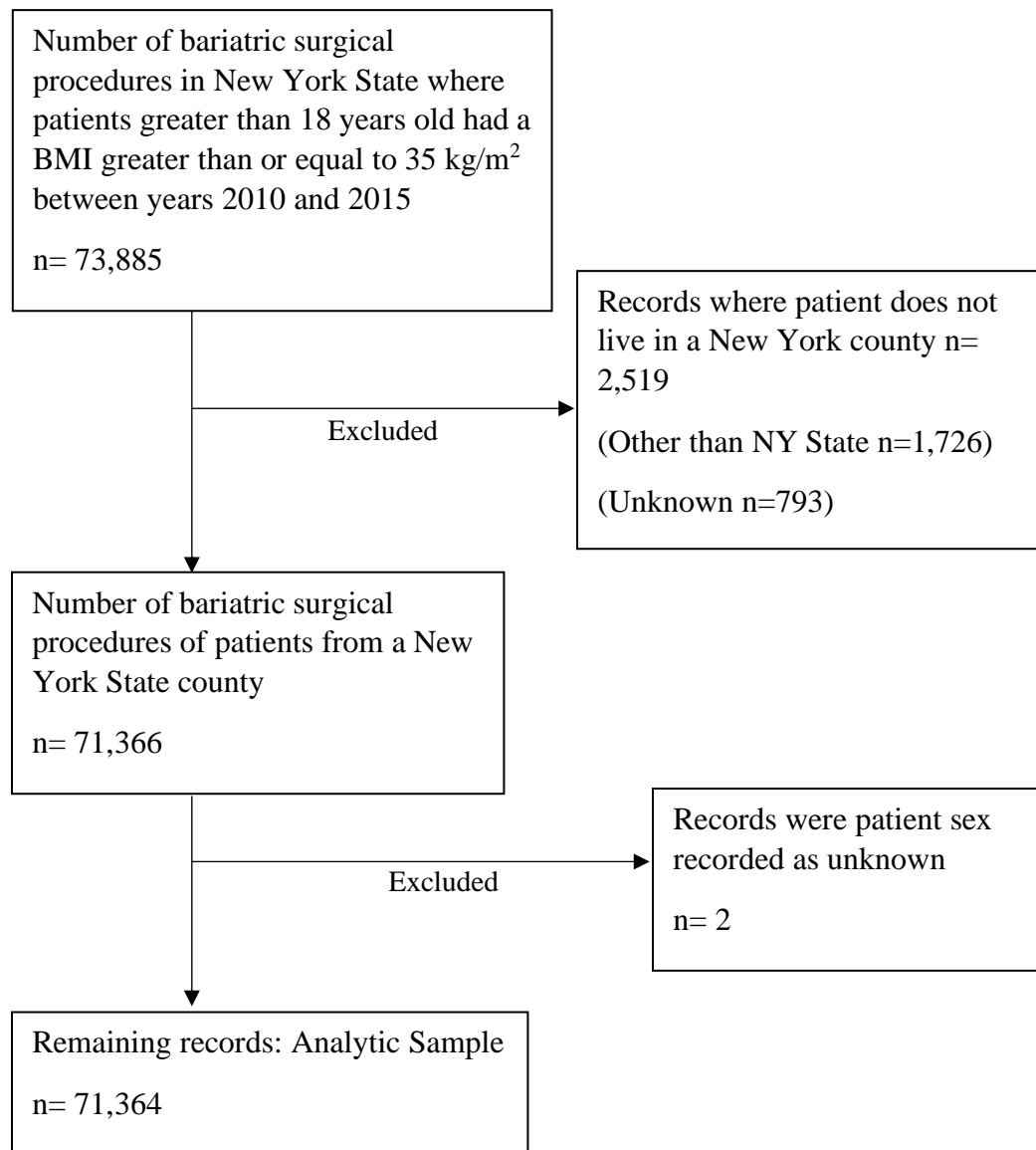
Inclusion criteria were bariatric surgical procedures performed in the State of New York between the years 2010 to 2015. Bariatric surgery procedure records included sleeve gastrectomy (International Classification of Disease Code 9<sup>th</sup> revision (ICD-9) procedure codes 43.82 and 43.89), Roux-en-Y gastric bypass (ICD-9 procedure codes 44.38-44.39), and laparoscopic adjustable gastric banding (ICD-9 procedure codes 44.95). The bariatric surgical procedure records included adults (greater than 18 years old at the time of the procedure) that were obese

(BMI of 35 kg/m<sup>2</sup> or more). Obese patient records were identified using ICD-9 diagnostic codes V85.3 – V85.45.

A total of 73,885 bariatric surgery records for adult patients were in the SPARC database between 2010-2015. Bariatric surgical procedure records were excluded if the patient did not live in a New York State County (N = 1,726) or had missing county data (N = 793) and if the record did not have recorded patient sex (N= 2). The final sample included 71,364 bariatric surgery records. Since the de-identified SPARCS dataset did not have a unique patient identifier, it was not possible to determine whether a patient was undergoing primary or secondary/revisional bariatric surgery operation. However, there are unique ICD-9 procedure codes for secondary, or revisional, bariatric surgery procedures. Since the revisional codes were not included in the records extracted from SPARCS, it is likely that all of the records in the final sample are primary surgical procedures of unique patients. Additionally, since SPARCS only included sex of the patient, not gender, sex and gender will be used interchangeably in this study. Figure 2 shows the inclusion and exclusion process of creating the final bariatric surgical procedure population.

**Figure 2. Inclusion and Exclusion Criteria Flowchart for Bariatric Surgical Procedure**

**Population**



**Research Question 1: Is there an association between county gender inequality and sex of the bariatric surgery patient?**

*Unit of analyses*

To answer this question, the unit of analysis is the patient.

### ***Dependent Variable***

At the individual-level, our dependent variable is the sex of the patient undergoing bariatric surgery patient, either male or female.

### ***Primary Independent Variable***

The main independent variable is county-level gender inequality, which was developed using the United Nation's Gender Inequality Index (GII). The GII was originally developed to measure gender inequality at the country level. The index is typically calculated yearly using data about a country's maternal mortality rate, adolescent birth rate, female and male secondary education rate, female and male parliamentary or government ratio, and labor force participation rate (see Table 1) (Gaye et al., 2010). The GII was chosen because it was the only calculable measure of gender inequality that has been made publicly available from a reliable source.

For this study, we calculated the GII for each of New York's (62) counties using New York county-level data. County-level data on maternal mortality rates, adolescent birth rate, secondary education rates, parliamentary or government seats, and labor force participation rates were obtained from the AHRF, ACS, the CDC's National Center for Health Statistics, and the U.S. Census. Table 1 includes a list of the data sources and formulas used to calculate at the county level of each of the indicators that are used in the GII.

**Table 1. Gender Inequality Index Dimensions, Indicators, Data Sources, Calculation, and Description**

<b>Dimension</b>	<b>Indicator</b>	<b>Source/Year</b>	<b>Calculation</b>
Health	Maternal Mortality Ratio (MMR): The number of maternal deaths per 100,000 live births. <sup>1</sup>	Maternal Deaths: SPARCS inpatient and outpatient data using ICD-9 codes for maternal death 2010-2015  Number of Live Births: AHRF yearly data from 2010-2015	$\frac{\text{number of maternal deaths}}{\text{number of live births during that period}} * 100,000$
Health	Adolescent birth rate (ABR): Births per 1,000 women ages 15-19	ABR: National Center for Health Statistics within the Center for Disease Control 2010 - 2015	$\frac{\text{number of live births to adolescent women}}{\text{number of adolescent women}} * 1,000$
Empowerment	Percent female and male population above 25 years of age with at least some secondary education	American Community Survey (ACS) 2011-2015	$\text{Female} = \frac{\text{number of females above 25 with at least some secondary education}}{\text{total female population above 25}} * 100$ $\text{Male} = \frac{\text{number of males above 25 with at least some secondary education}}{\text{total male population above 25}} * 100$
Empowerment	Percent female and male shares of parliamentary seats or county-level government seats	County websites (current county legislation)	$\text{Female} = \frac{\text{number of seats held by females}}{\text{total number of seats in the county}} * 100$

Dimension	Indicator	Source/Year	Calculation
			$\text{Male} = \frac{\text{number of seats held by males}}{\text{total number of seats in the county}} * 100$
Labor Market	Percent female and male labor force participation rates (LFPR)	AHRF Labor force: 2012-2016 Civilian non-institutionalized population: 2012-2016	$\text{LFPR} = \frac{\text{number of individuals in labor force in a county}}{\text{civilian, non-institutionalized population in a county}} * 100$ <p>Labor force = employed + non-employed</p> <p>LFPR calculated separately for men and women</p>

Notes: <sup>1</sup> The minimum value of maternal mortality rate is 10 deaths per 100,000 births (Gaye et al., 2010)

