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Body Image and Anthropometric Measurements in Bariatric Surgery Patients

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Body Image and Anthropometric Measurements in Bariatric Surgery Patients

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Abstract

Purpose: The purpose of this study was to explore body image and anthropometric (body mass index) measurements in bariatric surgery patients over three months.

Conceptual framework: The dimensions of body image are body attitude, Appearance Evaluation, body checking, body space, body size, and Appearance Orientation. Body attitude is affective distress related to one’s weight, shape, size, and fatness. Appearance Evaluation is feelings of satisfaction or dissatisfaction with one’s looks. Body checking is the repeated scrutiny of one’s body size, shape, and weight. Perceived body space is the amount of space individuals perceive their bodies to occupy. Perceived body size is body size estimation, measured using silhouettes. Appearance Orientation is self-focus on one’s appearance or grooming.

Method: A one group pretest-posttest design was used to study 67 adults before and three months after bariatric surgery. The overall sample included these surgeries: Roux-en-Y gastric bypass (RYGB; n=35), sleeve gastrectomy (SG; n=28), and laparoscopic adjustable gastric band (LAGB; n=4). Six self-report body image measures and anthropometric measures (BMI, percent estimated BMI loss-%EBMIL) were analyzed. Differences in outcomes over three months were examined for the overall sample and within the two surgery groups (RYGB and SG). Differences between the two surgeries were also examined. Comparisons with the LAGB were not made, given the small number of these surgeries.
Results: Significant ($p<.001$) improvements were found in four of six body image measures and in BMI over 3 months for the overall sample and within the two surgery groups. No significant differences were found in body image or BMI between surgery groups. %EBMI loss was 32.8% for the overall sample.

Conclusions: This is the first study to examine body image in bariatric surgery patients at 3 months. Changes in body image and anthropometric measures were clinically significant. Body image outcomes not just BMI should be measured at bariatric surgery patients’ clinical appointments.
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CHAPTER 1

Introduction

In this chapter the problem, problem statement, purpose, background, and significance surrounding the issue of body image in the adult bariatric surgery patient are discussed. In addition, associated assumptions and the research questions for the current study are presented. The overall aim is to add new knowledge to the bariatric literature through the study of body image and anthropometric measurements in adult bariatric surgery patients before and three months following surgery, where now a paucity of research exists.

Problem

Randomized clinical trials demonstrate that bariatric surgery is the most effective therapy for sustained weight loss in the extremely obese population (Ashrafian, le Roux, Darzi, & Athanasian, 2008). Bariatric surgery, also known as weight loss surgery, symbolizes new hope for these individuals. The popularity of the surgery has risen as more bariatric procedures are performed in the United States every year (American Society for Metabolic and Bariatric Surgery, 2011). Weight loss from the surgery produces many benefits including the amelioration or resolution of diabetes, improvement or remission of obstructive sleep apnea, and reduced cardiovascular mortality and morbidity (Sjostrom et al., 2012).

Fifteen million Americans have morbid obesity and approximately 193,000 bariatric procedures were performed in the United States in 2014 (ASMBS, 2015). Bariatric surgery patients may experience concerns with body image following the operation due to the fact that weight loss can be rapid (Gilmartin,
The different types of surgery offered may result in varying degrees of weight loss (Dixon et al., 2008; Ikramuddin et al., 2013; Mingrone et al., 2012; O'Brien et al., 2006; Schauer et al., 2012). Moreover, weight regain is not unusual following the surgery (Colquitt, Picot, Loveman, & Clegg, 2009; Cooper et al., 2015; Freire, Borges, Alvarez-Leite & Correia, 2012).

Unfortunately the construct of body image is overlooked and not routinely measured clinically. The bariatric literature seldom addresses the difficulties patients face as they adjust to a new body image following rapid and massive weight loss. This is significant given that individuals carry various pictures of themselves in their own mind which solidify over time (Markus, Hamill, & Sentis, 1987). Inaccurate images of self can make postoperative recovery difficult as people struggle to keep pace with the actual physical changes occurring to their bodies (Natvik, Gjengedal, & Råheim, 2013). Patients in qualitative studies after bariatric surgery, describe being delighted with their new figures, while others describe emotions of feeling fat, shopping in “big stores”, and attempting to sit in chairs that are too big (Ogden et al., 2006). Some patients look in the mirror and still see a fat person staring back at them. They wonder if there will ever be a time when they see themselves as a thin person (Meana & Ricciardi, 2008).

**Problem Statement**

No body image theory specific to the bariatric surgery patient was found in the literature. Bariatric researchers seldom clearly define the body image concept they are measuring and utilize various instruments without thought to exactly
what the measure taps into (Thompson, Heinberg, Altabe, & Tantleff-Dunn, 1999). There is a paucity of research examining body image concepts and anthropometric measurements in the bariatric literature. Few studies examining body image across the various types of surgeries were found. Correlational studies between anthropometric measurements and body image have demonstrated conflicting results (Dixon, Dixon, & O’Brien, 2002; Hrabosky et al., 2006; Sarwer et al., 2010; Teufel et al., 2012).

**Purpose**

The purpose of the current study was to describe body image and anthropometric measurements in adult bariatric surgery patients over a three month period following surgery. The correlation between the changes in anthropometric measurements and the changes in body image concepts was examined. The differences in body image and anthropometric measurements, after as compared to before surgery, were examined, as well as differences between bariatric surgeries (gastric bypass and sleeve gastrectomy).

**Background**

A great number of extremely obese individuals struggle with weight their entire lives (Bocchieri, Meana, & Fisher, 2002). Treatments that typically allow for weight loss in the mild to moderately obese population such as diets, behavior therapy or drugs are only moderately effective in this population and are often followed by weight regain (Hainer, Toplak, & Mitrakou, 2008).

Bariatric surgery has become increasingly popular as a tool to achieve weight loss in the extremely obese when other treatments fail. The most
commonly performed bariatric surgical procedures are the Roux-en-Y gastric bypass, the sleeve gastrectomy, and the laparoscopic adjustable gastric banding, (Buchwald & Oien, 2009). The biliopancreatic diversion with duodenal switch is offered to severely obese individuals, and will not be highlighted in this dissertation (Smith, Schauer, & Nguyen, 2008). These procedures can be performed laparoscopically, minimizing wound infections and incisional hernias (Reoch et al., 2011).

In the **Roux-en-Y gastric bypass**, the gastric volume is restricted by creating a 15-30 ml gastric pouch, while nutrient flow is rerouted from the stomach directly into the proximal jejunum via a gastrojejunal anastomosis (Elder & Wolfe, 2007). Food intake is limited by the small pouch and the absorption of food is reduced by excluding most of the stomach, duodenum, and upper intestine (Mechanick et al., 2008). The Roux-en-Y gastric bypass is considered the gold standard in bariatric procedures (Miller & Choban, 2011).

The **sleeve gastrectomy** is accomplished by resecting the greater curvature of the stomach and producing a tubular stomach that resembles the size and shape of a banana. The resection of the stomach body and fundus produce major endocrine changes (Kerrigan, Magee, & Mitchell, 2011). The number of sleeve gastrectomies performed in the United States is on an upward trend.

The **laparoscopic adjustable gastric banding** is the least invasive bariatric procedure and is considered purely restrictive. This procedure involves placing a band across the upper portion of the stomach, creating a small pouch. A balloon
lines the inside of the band and this is adjusted in order to affect the diameter of this portion of the stomach. The pressure the inflated band exerts on the stomach delays the passage of food out of the pouch and into the distal stomach. This causes patients to feel full and reduces appetite (Miller & Choban, 2011).

Bariatric surgery may produce metabolic benefits, however patients who undergo the procedure may not anticipate the profound impact surgery can have on their body image. For example, rapid and massive weight loss results in hanging redundant skin that people consider ugly (Kinzl, Traweger, Trefalt, & Biebl, 2003; Gilmartin, 2013). Qualitative research indicates that sudden changes in weight and body image can have an intense effect on individuals and views of self (Gilmartin, 2013; Meana & Ricciardi, 2008; Ogden et al., 2006).

Body image is significant in bariatric surgery patients given that the various surgical procedures available may induce varying degrees of weight loss (Carlin et al., 2013). Patients must adjust to a new size and shape as the weight falls off (Meana & Ricciardi, 2008). Furthermore patients often struggle long-term to maintain the weight loss (Mechanick et al., 2008).

A great deal of body image research has taken place over the years by such researchers as Schilder (1950), Fisher and Cleveland (1968), McCloskey (1976), Brown, Cash and Mikulka (1990), Slade (1994), Flynn and Fitzgibbon (1996), Muth and Cash (1997), and Cash and Pruzinsky (2002). Slade (1994) and Cash and Pruzinsky (2002) developed models of body image, but this work has not been extended to the bariatric surgery patient.
Anthropometric measurement is important in the bariatric surgery patient because it can be used to assess body composition changes that occur as a person loses weight (National Health and Nutrition Examination Survey, 2013). Weight, BMI, Percent excess body mass index loss (%EBMIL), waist circumference, and neck circumference are examples of anthropometric measurements. Rapid weight loss transforms a patient’s body shape, size, and distribution of fat. This transformation can potentially alter a person’s perception of themselves and hence body image.

**Significance**

This study expands knowledge in the area of body image in patients within the first 3 months following bariatric surgery who face rapid and massive weight loss. It demonstrates the importance of measuring body image both preoperatively and postoperatively in order to identify patients most vulnerable to body image concerns following surgery. Results from the current study will advance body image theory construction and provide new knowledge that will facilitate the conduct of larger longitudinal studies in bariatric surgery patients. This study highlights the need to improve and develop body image assessment measures in the bariatric population. Understanding the construct of body image is necessary in order for clinicians to effectively counsel patients, provide enhanced bariatric group support, and to offer psychosocial assistance to patients who struggle with the rapid changes occurring to their bodies postoperatively.
Assumptions

The following assumptions underlie this study:

1. All individuals possess a mental image of their own body.
2. Adjusting to a new body image is important in bariatric surgery patients.
3. Waist circumference symbolizes central fat or abdominal fat mass (subcutaneous fat and intra-abdominal fat).
4. Obese individuals have a large amount of neck soft tissue.
5. Neck circumference is an index of upper body fat distribution.

Research Questions

The following research questions guided this study:

1. What is the body image of bariatric surgery patients at baseline and three months following surgery in the overall sample?
2. What are the anthropometric measurements (BMI, %EBMIL) in bariatric surgery patients at baseline and three months following surgery in the overall sample?
3. Is there a difference in body image in bariatric surgery patients over three months in the overall sample?
4. Is there a difference in anthropometric measurements in bariatric surgery patients over three months in the overall sample?
5. What is the correlation between the change in anthropometric measurements and the change in body image in adult bariatric surgery patients over a three month period?
6. What is the body image of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?

7. What are the anthropometric measurements (BMI, %EBMIL) of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?

8. Is there a difference in the change in body image over three months between the two surgeries (gastric bypass or sleeve gastrectomy)?

9. Is there a difference in the change in anthropometric measure (BMI) over three months between the two surgeries (gastric bypass and sleeve gastrectomy)?
CHAPTER 2

Introduction

In this chapter, the theoretical definitions, review of the literature on obesity, pathophysiology of obesity, bariatric surgery as a cure for obesity, review of the literature on body image, review of the literature on types of anthropometric measurements, review of the literature on anthropometric measurements after surgery, and discussion of the metabolic changes brought on by bariatric surgery will be presented. A conceptual model for the current study is also presented. The literature review is presented with a summary of the literature as it relates to the state of the science of body image and anthropometric measurements in the bariatric surgery patient.

Theoretical Definitions

Obesity

Obesity is a disease that causes an abnormal or excessive accumulation of fat that may impair one’s health, and is the result of an imbalance between energy intake and energy expenditure (American Medical Association, 2013; Goossens, 2008; Mechanick, Garber, Handelsman, & Garvey, 2012; World Health Organization [WHO], 2013).

Body Image

Body image is a multidimensional psychological construct, one that forms in our own mind as the picture of our own body, or the way the body appears to ourselves (Cash & Pruzinsky, 2002; Schilder, 1950); the components of which
are body image concern, Appearance Orientation, global body satisfaction, body image avoidance, body checking, perceived body space, and body percept.

**Body Image Concern**

Body image concern refers to affective distress regarding one’s appearance characterized by preoccupation or over concern about issues related to weight and shape, and to evaluation of self-worth largely in terms of weight and shape or the control of weight and shape. It includes emotions such as uneasiness, weight phobia (fear of being or becoming fat), body depersonalization (detachment), and body disparagement (individuals find their body loathsome or revolting; Ben-Tovim & Walker, 1991; Cuzzolaro, Vetrone, Marano, & Garfinkel, 2006; Fairburn, Cooper, & Shafran, 2003; Thompson & Van den Berg, 2002).

**Appearance Orientation**

Appearance Orientation refers to the degree of cognitive importance (salience) of and attention to physical appearance, physical fitness and strength. Cognitive aspects refer to investment in one’s appearance (Brown et al., 1990; Thompson & Van den Berg, 2002).

**Global Body Satisfaction**

Global body satisfaction refers to evaluative thoughts and beliefs about one’s physical body, such as figure, weight, and shape. It refers to overall satisfaction-dissatisfaction with one’s appearance (Brown et al., 1990; Thompson & van den Berg, 2002).
Body Image Avoidance

Body image avoidance is defined as “behavioral avoidance reflective of dissatisfaction with appearance—refers to avoidance of situations or objects due to their elicitation of body image concerns” (Thompson & van den Berg, 2002, p 142).

Body Checking

Body checking refers to compulsive self-monitoring, idiosyncratic checking, or the repeated scrutiny of one’s body parts, body size, shape, and weight. This can include personal mannerisms unique or peculiar to an individual. “Examples of this behavior includes examining oneself in mirror, using the fit of clothes to judge whether size has changed, comparing one’s appearance to other people, and asking others for reassurance” (Cuzzolaro et al., 2006; Reas, Whisenhunt, Netemeyer, & Williamson, 2002; Shafran, Leek, Payne, & Fairburn, 2007).

Perceived Body Space

Perceived body space is “the amount of space individuals perceive their bodies to occupy, and indicates perception of the limits of body boundaries” (Schlachter, 1971).

Body Percept

Body percept is the internal visual image of body shape and size. There are three types of body percept and they include objective, subjective, and optative. Objective percept refers to the shape or outline of the body as it objectively exists. Subjective percept refers to how an individual perceives the
shape and/or outline of their body. Optative percept is the shape or outline which an individual would like to have (Collins, 1986; Waller & Barnes, 2002).

**Weight**

Weight is defined as how heavy someone is, and can be measured in kilograms or pounds (Oxford Advanced Learner’s Dictionary, 2014).

**Height**

Height is defined as the measurement from base to top (of a standing person) or from head to foot (Oxford Advanced Learner’s Dictionary, 2014).

**Body Mass Index**

Body mass index (BMI) is a number calculated from a person’s weight and height. BMI provides a reliable indicator of body fatness and is used to screen for weight categories that may lead to health problems (Centers for Disease Control and Prevention, 2011). It provides the most useful population-level measure of overweight and obesity because it is the same for both sexes and for all ages of adults (WHO, 2013).

**Percent Excess Body Mass Index Loss**

Percent excess body mass index loss (%EBMIL) is the percentage of excess body mass index units a patient has lost from the beginning of treatment to follow-up, relative to a BMI of 25 (American Society for Bariatric Surgery Standards Committee, 2005).

**Cylinder**

A cylinder is a three dimensional geometric figure that has two congruent and parallel bases (Oxford Advanced Learner’s Dictionary, 2014). The human
body can be separated into cylinders, each with its associated circumference.

An example of a body cylinder is waist circumference. The cylinder fills or shrinks as regional changes in fat occur during periods of energy imbalance. Therefore, circumferences become larger or smaller as the body fills or loses fat (Heymsfield, Martin-Nguyen, Fong, Gallagher, & Pietrobelli, 2008).

**Circumference**

Circumference is the length of a line that goes around something or that makes a circle or other round shape. Circumference is the same as a perimeter (Oxford Advanced Learner's Dictionary, 2014).

**Waist Circumference**

Waist circumference is a perimeter that provides an estimate of body girth at the level of the abdomen (Klein et al., 2007). It is the most practical anthropometric measurement for assessing a patient’s abdominal fat content before, and during weight loss treatment (National Heart Lung and Blood Institute, 2011).

**Neck Circumference**

Neck circumference is the distance around the neck (Hall, Allanson, Gripp, & Slavotinek, 2007). Neck circumference is a method of differentiating between normal and abnormal fat distribution. It is a marker of upper body subcutaneous adipose tissue distribution (Aswathappa, Garg, Kutty, & Shankar, 2013).

**Body Compartment**

A compartment is defined as a section of a container in which certain items can be kept separate from others (Oxford Advanced Learner's Dictionary,
2014). A body compartment is a type of tissue such as fat mass or fat free mass. Examples of body compartments include subcutaneous adipose tissue, visceral adipose tissue, total body adipose tissue, and skeletal muscle (Heymsfield et al, 2008).

**Literature Review on Obesity**

Obesity is the second leading cause of preventable deaths next to smoking, and is associated with health problems such as diabetes, heart disease, hypertension, stroke, liver and gall bladder disease, osteoarthritis, sleep apnea and respiratory problems, cancer, premature death, and decreased quality of life (Agency for Healthcare Research and Quality, 2011). Obesity has become a national and international public health crisis (Hamdy, 2013). In 2008, an estimated half a billion adults worldwide were classified as obese (WHO, 2013).