### ***Gender Inequality Index Indicator Explanations***

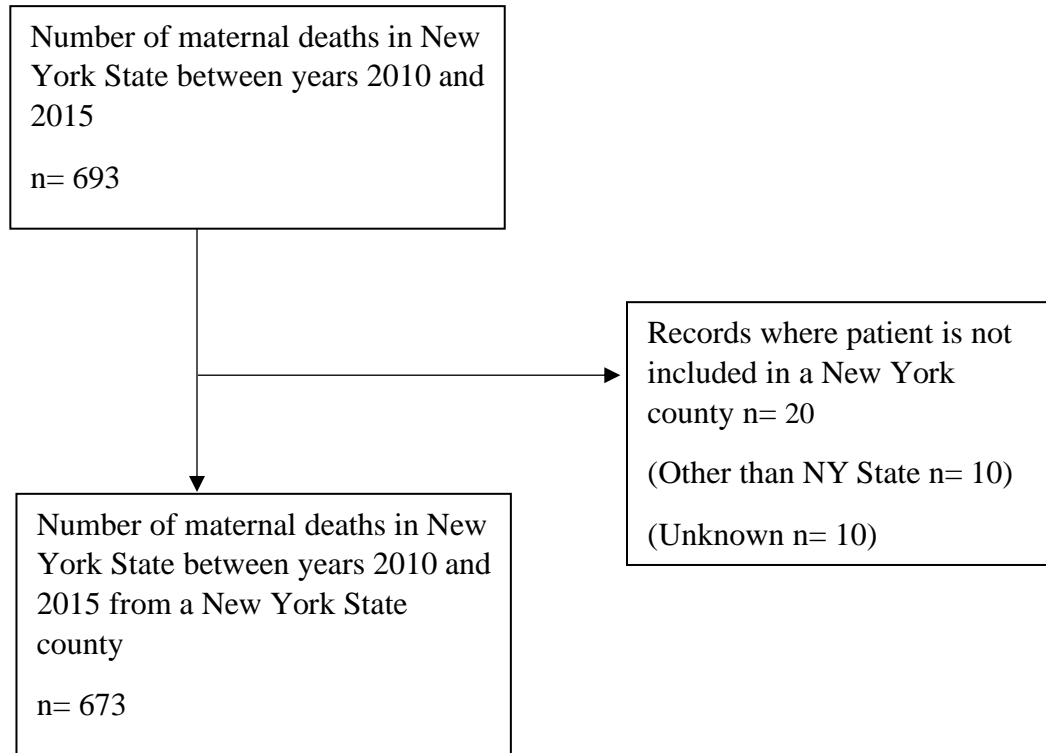
#### ***Maternal Mortality Rate***

Maternal mortality rate (MMR), or the number of maternal deaths per 100,000 live births, was calculated by using maternal mortality and the number of live births. Maternal death data were extracted from SPARCS for the years 2010 to 2015 using ICD-10 codes O00-O95; O98-O98 and ICD-9 codes 630-676. All maternal deaths where the patient was not identified as from a New York State county were excluded (see Figure 3). The total number of live births per county for the years 2010 to 2015 were taken from the AHRF dataset. The calculation of MMR is shown in Table 1.

According to the GII technical documentation, the minimum MMR should be 10 deaths per 100,000 births since countries with were than 10 deaths per 100,000 births are essentially performing at the same level, and the minute differences under 10 are random (Gaye et al.,

2010). As such, all of the counties that had fewer than 10 maternal deaths per 100,000 births (22 out of 62 total counties, or 35% of the counties) were changed to 10 maternal deaths to follow the GII guidelines.

**Figure 3: Inclusion and Exclusion Criteria for Maternal Mortality**



*Adolescent Birth Rate*

Adolescent birth rate (ABR) data, or the number of births to women aged 15 years old to 19 years old per 1,000 births, were taken directly from the Center for Disease Control’s National Center for Health Statistics dataset on ABR for the years 2010 to 2015 for all New York State Counties. An average of the yearly ABR was taken for the final ABR value.

*Secondary Education*

The secondary education rate data, or the percentage of females and males above the age of 25 years old with at least some secondary education, were taken from the ACS, showing a 5-year educational attainment average from 2011 to 2015. This dataset included the total

population of females and males above 25 years old by county in addition to the educational attainment of females and males above 25 years old. Table 1 contains the calculation for female and male secondary education percentages.

### *Parliamentary Rates*

Parliamentary rates for females and males, or the percent of government seats held by each sex, were taken directly from county websites using county government titles such as “County Board of Legislators,” “County Legislators,” and “Council Members” (“Council Members & Districts - New York City Council,” n.d.; “County Legislators | Albany County, NY,” n.d.; “Legislators | Allegany County, New York,” n.d.). The number of males and females were totaled for each county by using both names and images, when possible, to determine the sex of the government official. If an image was not readily available, the government official was searched using Google to find an image of that person to make a determination on sex. This method may lead to some misclassification of sex. The ideal determination of sex would be to ask the person directly. For the 5 New York City counties (Bronx, New York, Kings, Queens, and Richmond), there were two New York City Council Members that crossed county lines. Those two council members were included for both counties that they represented (“Council Members & Districts - New York City Council,” n.d.).

The female parliamentary rate was calculated by taking the number of seats held by females divided by the total number of seats, and the male parliamentary rate was calculated by taking the number of seats held by males divided by the total number of seats which is shown in Table 1.

According to the GII technical documentation, counties with a parliamentary rate of 0% should be coded as 0.1% to allow for the computation of the index. Additionally, it is reasonable

to assume that there is likely some minimal level of influence on the government by women (Gaye et al., 2010).

### *Labor Force Participation Rate*

The labor force participation rate data, or the measure of an economy's workforce, were calculated from AHRF data. This dataset included labor force data (employed and non-employed population) and the civilian non-institutionalized population for 2012 to 2016. The calculation for female and male labor force participation rate is seen in Table 1.

### *Gender Inequality Index (GII)*

To calculate the GII, we used the formula delineated by the United Nations (Gaye et al., 2010). The first step is to aggregate across the three dimensions of health, empowerment, and labor market for each gender group through using geometric means:

The aggregation for females is:

$$G_F = \sqrt[3]{\left(\frac{10}{MMR} * \frac{1}{ABR}\right)^{1/2} * (PR_F * SE_F)^{\frac{1}{2}} * LFPR_F}$$

Where MMR is the maternal mortality rate, ABR is the adolescent birth rate,  $PR_F$  is the parliamentary rate of females,  $SE_F$  is the secondary education rate of females, and  $LFPR_F$  is the labor force participation rate of females.

The aggregation for males is:

$$G_M = \sqrt[3]{1 * (PR_M * SE_M)^{\frac{1}{2}} * LFPR_M}$$

Where  $PR_M$  is the parliamentary rate of males,  $SE_M$  is the secondary education rate of males, and  $LFPR_M$  is the labor force participation rate of males.

After the aggregation for females and males, a harmonic mean aggregates the male and female indices to create a gender index that is equally distributed. The harmonic mean highlights

the inequality between females and males and adjusts for the inequalities that overlap in the dimension or the association between different dimensions.

$$\text{HARM}(G_F, G_M) = \left[ \frac{(G_F)^{-1} + (G_M)^{-1}}{2} \right]^{-1}$$

A reference standard must be used to compute inequity. It is obtained through the aggregation of male and female indices that treat each gender equally and use equal weighting and aggregating across the three dimensions of health, empowerment, and labor market.

$$G_{\bar{F}, \bar{M}} = \sqrt[3]{\overline{\text{Health}} * \overline{\text{Empowerment}} * \overline{\text{LFPR}}}$$

Where:

$$\overline{\text{Health}} = \frac{\left( \sqrt{\frac{10}{\text{MMR}} * \frac{1}{\text{ABR}}} \right) + 1}{2}$$

$$\overline{\text{Empowerment}} = \frac{(\sqrt{\text{PR}_F * \text{SE}_F} + \sqrt{\text{PR}_M * \text{SE}_M})}{2}$$

$$\overline{\text{LFPR}} = \frac{(\text{LFPR}_F * \text{LFPR}_M)}{2}$$

Finally, to yield the GII, the gender index is compared to the reference standards.

$$\text{GII} = 1 - \frac{\text{HARM}(G_F, G_M)}{G_{\bar{F}, \bar{M}}}$$

The possible range of the GII is from 0 to 1, where 0 represents total gender equality, and 1 represents total gender inequality. As such, a higher GII score represents higher gender inequality (Gaye et al., 2010).

For the analysis, gender inequality was broken into terciles based on GII to understand nuances in the levels of gender inequality. The group with the lowest gender inequality had GII values of less than 0.1794, the group with mid-level of gender inequality had GII values between

0.1794 to 0.2623, and the group with the highest levels of gender inequality included GII values equal to or greater than 0.2624.

### ***Covariates***

Covariates at the individual-level will include patient-level demographics such as type of patient insurance, age, race, and ethnicity. Patient insurance was included in the model because insurance could reflect income status, and patient income was not included in the SPARCS dataset. Patient insurance was constructed into five groups, including Medicare, Medicaid, other government, private, and other insurance. “Other government” insurance includes local, state, or federal insurance beyond Medicare and Medicaid. “Other” insurance includes categories such as self-pay. Age was included in the model since age is significantly associated with obesity, and as age increases, the prevalence of obesity increases (Hales et al., 2017). The age variable was divided into three groups (<40 years of age, between 40 years of age to less than 60 years,  $\geq 60$  years of age) based on the reported changing prevalence of obesity documented for these age groups (Hales et al., 2017; Halpern et al., 2017). Race and ethnicity were chosen as a covariate due to the association of racial/ethnic inequality with obesity and potential varying preferences for bariatric surgery across racial and ethnic groups (Fuchs et al., 2015; Hales et al., 2017). Categories of race and ethnicity included non-Hispanic white, non-Hispanic black or African American, Hispanic, Asian, Native American/Pacific Islander/Alaskan Native, and non-Hispanic other race which includes patient identified “other race” and “multiracial.”

### ***Statistical Analysis for Research Question 1***

The overall goal of this statistical analysis was to understand if there is an association between county-level gender inequality and sex of the bariatric surgery patient. The unit of analysis is the patient.

Descriptive statistics were run on indicators of the GII and covariates. Multivariable logistic regression was performed to understand how gender inequality is associated with the likelihood that a person receiving bariatric surgery was female while controlling for covariates. The multivariable logistic regression models were used to calculate odds ratios and 95% confidence intervals. All analyses were set at the significance level of  $<0.05$ . Statistical analyses were performed using Stata software, version 15.1 (StataCorp, College Station, Texas).