**Obesity as a Disease**

In the years 2009 and 2010, 35.7% or 78 million adults in the United States were obese (Ogden, Carroll, Kit, & Flegal, 2012). The classification of obesity as a disease, by organizations such as the American Association of Clinical Endocrinologists (Mechanick et al., 2012) and the American Medical Association (2013), emphasize the magnitude of this crisis. Researchers estimate a 33% increase in obesity prevalence and a 130% increase in severe obesity prevalence over the next two decades (Finkelstein et al., 2012). It is predicted that if current trends continue, by 2030, obesity-related medical costs may rise by $48 to $66 billion a year in the United States (Finkelstein, Trogdon, Cohen, & Dietz, 2009).
Classifications of Obesity

Body mass index (BMI) is an index of weight-for-height that is often used to classify overweight and obesity in adults (WHO, 2013). It provides an estimate of body fat and is a gauge of risk for diseases that can occur with excess body fat (National Heart Lung and Blood Institute, 2013). Several classifications and definitions for the degrees of obesity are accepted; however the most widely recognized classifications are from the WHO (2013). These obesity classifications include Grade I (overweight) BMI 25-29.9 kg/m², Grade II (obese) BMI 30-39.9 kg/m², and Grade III (severe or morbid obesity) BMI ≥ 40 kg/m². It is important to note that in the surgical literature severe obesity is further classified into categories and these are 1) morbid obesity BMI 40-49 kg/m²; 2) super obese BMI 50-59 kg/m²; and 3) super/super obese BMI > 60 kg/m² (Renquist, 1998).

Aspects of Obesity Associated with Comorbidities

Obesity is associated with an array of comorbidities that significantly increase morbidity and mortality in those who suffer from the disease. In addition to total fat mass, other aspects of obesity have been linked to comorbidity: fat distribution, ethnicity, age of obesity onset, and intra-abdominal pressure (Hamdy, 2013).

Fat distribution. Evidence has pointed to key differences between intraabdominal visceral fat and peripheral or subcutaneous fat in the pathogenesis of medical problems in humans. The link between regional adipose tissue distribution and metabolic complications was first suggested by Vague (1947). He proposed that a male pattern of body fat distribution, known as
android obesity, is the form of obesity more likely to be accompanied by diabetes, gout, hypertension, and heart disease, while the female pattern of obesity known as gynoid obesity is rarely associated with complications. Over the years, studies suggest that central adiposity is more strongly associated with metabolic and cardiovascular complications than overall adiposity (Ammar et al., 2008; Folsom, Prineas, Kaye & Munger, 1990; Kissebah et al., 1982; Klein et al., 2007; Krotkiewski, Björntorp, & Sjöström, 1983; Zamboni et al., 1992) and that peripheral fat may act as a protective factor against cardiovascular and diabetes-related mortality (Kissebah et al., 1982; Klein et al., 2007; Krotkiewski et al., 1983; Lissner, Björkelundm, Heitmann, Seidell, & Bengtsson, 2001; Tanko, Bagger, Alexandersen, Larsen, & Christiansen 2003).

It has become clear that although BMI is an adequate index of adiposity to describe populations, an anthropometric measurement such as waist circumference to depict body shape is also necessary in order to differentiate overweight and obese patients with a high-risk body fat distribution (Després, 2012; Janssen, Heymsfield, Allison, Kotler, & Ross, 2002).

Studies have demonstrated that waist circumference is an appropriate index of intra-abdominal fat mass (Pouliot et al., 1994) and that it correlates well with percentage of total body fat (Flegal et al., 2009). Additional work has shown that waist circumference is a better indicator of abdominal visceral adipose tissue accumulation than the waist-to-hip ratio (Balkau et al., 2007; Pouliot et al., 1994; Wang & Hoy, 2004; Wei, Gaskill, Haffener, & Stern, 1997). Clinical practice guidelines (Department of Veterans Affairs and Department of Defense, 2006;
Jensen et al., 2013; National Institutes of Health Heart Lung and Blood Institute, 2011) suggest waist circumference be used as a convenient, inexpensive, and effective measure to assess central obesity and provide information regarding cardiovascular and diabetes risk.

**Ethnicity and body fat distribution.** Ethnicity may have an impact on adipose tissue chemistry and body fat distribution (Goedecke et al., 2011; Joffe, Goldberg, Feinsten, Kark, & Seftel, 1979; Tittelbach, Nicklas, Ryan, & Goldberg, 2004). Joffe and colleagues (1979) studied adipose tissue cell size in African American women and discovered significant regional variations. The researchers found that the gluteal adipocytes were larger than those of other sites in both obese and non-obese women. Goedecke et al. (2012) measured expression of genes involved in adipogenesis and lipogenesis in abdominal and gluteal fat depots in African American and White women and found that these genes were down-regulated with obesity in African American women compared with White women. The expression of these genes correlated positively with insulin sensitivity, independent of age and fat mass (p < 0.05; Goedecke et al., 2011). A clinical example of this premise is a 32-year old African American female presenting for a preoperative psychiatric evaluation. This patient, weighing in at 350 pounds, is 5 ft. 5 in., has hyperlipidemia and a very large gluteal adipose tissue depot. Prolonged inflammation of the fat cells impairs adipogenesis, increases hypoxia and oxidative stress, rendering subcutaneous adipocytes dysfunctional (Bays et al., 2008). Now metabolic disease such as type 2 diabetes, hypertension, and heart disease can strike, just as it has in her parents.
**Age of obesity onset.** Body mass index and abdominal obesity in adolescence or early adulthood may be related to a higher risk of developing comorbidities later in adulthood in both men and women (Reis et al., 2013; The, Richardson, Gordon, & Larsen, 2013). Researchers, using a large nationally representative sample, found that diabetes risk is high in persons who were obese as adolescents relative to those with adult onset obesity (The et al., 2013). Reis et al. (2013) discovered that a longer duration of overall and abdominal obesity arising in young adulthood was associated with coronary artery calcification during middle age, independent of the degree of adiposity. Another group of researchers found that a gain in BMI during early adulthood may be more important in influencing obesity biomarker levels than an increase in BMI later in life. Biomarkers such as adiponectin, C-reactive protein, HDL cholesterol, and HbA1c were examined (Montonen, Boeing, Schleicher, Fritsche, & Pischon, 2011).

**Intra-abdominal pressure.** Central obesity leads to increased intra-abdominal pressure. The co-morbidities that accompany obesity are believed to be due to chronically increased intra-abdominal pressure (Lambert, Marceau, & Forse, 2005; Nguyen et al., 2001; Sugerman, Windsor, Bessos, & Wolfe, 1997; Veralia, Hinojosa, Nguyen, 2009). A line of evidence supporting the hypothesis is demonstrated in bariatric surgery patients who lose significant amounts of weight and their intra-abdominal pressure decreases (Sugerman, Felton, Salvant, Sismanis, & Kellum, 1995; Verela et al., 2009). In a small nonrandomized group of bariatric surgery patients with a diagnosis of idiopathic intracranial
hypertension, significant reductions in cerebral spinal fluid opening pressure during spinal tap were present 34 months following gastric bypass surgery, indicating a reduction in intra-abdominal pressure (Sugerman et al., 1995). Subjects experienced resolution of papilledema and reduced or resolved headaches and tinnitus. In a nonrandomized study of laparoscopic gastric bypass and band patients systemic hypertension was significantly associated with elevated intra-abdominal pressure, but not with other obesity-related co-morbid conditions (Varela et al., 2009). Clearly randomized clinical trials are needed to determine if elevations in intra-abdominal pressure are linked to the various co-morbidities associated with obesity.

**Pathophysiology of Obesity**

The study of obesity is a challenge given that disturbance in one organ or tissue can modify the function of others, making the separation of cause and effect difficult to establish (Wisse, Kim, & Schwartz, 2007). Various pathophysiological mechanisms produce the comorbidities associated with obesity. Researchers continue to uncover data as they piece the multifaceted picture of pathophysiology together. This section will examine three distinct aspects of the pathophysiology of obesity: the dynamics of adipose tissue, gut microbiota, and the brain reward center.

**Adipose Tissue**

Adipose tissue is comprised of lipid-filled adipocytes, endothelial cells, pericytes (prospective adipocytes), fibroblasts (structural support), preadipocytes, mast cells, and immune cells (macrophages and T-cells). Many of these cells
function in the synthesis and cycling of the extracellular matrix (ECM). The ECM is thought to create unique environments in each of the body’s anatomical adipose tissue depots (Lee, Wu, & Fried, 2010). The following section will describe adipose tissue as an endocrine organ and lipid storage depot, lipid metabolism, the life of the adipocyte, and adipose tissue expansion.

**Adipose tissue as an endocrine organ.** Lipids or fats are stored in cells throughout the body in a connective tissue called adipose tissue (Ophardt, 2003). Adipose tissue is recognized as a biologically active tissue, a metabolic organ, playing a major role in whole-body energy homeostasis (Attie & Scherer, 2009; Frayn, Karpe, Fielding, Macdonald, & Coppack, 2003; Kershaw & Flier, 2004; Rondinone, 2006; Siiteri, 1987; Suganami, Tanaka, & Ogawa, 2012; Sun et al., 2011; Wood, 2006; Wronska & Kmiec, 2012). Fat cells, known as adipocytes, secrete an array of proteins called adipokines that may act both locally and systemically (Goossens, 2008). Adipokines have the capability to communicate with the brain regarding energy storage and play a role in the regulation of body weight (Yi & Tschöp, 2012).

It was the discovery of leptin in 1994 that established adipose tissue as an endocrine organ (Zhang et al., 1994). It is now known that leptin is one of many adipokines, secreted by adipose tissue and possessing an array of local, peripheral, and central effects (Kershaw & Flier, 2004; Frayn et al., 2003; Redinger, 2007; Rondinone, 2006). Leptin exhibits effects in nearly every body system (Ashrafian et al, 2008). It is especially known for its influence on the hypothalamus to decrease food intake (Park & Torquati, 2011). Levels of leptin
are positively correlated with the amount of body fat (Considine et al., 1996; Kershaw & Flier, 2004); therefore it is believed that obesity is a result of leptin resistance (Bloomgarden, 2006). Increased leptin blood levels, as a result of leptin resistance, are associated with hypertension (Shankar & Xiao, 2010), left ventricular hypertrophy (Perego et al., 2005), intima-media thickness, atheroma formation, and myocardial infarction (Soderberg et al., 1999).

Adipokines are linked to appetite, satiety, glucose and lipid metabolism, blood pressure, inflammation, and immune functions (Lago, Dieguez, Gomez-Reino, & Gualillo, 2007). The majority of pro-inflammatory adipokines, also known as cytokines (Xu, Pories, Dohm, & Ruderman, 2013), originate in the white adipose tissue, and are at increased levels in obese individuals (Bikman, 2012; Redinger, 2007; Rodriguez-Henandez, Mendia-Simental, Rodriguez-Ramirez, & Reyes-Romero, 2013; Rondinone, 2006). When adiposity reaches a certain threshold, changes take place in the adipocytes that activate macrophages to secrete cytokines such as tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), C-reactive protein (CRP), and resistin (Kershaw & Flier, 2004; Redinger, 2007; Rondinone, 2006). Activated macrophages increase dramatically triggering further infiltration of peripheral monocytes and macrophages into fat and impairing adipocyte insulin signaling (Xu et al., 2003).

It has been proposed that macrophages exist in two polarized states: M1 and M2, and that equilibrium between the two is necessary for acceptable adipocyte function (Lumeng, Bodzin, & Saltiel, 2007). The M1 macrophage operates in states of overnutrition and has been correlated with insulin
resistance. The M2 macrophage accumulates during negative energy balance and is believed to regulate tissue repair and prevent excess inflammation. The mechanisms through which diet-induced obesity leads to a change from the M2 to M1 state is currently unknown (Lumeng et al.). Research has demonstrated that the presence of dead adipocytes is a pathologic feature in obesity and that their death promotes macrophage recruitment and accumulation (Cinti et al., 2005; Sun, Kusminski, & Scherer, 2011). Studies are needed to determine if macrophages respond to, or directly contribute to, adipocyte death (Lee et al., 2011).

**Adipose tissue as a lipid storage depot.** Adipose tissue is the chief lipid storage depot in the body and buffers the daily influx of dietary fat entering the circulation (Goossens, 2008). Established in the literature is the notion that storage of fatty acids in adipocytes can reach a near maximum level with increased adipose tissue mass, at which time fatty acids will begin to accumulate in skeletal muscle, pancreatic islets, and the liver. Increased fatty acid influx to these areas can lead to hyperinsulinemia, impaired glucose tolerance, and hepatic steatosis (Blüher, 2010; Evans, Barish, & Wang, 2004; Horowitz & Klein, 2000; Sun, Kusminski, & Scherer, 2011).

Karpe, Dickmann and Frayn (2011) disagree with the concept that fatty acid accumulation reaches maximum levels, and believe that, as adipose tissue mass grows; free fatty acid release per kilogram adipose tissue can actually decrease. The researchers performed a systematic review and calculated difference in fat mass and free fatty acid concentration between control and
obese/overweight groups in each study. They concluded that fasting plasma free fatty acid concentration is largely unrelated to body fat mass. The researchers agree that in some obese individuals, elevation of free fatty acids is indisputable, but argue that even severe insulin resistance can be present without elevation of fatty acid concentrations (Karpe et al.). Clearly more studies are needed to elucidate associations between obesity, fatty acids, and insulin resistance.

**Lipid metabolism.** This is a state of dynamic equilibrium. Some lipids are being oxidized to meet energy needs, as others are being synthesized and stored (Ophardt, 2003). Fat is the largest energy reserve in humans. Most of the tissues are involved in fatty acid metabolism, but there are three that play a vital role: adipose tissue, skeletal muscle, and the liver. All of these tissues have a store of triacylglycerol that can be hydrolyzed to release fatty acids. Adipose tissue fat storage is stimulated and fat utilization suppressed by insulin, leading to a drive to store energy after a meal. Muscle fatty acid metabolism is more sensitive to physical activity given that fatty acid utilization increases immensely. There is a partnership among the tissues as adipose tissue fat mobilization increases to meet the demands of skeletal muscle during exercise. If triacylglycerol accumulates markedly in the skeletal muscle and liver, then insulin resistance arises. This resistance may be present with a lack of exercise and an excess intake of fat (Frayn, Arner, Yki-Järvinen, 2006).

**Lipolysis.** This is the process whereby lipids are broken down into glycerol and fatty acids so they can be oxidized to generate ATP. Several hormones stimulate hydrolysis: epinephrine, norepinephrine, cortisol, thyroid
hormone, and human growth hormone (King, 2013). Lipids ingested as food are
digested in the small intestine where bile salts stimulate emulsification.
Pancreatic lipase hydrolyzes lipids into fatty acids and glycerol (Ophardt, 2003).
Fatty acids are broken down on the mitochondria of cells to generate acetyl-coA.
Acetyl-coA then enters the Kreb’s cycle where reduced coenzymes are
produced. The electron transport chain uses resulting reduced coenzymes to
generate ATP (King, 2013).

Fatty acids released from adipose tissue enter the blood and are bound to
albumin for transport to peripheral tissues (King, 2013). Given that lipids are not
soluble in blood, they are transported by lipoproteins to cells in the body. Lipids in
the blood are absorbed by liver cells in order to provide energy for cellular
activities. Some of these same lipids are used by brain cells to synthesize brain
and nerve tissue. Excess lipids in the blood are eventually converted into adipose
tissue (Ophardt, 2003).

**Lipogenesis.** This is the metabolic process that converts simple sugars to
fatty acids and synthesizes triacylglycerols via a reaction with fatty acids and
glycerol. Acetyl-CoA starts this process in the cytoplasm of the cell. Following
lipogenesis, tricylglycerols are packaged as very low-density lipoproteins and
secreted by the liver, where they can assist with transport of lipids and
cholesterol throughout the body (Frayn et al., 2006).

**The life of the adipocyte.** Two different processes can lead to increased
adipose tissue size: hypertrophy (an increase in volume) or hyperplasia (an
increase in cell number; Arner et al., 2010; Sims, Goldman, Gluck, & Horton,
1968; Spaulding et al., 2008; Sun et al., 2011). It is recognized that adipocytes will expand to a certain size at which time hypertrophy gives way to hyperplasia (Faust, Johnson, Stern, & Hirsch, 1978), necrosis, and death (Sun et al.). Cinti et al. (2005) discovered a higher adipocyte turnover due to an elevated rate of cell death. Electron microscopy validated adipocyte death by characterizing necrosis, ruptured plasma membranes, dilated endoplasmic reticulum, cell debris, and small lipid droplets in the cytoplasm (Cinti et al.). They found greater than 90% of all macrophages in white adipose tissue of obese mice and humans, localized to dead adipocytes, and fused together to form a multinucleated giant cell called a “crown-like structure.” The process by which hypertrophy stimulates cell death is unclear, but studies implicate cell stress (Attie & Scherer, 2009; Cinti et al.).

The lifespan of a subcutaneous adipocyte in humans is estimated at 2-3 years by some researchers (Strawford, Antelo, Christiansen & Hellerstein, 2004) or 8.3 years by others (Spaulding et al., 2008). Spaulding and colleagues (2008) studied fat cell turnover in humans by utilizing a novel technique. The researchers estimated the birth of cells in humans by labeling DNA via radioactive fallout. They discovered that in lean and obese individuals, the total number of adipocytes increase during childhood and adolescence, and then level off and remain constant with little variation during adulthood. Roughly 10% of fat cells are renewed annually at all ages and body mass index (BMI), and a decrease in BMI or weight loss does not alter the adipocyte turnover rate (Spaulding et al., 2008).
Questions still exist regarding adipocyte lifespan, turnover, and general fate (Sun et al., 2011). Researchers agree that adipocyte hypertrophy occurs in obesity, but they still debate as to whether adipocyte number remains constant in an adult, or whether the capacity to undergo hyperplasia is age specific. Arner et al. (2010) studied abdominal adipose tissue morphology and turnover in 764 lean and obese adult men and women and found that occurrence of adipose hypertrophy or hyperplasia was not influenced by sex or body weight. The researchers found a correlation ($r = .61$, $p < .0001$) between subcutaneous adipose morphology and the total adipocyte number in the body over a large BMI range (18-60 kg/m²). This data led them to believe that common factors regulate adipose morphology and adipocyte number. They found that adipose morphology appears to be related to the generation of new adipocytes. Subjects with hypertrophy generated 70% less adipocytes per year than those with hyperplasia (Arner et al.). The researchers hypothesize that in hypertrophy the body produces few adipocytes over time requiring existing adipocytes to accumulate more lipids in comparison to the hyperplastic state.

**Adipose tissue expansion.** Scientists believe that a distinction should be made between healthy adipose tissue expansion and pathological adipose tissue expansion (Blüer, 2010; Spalding et al., 2008; Sun et al., 2011). They hypothesized that healthy expansion involves enlargement of the fat pad due to heightened recruitment of adipocyte precursor cells that become small adipocytes, and that vascularization takes place in the tissues with minimal inflammation and low numbers of macrophages (Blüer, 2010; Sun et al., 2011).
In contrast, pathological adipose tissue expansion involves rapid growth of the tissue by means of enlargement of existing fat cells, high numbers of macrophages, and limited vessel development. This type of expansion leads to tissue hypoxia, adipocyte necrosis, adipokine secretion, inflammation, and fibrosis (Cinti et al., 2005; Pasarica et al., 2009; Sun, et al., 2011). Scientists speculate that the chronic inflammation of fat cells is what eventually leads to insulin resistance (Pasarica et al.; Sun et al.; Xu et al., 2013).

It is posited that the ECM plays a role in regulating the expandability as well as the angiogenesis of adipose tissue (Sun et al., 2011; Spencer et al., 2011), and that each adipose tissue depot has its own unique ECM environment (Lee et al., 2010). A recent study of the ECM components in human/obese insulin resistant adipose tissue supports the pathological tissue expansion hypothesis. Investigators found an increase in large blood vessels and a decrease in capillaries and elastin. It is believed that this makes adipose tissue stiffer; resulting in less adipocyte expansion and capillary proliferation, thus promoting insulin resistance (Spencer et al.). Future studies are necessary to assess the intricacies of adipocyte cell expansion and lifespan, ECM, and the angiogenesis of adipose tissue.

**Gut Microbiota**

Intestinal microbial flora, also known as gut microbiota, have recently been suggested to effect nutrient acquisition and energy balance, playing an important role in obesity and its related diseases (Backhed et al., 2004; Fei & Zhao, 2012; Ley et al., 2005; Turnbaugh et al., 2006). The adult human intestine is populated
with 10-100 trillion microorganisms (Savage, 1977) and is a collection of bacteria, viruses, archaea, fungi, and unicellular eukaryotes (Harris, Kassis, Major, & Chou, 2012). This environment has been investigated for decades, but new techniques based on microbial DNA sequencing have profoundly transformed the ability to study these organisms (Tilg & Kaser, 2011). This section will summarize recent findings concerning the relationship between gut microbiota and obesity, gut alterations, energy acquisition, and chronic inflammation.

Evidence of gut alterations. Early evidence for an altered microflora linked to obesity came from studies in the leptin-deficient obese ob/ob mouse model. Gene sequencing of microbiota from the ceca of ob/ob mice, lean ob/+ , and wild-type siblings and their ob/+ mothers, all fed the same polysaccharide rich diet, revealed that ob/ob mice had a 50% reduction in the abundance of Bacteroidetes and a proportional increase in Firmicutes (Ley et al., 2005). Turnbaugh et al. (2006) transplanted ceca luminal contents from obese or lean mice into germ-free recipients. The mice receiving the obese donors’ ceca contents gained more weight over a 2-week period than recipients of the lean microbes, despite comparable food intake. These effects led investigators to believe a possible link existed between gut microflora and obesity.

Ley, Turnbaugh, Klein, and Gordon (2006) extended this work to humans and examined twelve obese people randomly assigned to a fat restricted or a carbohydrate restricted low calorie diet. Gene sequencing completed on stool samples revealed that 70% of the 4,074 species identified were unique to each person. Members of the Firmicutes/Bacteroidetes dominated the microbiota.
Before the diet therapy, obese subjects had fewer *Bacteroidetes* and more *Firmicutes* than lean controls. Over time *Bacteroidetes* increased and *Firmicutes* decreased irrespective of diet (Ley et al.).

These types of gut alterations were not found by all investigators. Schwierz et al. (2010) reported lower ratios of *Firmicutes* to *Bacteroidetes* in obese human adults compared to lean controls. Another study by Duncan et al. (2008) did not find a relationship in humans between BMI or weight loss, and *Bacteroidetes*. These mixed results lead some researchers to believe that differences at the phylum level are not as important as metagenomic-based characteristics. It is essential to note the methodological variations among these studies. Confounders such as drugs, diet, and day-to-day variability in microbial composition, as well as the need for well-controlled study designs cannot be stressed enough (Tilg & Kaser, 2011).

**Energy acquisition.** Gut microbiota aid the host by facilitating the extraction of calories from otherwise indigestible polysaccharides in the diet (Flint, Bayer, Rincon, Lamed & White, 2008). Germ-free mice (those with an absence of microorganisms) raised in aseptic environments are significantly leaner than conventionally raised mice (Bached et al., 2004). Studies of these germ-free mice reveal that the gut flora augments adiposity by increasing energy extraction from food and by regulating fat storage (Bached et al., 2004; Bached, Manchester, Semenkovich, & Godon, 2007).

Bached et al. (2004) administered normal mouse microbiota to germ-free mice and found a 60% increase in body fat content. Statistically significant
elevations in fasting glucose, insulin levels, and an insulin-resistant state were noted within 14 days despite reduced food intake. The same researchers found a 122% increase in lipoprotein lipase (LPL) which controls fatty acid release from triglyceride-rich lipoproteins in the muscle, heart, and fat (Mandard et al., 2006). It was hypothesized that the microbiota induced an increase in LPL activity via an enzyme called angiopoietin-like protein 4 (ANGPTL4). When the normal mouse microbiota was administered to germ-free mice, ANGPTL4 production was suppressed in the intestine and a greater proportion of triglycerides were deposited in the adipose tissue (Bached et al., 2007).

Studies of the ANGPTL4 gene have taken place in humans. Romeo et al. (2007) examined a very large population of humans of mixed ethnicity, and found the gene more prevalent in individuals with low triglycerides and high density lipoproteins, while Staiger et al. (2008) found ANGPTL4 plasma levels correlated with fasting fatty acid levels and adipose tissue lipolysis. Recently Robciuc et al. (2011) studied 121 twin pairs and found that variation in ANGPTL4 concentration was modestly accounted for by genetic factors, suggesting a role of ANGPTL4 in acquired obesity in humans. Additional investigations examining the role of ANGPTL4 as it relates to the human intestine and lipid metabolism are necessary.

**Chronic inflammation.** The cytokines that are at increased levels in obese individuals produce chronic inflammation (Bikman, 2012; Redinger, 2007; Rodriguez-Henandez et al., 2013; Rondinone, 2006) and recent work has demonstrated that gut bacteria can initiate this inflammation (Cani et al., 2007,
Verdam et al., 2013). Endotoxin lipopolysaccharide (LPS), derived from the cell wall of gram negative bacteria circulates at low concentrations in the blood of healthy individuals. Diet induced obesity is associated with increased LPL concentrations, a condition termed "metabolic endotoxemia" (Cani, 2007). Consumption of a high-fat meal in both mice and humans results in significant increases in endotoxin concentrations and a change in gut microbiota (Amar et al., 2008; Cani et al., 2008).

**Brain Reward Systems**

Obesity is characterized by overeating that continues despite an expressed desire to limit consumption, and knowledge of the profound negative consequences (Puhl, Moss-Raucin, Schwartz, & Brownell, 2008). Scientists believe that food consumption is driven by two parallel systems with central nervous system circuitry that interact with one another to influence food intake (Hommel et al., 2006; Lutter & Nestler, 2009; Morton, Cummings, Baskin, Barsh, & Schwartz, 2006). One system is the homeostatic system, and this includes hormonal regulators of hunger, satiety, and adiposity levels such as leptin, ghrelin, and insulin; while the brain reward or hedonic system involves palatability, motivation, food seeking behaviors, and food cues (Kenny, 2011). The hypothalamus is the second system and is recognized as the key brain region controlling food intake as it relates to caloric and nutrition requirements (Dietrich & Horvath, 2009). This section will provide a brief overview of the brain reward system and how it is hypothesized to contribute to the development of obesity.
Overconsumption of highly palatable, energy dense food is considered a major cause of the recent surge in obesity in America (Hill, Wyatt, Reed, & Peters, 2003; Swinburn, Sacks, & Ravussin, 2009). Gaining pleasurable effects from palatable food is a powerful force that in certain people can supersede homeostatic signals (Zheng, Lenard, Shin, & Berthoud, 2009). Dopamine plays a vital role, given that it is activated in humans and laboratory animals in response to palatable food (Nestler, 2005; Wang et al., 2001).

Research has uncovered a potential dysfunction in dopamine mechanisms whereby reward deficits arise in response to overconsumption of appetizing food during the development of obesity (Kenny, 2011). Investigators found that dopamine D2 receptor availability was significantly lower in obese individuals compared to nonobese controls (Volkow et al., 2008; Wang et al., 2001). Wang et al. found the lowest D2 receptor values had the largest BMI’s. Brain imaging studies in obese humans have uncovered a decline in striatal dopamine D2 receptor activity in response to palatable food as compared to lean counterparts (Stice, Yokum, Blum & Bohon, 2010). Scientists hypothesize that decreased D2 receptor signaling likely reduces sensitivity to rewards. Therefore obese individuals will compensate for decreased activation of these circuits by overeating (Wang et al.). The overeating diminishes the reward from palatable food, driving further overeating and weight gain (Stice, Spoor, Bohon, Veldhuizen, & Small, 2008). Researchers believe that individuals may anticipate more reward from energy dense food and experience greater somatosensory
gratification when eating, yet experience less dopamine release when food is consumed, given that each entails a separate neural circuitry (Stice et al., 2008).

Scientists have discovered similar findings in rats. Johnson and Kenney (2010) detected down regulated dopamine D2 receptors in obese rats and demonstrated that overconsumption of palatable food triggered compulsive overeating. In their research, rats with a history of lengthy access to palatable food continued to eat even in the presence of unpleasant conditioned stimulus (light cue) that predicted the delivery of foot shocks. The obese rats became resistant to the negative consequences of their scavenging behavior and risked their lives in order to consume palatable food, even when less palatable food was available in a safer environment. In contrast, the same conditioned stimulus disrupted palatable food consumption in lean rats with limited exposure to energy-dense food (Johnson & Kenny).

Drugs of abuse, like food, stimulate the release of dopamine in the mesocorticolimbic dopamine system that causes a subjective experience of excitement and gratification that reinforces use (Hyman, Malenka, & Nestler, 2006). Positron Emission Tomography was used to evaluate the dopamine D2 receptors in brains of alcoholics (Heinz et al., 2004). Scientists found significant reductions in D2 receptor availability in alcoholic subjects compared to nonalcoholic controls (Volkow et al., 2001). It is interesting to note that a study of methamphetamine abusers also demonstrated significant reductions in D2 receptor availability compared to non-drug-abusing comparison subjects (Volkow et al., 2001).
Randomized clinical trials will be needed to investigate whether abnormalities in the brain reward circuitry increase risk for weight gain (Stice et al., 2008). Scientists may find answers by understanding the role of genes in regulating homeostatic reward responses and the involvement of certain neurotransmitters. Study of the neurobiology of the opposite condition that underlies the decrease in food cravings and hunger following bariatric surgery may also provide clues (Volkow, Wang, & Baler, 2011).

**Bariatric Surgery as a Cure for Obesity**

Bariatric surgery was first performed in 1953 and advances in both malabsorptive and restrictive procedures have occurred since that time (Buchwald & Buchwald, 2002). Bariatric surgery has become increasingly popular as a treatment for severe obesity. Approximately 150,000-160,000 adults had bariatric surgery in 2010 (ASMBS, 2013). It is forecast that in the near future there will be 31 million Americans who may qualify for weight loss surgery (Poirier et al., 2011). Despite the high cost of bariatric surgery and its potential complications, the surgery is related to a decline in the costs of prescription drugs, physician visits, and hospital costs such as emergency department visits (Cremieux, 2008; Markary et al., 2010). Third-party payers can anticipate bariatric surgery paying for itself through decreased comorbidities within two to four years (Cremieux).

Patients with severe obesity do not have control of their eating. Many do not experience a reduction in appetite after a meal, and therefore continue to consume additional calories (Puhl et al., 2008). Bariatric surgery attempts to
address these problems by regulating portion size, interfering with absorption of calories, and influencing satiety signaling between the gut and the brain (Kerrigan et al., 2011; Oschner et al., 2011).

The most recent guidelines addressing clinical practice for perioperative, nutritional, metabolic, and nonsurgical support of the bariatric surgery patient were updated in 2013 by the American Association of Clinical Endocrinologists, the Obesity Society, and the American Society for Metabolic and Bariatric Surgery (Mechanick et al., 2013). These guidelines include surgical procedures in use as well as those under investigation, evidence, and recommendations for practice. The most commonly performed procedures are the Roux-en-Y gastric bypass, the sleeve gastrectomy, and the adjustable gastric banding (Buchwald & Oien, 2009). The biliopancreatic diversion, with or without duodenal switch is offered to extremely obese individuals (Smith et al., 2008). These procedures can be performed laparoscopically minimizing wound infections and incisional hernias (Reoch et al., 2011).

**Types of Bariatric Surgery**

**Roux-en-Y Gastric Bypass.** In this procedure, the gastric volume is restricted by creating a 15-30 ml gastric pouch and nutrient flow is rerouted from the stomach directly into the proximal jejunum via a gastrojejunal anastomosis (Elder & Wolfe, 2007). Food intake is limited by the small pouch and the absorption of food is reduced by excluding most of the stomach, duodenum, and upper intestine (Mechanick et al., 2008). The Roux-en-Y gastric bypass is considered the gold standard in bariatric procedures (Miller & Choban, 2011).
**The Sleeve Gastrectomy.** This procedure is accomplished by resecting the greater curvature of the stomach and producing a tubular stomach that resembles the size and shape of a banana. The resection of a significant portion of the stomach body and fundus produces major endocrine changes (Kerrigan et al., 2011). It is believed that there is a decreased amount of ghrelin due to the resection of the stomach. This decrease in ghrelin may reduce hunger more than a restrictive operation such as the gastric band (Karamanakos, Vagenas, Kalfarentzos, & Alexandrides, 2008). The sleeve gastrectomy is simpler to perform surgically because there is no rerouting of the intestinal tract. The surgery has less malabsorption, placing fewer restrictions on what patients can eat compared to the gastric bypass procedure (Carlin et al., 2013). Surgeons are pleased with the excellent weight loss, ease of performance, and shorter operating times as compared with the Roux-en-Y gastric bypass (Helmiö et al., 2012). The number of sleeve gastrectomies performed in the United States have risen dramatically, as well as the institutions performing the procedure (Buchwald & Oien, 2013; Nguyen, Nguyen, Gebhart, & Hohmann, 2013).

**Laparoscopic Adjustable Gastric Banding.** This procedure is safe, quick to perform, and is the least expensive of the bariatric surgeries offered (Kerrigan et al., 2011). It is the least invasive bariatric procedure, and is considered purely restrictive given that it involves placing a band across the upper portion of the stomach, creating a small pouch. A small balloon lines the inside of the band and this can be adjusted in order to affect the diameter and rate of passage of food out of the pouch and into the distal stomach (Miller &
Choban, 2011). The presence of the band prompts patients to chew food carefully and slowly, while making them feel full quicker (Kerrigan et al.). The laparoscopic adjustable gastric banding is the third most commonly performed bariatric surgery procedure performed worldwide (Buchwald & Oien, 2013).

**Postoperative bariatric surgery care.** The most vital component of a successful bariatric procedure is the postoperative care provided following the surgery (Kerrigan et al., 2011). Research demonstrates that the most successful patients are those who receive ongoing follow-up and emotional support (Funnell, Anderson, & Ahroni, 2005; Harvey-Berino, Pintauro, Buzzell, & Gold, 2004; Hildebrandt, 1998; Marcus & Elkins, 2004). The bariatric guidelines suggest support group participation following hospital discharge, as patients need assistance in adapting to rapid weight loss (Mechanick et al., 2008). A quality multidisciplinary team of surgeons, nurses, dieticians, physical therapists, and psychologists is essential. Patients must form lasting relationships with these people in order to cope with body image transformations and adequately self-manage eating behavior and other lifestyle alterations that arise following the surgery (Kerrigan et al.).