**Research Question 2: Is there an association between county gender inequality and the percent female bariatric surgeries at a county-level?**

***Unit of analyses:***

To answer this question, our unit of analysis was county (N=62)

***Dependent Variable***

For this question, our dependent variable is the percent female bariatric surgical procedures per county. The percent was determined for each county by taking the total number of females who underwent a bariatric surgical procedure divided by the total number of bariatric surgical procedures using data from SPARCS.

***Primary Independent Variable***

The main independent variable is county-level gender inequality, as described above. Due to the small sample size (N=62), GII was not split into terciles for the analysis.

***Covariates***

Covariates at the county-level include median household income by county, percent of county population between ages 18 to 64 years old without health insurance, the percent of obese adults by county, and population density. The median household income per county was included in the model since areas with lower socioeconomic status are often associated with food

deserts and other obesity-related factors (Reidpath et al., 2002). The percent of the county population without health insurance was included since health insurance status is associated with the path to bariatric surgery (Ju et al., 2019). These two variables were obtained from AHRF for the years 2010 to 2015. The percent of obese adults in a county was included because the rates of obesity within a county may influence the rate of bariatric surgical procedures being performed. This variable was obtained from the New York State's website (data.ny.gov) of publicly available data for the year of 2018. The population density was included because individuals in more rural communities are 23% less likely to undergo bariatric surgery compared to their urban counterparts. As such, population density likely effects the rates of bariatric surgery in a county (Wallace et al., 2010). The population density variable was taken from the AHRF for the year 2010 and is defined as the population per square mile.

### ***Statistical Analysis for Research Question 2***

The overall goal of this statistical analysis was to understand if there was an association between county-level gender inequality and the county-level percent female bariatric surgeries. The unit of analysis is the county-level percent of female bariatric surgeries.

A univariate analysis was conducted for the dependent and independent variables and covariates, including mean, standard deviation, and range. In addition to descriptive statistics, histograms and Shapiro-Wilk test were done to test for normality, and two-way scatter plots were used to look at linearity of the dependent and independent variable prior to conducting a Pearson correlation test. A Pearson correlation test was performed on the dependent variable, primary independent variable, and covariates to test for collinearity using a cutoff of  $r = 0.50$ . Collinear variables ( $r$ -value equal to or greater than 0.50) would not be used in the same linear regression model. Following Pearson correlation, an unadjusted linear regression was performed to understand how the metrics of gender inequality are associated with the county-level percent

female bariatric surgery procedures. The model was adjusted in a sequential process to include covariates based on the results of the Pearson correlation. Statistical analyses were performed using Stata software, version 15.1 (StataCorp, College Station, Texas).

## **Results**

### ***Population***

Between the years 2010 and 2015, we identified 71,364 records of bariatric surgical procedures in New York State where patients were 18 years or older, lived in a New York State county, and had a BMI greater than or equal to 35 kg/m<sup>2</sup>. Characteristics of patients who underwent a bariatric surgical procedure in the State of New York between 2010 and 2015 are seen in Table 2. The sex distribution of the bariatric surgery population was 79.15% female and 20.85% male. The mean age was 43.54 years. The majority of patients were non-Hispanic white, and the majority used private insurance to cover their procedures.

**Table 2: Bariatric Surgery Population Demographics (n= 71,364)**

<b>Characteristic</b>	<b>n=</b>	<b>Percent or mean (SD)</b>
Sex		
Male	14,878	20.85%
Female	56,486	79.15%
Age	71,364	43.54 (11.85)
Ethnicity and Race		
Non-Hispanic White	38,588	54.07%
Non-Hispanic Black or African American	10,730	15.04%
Non-Hispanic Native American/ Alaska Native	142	0.20%
Non-Hispanic Asian	247	0.35%
Non-Hispanic Native Hawaiian/Other Pacific Islander	31	0.04%
Non-Hispanic Other Race <sup>1</sup>	6,429	9.01%
Hispanic White <sup>3</sup>	3,161	4.43%
Hispanic Black or African American <sup>3</sup>	1,438	2.02%
Hispanic Native American/ Alaska Native <sup>3</sup>	8	0.01%
Hispanic Asian <sup>3</sup>	0	0.00%
Hispanic Native Hawaiian/Other Pacific Islander <sup>3</sup>	9	0.01%
Hispanic Other Race <sup>3</sup>	7,944	11.13%
Unknown <sup>2</sup>	2,637	3.70%
Insurance		
Private	40,403	56.62%
Medicare	4,399	6.16%
Medicaid	18,810	26.36%
Other government	443	0.62%
Other	7,309	10.24%

Note: <sup>1</sup> “Other Race” includes categories of other race, multiracial, and unknown race, <sup>2</sup>“Unknown” includes unknown ethnicity, <sup>3</sup>part of “Hispanic” group for multivariable analysis

### **Counties**

There was a total of 62 counties in the state of New York. The mean, standard deviation, and range of the GII, the GII component variables, and county-level covariates are presented in Table 3. The primary independent variable, GII, ranged from 0.035 to 0.67, with a mean of 0.28.

**Table 3: Primary Independent Variable and Covariates by County (n=62)**

Variable	Mean (SD) Or Percent	Range
Gender Inequality Index	0.28 (0.14)	0.035 - 0.67
Maternal Mortality Ratio	38.31 (16.32)	10.00 - 90.68
Adolescent Birth Rate	19.88 (7.52)	4.36 – 40.00
Secondary Education Female	93.81 (4.09)	85.33 - 98.99
Secondary Education Male	93.72 (3.70)	85.65 - 98.69
Parliamentary Rate Female	0.24 (0.13)	0.01 - 0.53
Parliamentary Rate Male	0.76 (0.13)	0.47 - 0.99
Labor Force Participation Rate Female	39.16 (1.78)	33.45 - 41.69
Labor Force Participation Rate Male	41.74 (2.78)	35.70 - 46.04
% Population without Health Insurance	12.38 (2.23)	8.44 – 22.13
% Obese Adults	30.71 (5.19)	16.90 - 44.80
Median Household Income <sup>1</sup>	52,690 (12,468)	33,198 – 94,879
Population Density <sup>2</sup>	30,146 (108,042)	28 – 694,684

Notes: <sup>1</sup>U.S. Dollars, <sup>2</sup>population per square mile

New York State county information, including the total population, percent female of the total population, the total number of bariatric surgical procedures, and the percent female bariatric surgical procedures are found in Table 4. The total county population ranged from 4,760 people per county to 2,595,259 people per county. The percent female population, or the total female population divided by the total population multiplied by 100, had a range of 44.90% to 52.92%. The number of bariatric surgeries ranged from 12 bariatric surgeries per county to 8,355 bariatric surgeries per county, and the percent female bariatric surgery procedures, or the number of females who underwent a bariatric surgery divided by the total population who underwent a bariatric surgery multiplied by 100, ranged from 68.82% to 85.81% with a mean of 78.68%.

**Table 4: Total Population and Percent Females of Counties and Number of Bariatric Surgeries and Surgery Percent Females of Counties (n=62)**

<b>County Name</b>	<b>Total Population <sup>1</sup></b>	<b>Percent of Females in the Population <sup>1</sup></b>	<b>Number of Bariatric Surgeries</b>	<b>Bariatric Surgery Percent of Females</b>
Albany	307,463	51.61%	766	81.85%
Allegany	48,070	49.42%	168	79.17%
Bronx	1,428,357	52.92%	8,335	85.57%
Broome	198,093	50.85%	441	80.73%
Cattaraugus	78,962	50.50%	330	79.09%
Cayuga	79,173	48.75%	368	75.00%
Chautauqua	132,646	50.41%	443	81.72%
Chemung	88,267	50.41%	432	78.70%
Chenango	49,549	50.19%	175	85.14%
Clinton	81,685	48.45%	319	79.00%
Columbia	62,195	49.76%	97	74.23%
Cortland	49,043	51.22%	246	77.64%
Delaware	46,901	49.86%	86	75.58%
Duchess	296,928	50.27%	1,022	77.39%
Erie	921,584	51.63%	3,987	80.94%
Essex	38,912	47.87%	108	79.63%
Franklin	51,280	44.90%	323	74.61%
Fulton	54,606	50.16%	371	79.25%
Genesee	59,458	50.19%	260	76.15%
Greene	48,312	48.26%	97	81.44%
Hamilton	4,760	49.45%	12	83.33%
Herkimer	64,034	50.65%	303	74.26%
Jefferson	118,947	47.98%	1,045	79.92%
Kings	2,595,259	52.64%	6,611	80.36%
Lewis	27,124	49.44%	194	82.47%
Livingston	64,801	49.89%	243	81.07%
Madison	72,427	50.78%	481	80.67%
Monroe	749,356	51.69%	2,565	80.90%
Montgomery	49,779	50.77%	289	85.81%
Nassau	1,354,612	51.52%	3,570	74.43%
New York	1,629,507	52.78%	4,698	81.98%
Niagara	214,150	51.36%	1,179	79.07%
Oneida	233,558	50.19%	1,473	77.05%
Onondaga	468,304	51.70%	2,870	76.93%
Ontario	109,192	50.94%	434	77.19%