**Literature Review on Body Image**

**Body Image: Not a Simple Construct**

Body image is not a simple construct as implied by Schilder’s 1950 definition: “the picture of our own body which we form in our mind, that is to say the way in which the body appears to ourselves” (Schilder, p.11). Body image is a multifaceted construct that has been defined by researchers in a variety of
ways (see Table 1; Brown et al., 1990; Cash & Pruzinsky, 2002; Fisher & Cleveland, 1968; Flynn & Fitzibbon, 1996; Grogan, 2008; Schilder, 1950; Slade, 1994; Thompson, 1990; Walters-Brown & Hall, 2012; Wolszon, 1998). There are numerous other terms for body image in the literature (see Table 2). These body image terms are often applied interchangeably creating confusion and problems with measurement (Thompson et al., 1999; Thompson, 2004).

**Toward a Definition of Body Image in the Bariatric Surgery Patient**

Review of body image in the bariatric surgical literature demonstrates that theoretical definitions of concepts are rarely stated (Adami, Marinari, Bressani, Testa, & Scopinaro, 1998; DePanfilis et al., 2007; Hrabosky et al., 2006; Munoz et al., 2010; Sarwer, Wadden, Moore, Eisenberg, Raper, & Williams, 2010; vanHout, Fortuin, Pelle, & Heck, 2008) and when they are, the theoretical definition seldom matches the operational definition (Buser, Lam, & Poplawski, 2009). Researchers seldom provide rationale for their choice of a particular body image instrument. Sometimes measures without adequate reliability are utilized and only occasionally are multiple measures of body image incorporated into studies. Furthermore, researchers use parts of concepts, and the theory on which the instrument is based is often not published.

Body image in the bariatric surgical patient is briefly mentioned in the bariatric guidelines (Mechanick et al., 2008). An extensive review of the body image construct or a recommendation for routine assessment is not included in the guidelines. In 2004, an ad hoc committee of the then named American Society for Bariatric Surgery, released a document suggesting measures for pre-
surgical psychological assessment. This document states that bariatric surgery patients face shifting body image, however only two of the 27 recommended instruments address body image (Lemont, Moorehead, Parish, Reto, & Ritz, 2004).

**Conceptual Model of Body Image in the Bariatric Surgery Patient**

No sound theory of body image as it relates to the bariatric patient could be found in the literature. Slade (1994) and Cash and Pruzinsky (2002) developed body image models; however these models have not been extended to the bariatric surgery patient. Expanding these particular models to fit the bariatric surgery patient is not worthwhile, which made it necessary to build a model based on a review of the literature. In order to build a model, instruments with high reliability and validity were synthesized and items practical to both males and females were identified. The model that surfaced from this synthesis can be applied to the bariatric surgery patient (see Figure 1). The concepts from the bariatric surgical literature are body image concern, Appearance Orientation, global body satisfaction, body image avoidance, and body checking. Two additional concepts from the body image literature, but not mentioned in the bariatric literature, were added in order to include patient perceptions. These concepts are perceived body space and body percept.

It is important to include the concepts of perceived body space and body percept given that qualitative research on bariatric surgery patients reveals that individuals may still consider themselves obese years later, despite massive weight loss. Participants from studies continue to describe emotions of feeling fat
(Alegria & Larsen, 2015; Engstrom & Forsberg, 2011; Meana & Ricciardi, 2008; Natvik, Gjengedal, & Raheim, 2013; Ogden et al., 2006). Some patients look in the mirror and still see a fat person. They gravitate toward the “big stores” for clothing and search for large chairs without arms. One man, five years following surgery, described how he continues to twist his body to stand sideways against a wall when meeting someone in a corridor. He constantly miscalculates, bumping into table corners and other objects (Natvik et al. 2013).

**Obesity and Body Image in the Bariatric Surgery Candidate**

The emotional harm suffered from many years of chronic obesity is overwhelming, and the shame one experiences after repeated failures with dieting is disheartening (Van Etten & Grimaldi, 2011). An obese person may experience years of isolation, humiliation, and stigma (Stunkard & Wadden, 1992). They report overwhelming public prejudice and discrimination directed at them because of their weight (Schwartz & Brownell, 1992). The value that society puts on thinness creates a shame that makes going out in public places grueling. Obese individuals must search for appropriate sized chairs, squeeze in airplane, theater, and restaurant seats, and endure stares from strangers, all because of their weight (Livingston & Fink, 2003). Many obese persons are in constant fear the chair they are seated in will break (Christiansen, Borge, & Fagermoen, 2012).

Obesity stigma negatively impacts social behavior and body image. (Lewis et al., 2011), analyzing data from a qualitative research study, described three forms of stigma. The types of stigma that emerged from their work are: direct, indirect, and environmental. All forms may play a role in how a fat person views
self. Direct stigma is the most obvious form of stigma and examples of it are workplace discrimination, verbal abuse, and being laughed at. Indirect stigma is more understated and subjective. Obese individuals describe it by relating emotions of fear of humiliation when eating in public places, feeling judged by the contents of their grocery cart, and being ignored by customer service. The environmental form of stigma has a particularly harmful effect on body image. Examples include unsuitable public seating, inappropriate sized seatbelts, and lack of appropriate clothing choices (Lewis et al., 2011).

Stigma and discrimination can create significant anxiety, and persons with severe obesity are more likely to report it (Carr & Friedman, 2005; Durso, Lanter, & Hayashi, 2012; Lewis et al., 2011). This stress can have a damaging impact on eating behavior (Durso et al., 2012). It is known that the prevalence of binge eating increases with adiposity (Bruce & Agras, 1992; Hudson, Hiripi, Pope, Kessler, 2007; Telch, Agras, & Rossiter, 1988). Binge eating is defined as eating a very significant amount of food within a relatively short period of time and feeling a sense of loss of control while eating to the point of being unable to stop. Individuals may eat too quickly and when they are not hungry (American Psychiatric Association, 2013). Binge eaters are often preoccupied with eating and food, and express more dissatisfaction with weight (Kuehnel & Wadden, 1993; Striegel-Moore, Wilson, Wilfrey, Elder, & Brownell, 1998). Studies of patients in weight management programs have demonstrated that negative body image is significantly related to binge eating (Cargill, Pera, Niaura, & Abrams, 1999; Mussell et al., 1996). Furthermore, an increased desire for a more slender
body has been significantly related to a greater frequency of binge eating (Cargill et al.; Legenbauer et al., 2011).

Researchers have linked binge eating to body image distress (Striegel-Moore et al., 1998; Wilfrey, Schwartz, Spurrell, & Fairburn, 2000). Body image distress is common in severe obesity (Adami, Meneghelli, Bressani, & Scopinaro, 1999; Adami et al., 1998; DePanfilis et al., 2007; Foster, Wadden, & Vogt, 1997; Neven et al., 2002; Stunkard & Wadden, 1992). Compared to non-obese binge eaters, obese binge eaters are more preoccupied with eating, weight, and shape. Obese binge eaters may value weight and shape more than other aspects of life such as career, family, or relationships (Striegel-Moore et al., 1998; Wilfrey et al., 2000).

Weight cycling is a phenomenon that may be present in the obese bariatric surgery candidate (Roehrig et al., 2009). Weight cycling refers to a repeated loss and regain of weight, also known as yo-yo dieting. Many candidates of bariatric surgery make numerous attempts to lose weight via conventional approaches such as with diets or medications (Gibbons et al., 2006; Hainer et al., 2008). Weight regain after discontinuing pharmacological and behavioral treatment programs can be significant (Gibbons et al.).

There is a paucity of research evaluating the outcomes of weight cycling. The lack of a uniform definition and measure for weight cycling also complicates its study (Qazi & Keval, 2013). Weight cycling has been linked to body image dissatisfaction and binge eating (Petroni et al., 2007; Qazi & Keval, 2013; Roehrig et al., 2009; Venditti, Wing, Jakicic, Butler, & Marcus, 1996; Womble et
A recent qualitative study points to women being self-conscious about body size and shape, driving them to diet (Qazi & Keval, 2013). In the Nurses’ Health Study II, Field et al. (2004) found that severe weight cyclers were significantly heavier than their mild weight cycling and non-cycling peers. The researchers discovered that weight cyclers were significantly more likely than no cyclers to engage in both overeating and binge eating. Weight cyclers were also found to be significantly more likely to use diet pills than non-cyclers (Field et al.). Various factors likely drive individuals to adopt a weight cycling behavior. Clearly more research is needed to elucidate this concept and its impact on the bariatric surgery candidate.

In our Western society, bodily size is a crucial part of an individual’s self-representation (Knutsen, Terragni & Foss, 2011). Many obese bariatric surgery candidates have been obese since youth. Respondents from qualitative research studies describe how childhood teasing and bullying creates feelings of shame for their large bodies (Meana & Ricciardi, 2008; Ogden et al., 2006). Participants report displeasure viewing themselves in mirrors and photographs (Christiansen et al., 2012). Obese people feel as if they are “living in a box” (Christiansen et al.) and describe emotions of being “trapped” in huge bodies (Knutsen et al., 2011). Participants engage in a denial regarding how large they have become, while others claim they lack a physical image of self (Meana & Ricciardi, 2008). However, many obese individuals claim that their self-image is centered on an inner self, and not on their shells or bodies (Meana & Ricciardi, 2008). The motivation for some to seek bariatric surgery is not only to improve comorbidities,
but to feel better about their appearance (Kinzel et al., 2001; Meana & Ricciardi, 2008; Munoz et al., 2007).

**Body Image Following Bariatric Surgery**

Striking improvements in body image occur following bariatric surgery (Camps, Zervos, Goode & Rosemurgy, 1996; Dixon, Dixon, & O’Brien, 2001; Mitchell et al., 2008) as patients experience rapid and dramatic weight loss. Obese patients may lose an average of two thirds of their excess body weight within two years following the surgery (Bocchieri et al., 2002). Patients who have lost massive amounts of weight have expressed that they would prefer to be normal weight with a major handicap (deaf, legally blind, amputee) than be morbidly obese (Rand & Macgregor, 1991). Others would forego being a multi-millionaire, morbidly obese person, just to be thin. Many individuals express that they would be willing to risk death to attain their “dream weight” (Wee, Jones, Davis, Bourland, & Hamel, 2006). Attitudes and feelings such as these demonstrate the significance of body image in a person’s life.

A review of the literature for body image following bariatric surgery demonstrates mixed results (Teufel et al., 2012). Some patients experience considerable improvement in body image across the various surgical procedures (Adami et al., 1998; De Panfilis et al., 2007; Dixon et al., 2001; Hrabosky et al., 2006; Neven et al., 2002; Pecori, Cervetti, Marinari, Migliori, & Adami, 2007; Sarwer et al., 2010; Teufel et al., 2012; van Hout et al., 2008), while others have a negative view of their bodies (Gilmartin, 2013; Hotter et al., 2003; Kinzl et al., 2003; Meana & Ricciardi, 2008). Many postoperative patients are still grappling
with having had the surgery in the first place, as family and friends often do not understand their motivation, and feel that they have taken the easy way out (Grimaldi & Van Etten, 2011; Meana & Ricciardi, 2008).

Very few studies have examined body image or psychosocial concerns of the postoperative bariatric surgery patient. Existing literature primarily focuses on the physiologic outcomes of bariatric surgery (Bocchieri et al., 2002; Grimaldi & Van Etten, 2010). Many patients can expect to reach a near nonobese state within six months following surgery (ASMBS, 2013). Even positive changes that accompany such significant weight loss can create an array of psychosocial challenges (Bocchieri et al.). Some patients fail to alter food consumption and lifestyle, and as a result experience negative outcomes such as an end to weight loss, regain of weight, eating disorders, and decline in quality of life (Grimaldi & VanEtten; Buchwald & Williams, 2004).

Participants in qualitative research studies, that report positive body image outcomes following weight loss surgery, speak of being shocked, giddy, and delirious at the sight of their shrinking bodies (Meana & Ricciardi, 2008; Sutton, Murphy, & Raines, 2009). Participants use language such as “melted off”, “poured off”, and “dropped off” to describe how the weight disappeared in the first few months following surgery (Sutton et al., 2009). Many patients describe improved confidence and body image and less embarrassment following surgery (Bocchieri et al., 2002; Dixon et al., 2002; Meana & Ricciardi, 2008; Ogden et al., 2006; Teufel et al., 2012).
The physical changes that come from rapid weight loss can have an effect on marriages. There is a paucity of research addressing marital life and sexual relationships following bariatric surgery. Some postoperative bariatric surgical patients state that the surgery impacts their intimate relationships in a positive way. Patients report higher self-esteem, less physical limitations, heightened libido, and improved orgasms following bariatric surgery (Camps et al., 1996; Kinzel et al., 2003; Meana & Ricciardi, 2008; Rand, Kulda, & Robbins, 1982).

Conversely, role changes that accompany the weight loss can threaten some marriages (Neil, Marshall, & Yale, 1978). The consequences of rapid and massive weight loss can leave patients with a negative view of their bodies. This impacts intimate relationships given that patients are unhappy with flabby skin, abdominal overhang, and pendulous breasts (Kinzel et al, 2003; Meana & Ricciardi, 2008). Others experience problems in relationships due to their new body because friends and husbands are jealous of their transformation (Bocchieri, Meana, & Fisher, 2002; Kinzel, 2003). Increased independence and enhanced self-esteem is perceived as threatening to some spouses (Bocchieri et al., 2002). Instability created by these changes can lead to separation and divorce (Neil et al.).

**Measurement of Body Image**

It is necessary to choose the appropriate instrument to measure the aspect of body image one is interested in studying. One must select an instrument that matches a particular component of body image (Thompson, 2004). There is evidence of at least ten body image instruments utilized by
researchers and clinicians in the bariatric literature (see Table 3). The most widely used measures are the Body Shape Questionnaire (Cooper, Taylor, & Cooper, 1987), the Appearance Evaluation and Appearance Orientation subscales of the Multidimensional Body Self-Relations Questionnaire (Brown et al., 1990), the drive for thinness and body dissatisfaction subscales of the Eating Disorders Inventory (Garner, Olmstead, & Polivy, 1983), and the Eating Disorder Examination Questionnaire (Fairburn & Beglin, 1994). Nine of these instruments are self-report measures that incorporate Likert-type scales (Ben-Tovim & Walker 1991; Brown, Cash, & Mikulka, 1990; Cash, Fleming, Alindogan, Steadman, & Whitehead, 2002; Cooper et al., 1987; Cuzzolaro et al., 2006; Fairburn & Beglin; Garner et al., 1983; Probst, Vandereycken, Van Coppenolle, & Vanderlinde, 1995; Reas et al., 2002), while two are silhouette figure rating scales (Song et al., 2006; Stunkard, Sorensen, & Schulsinger, 1983).

Some interesting non paper and pencil tests were identified in the body image literature (see Table 4). These are described in the literature as body image accuracy techniques. Accuracy techniques may include the image marking method (Askevold, 1975), video camera technique (Collins, 1986), wooden movable beams (Dillon, 1962), adaptive probit estimation (Watt & Andrews, 1981), topographic method (Schlachter, 1971), or an adjustable light beam method (Thompson & Spana, 1988). One method that is simple is the Topographic Device. This technique involves construction of device with concentric circles set off one inch apart. Subjects stand in the center and are asked to identify the circle they feel best represents the space their body
occupies. Random numbers are assigned to each circle, and subsequently converted to inches to obtain a measurement of perceived body space (Schlachter, 1971). Body image accuracy measures, except the Topographic Device, are expensive and were not studied extensively in the literature.

**Synthesis, Research, and Theory Construction**

A systematic review of the literature was conducted to evaluate self-report instruments purporting to measure body image. The review was performed in order to explore current understanding of the body image construct. The first aim of the review was to find widely used body image instruments. The second aim was to find reliable and valid body image instruments for bariatric surgery patients. The third aim was analyze the body image concepts that each instrument queried.

A search of the Cochrane library, CINHAL, PubMed, PsychInfo, MEDLINE, Academic Search Complete, and HAPI was conducted. Inclusion criteria were (a) studies in nursing, psychiatry, medicine, and surgery written in English, (b) studies in adult human subjects, and (c) studies at least 3 months in duration. Search terms included the following headings, descriptions, and key words: “overweight”, “obesity”, “morbid obesity”, “body size”, “body shape”, “bariatric surgery”, “weight loss surgery”, “bariatric”, “gastric bypass surgery”, “Roux-en-Y gastric bypass”, “laparoscopic gastric band”, “sleeve gastrectomy”, “body image”, “appearance orientation”, “body dissatisfaction”, “body satisfaction”, “body image disturbance”, “body checking”, “body avoidance”, “body image concern”, “body image investment”, “body uneasiness”, “body
depersonalization”, “body disparagement”, “body size estimation”, “perceived body space”, and “body percept”. These search terms were combined with singular and plural terms for instruments: “assessment”, “questionnaire”, “measure”, “scale”, “inventory”, “figure rating scale”, “figural drawing”, “pictorial”, and “silhouette”.

For the first aim of the review, to identify body image instruments, approximately seventy-five body image instruments were evaluated. The second aim, to find reliable and valid body image instruments in bariatrics, ten instruments widely used in the obese and/or bariatric population were obtained (see Table A3). All related publications for the ten body image measures that provided data about instrument development, reliability and validity were retrieved and evaluated (Brown et al., 1990; Marano et al., 2007; Probst et al., 1995; Reas, White, & Grilo, 2006; Rosen, Jones, Ramirez, & Waxman, 1996). Construct validity of the instruments were established with the Eating Disorder Inventory (Garner et al., 1983) or the Body Shape Questionnaire (Cooper et al., 1987). The Body Image States Scale (Cash & Pruzinsky, 2002), exhibiting no factor analysis, was deemed inappropriate given its contextual nature. The factor analysis of the Eating Disorder Examination Questionnaire in bariatric surgery candidates did not replicate original subscales (Hrabosky et al., 2006); therefore it was also ruled out.