County Name	Total Population <sup>1</sup>	Percent of Females in the Population <sup>1</sup>	Number of Bariatric Surgeries	Bariatric Surgery Percent of Females
Orange	375,384	49.95%	2,089	76.53%
Orleans	42,204	50.24%	167	83.23%
Oswego	121,183	49.92%	1,057	77.39%
Otsego	61,399	51.35%	133	82.71%
Putnam	99,488	50.15%	370	68.82%
Queens	2,301,139	51.53%	4,617	80.37%
Rensselaer	159,900	50.63%	480	81.88%
Richmond	472,481	51.60%	1,527	71.68%
Rockland	320,688	50.96%	1,172	70.07%
Saratoga	112,011	49.11%	983	79.20%
Schenectady	223,774	50.68%	971	79.70%
Schoharie	154,796	51.41%	798	81.31%
Schuyler	31,913	50.03%	106	79.25%
Seneca	18,410	49.69%	53	72.26%
Steuben	35,144	47.28%	137	75.86%
St. Lawrence	98,665	50.45%	319	75.81%
Suffolk	1,501,373	50.76%	6,364	75.06%
Sullivan	76,330	48.92%	552	77.58%
Tioga	50,199	50.61%	119	81.51%
Tompkins	103,855	50.77%	243	75.72%
Ulster	181,300	50.27%	601	78.74%
Warren	65,180	50.94%	349	85.39%
Washington	62,700	48.21%	357	81.23%
Wayne	92,416	50.52%	396	79.55%
Westchester	967,315	51.72%	2,732	76.54%
Wyoming	41,446	45.85%	242	79.75%
Yates	25,187	51.28%	89	73.03%

Notes: <sup>1</sup> Taken from American Community Survey 5-year estimate 2011 – 2015

**Research Question 1: Is there an association between county gender inequality and sex of the bariatric surgery patient?**

***Unadjusted analysis***

To determine the association between county gender inequality and the sex of the bariatric surgery patient, we first performed a simple logistic regression to predict the likelihood

of the individual undergoing bariatric surgery being a female. In the unadjusted model, bariatric surgery patients living in counties in the middle levels of gender inequality (GII: 0.1795 – 0.2623), had marginally higher odds of being female compared with patients in counties with the lowest levels of gender inequality (GII: <0.1794) (Odds Ratio = 1.04; 95% CI, 0.99 – 1.10;  $p = 0.051$ ). Bariatric surgery patients residing in counties with the highest level of gender inequality (GII  $\geq 0.2624$ ), were significantly more likely to be female than male (Odds Ratio = 1.34; 95% CI, 1.28 – 1.41;  $p < 0.001$ ).

### ***Adjusted Multivariate Analysis***

We then adjusted our logistic regression model to account for patient-level covariates, including race/ethnicity, age, and insurance type. The results can be seen in Table 5. Compared with patients living in counties with the lowest levels of gender inequality, bariatric surgery patients residing in counties with the highest levels of gender inequality had 1.11 times the odds of being a female ( $p < 0.01$ ). Bariatric surgery patients residing in counties with mid-levels of gender inequality in comparison to patients living in counties with the lowest levels of gender inequality had 0.97 times the odds of being a female, but the results were not significant ( $p = 0.262$ ). Furthermore, several of the covariates were associated with the odds of being female. In comparison to non-Hispanic Whites, non-Hispanic Blacks or African Americans were almost 2 times more likely (odds ratio=1.972) of being female ( $p < 0.01$ ). Hispanics and people of other races/ethnicities, in comparison to non-Hispanic Whites, had 1.294 ( $p < 0.01$ ) and 1.180 ( $p < 0.05$ ) times the odds of being female, respectively. As age increased, the odds of being female decreased. In comparison to patients less than 40 years old, patients between 40 years old and less than 60 years old and patients 60 years old or older had 0.782 ( $p < 0.01$ ) and 0.638 ( $p < 0.01$ ) times the odds of being a female. For insurance, patients who had Medicare, in comparison to

private insurance, were significantly associated with decreased odds (OR=0.875) of being female (p<0.01). Patients with Medicaid, other government insurance, or other types of insurance/payment, in comparison to patients with private insurance, were significantly associated with increased odds (OR= 1.423; OR=1.729; OR=1.126, respectively) of being female (all p<0.01).

**Table 5: Results of Multivariate Logistic Regression Analysis for Predicting Sex of Bariatric Surgery Patient (n= 71,364)**

Variable	Odds Ratio	Std. Error	95% Confidence Interval		p-value
<b>Gender Inequality (Ref: Low (GII &lt; 0.1795))</b>					
Mid (GII 0.1795 – 0.2623)	0.972	0.025	0.924	1.022	0.262
High (GII ≥ 0.2624)	1.109	0.028	1.056	1.164	<0.001
<b>Race/Ethnicity (Ref: Non-Hispanic White)</b>					
Non-Hispanic Black or African American	1.972	0.063	1.853	2.098	<0.001
Hispanic	1.294	0.037	1.223	1.369	<0.001
Asian	0.821	0.121	0.615	1.097	0.121
Native American/ Pacific Islander	1.183	0.226	0.814	1.719	0.378
Other	1.108	0.038	1.036	1.185	0.003
<b>Age (years) (ref: &lt; 40)</b>					
≥40 and <60	0.782	0.017	0.750	0.815	<0.001
≥60	0.638	0.022	0.596	0.683	<0.001
<b>Insurance (ref: Private)</b>					
Medicare	0.875	0.034	0.811	0.943	0.001
Medicaid	1.423	1.423	1.352	1.498	<0.001
Other government	1.729	1.729	1.320	2.265	<0.001
Other	1.126	1.126	1.055	3.616	<0.001

## **Research Question 2: Is there an association between county gender inequality and the percent female bariatric surgeries at a county-level?**

### ***Normality and Linearity Tests***

Histograms and a Shapiro-Wilk test were used to test for the normality of the dependent and independent variables. The histogram of the dependent variable, percent female bariatric surgeries, appeared normally distributed. The histogram of the independent variable, the gender inequality of the county, was right-skewed and not normally distributed. These variables were further tested with the Shapiro-Wilk test, which confirmed that the dependent variable was normally distributed and the independent variable was not.

A two-way scatter plot was used to assess the linear relationship between percent female bariatric surgeries and the gender inequality of the county. The overall relationship seemed linear based on the scatter plots and lines of best fit, and there seems to be constant variance. Based on one of the variables being normally distributed, constant variance, a linear relationship, the independence of these two variables, and the random and unbiased nature of the variables, we can perform a Pearson correlation.

### ***Pearson Correlation***

A Pearson correlation analysis was conducted to assess associations between the county gender inequality, county-level percent bariatric surgeries, and covariates to anticipate confounding and collinearity. The results of the Pearson correlation are seen in Table 6. Pearson correlation found that percent of female and gender inequality had a moderate positive correlation ( $r=0.359$ ,  $p<0.01$ ).

Further exploration found that percent female had a statistically significant moderate positive correlation with the percentage of obese adults ( $r=0.308$ ,  $p<0.05$ ) and a statistically significant moderate negative correlation with the median household income ( $r= -0.494$ ,  $p<0.01$ ).

Percent female did not have statistically significant correlations with the percent of 18 to 64-year-olds without health insurance and population density. Gender inequality had a statistically significant small positive correlation with the percent of 18 to 64-year-olds without health insurance ( $r=0.288$ ,  $p<0.05$ ) and a statistically significant moderate negative correlation with median household income ( $r= -0.391$ ,  $p<0.01$ ). Gender inequality did not have statistically significant correlations with the percentage of obese adults and population density. The Pearson correlation eliminated population density from the linear regression model due to the lack of significance with both the primary dependent and primary independent variables. Due to the statistically significant strong negative correlation between median household income and the percent obese adults ( $r= -0.600$ ,  $p<0.01$ ), the two covariates will not be used in the same linear regression model.

**Table 6: Pearson Correlation Matrix of Variables**

	Dependent	Independent		Covariates		
	Percent female	Gender Inequality	Percent Obese Adults	Percent without Health Insurance	Median Household Income	Population Density
Percent Female	1.000					
Gender Inequality	0.359**	1.000				
Percent Obese Adults	0.308*	0.197	1.000			
Percent without Health Insurance	0.100	0.288*	-0.114	1.000		
Median Household Income	-0.494**	-0.391**	-0.600**	-0.225	1.000	
Population Density	0.189	0.139	-0.3927**	0.400**	0.415	1.000

Notes: \* $p<0.05$ , \*\* $p<0.01$

### ***Linear Regression***

A set of linear regression models were run to analyze the relationship between county-level gender inequality and female percent of bariatric surgery procedures at a county-level after

controlling for any collinear or confounding effects. Percent female bariatric surgery procedures by county, county-level gender inequality, percent of the population between 18 and 64 years old without health insurance, percent of obese adults, and the median household income were included in the final models.

An unadjusted linear regression model (Model 1a), seen in Table 7, used only gender inequality to predict the percent female of bariatric surgery operations at a county-level. Gender inequality (coeff.=0.112,  $p<0.01$ ) significantly predicted the female percent of bariatric surgery patients. Gender inequality explained 11.5% of the linear variability in the percent female bariatric surgical procedures at a county-level. As such, for a 10% increase in county gender inequality, we could expect to see a 1.12 increase in the percent of bariatric surgery patients that are female.

One of the two final linear regression models (Model 1c) seen in Table 7 adjusted for percent 18-64-year-olds without insurance and the percent of obese adults in the county. The final model included gender inequality (coeff.=0.093,  $p<0.05$ ), percent 18-64-year-olds without insurance (coeff.=0.073,  $p=0.727$ ), and the percent of obese adults in the county (coeff.=0.161,  $p<0.01$ ). Gender inequality and percent of obese adults significantly predicted the percent female bariatric surgical operations. Overall, the independent variable and two covariates explained 14.7% of the linear variability in the percent female bariatric surgery procedures at a county-level. As such, for a 10% increase in county gender inequality, we can expect to see an increase of 0.93 in the percent female bariatric surgical procedures.