The third aim of the review was to analyze the body image concept/concepts that each of the ten instruments queried. Full instruments were obtained for analysis and items were independently reviewed by two reviewers.
An iterative process resulted in the refinement of theoretical and operational definitions for the body image concept or concepts that each instrument measured (see Table A5). Five body image concepts surfaced from this work in bariatric surgery patients.

The following measures were chosen for this study due to good validity and reliability, ease of administration, and for usefulness in both men and women: the Body Attitude Test, the Body Uneasiness Test Part A, the Multidimensional Body Self-Relations Questionnaire-Appearance Orientation subscale, the Body Checking Questionnaire, the Pictorial Body Image Assessment, and the Topographic Device.

**Literature Review on Anthropometric Measurements**

**Types of Anthropometric Measurements Available in the Literature**

Anthropometric measurements depict body mass, size, shape, and amount of fatness (Bray & Ryan, 2006). Given that overweight and obesity are largely related to the deposition of adipose tissue, it is helpful to assess excess adiposity in patients during weight loss interventions and following bariatric surgery. Various methods to assess for adiposity and body composition are discussed in the literature. Some methods are more expensive, time-consuming, and involve a high degree of technical training and skill. Hydrostatic weighting, air displacement plethysmography, skinfold measurement, and imaging methods such as computerized tomography, and magnetic resonance imaging are examples of such methods (Cornier et al., 2011). The less complex methods available to researchers for assessing adiposity in the “field” and in the literature
are body mass index (BMI), circumferences, diameters, and ratios. These measures are discussed in the following section. Table A6 presents definitions, rationale for use, advantages and disadvantages, reproducibility/correlation and references for various measures.

**Body mass index.** Body mass index is one of the most commonly cited anthropometric measures in the literature to assess for total body adiposity. It is often used in epidemiological studies and as a screening tool for the assessment of overweight and obesity (Cornier et al., 2011; Oria et al., 2005). BMI is a convenient, indirect, noninvasive method that can be used on a large number of subjects with minimal cost. It has become the gold standard for distinguishing patients at increased risk of obesity-related adverse health outcomes (Klein et al., 2007). BMI is calculated as body weight in kilograms divided by height in meters squared (kg/m$^2$; Cornier et al.). A disadvantage of using BMI is that it does not differentiate between lean and fat mass. Patients of normal weight, who possess excess body fat, may not be diagnosed as overweight or obese. Conversely, patients who are athletic may have a high BMI due to increased muscul arity rather than increased fatness (CDC, 2011). There is a significant linear correlation between BMI and percent of body fat; however it varies by sex, age, and ethnicity (CDC, 2013; Gallagher et al., 1996; Prentice & Jebb, 2001). Women tend to have more body fat than men at the same BMI, while older individuals, on average, tend to have more body fat than younger individuals (CDC, 2013). Furthermore, the relationship between percent body fat and BMI is different among different ethnic groups (Deurenberg, Yap, & van Staveren,
1998). Despite these limitations, BMI is recommended by the American Heart Association for the assessment of body fatness given its global recognition and ease of calculation (Cornier et al., 2011).

**Percent excess weight loss.** This measure indicates the weight that a person has lost or gained relative to 1983 Metropolitan Height and Weight Tables for a person of medium frame (ASMBS, 2005). Percent excess weight loss (%EWL) is calculated by taking preoperative weight, subtracting follow-up weight, and dividing by preoperative weight minus ideal body weight and multiplying times 100. Percent excess weight loss is recommended by the ASMBS as a calculation follow-up after surgery (Oria et al., 2005). It is the most frequently cited measure in the bariatric literature.

**Percent excess body mass index loss.** This measure indicates the percentage of BMI units a patient has lost from the beginning of treatment to follow-up, relative to a BMI of 25, and can be expressed as %EBMIL.

**Circumferences.** These measures are often used to track changes in body shape and size during weight loss, and assess patterns of body fat distribution (Johnston et al., 1988; National Institutes of Health, 2000; Ness-Abramof & Apovian, 2008). Waist, hip, thigh, calf, mid upper arm, and neck circumferences are cited in the literature (Ben-Noun, Sohar, & Laor, 2001; Haboubi, Kennedy, Sheriff, & Haboubi, 2010; Jung, Kimm, Yun, & Jee, 2013; Kim et al., 2011; Kuk, Janiszewski, & Ross, 2007; Mason, Craig, & Katzmarzyk et al., 2008; Pouliot et al., 1994). Circumference measures can be easily incorporated into physician office visits given that the technique can be
completed by minimally trained personnel in a relatively timely fashion (Cornier et al., 2011).

**Mid upper arm circumference.** This is a measure of the upper arm circumference at the mid-point of the arm between the acromion process and the tip of the olecranon (Gibson, 2005). It has been used in the past as a rapid method of assessing nutritional status in patients without requiring extensive training or materials (Gibson; Powell-Tuck & Hennessy, 2003). The measure is more frequently utilized in the pediatric population. Mid upper arm circumference has been employed to screen for obesity in preschool children (de Almeidia et al, 2003); however only one study was that estimated body fat in obese subjects (Haboubi et al., 2010).

**Waist circumference.** This measure is perhaps the most frequently utilized given that it is simple, inexpensive, reliable, and complements the BMI measurement (Cornier et al., 2011). Furthermore, waist circumference is often used as a surrogate marker of abdominal fat mass because it correlates with subcutaneous and intraabdominal fat mass and is associated with an array of metabolic disorders (Després, 2012; Klein et al., 2007). One disadvantage of waist circumference is that there is no standardized approach to measurement, given that numerous protocols are mentioned in the literature (National Institutes of Health, 2000; Wang et al., 2003; Willis et al., 2007; World Health Organization, 2008). As many as eight different measurement locations have been cited in the literature for waist circumference: (a) midpoint between the lowest rib and the iliac crest (World Health Organization, 2008); (b) the umbilicus (Willis et al.,
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2007); (c) high point of the iliac crest (National Institutes of Health, 2000; Ninomiya et al., 2004); (d) point of minimal circumference (Dagenais et al., 2004); (e) one inch above the umbilicus (Folsom et al., 2000); (f) one centimeter above the umbilicus (Wildman et al., 2005); (g) below the lowest rib (Bosy-Westphal et al., 2010; Wang et al., 2003); and (h) point of largest circumference around the waist (Nicklas et al., 2004).

Technical considerations of waist circumference measures. Precision of the waist circumference measurement is high at any given site (Klein et al., 2007; Mason & Katzmarzyk, 2009); however reproducibility depends on the person taking the measurements (Wang et al., 2003). Potential error can result when the tape measure is incorrectly positioned. It is important to position the tape around the participant in a plane perpendicular to the long axis of the body (Wang et al.). Mason & Katzmarzyk (2009) noted that when participants are obese, large deposits of subcutaneous fat can sometimes prohibit the tape measure from lying flat against the skin. Additionally proper positioning of the tape measure can be obscured when the umbilicus is located below the level of the iliac crest, as it often is in extremely obese individuals. An expert panel and the American Heart Association suggest that waist circumference be measured utilizing bony prominences (Cornier et al, 2011; Ross et al., 2009). Fixed skeletal sites with repeated measures of waist circumference are unaffected by weight changes and may make measurement easier (Cornier et al.; Mason & Katzmarzyk; Ross et al.). The National Institutes of Health (2000) protocol for waist circumference requires palpating the iliac crest for measurement, while the World Health
Organization (2008) protocol requires the identification of two bony landmarks, a measured distance between the two, and the calculation of a midpoint, prior to measurement. The World Health Organization protocol may be more difficult and time consuming than the National Institutes of Health protocol (Ross et al.). Waist circumference measurements are typically taken three times and readings averaged. It is recorded to the nearest 0.1 cm (Klein et al.; CDC, 2013).

**Neck circumference.** This anthropometric measure can be used to provide information about upper body adipose tissue distribution. It is a quick measure that is unaffected by clothing and respiratory movement (Zhou et al., 2013). Researchers have demonstrated an association between upper body fat, diabetes, and cardiovascular disease risk (Chan, Rim, Colditz, Stampfer, & Willett, 1994; Déprés et al., 1990; Kissebah et al., 1982). The theory of upper body adipose tissue leading to metabolic disease was first proposed by Vague (1956). He used the neck skinfold to assess upper body fat distribution. Since that time, neck circumference has been linked to insulin resistance, diabetes, and cardiovascular disease risk factors (Aswathappa et al., 2013; Ben-Noun & Laor, 2004; Ben-Noun & Laor, 2006; Cornier et al., 2011; Freedman & Rimm, 1989; Onat et al., 2009; Preis et al., 2010; Sjostrom, Hakangard, Lissner, & Sjostrom, 1995; Sjostrom, Lissner, & Sjostrom, 1997; Stabe et al., 2013; Zhou et al.). Changes in neck circumference have been positively associated with changes in body mass index, waist circumference, waist-to-hip ratio, total cholesterol, low density lipoprotein, triglycerides, fasting glucose and uric acid levels (Ben-Noun & Laor, 2006).
One disadvantage of neck circumference is that there is no standardized approach to measurement given that different protocols are cited in the literature. As many as four different measurement sites have been mentioned in the literature: (a) the upper margin of the laryngeal prominence (Adam’s apple; Yang et al., 2010); (b) midway between the mid-cervical spine and mid-anterior neck, just below the laryngeal prominence (Ben-Noun et al., 2001; Kouchi, Mochimaru, Tsuzuki, & Yokoi, 1999; Onat et al., 2009; Zhou et al., 2013); (c) above the cricothyroid cartilage (Laakso, Matilainen, & Keinänen-Kiukaanniemi, 2002); (d) just below the thyroid cartilage (Fink, 2012; Hingorjo, Qureshi, & Mehdi, 2012).

**Technical considerations of neck circumference measures.** Precision of neck circumference is similar to waist circumference given that placement of the tape measure is key to a reliable measure. Potential error in neck circumference can occur when a subject’s neck is very broad due to excessive protrusion of the trapezius muscle, skin folds, or webs. If such anatomy is encountered, the tape measure should be meticulously placed in order to follow the surface of the skin. The horizontal plane where the measurement is taken should be carefully selected to include the most prominent portion of the neck just below the thyroid cartilage (Fink, 2012).

**Sagittal abdominal diameter.** This is a promising new measure that provides a gauge of abdominal height. It is calculated with computerized tomography, magnetic resonance imaging, or with a simple caliper. Studies demonstrate sagittal abdominal diameter to be a good marker of abdominal visceral adiposity, insulin resistance, and coronary heart disease; however
standardized methods for measurement have not been developed or validated, nor have normal thresholds been identified (Cornier et al., 2011; Pouliot et al., 1994; Risérus et al., 2004; Sampaio, Simões, Assis, & Ramos, 2007; Zamboni et al., 1998).

**Ratios.** Researchers have calculated ratios from anthropometric data in order to assess adiposity and predict the risk of certain metabolic disorders. Two of the most commonly used methods are the waist-to-hip ratio and the waist-to-height ratio (Cornier et al., 2011; De Baerdemaeker, Van Limmen, & Van Niewenhove, 2013). Waist-to-thigh ratio has also been reported. Studies have linked cardiovascular disease to greater waist-to-hip circumference (Elsayed et al., 2008; Reis et al., 2009; Taylor, et al., 2010) and greater waist-to-height ratio (Gelber et al., 2008). Meisinger, Döring, Thorand, Heier, and Löwel (2006) discovered that BMI, waist circumference, and waist-to-hip ratio are strongly and independently related to Type 2 diabetes in both sexes.

The use of ratios as indices of upper to lower body fat distribution remains controversial (Cornier et al., 2011). Variability in hip circumference represents differences in subcutaneous, gluteal muscle, and pelvic width (Reis et al., 2009). Advocates of the measure claim it provides predictive information about regional fat distribution and body shape when it is combined with other measures such as the waist circumference. In contrast, ratio measurements have been criticized due to their complex biologic interpretation (Reis et al.). Després et al. (1990) point out that a high waist-to-hip ratio may be obtained in an individual with a small hip circumference or a low ratio in an individual with a larger hip
circumference, possessing the same abdominal girth. These two individuals may not differ in regard to amount of abdominal fat, but it may be falsely concluded that they differ on the basis of waist-to-hip ratio values. Furthermore, weight loss interventions reduce both numerator and denominator resulting in no observed change in the ratio (Després et al. 1990; Kay & Singh, 2006). In a recent scientific statement, the American Heart Association did not recommend the routine use of ratios to assess adiposity (Cornier et al., 2011).

In summary, the anthropometric measurements that were used in this dissertation were weight, height, body mass index, percent excess body mass index loss, and the circumference measures of waist and neck.

**Geometric Model**

The Geometric model links body volume (body weight) with circumference and body mass index (weight to height ratio; Heymsfield et al., 2008). Each individual has a bodily configuration that is distinctly their own. The adult human body is cylindrical in shape. The body is further segmented into smaller cylinders including associated circumferences. These cylinder circumferences and volumes relate to body compartments (Heymsfield et al.). The model predicts that body volume is directly linked to a measure of body circumference and height; therefore body volume is measured by BMI (weight and height), waist, and neck circumference. These regional circumferences reflect variation in body shape. The body can be measured as a series of cylindrical shapes. As the body fills or loses fat during periods of energy imbalance there are regional differences in the rates and amount of deposits or metabolized fat (Heymsfield et al.). The
cylinder fills as regional changes occur, that is to say, as fat cells fill, circumferences become larger. In contrast, as fat cells shrink, circumferences become smaller. If one measures the same points, as well as the widest points on the cylinder, it will provide information as to body volume (body weight) and shape.
Figure 1. The Geometric Model (Heymsfield et al., 2008)
Literature Review on the Anthropometric Measurements After Bariatric Surgery

The aim of this section is to review the existing evidence on anthropometric measurements following bariatric surgery according to each type of procedure. Specifically this review will compare and contrast weight, BMI, %EBML, and waist and neck circumference, following the three types of bariatric surgery. A search of the Cochrane library, CINHAL, PubMed, MEDLINE, and Academic Search Complete was conducted. Inclusion criteria were (a) studies in nursing, medicine, and surgery written in English, (b) studies in adult human subjects, and (c) studies at least 3 months in duration. Search terms included the following headings, descriptions, and key words: “obesity,” “weight loss,” “bariatric surgery,” “weight loss surgery,” “bariatric,” “gastric bypass surgery,” “Roux-en-Y gastric bypass,” “laparoscopic gastric bypass,” “laparoscopic gastric band,” “sleeve gastrectomy,” “laparoscopic sleeve gastrectomy,” “randomized controlled trial,” “clinical trial,” “anthropometrics,” “anthropometric measures,” “body composition,” “BMI,” “body mass index,” “weight,” “%EWL,” “percent estimated weight loss,” “circumference measures,” “waist circumference,” and “neck circumference”. Medical management is defined as a program that includes counseling and education on weight loss, instruction on physical exercise, as well as social support. Significant is defined as statistically significant at $p \leq 0.05$. 

Weight

Four randomized controlled studies demonstrated significant reductions in weight following Roux-en-Y gastric bypass, sleeve gastrectomy, and laparoscopic adjustable gastric banding compared to medical management (Dixon et al., 2008; Ikramuddin et al., 2013; Mingrone et al., 2012; Schauer et al., 2012). Significant reductions in weight were observed following Roux-en-Y gastric bypass (56-100 lbs), sleeve gastrectomy (56 lbs), and laparoscopic adjustable gastric banding (41-46 lbs; Dixon et al., 2008; Ikramuddin, 2013; Mingrone, 2012; Schauer et al.). Significant reductions in weight were observed following Roux-en-Y gastric bypass and sleeve gastrectomy in one study as early as 3 months following surgery (Schauer et al.). Compared to medical management, weight was not significantly reduced in one randomized controlled trial of laparoscopic adjustable gastric banding at six months, but was significantly reduced at the 12, 18, and 24 month time points (O'Brien et al., 2006).

One nonrandomized study with a control group, but no random assignment, compared Roux-en-Y gastric bypass to medical management and found no significant between group differences for weight at 12 months. Significant reductions in mean weight were found within the Roux-en-Y gastric bypass group at 12 months (52 lbs). However, significant reductions in mean weight were also found in the medical management group at 12 months (45 lbs; Kulovitz, Kolkmeyer, Conn, Cohen, & Ferraro, 2014).
In two nonrandomized studies in patients where weight was measured before and after Roux-en-Y gastric bypass surgery, significant reductions in mean weight were observed (74 and 83 lbs, respectively; del Genio et al., 2009; Lima Filho, Ganem, & de Cerqueira, 2011). del Genio et al. reported significant weight reductions as early as 1.5 months after surgery (37 lbs), and this mean weight loss improved to 74 lbs at the 7.5 month time point. Lima Filho et al. (2011) found significant reductions in mean weight after 24 months (83 lbs; see Table 7).

**Body Mass Index**

Three randomized controlled trials demonstrated significant reductions in BMI following Roux-en-Y gastric bypass, sleeve gastrectomy, and laparoscopic adjustable gastric banding compared to medical management (Ikramuddin et al., 2013; Mingrone et al., 2012; Schauer et al., 2012). Significant reductions in BMI were observed following Roux-en-Y gastric bypass (27.0- 44.9 kg/m² to 25.8-31.8 kg/m³), sleeve gastrectomy (27.0- 43.0 kg/m² to 27.2- 31.3 kg/m²; Ikramuddin et al., 2013; Mingrone et al., 2012; Schauer et al., 2012). Compared to medical management, BMI was not significantly reduced in one randomized controlled trial of laparoscopic adjustable gastric banding at 6 months, but was significantly reduced at the 12, 18, and 24 month time points (O’Brien et al., 2006).

One nonrandomized study with a control group, but no random assignment, compared Roux-en-Y gastric bypass to medical management and found no significant between group differences for BMI at 12 months. Significant
reductions in mean BMI were found in the Roux-en-Y gastric bypass group at 12 months (46.6 kg/m$^2$ to 38.1 kg/m$^2$). However, significant reductions in mean BMI were also found in the medical management group at 12 months (45.3 kg/m$^2$ to 37.5 kg/m$^2$; Kulovitz et al., 2014).

Seven additional nonrandomized studies demonstrated significant reductions in BMI following the Roux-en-Y gastric bypass and the sleeve gastrectomy (del Genio et al., 2009; Fuks et al., 2009; Himpens, Dobbeleir, & Peeters, 2010; Karamanakos et al., 2008; Lima Filho et al., 2011; Sammour et al., 2010; Zachariah et al., 2013). Significant reductions in BMI were observed following Roux-en-Y gastric bypass as early as 1 month (46.6 kg/m$^2$ to 41.9 kg/m$^2$), and at 1.5, 3, 6, 7.5, 12, and 24 months following surgery (49.8- 40.7 kg/m$^2$ to 43.8- 27.2 kg/m$^2$; del Genio et al.; Karamanakos et al.; Lima Filho et al.). Five nonrandomized studies demonstrate that sleeve gastrectomy significantly reduces BMI as early as 1 month (45.1 kg/m$^2$ to 41.0 kg/m$^2$), and at 3, 6, 12, 36, and 72 months following surgery (50.3- 37.2 kg/m$^2$ to 38.5- 26.6 kg/m$^2$; Fuks et al., 2009; Himpens et al., 2010; Karamanakos et al.; Sammour et al., 2010; Zachariah et al., 2013; see Table A7).

**Percent Excess Weight Loss**

Percent excess weight loss (%EWL) is the percentage of excess weight that the patient has lost or gained relative to the 1983 Metropolitan Height and Weight Table for a person of medium frame and is the most frequently cited measure in the bariatric literature (American Society for Bariatric Surgery Standards Committee, 2005). Three randomized clinical trials reported a superior
%EWL following Roux-en-Y gastric bypass, sleeve gastrectomy, and laparoscopic adjustable gastric banding compared to medical management (Mingrone et al.; O'Brien et al., 2006; Schauer et al., 2012). Mingrone et al. (2012) reported significant change in mean %EWL in the Roux-en-Y gastric bypass at 24 months (68.8% compared to 9.29%). Schauer et al. reported a significant change in mean %EWL in both the Roux-en-Y gastric bypass (88%) and the sleeve gastrectomy (81%) compared to the control group at 12 months (13%). Compared to medical management, mean %EWL was not significant in one randomized controlled trial of laparoscopic adjustable gastric banding at 6 months, but was significant at the 12, 18, and 24 month time points (78.6%, 83.6%, 87.2% respectively; O'Brien et al., 2006).

In addition, one nonrandomized study reported significant change in mean %EWL between 1 and 12 months for both the Roux-en-Y gastric bypass (20.5% at one mo; 60.5% at 12 mos) and the sleeve gastrectomy (18.2% at one mo; 69.7% at 12 mos; Karamanakos et al., 2008). Another nonrandomized study demonstrated significant change in mean %EWL in sleeve gastrectomy patients between 36 and 72 months (77.5% at 36 mos; 53.3% at 72 mos; Himpens et al., 2010). Sammour et al. (2010) found significant change in mean %EWL when comparing patients after sleeve gastrectomy with a BMI < 50 (70.8%) with patients of a BMI ≥ 50 (53.6%) at 12 months. These results are not surprising given that researchers have established the heavier the patient, the smaller the %EWL (van de Laar, de Caluwé, & Dillemans, 2011). One study failed to demonstrate significant change in mean %EWL in sleeve gastrectomy patients.
between 12 months (72.39%) and 24 months (72.63%; Zachariah et al., 2013; see Table 7).

**Percent Excess Body Mass Index Loss**

Unfortunately there is no standardized method for reporting weight loss in the bariatric literature (Dixon, McPhail, & O’Brien, 2005). In 1997, The American Society for Bariatric Surgery Standards Committee recommended the use of the metric system and BMI to classify obesity (ASBS, 1997). In 2005, the same committee recommended %EWL continue to be used as a measure of weight loss, but that changes in postoperative BMI also be included when reporting outcomes following bariatric surgery (ASBS, 2005). Percent excess weight loss (%EWL) has less relevance given multiple criticisms of the outdated 1983 Metropolitan Height and Weight Tables (Dietel & Shahi, 1992). In recent years, percent excess body mass index loss (%EBMIL) is more widely used, and is being adopted as the standard measure for studies of granting bodies (Dietel, Gawdat, & Melissas, 2007). Therefore %EBMIL was used in this dissertation study.

One cross-sectional study found a %EBMIL of 46.6% at three months in RYGB patients (Kadera et al., 2009). A retrospective review conducted by Abbatini et al. (2010), reported a 42.5% EBMIL in RYGB patients after three months. Nosso et al. (2011), utilizing a pre-test post-test design, found a 39.1% EBMIL at three months in SG patients, while Abbatini et al. (2011) reported a much lower %EBMIL of 25.9% after three months in SG patients.
Waist Circumference

Two randomized controlled trials demonstrated significant reductions in mean waist circumference after 12 (114 cm to 90 cm; Ikramuddin et al., 2013) and 24 months (125.4 cm to 98.6 cm; Mingrone et al., 2012) following Roux-en-Y gastric bypass. Significant reductions in waist circumference were also observed following laparoscopic adjustable gastric band surgery after 24 months (114.1 cm to 95.8 cm; Dixon et al., 2008). The sleeve gastrectomy trials reviewed did not measure waist circumference.

One nonrandomized study with a control group, but no random assignment, compared Roux-en-Y gastric bypass to medical management and found no significant between group differences for waist circumference at 12 months. Significant reductions in mean waist circumference were found in the Roux-en-Y gastric bypass group at 12 months (116 cm). Significant reductions in mean waist circumference were also found in the medical management group at 12 months (110.5 cm; Kulovitz et al., 2014). In another nonrandomized study using one group of Roux-en-Y gastric bypass patients, waist circumference was not significantly reduced at 1.5 months, but was significantly reduced at 7.5 months (141.3 cm to 117.9 cm; del Genio et al., 2009; See Table 7).

Neck Circumference

Randomized controlled studies assessing neck circumference following any of the three bariatric surgeries could not be found. One nonrandomized study demonstrated significant reductions in neck circumference at 4 months following Roux-en-Y gastric bypass (43.35 cm to 38.18 cm; Santos, Filho, Campello,
Another nonrandomized study demonstrated significant reductions in neck circumference at 24 months following Roux-en-Y gastric bypass surgery (47.2 cm to 39.3 cm in males; 40.5 to 33.3 cm in females; Lima Filho et al., 2011).

In summary, thirteen different studies were included in this review. Five randomized controlled trials compared bariatric surgery with medical management and assessed changes in anthropometric measurements at different time points. Eight nonrandomized studies compared different bariatric surgeries and changes in anthropometric measurements following surgery. Significant reductions in weight, BMI, %EWL, waist circumference, and neck circumference take place following bariatric surgery. Although researchers have studied patients at various time points, very little is known about the changes that occur in anthropometric measures as early as three months following surgery.

**Metabolic Changes Brought on by Bariatric Surgery**

The amelioration of diabetes is one of the many metabolic alterations brought on by bariatric surgery. These operations produce additional health benefits linked to the metabolic syndrome (Ashrafian et al., 2008). The mechanism by which the surgery accomplishes this is a topic of ongoing research, debate, and controversy. The purpose of this section is to describe the relationship between the pathophysiology of obesity and the effects brought on by bariatric surgery. It will describe the role of gastrointestinal hormones and adipokines.
Role of Gastrointestinal Hormones

Ghrelin. It was originally thought that calorie restriction and nutrient malabsorption were the mechanisms that induced weight loss in bariatric surgical patients (Park & Torquati, 2011; Rao & Kini, 2011). Research has demonstrated that gastrointestinal hormones play a significant role in the metabolic alterations that take place following surgery. One of the first hormones related to obesity and bariatric surgery to gain the interest of researchers was ghrelin. Ghrelin is the only known circulating orexin, a hormone that plays a role in regulating premeal hunger and meal initiation, as well as long-term energy balance (Cummings et al., 2001).

A real paradox exists in the fact that ghrelin levels in individuals of lower weight are significantly higher compared to the obese (Park & Torquati, 2011). There is evidence that ghrelin is significantly reduced following Roux-en-Y gastric bypass (RYGB; Cummings et al., 2002; Lin et al., 2004; Morinigo, et al., 2008), and sleeve gastrectomy (SG; Dimitriadis et al., 2013), but not after laparoscopic gastric banding, where levels are not changed (Langer et al., 2005), or are increased (Carroll, Franks, Smith & Phelps, 2009). Bohdjalian et al. (2010) determined that fasting ghrelin plasma levels stay decreased five years after SG. In contrast, some studies have found that in the months following RYGB, fasting ghrelin levels are significantly increased (Garcia-Fuentes et al., 2008; Sundbom, Holdstock, Engstrom, & Karlsson, 2007). One study found significant inverse correlation between fasting ghrelin levels and BMI (Ybarra et al., 2009). The researchers discovered that as ghrelin levels increased, BMI decreased.
Inconsistent findings in the literature have led researchers to hypothesize various explanations for ghrelin levels. A randomized clinical trial comparing RYGB with SG confirmed that both operations reduce ghrelin, more so after SG. Researchers believe that the resection of the gastric fundus has a greater impact on ghrelin levels than simply bypassing it (Peterli et al., 2009). Other possible theories that may have an effect on ghrelin include hyperinsulinemia and/or insulin resistance (McLaughlin et al., 2004), different configurations of the pouch (Pories, 2008), and integrity of the vagus nerve (le Roux et al., 2005). Nevertheless the mechanism of plasma ghrelin changes following bariatric surgery demands further elucidation.

**Glucagon-like peptide-1.** Glucagon-like peptide-1 (GLP-1) is an amino acid peptide released by the L-cells in the intestine that stimulates insulin secretion by the pancreas. It increases beta-cell mass by promoting cell mass and growth and inhibiting apoptosis (Ionut & Bergman, 2011). GLP-1 levels increase in response to the presence of nutrients in the lumen of the distal intestines, and has been shown to induce appetite suppression in both obese and normal weight humans (Doyle & Egan, 2001). It has been hypothesized that increased levels of GLP-1 following RYGB can be accounted for by the surgical procedure which promotes a more rapid delivery of nutrients to the distal gut (Nasland & Kral, 2006). There is a significant increase in GLP-1 levels following RYGB (le Roux et al., 2007; Whitson et al., 2007) and levels have been noted to increase after SG (Peterli et al., 2009). GLP-1 levels are significantly higher in
RYGB subjects compared to gastric banding subjects (Korner, et al., 2007; Rodieux et al., 2008).

Researchers have attempted to explain the role of GLP-1 in surgical weight loss by examining its blood levels in relation to food intake, hunger, and satiety. Surgical procedures associated with increases in plasma GLP-1 (RYGB and biliopancreatic diversion) demonstrate greater weight loss (Korner et al., 2009). Le Roux and colleagues (2007) measured GLP-1 levels in a prospective trial following RYGB and found increases were significantly correlated with decreases in hunger and fullness scores, while Morinigo et al. (2006) found a three-fold increase in GLP-1 levels but no correlation with eating behavior. Outcomes from recent investigations suggest that the physiologic effects of GLP-1 on glucose metabolism are more complex and not the result of enhanced secretion alone (Salehi, Prigeon, D’Alessio, 2011; Jiménez, Cassamitjana, Viaplana-Masclans, Lacy, & Vidal, 2013). Clearly additional research is needed to pinpoint causal relationships between GLP-1, weight loss, and eating behavior.

**Glucose-dependent insulinotropic polypeptide.** Glucose-dependent insulinotropic peptide (GIP) is secreted by the K cells of the duodenum and jejunum in response to ingested nutrients (Hage, Safadi, Salti, & Nasrallah, 2012). GIP promotes beta cell proliferation and plays a role in insulin secretion especially in the postprandial phase (Yamada et al., 2006). GIP also works physiologically on nutrient uptake into adipocytes and is a chief molecule in fatty acid metabolism (Rao & Kini, 2011; Yamada et al.). Studies assessing GIP and
its part in RYGB surgery have been inconclusive. Some investigations have demonstrated a decrease in GIP levels after surgery (Clements, Gonzalez, Long, Wittert & Laws, 2004; Rubino, et al., 2004), while others have reported an increase (Laferrière et al., 2007). In a recent study, one of the first of its kind, researchers found a significant increase in GIP gene expression following RYGB. Furthermore, the increase correlated with resolution of type 2 diabetes (Moran-Atkin, Brody, Fu, & Rojkind, 2013). Additional studies are warranted to further understand the role of GIP in the physiology of bariatric surgery.

**Peptide YY.** Peptide YY (PYY) is another gastrointestinal hormone synthesized and released from the L-cells within the distal gut that has anorectic effects (Arora, & Anubhuti, 2006; Karra, Chandarana, Batterham, 2009). It is believed that PYY stimulates neurons in the hypothalamus (neuropeptide Y neurons) to terminate feeding and nutrient intake (Karra et al.; Park & Torquati, 2011). It also plays a role in energy expenditure and fuel partitioning (Karra et al.). PYY release in response to feeding may be diminished in obese individuals (Batterham et al., 2003).

Evidence suggests that both the malabsorptive (Chan, Rim, Colditz, Stampfer, & Willett, 2006; le Roux et al., 2006; Morinigo et al., 2006; Morinigo et al., 2008; Naslund, & Kral, 2006; Rodieux et al., 2008) and restrictive (Depula, Macedo, Schraibman, Mota, & Vencio, 2008; Peterli et al., 2009) bariatric procedures lead to a rise in fasting postprandial PYY levels. PYY plasma levels rose significantly as early as two days after RYGB; suggesting this is a direct result of surgery ((le Roux et al., 2007; Scott & Batterham, 2011). Furthermore,
researchers have demonstrated that a higher PYY response to meal intake significantly predicted better weight loss (Morinigo et al., 2008).

PYY may play a major role in the interaction with other gut hormones affected by RYGB (Scott & Batterham, 2011). A recent study by Chronaiou et al. (2012) conceivably supports this theory. In a randomized controlled trial, they performed standard RYGB on one group of patients and RYGB with gastric fundus resection (RYGB-FS) on another group. They found that fasting ghrelin levels in the RYGB-FS group decreased significantly. Additionally they discovered significantly higher postprandial PYY, GLP-1, and insulin secretion in the RYGB-FS as compared to the standard RYGB group (Chronaiou et al.). Investigators concluded that the gastric fundus resection made a difference in the postprandial secretion of PYY, GLP-1, and insulin.

Role of Adipokines

Bariatric surgery, especially RYGB, is believed to improve cardiovascular risk factors by augmenting the leptin/adiponectin ratio and improving lipid profiles (Appachi et al., 2011; Batsis et al., 2007), while reducing left ventricular mass (Oliver et al., 2009; Owan et al., 2011). One theory for these alterations is that the biological responses to bariatric surgery impact the heart structurally due in part to leptin signaling (Leichman et al., 2008; Perego et al., 2005). Fasting leptin levels drop following bariatric surgery (Depaula et al., 2008; Korner et al, 2009; Rubino et al., 2004), consistent with decreasing weight and fat loss (Czupryniak et al., 2007; Fried et al., 2000; Molina et al., 2003; Vendrell et al., 2004), while
circulating adiponectin levels rise (Faraj et al., 2003; Hindle et al., 2010; Illán-Gómez et al., 2012; Linscheid et al., 2008).

The pathophysiology of obesity as it relates to the bariatric surgical patient is complex and comprised of an infinite number of factors. The mechanisms by which bariatric surgery leads to alterations in insulin, ghrelin, GLP-1, GIP, PYY, leptin, and adiponectin are just beginning to be understood.

**Summary of Literature Review**

A great number of Americans are turning to bariatric surgery as a treatment for severe obesity making the study of pathophysiology and the mechanisms of surgery vital. The pathophysiology of obesity is multifaceted and related to factors such as adipose tissue dynamics, the composition of human intestinal flora, brain reward systems, and genes. Studies demonstrate that gastrointestinal hormones play a significant role in weight loss and the amelioration of comorbidities following surgery. Additional research is warranted to further elucidate the pathophysiology of obesity as well as the role of gastrointestinal hormones following the various types of surgery.