**Table 7: Results of Linear Regression Analysis Predicting the Percent Female of Bariatric Surgery at a County-Level**

Variables	Model 1a			Model 1b			Model 1c			Model 1d		
	Coeff.	p-value	95% Confidence Interval	Coeff.	p-value	95% Confidence Interval	Coeff.	p-value	95% Confidence Interval	Coeff.	p-value	95% Confidence Interval
Gender Inequality †	0.112	0.004**	0.07 0.188	0.113	0.006**	0.033 0.192	0.093	0.023*	0.013 0.122	0.065	0.097	-0.012 0.143
Percent without Health Insurance				-0.006	0.978	-0.425 0.413	0.073	0.727	-0.342 0.487	-0.092	0.638	-0.479 0.296
Percent Obese Adults							0.161	0.042*	0.006 0.316			
Median Household Income										-1.25	0.001**	-1.971 -0.530
Model Statistics	N= 62		Adjusted R <sup>2</sup> = 0.115	N=62		Adjusted R <sup>2</sup> = 0.100	N=62		Adjusted R <sup>2</sup> = 0.147	N=62		Adjusted R <sup>2</sup> = 0.242

Notes: \*p<0.05, \*\*p<0.01, † multiplied by 100 for analysis

The second final linear regression model (Model 1d) seen in Table 7 adjusted for percent 18-64-year-olds without insurance and the median household income. The final model included gender inequality (coeff.=0.065, p=0.097), percent 18-64-year-olds without insurance (coeff.= -0.092, p=0.638), and the median household income (coeff.= -1.25, p<0.01). Overall, the independent variable and two covariates explained 24.2% of the variability in the percent female bariatric surgery procedures at a county-level. As such, for a 10% increase in county gender inequality, we can expect to see an increase of 0.65 in the percent female bariatric surgery patients.

## **Discussion**

This study aimed to understand if there is an association between county-level gender inequality and the sex of the bariatric surgery patient and to understand if there is an association between county-level gender inequality and the county-level percentage of female bariatric surgeries. To our knowledge, this is the first study that analyzed the bariatric surgery gender gap in terms of county-level gender inequality, and our results demonstrate that county-level gender inequality is associated with the gender differences observed in bariatric surgery.

### ***Major Findings***

Overall, there were three major findings of this study. First, high levels of county-level gender inequality are significantly associated with more bariatric surgery patients being female. Second, that increasing levels of gender inequality predict an increase in the county-level percentage of female bariatric surgeries and that the effect of gender inequality at a population-level decrease when controlling for income. Third, within a single state, there are large variations in gender inequality across counties.

### ***Implications of Finding #1: Gender Inequality can Affect Treatment Choices at a Patient-Level***

We hypothesized, for our first research question, that counties with higher gender inequality are associated with a higher likelihood of the patient undergoing bariatric surgery being female. Our results confirmed this hypothesis, and we found higher gender inequality at the county-level was correlated with increased odds of the bariatric surgery patient being female. Additionally, these findings are consistent with the literature on the bariatric surgery gender gap. Previous studies reported that women make up approximately 80% of patients who undergo bariatric surgery, while men make up approximately 20% (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Martin et al., 2010; Young et al., 2016). Our population of bariatric surgery patients from 2010 to 2015 in the state of New York was comprised of 79.15% women and 20.85% men.

In comparison, the 2010 New York State obesity prevalence was 23.4% for females and 25.7% for males, and the adult population included 52.4% females and 47.6% males (U.S. Census Bureau, 2012; Wales & Brissette, 2012). As such, the prevalence of obesity between females and males in the state of New York was almost 50:50, while the bariatric surgery prevalence was 79:21. This unexpectedly large discrepancy between disease prevalence and treatment frequency modality highlights the gender differences and gap in bariatric surgery. These gender differences are concerning because the benefits of bariatric surgery are significant. Bariatric surgery has been reported to be the only available treatment that results in continued and sustained weight loss and, thus, a reduction of comorbidities related to obesity, such as type II diabetes and hypertension (Kochkodan, Telem, Amir, et al., 2018).

Since bariatric surgery is proven to be an effective obesity treatment, ideally, the bariatric surgery population would uniformly match with the obese population eligible for bariatric surgery (Bhogal et al., 2015). However, in the case of obesity and bariatric surgery, gendered disease prevalence and treatment prevalence do not align. As such, there is an unequal distribution of bariatric surgery treatment. Our study used gender inequality as a measure of differing societal standards and expectations of women and men. As such, it indicates that there is some societal influence related to gender inequality that results in it being more likely for a bariatric surgery patient to be female. In counties where there is greater gender inequality, men may feel more empowered and not have the societal pressure to change their bodies. Conversely, women in these counties may feel a greater need to change their bodies to fit certain societal expectations. In this case, women have a positive outcome of having surgery and losing weight, which decreases obesity-related co-morbidities. However, this also results in a negative outcome for men being less likely to have bariatric surgery, which results in worse health outcomes. An equitable health system would strive for the reflection of the eligible bariatric surgery population in the actual bariatric surgery population. Therefore, it is essential to mitigate the gender difference in bariatric surgery.

The bariatric surgery gender gap has been a considerable focus of study among bariatric surgeons, but there is no definitive reason for the gender differences. Several factors have been linked to this gap, such as demographic factors (i.e., age, race/ethnicity, insurance), gender differences in psychological factors (i.e., self-image and mental health), and gender differences in patterns of seeking healthcare (Farinholt et al., 2013; Fuchs et al., 2015; Kochkodan, Telem, & Ghaferi, 2018; Santry et al., 2007; Young et al., 2016). Furthermore, many studies have stated that the gender gap is likely influenced by the differing societal standards and expectations of

men and women (Fuchs et al., 2015; Kochkodan, Telem, Amir, et al., 2018; Santry et al., 2007).

Based on our findings, higher county-level gender inequality is significantly associated with the bariatric surgery patient more likely being female. Accordingly, gender inequality likely bears some influence on an individual's preference on whether to undergo bariatric surgery.

Additionally, since gender inequality is being used as a measure of societal standards, it may also inadvertently influence the provider's recommendation for a patient to undergo bariatric surgery or not.

Some studies have addressed the need to look more into the decision-making process for bariatric surgery to equalize access and decrease the gender gap (Martin et al., 2010; Zizza et al., 2003). As previously mentioned, our study identified higher gender inequality at a county-level is a predictor of the bariatric surgery patient being female. Our study demonstrates that gender inequality can affect treatment choices and that the bariatric surgery patient is more likely to be female in counties with higher gender inequality. These findings suggest that there are non-clinical influences that carry a disproportionate weight in the clinical decision-making process. This, too, is consistent with the literature. For example, one study that supports this looked at the decision-making process for patients eligible for bariatric surgery. The study highlighted that patients were more influenced by motivation to lose weight than the increased health benefits conferred by the bariatric procedure (Wee et al., 2013). The decision to undergo bariatric surgery is complex and multifaceted. The reasons for undergoing bariatric surgery would ideally be motivated by clinical reasons, which include physical and mental health, rather than societal reasons. Still, there are other factors, such as gender inequality, that play a large role in the process. Gender inequality is likely closely connected to the societal standards and expectations of men and women, which inadvertently influence the decisions and choices of an individual. As

such, these societal standards and expectations may encourage women to undergo bariatric surgery to appear a certain way and may encourage men to avoid undergoing bariatric surgery because the change of appearance may not be deemed as necessary.

One way to promote fewer gender differences in bariatric surgery would be to isolate clinical and societal influences in the bariatric surgery decision-making process. Gender inequality is not a simple indicator, and it may, therefore, be challenging to implement interventions specifically addressing gender inequality in a clinical setting until a more thorough understanding is developed. However, by educating clinicians on the influence of gender inequality, clinicians can create a more structured decision-making process for bariatric surgery to mitigate the effects of societal expectations and standards related to gender inequality. Furthermore, gender inequality is not easily modifiable. For example, there have been efforts to minimize the wage gap between males and females for decades. However, over the past ten years, the wage gap between genders has been stagnant. It has been projected that women in the U.S. will not achieve wage equity until the late twenty-first century and into the twenty-second century (Pham, Fitzpatrick, & Wagner, 2018). Since gender inequality is not something that will be modified significantly soon, providers should view gender inequality as a non-modifiable factor like sex, age, and race/ethnicity when it comes to treatment choices since county-level gender inequality is not modifiable by the physician. There are key distinctions between modifiable and non-modifiable factors, and clinical interventions should target modifiable factors and recognize and change how providers interact with non-modifiable factors like gender inequality (Perez, Pernat, & Chang, 2020). By providers focusing on modifiable factors at a clinical level, for example, the structure of the bariatric surgery decision-making process, there can be a change to the root causes in the care delivery process. Moreover, even though providers

cannot modify county-level gender inequality, there are likely steps that can be taken to emphasize the clinical importance of bariatric surgery and to encourage clinical decisions to be made due to clinical reasoning rather than the influence of gender inequality. By having a structured bariatric surgery decision-making process and making providers aware that gender inequality may influence a patient's decision on whether to undergo bariatric surgery, providers can be better equipped to mitigate gender differences in bariatric surgery.

***Implications of Finding #2: The Effect of Gender Inequality is Influenced by Income***

Our hypothesis for research question 2 stated that counties with higher gender inequality are associated with a higher percentage of female bariatric surgeries at the county-level. The results from this study confirmed our hypothesis and found that increasing levels of gender inequality predicted an increase in the percent female bariatric surgeries at a county-level. These results align with our findings from our first research question and highlight that county-level gender inequality impacts the bariatric surgery gender gap. With county-level gender inequality affecting an increased likelihood of the bariatric surgery patient being female and higher percentages of female bariatric surgeries at a county-level, it further indicates that societal factors, such as gender inequality, influence decision-making processes (such as the one to undergo bariatric surgery). These results also support the need to promote a reduction in gender differences in bariatric surgery by isolating clinical and societal influences in the bariatric surgery decision-making process.