There is a gap in the literature given that no body image theory exclusive to the bariatric surgery patient was found. A model specific to the construct of body image in this population was created (see Figure 1). The model was fashioned following the review of ten reliable and valid measures utilized in bariatrics. Theoretical and operational definitions were developed resulting in a unique set of measures that are most advantageous in this bariatric population and setting.
A gap in the literature exists given that very little is known regarding the changes in anthropometric measurements in patients as early as three months following bariatric surgery. Routine measurement of waist and neck circumference is seldom done in the bariatric surgery setting. The Geometric model links body volume with circumference and body mass index. The model depicts the adult human body as cylindrical in shape and asserts that it can be segmented into small cylinders including associated circumferences. It is important to differentiate overweight and obese patients with a high-risk body fat distribution. Anthropometric measurements such as waist and neck circumference reflect changes in shape following bariatric surgery and provide data regarding fat distribution. This study may demonstrate the significance of routine assessment of body image and anthropometric measures in the perioperative clinical setting.
CHAPTER 3

Introduction

In this chapter, the research questions, research design, sample, power analysis, setting, and instruments will be described. The procedures for data collection and data analysis are presented. The chapter will conclude with a description of the procedures used to protect human subjects.

Research Questions

The following research questions are:

1. What is the body image of bariatric surgery patients at baseline and three months following surgery in the overall sample?

2. What are the anthropometric measurements (BMI, %EBMIL) in bariatric surgery patients at baseline and three months following surgery in the overall sample?

3. Is there a difference in body image in bariatric surgery patients over three months in the overall sample?

4. Is there a difference in anthropometric measurements in bariatric surgery patients over three months in the overall sample?

5. What is the correlation between the change in anthropometric measurements and the change in body image in adult bariatric surgery patients over a three month period?

6. What is the body image of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?
7. What are the anthropometric measurements (BMI, %EBMIL) of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?

8. Is there a difference in the change in body image over three months between the two surgeries (gastric bypass or sleeve gastrectomy)?

9. Is there a difference in the change in anthropometric measure (BMI) over three months between the two surgeries (gastric bypass and sleeve gastrectomy)?

**Method**

**Research Design**

Approval was obtained from the Washington University and the University of Missouri-St. Louis. A one group pretest-posttest design was used to study 67 bariatric surgery patients before, and three months after surgery. Six self-report measures were administered and BMI was calculated. Differences in body image and BMI over three months for the entire sample and according to type of surgery (e.g. Roux-en-Y gastric bypass [RYGB] or sleeve gastrectomy [SG]), were examined. The effect of type of bariatric surgery (RYGB or SG) on body image and BMI over three months was also examined.

**Sample**

About 350-400 patients per year are seen at the bariatric surgeon’s practice located at Washington University Center for Advanced Medicine. A convenience sample was recruited from this group. The inclusion criteria for this sample was (a) age 18 or greater, (b) willing to consent to study, (c)
participants who sought bariatric surgery procedures Roux-en-Y gastric bypass, sleeve gastrectomy or laparoscopic adjustable gastric banding. Exclusion criteria for this sample was (a) participants unable to speak and understand the English language, (b) participants unable to stand for approximately ten minutes, and (c) those with a major postoperative complication such as anastomotic leak or stricture, gastric band slippage, gastric band erosion, or port-related problems. The power analysis revealed that 72 participants were needed to achieve a medium effect size with a power of .80 and an alpha value of .05 (Faul, Erdfelder, Buchner, & Lang, 2009).

**Setting**

Sessions with participants were scheduled to occur before or after clinic visits at the Center for Advanced Medicine and the Minimally Invasive Surgery clinic at the West County location.

**Body Image Instruments**

**The Body Attitude Test.** This was used to measure body image concern and global body satisfaction. This is a self-report questionnaire developed for female patients suffering from eating disorders and consists of 20-items that measures subjective body experience and attitude toward one’s body (Probst, Vandereycken, Van Coppenolle, & Vanderlinden, 1995). Psychometric properties have been tested in eating disorders, Weight Watchers, and normal subjects. The instrument consists of three subscales: (a) negative appreciation of body size, (b) lack of familiarity with one’s own body, and (c) general body
dissatisfaction. It is scored on a 6 point scale Likert-type scale: (0) never to (5) always. A sample item is “I’m inclined to hide my body (for example by loose clothing).” Maximum total score is 100. High scorers have more body image concern present. Low scorers have more global body satisfaction. The internal consistency is $\alpha = 0.93$. Test-retest reliability for the three subscales at one week has been established $r = 0.87$ to 0.92 (Probst et al., 1995). The measure took 2.5 to 3 minutes to complete.

**The Body Uneasiness Test Part A.** This is a 34-item instrument that was used to measure body image concern, body image avoidance, and body checking. Psychometric properties have been tested in eating disordered and normal subjects (Cuzzolaro, Vetrone, Marano, & Garfinkel, 2006), as well as obese patients with Class I, II, and III obesity (Marano et al., 2007). The instrument yields a total score expressed as a combined global severity index (an average rating of all 34 items), and has five subscales (a) weight phobia, (b) body image concerns, (c) avoidance, (d) compulsive self-monitoring, and (e) depersonalization or detachment feelings toward the body. All subscales were used. The weight phobia, body image concern, and body depersonalization or detachment feelings toward the body subscales measured body image concern. The body image avoidance subscale measured body image avoidance, and the compulsive self-monitoring subscale measured body checking. Items are rated on a 6-point Likert-type scale ranging from (0) never to (5) always. A sample item is “When I undress, I avoid looking at myself”. Higher ratings indicate greater body uneasiness. The internal consistency range is from $\alpha = 0.79$ to 0.90 for the
five subscales. Test–retest reliability for the five subscales at one week has been established \((r = 0.80\) to \(0.94;\) Cuzzolaro et al., 2006). The measure takes 4 to 6 minutes to complete.

**The Multidimensional Body Self-Relations Questionnaire Appearance Scales (MBSRQ-AS).** This was used to measure Appearance Orientation, global body satisfaction, and body attitude. This instrument has five subscales: Appearance Orientation, Appearance Evaluation, body areas satisfaction, Overweight Preoccupation, and self-classified weight (Cash, 2000). The following three subscales were used: Appearance Orientation to measure Appearance Orientation, Appearance Evaluation to measure global body satisfaction, and overweight preoccupation to measure body attitude. Psychometric properties of the subscales have been tested on a national survey sample of subjects aged 15 to 87 (Brown, Cash & Mikulka, 1990). *The Appearance Orientation subscale* consists of 12 items that measure investment in, and importance of, appearance. A sample item is “I don’t care what people think about my appearance.” High scorers place more importance on how they look. Low scorers are apathetic about their appearance. The internal consistency is \(\alpha = 0.88\) for men and \(\alpha = 0.85\) for women. A one month test-retest reliability for this subscale is \(r = 0.81\) for men and \(r = .91\) for women (Cash, 2000). *The Appearance Evaluation subscale* consists of 7 items that measure satisfaction with one’s looks. A sample item from this subscale is “I like my looks just the way they are.” High scorers are positive and demonstrate more body satisfaction and low scorers have a general unhappiness and demonstrate more body dissatisfaction. The internal
consistency is $\alpha = 0.88$ for both men and women. A one month test-retest reliability for this subscale is $r = 0.81$ for men and $r = 0.91$ for women (Cash, 2000). *The Overweight Preoccupation subscale* consists of 4 items that measures body image concern. A sample item from this subscale is “I constantly worry about being or becoming fat.” The internal consistency is $\alpha = 0.73$ for men and $\alpha = 0.76$ for women. A one month test-retest reliability for this subscale is $r = 0.79$ for men and $r = 0.89$ for women. Responses for the subscales are rated on a 5 point Likert-type scale that assesses level of agreement from (1) definitely disagree to (5) definitely agree. The measure takes 3 to 5 minutes to complete.

**The Body Checking Questionnaire.** This was used to measure body checking. This instrument consists of 23-items that assess the desire to lose weight, body dissatisfaction, and feelings of low self-esteem associated with body weight and shape. Psychometric properties have been tested in college students (Reas et al., 2002) and obese subjects with binge eating disorder (Reas, White, & Grilo, 2006). The instrument consists of three subscales (a) overall appearance, (b) specific body parts, and (c) idiosyncratic checking. Items are rated on a 5-point Likert-type scale ranging from (1) never to (5) very often. A sample item is “I check my reflection in glass doors or car windows to see how I look.” Higher scores reflect higher frequency of body checking behavior. Possible scores range from 23-115 (Reas et al., 2006). A total score was used in this study. The internal consistency range is from $\alpha = 0.83$ to 0.92 for the three subscales. Test-retest reliability at 7 to 21 days has been established $r = 0.94$ (Reas et al., 2002). The measure takes 3 to 5 minutes to complete.
The Pictorial Body Image Assessment. This was used to assess global body satisfaction (Song et al., 2006). This 13-point scale is a modified version of the Stunkard Silhouette Figure Rating Scale representing a wider spectrum of silhouettes (Stunkard et al., 1983). Figures in the scale were tailored to represent a wider spectrum of larger body shapes. These figures represent a spectrum of appearance from (1) underweight to (13) severely overweight. Seven silhouettes are on a scale ranging from underweight (BMI < 19) to the severely obese (BMI > 50). Between each silhouette there is an additional line on the scale representing a point between silhouettes. Participants are asked to choose the point representative of (a) their pre-weight loss appearance, (b) the point representing their current appearance, and (c) the point representing their ideal appearance. In order to assess the degree a person’s pre-weight loss appearance shape differs from their current shape, a discrepancy score is calculated by subtracting pre-weight loss appearance shape from their current shape. This score reflects body image dissatisfaction. The larger the discrepancy between the current and ideal ratings, the greater the body image dissatisfaction an individual is thought to experience. Concurrent validity for the Stunkard scale is $r = 0.99$. The test re-test correlation coefficients for ideal figure $r = 0.71$ for females, $r = 0.82$ for males; how you think you look $r = 0.89$ for females, 0.92 for males; how you feel most of the time $r = 0.83$ for females, $r = 0.81$ for males (Thompson & Altabe, 1990).

The Topographic Device. This was used to measure perceived body space. This device was originally designed by Schlachter (1971) and was
modified by Fawcett (1977). The modified version consists of a 5 foot square covered with concentric circles ranging from 11-54 inches in diameter. Each circle is one inch larger in diameter than the preceding one and is identified with a 2-digit random number unrelated to size or distance. Participants were asked to position self in center circle. They were then asked to imagine they were encased in a transparent cylinder whose base was one of the circles. The participant was asked to identify the circle that represented the space their body occupied. The random number code was converted to inches to obtain the measurement of perceived body space. The correlation coefficients for the modified Topographic Device in a sample of young adults were 0.89 for a three hour test-retest and 0.74 for a one-week period (Fawcett, 1977).

**Demographic Questionnaire**

Participants were asked to answer a set of demographic questions including age, gender, racial/ethnic background, marital status, occupation, highest grade completed in school, and age of onset of weight problem.

**Anthropometric Measurements**

**Weight.** This measure determines how heavy a person is. Weight was measured in pounds with the digital Detecto Bariatric scale. This device has a sturdy steel platform that can support participants who weigh up to 1000 pounds. The scale has a skid-proof and soft black rubber mat. It has stainless steel handrails with padded grips for those who are unsteady on their feet. Calibration of the scale takes place at least quarterly (Detecto, 2014)
**Height.** Standing height is an assessment of maximum vertical size. Height was measured using a Seca wall mounted stadiometer. Participants were asked to remove all hair barrettes, jewelry, buns, or braids from the top of the head. They were asked to stand up straight against the backboard with the body weight evenly distributed and both feet flat on the platform. Each participant stood with heels together and toes apart. Toes pointed slightly outward at approximately a 60° angle. Data collector checked that the back of the head, shoulder blades, buttocks, and heels made contact with the backboard. Data collector assured that participant aligned head in the Frankfort horizontal plane and perpendicular to the vertical backboard. The data collector assured that the participant was looking straight ahead, with shoulders relaxed, arms at sides, legs straight, and knees together. As the stadiometer head piece was lowered and resting firmly on the top of participant’s head, the participant was asked to take a deep breath, and to hold this position. The act of taking a deep breath helps straighten the spine for consistent and reproducible stature measurement (NHANES, 2013). Height was taken to the nearest 1/8 inch.

**Body mass index (BMI).** BMI was calculated using the formula weight in pounds/height in inches $^2 \times 703$.

**Percent excess body mass index loss (%EBMIL).** Percent excess body mass index loss was calculated using the formula (beginning BMI – follow-up BMI)/ (beginning BMI – 25) X 100 (ASBS, 2005).

**Waist circumference.** A perimeter that provides an estimate of body girth at the level of the abdomen is known as waist circumference. This provides
information about body shape (Klein et al., 2007). Waist circumference was measured using a fiberglass tape measure that did not stretch. The participant was asked to gather his or her shirt above the waist, cross the arms, and place the hands on opposite shoulders. They were asked to lower their pants and underclothing too slightly below the waist as needed. The measurement site was marked by standing on the participant’s right side. The right hip area was palpated to locate the ilium of the pelvis. A cosmetic pencil was used to draw a horizontal line just above the uppermost lateral border of the right ilium. This mark was crossed at the midaxillary line. This same process was used to mark the left hip accordingly. The measuring tape was positioned in a horizontal plane at the level of the measurement mark. The data collector assured the tape sat parallel to the floor and snug, but not compressing the skin. Measurement was taken three times and recorded to the nearest one fourth inch. Measurement was taken on bare skin at the end of expiration (NHANES, 2013). The reproducibility of waist circumference is high at all anatomic sites (Klein et al.). The intraobserver intraclass correlation coefficient for waist circumference is 0.987 and the interobserver intraclass correlation coefficient is 0.988 (Chen, Lear, Gao, Frohlich, & Birmingham, 2001).

**Neck circumference.** This is a measure of upper body subcutaneous adipose tissue distribution. Neck circumference was measured using a fiberglass tape measure in the midway of the neck between the mid-cervical spine and the mid-anterior neck. The measure was taken three times and recorded to the nearest 1/4 inch. It was taken in a plane as horizontal as possible, at a point just
below the thyroid cartilage. The thyroid cartilage is located at the level of the fourth and fifth cervical vertebrae. The thyroid cartilage was palpated by having participant raise their chin up and back and placing a finger on the center of chin and tracing down the neck (Muscolino, 2009). The first lump is the thyroid notch or prominence. When taking the measurement, participants were asked to stand erect with their head in the Frankfort horizontal plane (when the horizontal line from ear canal to the lower border of the orbit of the eye is parallel to the floor), shoulders down, and not hunched. Care was taken not to involve the shoulder or neck muscles in the measurement. The inter-observer reproducibility for neck circumference ranges from 0.928 (Adamus et al., 2011) to 0.961 (Kouchi et al., 1999). Intraclass correlation coefficient in one study was 0.832 (Adamus et al.). Correlations for neck circumference with waist circumference, weight, and BMI are high (Ben-Noun et al., 2001; Onat et al., 2009; Preis et al., 2010). Neck circumference correlates with waist circumference (r = 0.78) for women and (r = 0.75) for men. Neck circumference correlates with BMI (r = 0.80) for women and (r = 0.79) for men (p < 0.0001; Preis et al.).

**Data Collection Procedure**

**Recruitment.** A convenience sample of participants who met the eligibility criteria were recruited by the data collector from the bariatric outpatient clinics at Washington University and West County. Participants were sought at both outpatient clinics on three Mondays and one Friday per month. These visits took place two-three months prior to surgery. Participants were also sought at the preoperative teaching sessions held each Tuesday or Wednesday at the Center
for Advanced Medicine. These teaching sessions took place two-three weeks prior to surgery. Flyers were posted at both clinics and handed out by clinic staff to potential participants. Interested patients called the data collector. Recruitment continued until 87 patients consented to participate.

**Data Collection.** One data collector (a graduate student) collected all study data. Two sessions took place with participants: one session prior to bariatric surgery, and one session three months following bariatric surgery. The following was recorded: type and date of preoperative visit, type and date of surgery, and date of post-operative visit.

Participants were informed regarding the study purpose, protocol, and eligibility criteria. Sometimes the protocol was presented in a group setting at the clinic preoperatively, while at other times, potential participants were spoken to in a private exam room. Some participants had questions after the group meeting, and these were answered in a private exam room. Informed consent was obtained from each participant following review of the study purpose and protocol in a private exam room. Participants were given a copy of the signed consent form and the researcher’s phone number to call with questions about the study.

At the clinic visit, and before seeing the surgeon, participants were taken to an exam room where the data collector described the study protocol and obtained consent. Weight and height was completed first. Weight was taken and recorded to the nearest 0.2 pounds. The patient was informed of their weight. Height was taken and recorded to the nearest 1/8 inch. This was followed by neck and waist circumference; each measure was taken three times, averaged,
and recorded to the nearest 1/4 inch. The Topographic body image measure was administered next. Following this, the data collector administered the pen and pencil body image measures. Lastly, the participant was asked to complete the demographic sheet. The study visit took approximately 30 minutes. The data collector called to reschedule a session when a participant did not keep an appointment. The participant was asked if they wished to continue in the study. Three separate attempts were made at different days and times in an effort to reach participants.

**Protection of Human Subjects**

Approval for this research was obtained from the Washington University Human Subjects Committee. The study had no foreseeable physical risks. A non-physical risk was being uncomfortable or self-conscious by questions relating to one’s body. Informed consent was obtained from each participant following review of purpose and study protocol in a private exam room. Participants were given written information and the number of researcher to call with questions regarding protocol. Participants were reminded throughout the study that their participation was voluntary and that they could decide if they no longer wished to be part of the study. They were informed that they could decide not to answer any question that made them feel uncomfortable on any of the questionnaires. They were also informed that they could decline neck or waist circumference and choose not to stand on the laminated paper (Topographic) at either of the two sessions.
Each participant was assigned a code number that was used to safeguard their information. These code numbers were placed on the questionnaires, anthropometric data, and demographic collection forms. The data collector was in possession of the signed consent forms, questionnaires, anthropometric data, and demographic collection forms until they were placed in a double-locked office at Washington University. Only the research team members had access to participant information. A list of patients screened and those enrolled were kept on an encrypted flash drive that was stored in a double-locked office at Washington University. A second encrypted flash drive was used to store only coded data and this was transported and stored in a double-locked office.