Interestingly, our results highlight that the effect of gender inequality at a population-level decrease when controlling for median household income. Pearson correlation of GII and median household income resulted in a statistically significant moderate negative correlation with median household income ( $r = -0.391$ ,  $p < 0.01$ ). This demonstrates that as the county median

household income decreases, county-level gender inequality increases. The GII does not directly include income in its calculations but rather labor force participation rates of males and females (Gaye et al., 2010). The effect of gender inequality and income are not well studied. The majority of research pertains to the gender gap in pay (O'Neill, 2003; Pham et al., 2018). As such, the relationship between these two variables should be studied further to understand the full impact of income's effect on gender inequality.

### ***Implications of Finding #3: The Need for Multi-level Gender Inequality Measures***

To our knowledge, this is the first study to apply the United Nation's GII to a non-country level and using the GII outcome as an independent variable in research. Studies of gender inequality tend to be focused on the country-level, as demonstrated by the GII (Conceição et al., 2019). However, our findings highlight that within a single state, there are large variations in gender inequality across counties.

In the United Nations Development Programme's *2019 Report on Human Development*, the United States was ranked 42nd in the world for gender inequality with a GII value of 0.182 (Conceição et al., 2019). This value does not align with the mean GII value of the New York State counties (0.28), which indicates that there is variation in gender inequality not only across counties but also likely across states. For context, the country with the lowest GII was Switzerland with a GII value of 0.037, which compares to the New York State county with the lowest GII of 0.035. In contrast, the country with the highest GII was Yemen, with a GII value of 0.834. The New York State county with the highest GII value of 0.67, which was closest in value to the country ranked 157<sup>th</sup> for gender inequality, Côte d'Ivoire (Conceição et al., 2019). Furthermore, the UN divided the countries into four groups based on their human development ranking: very high human development, high human development, medium human development,

and low human development. Countries with very high human development had a mean GII value of 0.175; countries with high human development had a mean GII of 0.331; countries with medium human development had a mean GII of 0.501; and countries with low human development had a mean of 0.590 (Conceição et al., 2019). Using these criteria, the State of New York has counties ranging from very high human development to low human development. These large variations of GII within a single state highlight the importance of addressing gender inequality at multi-levels, not only at a country-level.

These differences in measured gender inequality at a county-level have not been reported before. Moreover, there could be benefits from having gender inequality being understood at smaller levels than countries. This indicates the need for, firstly, creating a gender inequality measure that is valid at smaller levels, such as counties, states, and territories. In the United States, this measure could allow for states, counties, and even cities to compare the level of gender inequality and compare best practices and policies as a way to strive for gender equality. Secondly, it highlights the need for increased gender equality within the U.S. A single measure of gender inequality of the U.S. does not show the nuances or variations in gender inequality throughout the country.

### ***Study Limitations***

This study is subject to the inherent limitations of a retrospective study conducted on a broad scale. First, the state of New York only has 62 counties, and for the county-level analysis, there were only 62 observations. Due to the study focusing solely on the 62 counties within the state of New York, these findings may not be generalizable to counties in other states. Furthermore, our logistic regression model is multi-level between patient and population, but a multilevel analysis was not performed. Another limitation was that this was the first time that the

GII was used at a county-level. There were no adjustments made to the calculations to modify index from a country-level to a county-level. The GII may not hold up statistically as it has never been tested at the county-level. This highlights the need for a multilevel measure for gender inequality. Additionally, we calculated the GII for the years that we were looking at bariatric surgeries; however, community-level gender inequality is something that changes over time (Conceição et al., 2019). As such, it could be more beneficial to look at gender inequality over a more extended period before individuals undergoing bariatric surgery to understand the influence of community gender inequality better.

One of the limitations of the SPARCS dataset used was that there was no unique patient identifier since it was a limited, de-identified dataset. Because of this, we could not confirm that we did not have any repeat bariatric surgery patients. However, there are ICD-9 codes for revisional and secondary bariatric procedures, and those codes were not included in our SPARCS extraction. Therefore, it is not likely that there are any repeat bariatric surgery patients. However, a unique patient identifier is required to confirm this more rigorously. Another limitation with the SPARCS data set is the difference in sex versus gender, and sex and gender were used interchangeably in this study. SPARCS only contains a variable on patient sex, not gender. The discussion on sex versus gender is ever evolving, and it is essential to note that biological sex and gender are different concepts. Currently, the difference between sex and gender is often understood as sex can be defined as a biological attribute, whereas gender can be defined as a sociocultural relationship (Moghadam & Senftova, 2005).

### ***Potential Future Research***

This study demonstrates that there is an association between gender inequality and gender differences in bariatric surgery. However, due to the small sample size with regards to New

York's counties, these results may not translate entirely to other areas in the United States. As such, the exploration of the association of gender inequality and gender differences in bariatric surgery should be scaled to a broader level. To address this, future studies could assess the same measures in California, as New York and California are the states that have granular surgical patient data and patient county codes available for analysis. The association between gender inequality could also be looked at by state or county at a national level.

Additionally, future research should further explore the GII, the validity of the measure at smaller sample sizes (i.e., county versus country), and potential modifications to better reflect the United States and the nuances between counties. We propose that in the United States, it may be worth changing the education measure from at least some secondary education to at least some college education. This change in education could reveal smaller nuances between populations because the U.S. has a high secondary education rate. For New York State, the secondary education rate for females and males were 85.33% to 98.99% with a mean of 93.81% and 85.65% to 98.69% with a mean of 93.72%, respectively. In comparison, between the years 2014 to 2018, the college graduation rate by New York State county ranged from 15.9% to 60.8% with a state average of 35.9% (U.S. Census Bureau, 2020). As such, more variation in education rates would reveal smaller nuances between counties. Additionally, there could be a modification in the process of dealing with small maternal mortality numbers. According to the GII technical documentation, the minimum MMR should be 10 deaths per 100,000 births since countries with fewer than 10 deaths are likely due to random chance. However, since we are calculating the GII at a county-level and not a country-level, it may be beneficial to keep non-zero MMRs below 10 the same and change the counties that have an MMR of 0 to 0.01 to have a non-zero number for the calculation. At a country-level, the small differences may not be important, but when

working at a smaller county-level, the small differences may be more impactful. It would also be worth further studying the relationship between median household income and gender inequality to understand the factors that may influence the effect of income on gender inequality.

Finally, it would be important to understand the bariatric surgery decision-making process further and create a framework to help mitigate the effect of gender inequality and other social factors on treatment choices. By focusing on modifiable clinical processes, steps can be taken to emphasize the clinical importance of bariatric surgery and to encourage clinical decisions to be motivated by clinical reasons, rather than societal reasons. These methods and processes should be further explored and studied as a way to lessen the gender differences in bariatric surgery.

## **Conclusion**

In summation, the gender difference in bariatric surgery patients is influenced by county-level gender inequality. This influence is seen both at a patient-level and a county-level. This study has important implications for the clinical decision-making process by demonstrating that gender inequality can affect bariatric surgery treatment choices. Ideally, clinical decisions would be made because of clinical reasoning; however, clinical decisions may be made because of non-clinical reasons like gender inequality. It is imperative to prioritize solutions to bridge the gender gap to promote equality in bariatric surgery, such as isolating clinical and societal influences in the bariatric surgery decision-making process.

Beyond clinical implications, this study emphasizes the importance of gender equality at community-levels because county-level gender inequality was associated with the gender differences in bariatric surgery. Understanding that there are nuances in gender inequality highlights the need for multilevel measurement tools for gender inequality. It additionally,

highlights that measures to obtain gender inequality should be addressed at the community-level not only the country-level. Moreover, in addition to countries, states and even counties should strive to attain gender equality, which promotes equality in healthcare and beyond.

### **Ethical Considerations**

This study was conducted under the Institutional Review Board at Massachusetts General Hospital.

Protocol Title: Assessment of Cost, Quality, Access, Disparities and Outcomes for Surgery

Protocol Number: 2019P002391

Principal Investigator Name: Chang, David C

## References

- Akan, G. E., & Grilo, C. M. (1995). Sociocultural influences on eating attitudes and behaviors, body image, and psychological functioning: A comparison of African-American, Asian-American, and Caucasian college women. *International Journal of Eating Disorders*, 18(2), 181–187. [https://doi.org/10.1002/1098-108X\(199509\)18:2<181::AID-EAT2260180211>3.0.CO;2-M](https://doi.org/10.1002/1098-108X(199509)18:2<181::AID-EAT2260180211>3.0.CO;2-M)
- Altabe, M. (1998). Ethnicity and body image: quantitative and qualitative analysis. *The International Journal of Eating Disorders*, 23(2), 153–159. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/9503240>
- Baum, C. L., & Ford, W. F. (2004). The wage effects of obesity: a longitudinal study. *Health Economics*, 13(9), 885–899. <https://doi.org/10.1002/hec.881>
- Bhogal, S. K., Reddigan, J. I., Rotstein, O. D., Cohen, A., Glockler, D., Tricco, A. C., ... Jackson, T. D. (2015). Inequity to the Utilization of Bariatric Surgery: a Systematic Review and Meta-Analysis. *Obesity Surgery*, 25(5), 888–899. <https://doi.org/10.1007/s11695-015-1595-9>
- Cachelin, F. M., Monreal, T. K., & Juarez, L. C. (2006). Body image and size perceptions of Mexican American women. *Body Image*, 3(1), 67–75. <https://doi.org/10.1016/j.bodyim.2005.10.006>
- Cachelin, F. M., Rebeck, R. M., Chung, G. H., & Pelayo, E. (2002). Does Ethnicity Influence Body-Size Preference? A Comparison of Body Image and Body Size. *Obesity Research*, 10(3), 158–166. <https://doi.org/10.1038/oby.2002.25>
- Cheney, A. M. (2011). “Most girls want to be skinny”: Body (Dis)satisfaction among ethnically diverse women. *Qualitative Health Research*, 21(10), 1347–1359.

<https://doi.org/10.1177/1049732310392592>

Commisson on Social Determinants of Health. (2008). Closing the gap in a generation: health equity through action on the social determinants of health. In *World Health Organization*. Geneva: Commisson on Social Determinants of Health.

Conceição, P., Assa, J., Calderon, C., Gray, G. R., Gulasan, N., Hsu, Y.-C., ... Philips, B. (2019). *Human Development Report 2019- Beyond income, beyond averages, beyond today: Inequalities in human development in the 21st century*. New York.

Council Members & Districts - New York City Council. (n.d.). Retrieved February 29, 2020, from <https://council.nyc.gov/districts/>

County Legislators | Albany County, NY. (n.d.). Retrieved February 29, 2020, from <https://www.albanycounty.com/government/county-legislature/legislator-list>

Demarest, J., & Allen, R. (2000). Body image: Gender, ethnic, and age differences. *Journal of Social Psychology, 140*(4), 465–472. <https://doi.org/10.1080/00224540009600485>

Fallon, A. (1990). Culture in the mirror: Sociocultural determinants of body image. - PsycNET. In T. F. Cash & T. Pruzinsky (Eds.), *Body images: Development, deviance, and change* (pp. 80–109). Retrieved from <https://psycnet.apa.org/record/1990-98350-004>

Farinholt, G. N., Carr, A. D., Chang, E. J., & Ali, M. R. (2013). A call to arms: obese men with more severe comorbid disease and underutilization of bariatric operations. *Surgical Endoscopy, 27*(12), 4556–4563. <https://doi.org/10.1007/s00464-013-3122-1>

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of All-Cause Mortality With Overweight and Obesity Using Standard Body Mass Index Categories. *JAMA, 309*(1), 71–82. <https://doi.org/10.1001/jama.2012.113905>

Flegal, K. M., Kruszon-Moran, D., Carroll, M. D., Fryar, C. D., & Ogden, C. L. (2016). Trends

- in Obesity Among Adults in the United States, 2005 to 2014. *JAMA*, 315(21), 2284.  
<https://doi.org/10.1001/jama.2016.6458>
- Fuchs, H. F., Broderick, R. C., Harnsberger, C. R., Chang, D. C., Sandler, B. J., Jacobsen, G. R., & Horgan, S. (2015). Benefits of Bariatric Surgery Do Not Reach Obese Men. *Journal of Laparoendoscopic & Advanced Surgical Techniques*, 25(3), 196–201.  
<https://doi.org/10.1089/lap.2014.0639>
- Furnham, A., & Baguma, P. (1994). Cross-cultural differences in the evaluation of male and female body shapes. *The International Journal of Eating Disorders*, 15(1), 81–89.  
Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/8124330>
- Gaye, A., Klugman, J., Kovacevic, M., Twigg, S., & Zambrano, E. (2010). *Human Development Research Paper 2010/46 Measuring Key Disparities in Human Development: The Gender Inequality Index*.
- Giardino, J. B., Keitel, M. A., Patelis, T., & Takooshian, H. (2017). The impact of weight stigma on decisions about weight loss surgery. *Stigma and Health*, 4(1), 19–29.  
<https://doi.org/10.1037/sah0000115>
- Hales, C. M., Carroll, M. D., Fryar, C. D., & Ogden, C. L. (2017). Prevalence of Obesity Among Adults and Youth: United States, 2015-2016 Prevalence of Obesity Among Adults and Youth: United States, 2015–2016. *NCHS Data Brief*, (288), 1–8. Retrieved from [https://www.cdc.gov/nchs/data/databriefs/db288\\_table.pdf#1](https://www.cdc.gov/nchs/data/databriefs/db288_table.pdf#1).
- Hales, C. M., Fryar, C. D., Carroll, M. D., Freedman, D. S., & Ogden, C. L. (2018). Trends in Obesity and Severe Obesity Prevalence in US Youth and Adults by Sex and Age, 2007-2008 to 2015-2016. *JAMA*, 319(16), 1723–1725. <https://doi.org/10.1001/jama.2018.3060>
- Halpern, M. T., Arena, L. C., Royce, R. A., Soler, R. E., Munoz, B., & Hennessy, C. M. (2017).

Neighborhood and Individual Sociodemographic Characteristics Associated with Disparities in Adult Obesity and Perceptions of the Home Food Environment. *Health Equity*, 1(1), 139–149. <https://doi.org/10.1089/heap.2017.0010>

Hennings, D. L., O'malley, T. J., Baimas-George, M., Al-Qurayshi, Z., Kandil, E., & Ducoin, C. (2017). *Surgery for Obesity and Related Diseases Buckle of the bariatric surgery belt: an analysis of regional disparities in bariatric surgery*. 1290–1296. <https://doi.org/10.1016/j.soard.2017.03.027>

Jarolimova, J., Tagoni, J., & Stern, T. A. (2013). Obesity: its epidemiology, comorbidities, and management. *The Primary Care Companion for CNS Disorders*, 15(5). <https://doi.org/10.4088/PCC.12f01475>

Jbara, N. A., & Darnton, G. (2019). *A Practical Approach for Measuring Women Empowerment*. Retrieved from <https://search.proquest.com/genderwatch/docview/2288609380/fulltextPDF/FEBECCB0160E41E9PQ/3?accountid=14434>

Jensen, M. D., & Ryan, D. H. (2014). New Obesity Guidelines: Promise and Potential. *JAMA*, 311(1), 23. <https://doi.org/10.1001/jama.2013.282546>

Jiang, S.-Z., Lu, W., Zong, X.-F., Ruan, H.-Y., & Liu, Y. (2016). Obesity and hypertension. *Experimental and Therapeutic Medicine*, 12(4), 2395–2399. <https://doi.org/10.3892/etm.2016.3667>

Ju, T., Rivas, L., Arnott, S., Olafson, S., Whitlock, A., Sparks, A., ... Lin, Paul P. Vaziri, K. (2019). Barriers to bariatric surgery: Factors influencing progression to bariatric surgery in a U.S. metropolitan area- ClinicalKey. *Surgery for Obesity and Related Diseases*, 15(2), 261–268. Retrieved from <https://phstwlpl2.partners.org:2093/#!/content/playContent/1-s2.0->

S155072891830457X?returnurl=null&referrer=null

- Khaodhiar, L., McCowen, K. C., & Blackburn, G. L. (1999). Obesity and its comorbid conditions. In *Clinical Cornerstone* (Vol. 2). [https://doi.org/10.1016/S1098-3597\(99\)90002-9](https://doi.org/10.1016/S1098-3597(99)90002-9)
- Kochkodan, J., Telem, D. A., Amir, •, Ghaferi, A., & Ghaferi, A. A. (2018). Physiologic and psychological gender differences in bariatric surgery and Other Interventional Techniques. *Surg Endosc*, 32, 1382–1388. <https://doi.org/10.1007/s00464-017-5819-z>
- Kochkodan, J., Telem, D. A., & Ghaferi, A. A. (2018). Physiologic and psychological gender differences in bariatric surgery.: MGH OneSearch. Retrieved August 13, 2019, from Surgical Endoscopy website: <https://phstwlp2.partners.org:3663/eds/pdfviewer/pdfviewer?vid=3&sid=63657ee6-b6b0-4326-bf9a-b96e62dfcc91%40pdc-v-sessmgr04>
- Legislators | Allegany County, New York. (n.d.). Retrieved February 29, 2020, from <https://www.alleganyco.com/government/legislators/>
- Martin, M., Beekley, A., Kjorstad, R., & Sebesta, J. (2010). Socioeconomic disparities in eligibility and access to bariatric surgery: a national population-based analysis. *Surgery for Obesity and Related Diseases*, 6(1), 8–15. <https://doi.org/10.1016/j.soard.2009.07.003>
- Moghadam, V. M., & Senftova, L. (2005). Measuring women’s empowerment: Participation and rights in civil, political, social, economic, and cultural domains. *International Social Science Journal*, (184), 389–412. <https://doi.org/10.1111/j.1468-2451.2005.00557.x>
- Money, J., Hampson, J. G., & Hampson, J. L. (1955). An examination of some basic sexual concepts: the evidence of human hermaphroditism. *Bulletin of the Johns Hopkins Hospital*, 97(4), 301–319.

- Muehlenhard, C. L., & Peterson, Z. D. (2011). *Distinguishing Between Sex and Gender: History, Current Conceptualizations, and Implications*. 791–803. <https://doi.org/10.1007/s11199-011-9932-5>
- Newman, B. J. (2016). Breaking the Glass Ceiling: Local Gender-Based Earnings Inequality and Women’s Belief in the American Dream. *American Journal of Political Science*, 60(4), 1006–1025. <https://doi.org/10.1111/ajps.12195>
- O’Neill, J. (2003). The gender gap in wages, circa 2000. *American Economic Review*, 93(2), 309–314. <https://doi.org/10.1257/000282803321947254>
- Ogden, C. L., Carroll, M. D., Fakhouri, T. H., Hales, C. M., Fryar, C. D., Li, X., & Freedman, D. S. (2018). Prevalence of Obesity Among Youths by Household Income and Education Level of Head of Household — United States 2011–2014. *MMWR. Morbidity and Mortality Weekly Report*, 67(6), 186–189. <https://doi.org/10.15585/mmwr.mm6706a3>
- Peeters, A., Barendregt, J. J., Willekens, F., Mackenbach, J. P., Mamun, A. Al, & Bonneux, L. (2003). Obesity in Adulthood and Its Consequences for Life Expectancy: A Life-Table Analysis. *Annals of Internal Medicine*, 138(1), 24. <https://doi.org/10.7326/0003-4819-138-1-200301070-00008>
- Perez, N. P., Pernat, C. A., & Chang, D. C. (2020). Surgical Disparities: Beyond Non-Modifiable Patient Factors. In J. B. Dimick & C. C. Lubitz (Eds.), *Health Services Research. Success in Academic Surgery* (2nd ed., pp. 57–69). [https://doi.org/10.1007/978-3-030-28357-5\\_5](https://doi.org/10.1007/978-3-030-28357-5_5)
- Pham, X., Fitzpatrick, L., & Wagner, R. (2018). The US gender pay gap: the way forward. *International Journal of Sociology and Social Policy*, 38(9–10), 907–920. <https://doi.org/10.1108/IJSSP-01-2018-0002>
- Pories, W. J. (2008). Bariatric Surgery: Risks and Rewards. *The Journal of Clinical*

*Endocrinology & Metabolism*, 93(11), 589–596. <https://doi.org/10.1210/jc.2008-1641>

Preston, S. H., Vierboom, Y. C., & Stokes, A. (2018). The role of obesity in exceptionally slow US mortality improvement. *Proceedings of the National Academy of Sciences of the United States of America*, 115(5), 957–961. Retrieved from

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5798364/pdf/pnas.201716802.pdf>

Puhl, R. M., & Heuer, C. A. (2010). Obesity Stigma: Important Considerations for Public Health. *American Journal of Public Health*, 100(6), 1019–1028.

<https://doi.org/10.2105/AJPH.2009.159491>

Reidpath, D. D., Burns, C., Garrard, J., Mahoney, M., & Townsend, M. (2002). An ecological study of the relationship between social and environmental determinants of obesity. *Health & Place*, 8(2), 141–145. [https://doi.org/10.1016/S1353-8292\(01\)00028-4](https://doi.org/10.1016/S1353-8292(01)00028-4)

Reither, E. N., Hauser, R. M., & Yang, Y. (2009). Do birth cohorts matter? Age-period-cohort analyses of the obesity epidemic in the United States. *Social Science and Medicine*, 69,

1439–1448. Retrieved from [https://pdf.sciencedirectassets.com/271821/1-s2.0-S0277953609X00213/1-s2.0-S0277953609005759/main.pdf?X-Amz-Security-](https://pdf.sciencedirectassets.com/271821/1-s2.0-S0277953609X00213/1-s2.0-S0277953609005759/main.pdf?X-Amz-Security-Token=AgoJb3JpZ2luX2VjEPb%2F%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIEBCNW3pwusL96cNsdrffxKDgNFuFhYGgYTzRUvpxJKGAiEAvUDPGOD3I5Ch)

[Token=AgoJb3JpZ2luX2VjEPb%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzL](https://pdf.sciencedirectassets.com/271821/1-s2.0-S0277953609X00213/1-s2.0-S0277953609005759/main.pdf?X-Amz-Security-Token=AgoJb3JpZ2luX2VjEPb%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIEBCNW3pwusL96cNsdrffxKDgNFuFhYGgYTzRUvpxJKGAiEAvUDPGOD3I5Ch)

[WVhc3QtMSJHMEUCIEBCNW3pwusL96cNsdrffxKDgNFuFhYGgYTzRUvpxJKGAiEA](https://pdf.sciencedirectassets.com/271821/1-s2.0-S0277953609X00213/1-s2.0-S0277953609005759/main.pdf?X-Amz-Security-Token=AgoJb3JpZ2luX2VjEPb%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIEBCNW3pwusL96cNsdrffxKDgNFuFhYGgYTzRUvpxJKGAiEAvUDPGOD3I5Ch)

[vUDPGOD3I5Ch](https://pdf.sciencedirectassets.com/271821/1-s2.0-S0277953609X00213/1-s2.0-S0277953609005759/main.pdf?X-Amz-Security-Token=AgoJb3JpZ2luX2VjEPb%2F%2F%2F%2F%2F%2F%2F%2F%2FwEaCXVzLWVhc3QtMSJHMEUCIEBCNW3pwusL96cNsdrffxKDgNFuFhYGgYTzRUvpxJKGAiEAvUDPGOD3I5Ch)

Rodgers, A., Woodward, A., Swinburn, B., & Dietz, W. H. (2018). Prevalence trends tell us what did not precipitate the US obesity epidemic. *The Lancet. Public Health*, 3(4), e162–e163.

[https://doi.org/10.1016/S2468-2667\(18\)30021-5](https://doi.org/10.1016/S2468-2667(18)30021-5)

Rosen, E. F., Anthony, D. L., Booker, K. M., Brown, T. L., Christian, E., Reed, R. R., & Petty, L. C. (1991). A comparison of eating disorder scores among African-American and white

- college females. *Bulletin of the Psychonomic Society*, 29(1), 65–66. Retrieved from <https://link.springer.com/content/pdf/10.3758/BF03334772.pdf>
- Rosner, S. (2002). Obesity: the disease of the twenty-first century. *International Journal of Obesity*, 26(4), 52–54. Retrieved from <https://www.nature.com/articles/0802209.pdf>
- Santry, H. P., Laurerdale, D. S., Cagney, K. A., Rathouz, P. J., Alverdy, J. C., & Chin, M. H. (2007). Predictors of Patient Selection in Bariatric Surgery. *Annals of Surgery*, 245(1), 59–67. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1867947/pdf/20070100s00010p59.pdf>
- Seth, S. (2009). *Oxford Poverty & Human Development Initiative (OPHI) Oxford Department of International Development OPHI WORKING PAPER NO. 23 Inequality, Interactions, and Human Development*. Retrieved from <http://ophi.qeh.ox.ac.uk/>
- Sljivic, S., & Gusenoff, J. A. (2019). The Obesity Epidemic and Bariatric Trends. *Clinics in Plastic Surgery*, 46(1), 1–7. <https://doi.org/10.1016/j.cps.2018.08.001>
- Thompson, A. E., Anisimowicz, Y., Miedema, B., Hogg, W., Wodchis, W. P., & Aubrey-Bassler, K. (2016). The influence of gender and other patient characteristics on health care-seeking behaviour: A QUALICOPC study. *BMC Family Practice*, 17(38). <https://doi.org/10.1186/s12875-016-0440-0>
- U.S. Census Bureau. (2012). *New York: 2010, Summary Population and Housing Characteristics, CPH-1-34*. New York.
- U.S. Census Bureau. (2017). *Health Insurance Coverage in the United States: 2017*.
- U.S. Census Bureau. (2020). U.S. Census Bureau QuickFacts: New York. Retrieved April 2, 2020, from <https://www.census.gov/quickfacts/NY>
- Udelsman, B. V., Jin, G., Chang, D. C., Hutter, M. M., & Witkowski, E. R. (2019). Surgeon

factors are strongly correlated with who receives a sleeve gastrectomy versus a Roux-en-Y gastric bypass. *Surgery for Obesity and Related Diseases*, 15(6), 856–863.

<https://doi.org/10.1016/j.soard.2019.03.040>

Wadden, T., Pories, W., Blair, S., & Hubbard, V. S. (2000). *The Practical Guide Identification, Evaluation, and Treatment of Overweight and Obesity in Adults*. Retrieved from

[https://www.nhlbi.nih.gov/files/docs/guidelines/prctgd\\_c.pdf](https://www.nhlbi.nih.gov/files/docs/guidelines/prctgd_c.pdf)

Wales, K. R., & Brissette, I. (2012). *Adult Overweight and Obesity in New York State, 2000-2010*. Albany.

Wallace, A. E., Young-Xu, Y., Hartley, D., & Weeks, W. B. (2010). Racial, socioeconomic, and rural-urban disparities in obesity-related bariatric surgery. *Obesity Surgery*, 20(10), 1354–

1360. <https://doi.org/10.1007/s11695-009-0054-x>

Wee, C. C., Huskey, K. W., Bolcic-Jankovic, D., Ellen Colten, M., Davis, R. B., & Hamel, M. (2013). Sex, Race, and Consideration of Bariatric Surgery Among Primary Care Patients with Moderate to Severe Obesity. *J Gen Intern Med*, 29(1), 68–75.

<https://doi.org/10.1007/s11606-013-2603-1>

Wiseman, C. V., Gray, J. J., Mosimann, J. E., & Ahrens, A. H. (1992). Cultural expectations of thinness in women: An update. *International Journal of Eating Disorders*, 11(1), 85–89.

[https://doi.org/10.1002/1098-108X\(199201\)11:1<85::AID-EAT2260110112>3.0.CO;2-T](https://doi.org/10.1002/1098-108X(199201)11:1<85::AID-EAT2260110112>3.0.CO;2-T)

Wolfe, B. M., Kvach, E., & Eckel, R. H. (2016). Treatment of Obesity: Weight Loss and Bariatric Surgery. *Circ Res*, 118(11), 1844–1855.

<https://doi.org/10.1161/CIRCRESAHA.116.307591>

Young, M. T., Phelan, M. J., & Nguyen, N. T. (2016). A decade analysis of trends and outcomes of male vs female patients who underwent bariatric surgery. *Journal of the American*

*College of Surgeons*, 222(3), 226–231. <https://doi.org/10.1016/j.jamcollsurg.2015.11.033>

Zizza, C. A., Herring, A. H., Stevens, J., & Carey, T. S. (2003). Bariatric Surgeries in North Carolina, 1990 to 2001: A Gender Comparison. *Obesity Research*, 11(12), 1519–1525. <https://doi.org/10.1038/oby.2003.203>