Participants were paid $30 for completion of instruments preoperatively and $50 for completion of instruments postoperatively.

**Data Analysis**

Data were analyzed using the statistical software program SPSS 22.0. For research questions 1, 2, 6, and 7 descriptive statistics was used to describe body image and anthropometric measurements of adults before and 3 months after surgery. Descriptive statistics was used to describe body image and anthropometric measurements according to the 3 types of bariatric surgery before and 3 months following surgery. For research questions 3, 4, 6, and 7 a repeated measures T-test was used to compare body image and anthropometric measurements before and three months after surgery and according to the two types of surgery. For research question 5 a Pearson’s Product Correlation was run to assess the relationship between change in BMI and the change in body image.
image concepts over three months. For research questions 8 and 9, a two-way ANOVA was used to determine if there was a difference in the change in body image and anthropometric measurements over 3 months between the two types of bariatric surgery (gastric bypass or sleeve gastrectomy).

A Cronbach’s alpha was used to determine internal consistency for each instrument used in the study. Correlations between measures were completed to make decisions regarding the measures that were kept for inferential statistical analysis. Those measures with a > .70 or greater on total score or subscale score, or with a low Cronbach’s alpha, were not incorporated in the inferential statistical analysis.
CHAPTER 4

Introduction

This chapter presents the findings of the study. Included here are a description of the overall sample; how missing data were handled; information about body image instruments used in the analysis; argument for use of the measures included in the analysis; results; and summary of results. The specific findings related to each research question are also presented.

Description of the Overall Sample

Eighty-seven bariatric surgery patients were initially recruited to participate in the study. Of those recruited, four did not schedule surgery, two had surgical complications and were excluded, one excluded herself due to poor weight loss, two died (unrelated to surgery), and six were lost to follow-up. Seventy-two of the participants recruited completed the study protocol. Five outliers were dropped from the study because postoperative visits were later than required. This decision was based on box plot analysis. Therefore, the overall sample consisted of a total of 67 participants that had one of the three bariatric surgeries RYGB, SG, or LAGB.

The overall sample ranged in age from 24 to 71 years with a mean age of 48.8 years (SD = 11.4). Seventy-six percent were women and 24% were men. The majority of the participants were Caucasian (70.1%). Participants were (28.4%) African-American and (1.5%) Hispanic. Most participants were married (66.7%), had an Associate’s or some college (52.2%), and were employed (73%). Participant mean age when the weight problem was first noticed was 21.1
years (SD = 12.3). Participant mean weight was 307.0 pounds (SD = 71.2) with a minimum weight of 185.6 pounds and a maximum weight of 573.8 pounds. Mean neck circumference was 16.6 inches (SD = 1.9) and mean waist circumference was 54.2 inches (SD = 7.0). Demographics and clinical variables are presented for the entire group and by surgery (see Table 8).

**Missing Data**

Sporadic missing data points were noted on pre and post body image measures. Based on personal communication with instruments’ authors, the allowable number of instrument items per subscale was determined to obtain a valid calculation of score. Only those cases were included within the scoring that had the acceptable number of items.

**Argument for Use of the Body Image Measures Included in the Analysis**

Fourteen measures of body image were used in this bariatric surgery study. Many were found to be intercorrelated. Based on a consultation with a statistician, decisions had to be made as to which measures should be included in the inferential statistical analysis. If correlations between subscales or correlations between total scores were ≥ 0.70, the measure was excluded from the analysis (see bold in Table 9). Internal consistency of each measure was also taken into consideration during this process. The MBSRQ-Overweight Preoccupation Subscale with an internal consistency of $\alpha = 0.47$ was excluded from the analysis (see bold in Table 9). A total of six body image measures were kept for data analysis (see Table 10). These measures were the Body Attitude Test (BAT), The Multidimensional Body Self-Relations Questionnaire (MBSRQ-
AS) Appearance Evaluation subscale (AE), the Body Checking Questionnaire (BCQ), the Topographic Device, and the Pictorial Body Image Assessment (PBIA) and the Multidimensional Body Self-Relations Questionnaire (MBSRQ-AS) Appearance Orientation (AO) subscale.

**Argument for Use of the Anthropometric Measures Included in the Analysis**

The anthropometric measures (weight, body mass index, neck circumference, and waist circumference) were highly intercorrelated. Therefore, body mass index was the measure that was included in the statistical analysis.

Percent excess body mass index loss (%EBMIL) was calculated and described using the formula (beginning BMI - follow-up BMI)/ (beginning BMI – 25) X 100 (ASMBS, 2005). This measure is an index, the percentage of BMI units a participant has lost from baseline to the three month follow-up, relative to a BMI of 25.

**Information about Body Image Instruments Used in the Analysis**

The Body Attitude Test (BAT) measures attitude toward one’s body. Lower scores indicate improved body image. In the current study, reliability of the BAT total score was $\alpha = 0.89$. The Multidimensional Body Self-Relations Questionnaire-AS (MBSRQ-AS) Appearance Evaluation (AE) subscale is a measure of body attitude and an indication of how satisfied a participant is with their body. Higher scores indicate improved body image. In the current study, reliability of the AE subscale was $\alpha = 0.79$. The Body Checking Questionnaire (BCQ) measures body checking. Lower scores reflect a lower frequency of body checking behavior, indicating improved body image. In the current study,
reliability of the BCQ was $\alpha = 0.92$. The Topographic Device measures perceived body space. Lower scores indicate that a participant feels that their body takes up less space, therefore reflecting improved body image. The Pictorial Body Image Assessment (PBIA) measures perceived body size. Lower scores indicate that a participant feels their body has been reduced in size reflecting improved body image. The MBSRQ-AS Appearance Orientation (AO) subscale measures the extent of investment in one’s appearance. High scorers place more importance on how they look, pay attention to their appearance, and engage in extensive grooming behaviors, indicating improved body image. In the current study, reliability of the AO subscale was $\alpha = 0.84$.

**Results**

**Research Question 1: What is the body image of bariatric surgery patients at baseline and three months following surgery in the overall sample?**

Descriptive statistics was utilized to determine body image in bariatric surgery patients at baseline and three months following surgery in the overall sample. The means and standard deviations are presented in Table 11.

**Research Question 2: What are the anthropometric measurements (BMI, %EBMIL) in bariatric surgery patients at baseline and three months following surgery in the overall sample?**

Descriptive statistics was utilized to determine the body mass index and %EBMIL (post measure only), at baseline and three months following bariatric surgery in the overall sample (see Table 11). The body mass index was 50.3
kg/m² (SD = 9.2) at baseline and 42.6 kg/m² (SD = 8.3) after three months. The %EBMIL was 32.8% at three months.

**Research Question 3: Is there a difference in body image in bariatric surgery patients over three months in the overall sample?**

Using a paired sample t-test, mean differences in body image were compared before and after bariatric surgery in the overall sample (see Table 11). Significant improvement (p = .001) in body image (body attitude, appearance evaluation, perceived body space, and perceived body size) was found over three months.

**Research Question 4: Is there a difference in anthropometric measurements in bariatric surgery patients over three months in the overall sample?**

Using a paired sample t-test, mean difference in BMI was compared before and after bariatric surgery in the overall sample (see Table 11). A significant (p = .001) reduction in BMI was found over three months.

**Research Question 5: What is the correlation between the change in anthropometric measurements and the change in body image in adult bariatric surgery patients over a three month period?**

Using a Pearson’s Product Correlation, the relationship between mean change in BMI and the mean change in body image over three months in the overall sample is presented (see Table 12). Only one correlation between BMI and body image was statistically significant. Specifically, a significant negative
low correlation was found between BMI and body checking ($r = -0.290, p < .05$), reflecting that participants with a lower BMI had increased body checking.

**Research Question 6: What is the body image of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?**

Using a paired sample t-test, mean differences in body image at baseline and three months following surgery according to type of bariatric surgery is presented (see Table 13). Body attitude decreased significantly ($t = 5.14, p < 0.001$) in the RYGB group and the SG group ($t = 6.59, p < 0.001$). Specifically body attitude, appearance evaluation, perceived body space, and perceived body size were improved, and this pattern was parallel within the RYGB and within the SG groups.

**Research Question 7: What are the anthropometric measurements (BMI, %EBMIL) of bariatric surgery patients over three months, according to type of bariatric surgery (gastric bypass or sleeve gastrectomy)?**

Using a paired sample t-test, mean difference in body mass index at baseline and three months following surgery according to type of bariatric surgery is presented (see Table 13). Body mass index decreased significantly ($t = 20.37, p < 0.001$) within the RYGB group and ($t = 21.39, p < 0.001$) within the SG group. The %EBMIL over three months was 33.6% for the RYGB and 33.7% for the SG.
Research Question 8: Is there a difference in the change in body image over three months between the two surgeries (gastric bypass or sleeve gastrectomy)?

A two-way, between-group ANOVA was performed to explore the effect of bariatric surgery on body image (see Table 14). Participants were divided into two groups based on type of bariatric surgery (RYGB or SG). There were no statistically significant differences in body image between the groups over three months.

Research Question 9: Is there a difference in the change in anthropometric measure (BMI) over three months between the two surgeries (gastric bypass and sleeve gastrectomy)?

A two-way, between-group ANOVA was performed to explore the effect of bariatric surgery on BMI (see Table 14). Participants were divided into two groups based on type of bariatric surgery (RYGB or SG). There was no statistically significant difference in BMI between the groups over three months.

Summary of the Results

The current study was conducted with predominately Caucasian female bariatric surgery patients from the Midwest. Most participants were married, employed, and had an Associate’s degree or some college. Significant improvements were found in body image (body attitude, appearance evaluation, perceived body space, and perceived body size) and BMI over three months in the overall group, and within each surgery group (RYGB and SG). A low, but significant negative correlation was found between BMI and body checking.
There were no significant differences in body image or BMI between the RYGB and the SG groups over three months. The %EBMIL over three months for the overall group was 32.8%, while the RYGB group was 33.6% and for the SG group it was 33.7%.
CHAPTER 5

Introduction

In this chapter, the summary of the study, results, limitations, implications for the results, rethinking body image, recommendations for future research, and conclusions are presented.

Summary of the Study

Fourteen measures of body image were reduced to six, and five anthropometric measures were reduced to one, BMI, for inferential statistical analysis. Reducing the number of measures was a decision made based on a consultation with a statistician, and after discovering intercorrelations between measures. Percent excess body mass index loss was kept and described over three months, in the total sample and by surgery. The term overall will be used to include the three bariatric surgeries (RYGB, SG, and LB).

This study examined the differences in body image and BMI before and three months after surgery; as well as the relationship between the mean change in BMI and the mean change in body image over three months. The current study examined differences in body image and BMI over three months within two bariatric surgery groups (RYGB or SG) and between each bariatric surgery group (RYGB or SG). Lastly, the current study described %EBMIL at three months for the overall sample, and for the RYGB and SG surgery groups.
Results

Demographic and Clinical Variables at Baseline

Most participants in the current study were White (70%) and employed (73%). The mean age when participants first discovered a weight problem was 21.1 years. The majority of participants were female, underscoring the importance of including males in further research on body image. Past studies have included predominantly females (Buser et al., 2009; Kinzl et al., 2011; Pecori et al., 2007; Rosenberger et al., 2006; Teufel et al., 2012; van Hout., 2008).

Overall mean participant weight at baseline in the current study was 307.0 pounds with a mean BMI of 50.30 kg/m$^2$, indicating super obesity. The current study reflects a wide range of BMI’s. The minimum BMI was 36.6 kg/m$^2$, indicating Class II obesity, or serious obesity. The maximum BMI was 78.1 kg/m$^2$, indicating super-super obesity. In contrast, some researchers perform surgery on much lower BMI’s. For example, Schauer et al. (2012) reported a mean RYGB BMI at baseline of 37.0 kg/m$^2$, Ikramuddin et al. (2013) reported a mean RYGB BMI at baseline of 34.9 kg/m$^2$, Himpens et al. (2010) reported a mean SG BMI at baseline of 39.9 kg/m$^2$, and Dixon et al. (2008) reported a mean LB BMI at baseline of 37.0 kg/m$^2$. Lower BMI’s may have been used to provide beneficial effects such as lowered blood glucose and the reversal of diabetes, thereby reducing the likelihood of comorbidities and complications.
Body Image

No randomized clinical trials examining body image in the bariatric surgery literature were found. No quantitative work was found in the literature as early as three months postoperative. Most studies are quasi-experimental, and examine patients six to twenty-four months following surgery. Only one cross-sectional study was found that examined body image in bariatric surgery patients across all three procedures (RYGB, SG, and LB; de Zwaan et al., 2014).

**Body Attitude Test (BAT).** A significant (p < .001) reduction in the mean BAT total score, indicating improved body image, was noted in the overall sample and within each surgery. Mean BAT total score in the current study was 60.0 (SD = 17.65) at baseline and 45.81 (SD = 16.36) at three months overall. Van Hout et al. (2008) studied body image over two years in a sample of bariatric surgery patients following vertical banded gastroplasty, similar to the LB procedure used in the current study. They found a significant (p < .001) reduction in the BAT total score after six months. Mean BAT scores in their study were 64.0 (SD = 15.4) at baseline and 36.9 (SD = 15.6) after six months. No significant improvement was noted between six months and one year, or one year and two years. No study in the literature examined body image in bariatric surgery patients within each surgery group RYGB or the SG using the BAT.

**MBSRQ-AS (Appearance Evaluation) Subscale.** A significant (p < .001) increase in the mean MBSRQ-AS (AE) subscale score was noted overall and within the two surgery group in the current study, indicating improved body image. Mean MBSRQ-AS (AE) in the current study was 1.23 (SD = 0.76) at
baseline and 1.73 (SD = 0.85) in the overall sample after three months. De Zwaan et al. (2014), using a cross-sectional design, found a significant (p < .001) increase in MBSRQ-AS (AE) in an overall sample of bariatric surgery patients undergoing RYGB, SG, and LB at twelve months. The mean MBSRQ-AS (AE) score was 1.46 (SD = 0.47) at baseline and 2.47 (SD = 0.80) at twelve months.

Dixon et al. (2002) used a pretest-posttest design to examine differences between groups over time. They found a significant (p < .001) increase in the MBSRQ-AS (AE) in LB patients over twelve months, and this level of improvement remained over four years. The mean MBSRQ-AS (AE) score in the study was 1.63 (SD = 0.6) at baseline and 2.63 (SD = 0.80) at one year. Neven et al. (2002) used a cross-sectional design in a small sample of RYGB patients to examine effects of RYGB on perceived body image at three weeks, six months, and one year following surgery. They found a significant (p < .001) increase in the MBSRQ-AS (AE) subscale after six months and after twelve months.

**Body Checking Questionnaire.** While the BCQ has been used in obese men and women with binge eating disorder (Reas et al., 2006), the current study is the first of its kind to use the BCQ in the bariatric surgery population. The current study found a significant, negative low correlation between mean change in BMI and mean change in body checking.

**Topographic Device.** Mean participant score on the Topographic Device in the current study was 21.78 (SD = 4.52) at baseline and 18.64 (SD = 3.93) at three months, indicating participants felt their bodies took up less space. The Topographic Device has not been used in the obese population; however
researchers have used it in pregnant women (Fawcett, 1977). The mean topographic score was 24.04 (SD = 7.0) at nine months of pregnancy and 16.16 (SD = 5.17) at the second month postpartum (Fawcett, 1977). Schlachter (1971) reported mean scores on the Topographic Device in young nonobese female adults as 12.47 (SD = 13.18). No study in the literature examined body image in bariatric surgery patients with the use of the Topographic Device.

**Pictorial Body Image Assessment (PBIA).** Significant (p < .001) decrease in mean scores on the PBIA was noted in the current study, indicating participants felt a reduction in their body size. Mean participant score on the PBIA was 9.19 (SD = 4.10) at baseline and 6.78 (SD = 1.93) in the overall sample at three months. No researcher has incorporated the use of the PBIA in the study of bariatric surgery patients at three months.

Although the current study was done using the PBIA, other research has examined bariatric surgery patients with use of a similar instrument, the Silhouette Figure Rating Scale (Stunkard et al., 1983). Munoz et al. (2010) found a significant (p < .001) decrease in perceived body size one year following RYGB. The mean perceived baseline body size was 8.12 (SD 1.19) and 5.78 (SD = 1.69) at one year follow-up, indicating that participants felt a reduction in body size at one year. Ratcliff et al. (2012) found a significant (p < .001) reduction in the current body size estimation from baseline to six months in a much smaller sample using the same measure. They also found that the mean perceived body size was 7.93 (SD = 1.1) at baseline and 6.44 (SD = 1.2) at six months. There were no significant differences from six to twelve months.
**MBSRQ-AS (Appearance Orientation) Subscale.** There was no significant difference in the mean score of the MBSRQ-AS (AO) subscale in the current study overall and within each surgery group over three months, indicating participants did not focus more on appearance postoperatively. de Zwaan et al. (2014) found no significant increase in the MBSRQ-AS (AO) overall in a sample of bariatric surgery patients (RYGB, SG, or LB). Dixon et al. 2002 found no significant differences in the mean scores of the MBSRQ-AS (AO) from baseline to twelve months, and this continued over four years.

**Anthropometric Measurements (BMI).** Significant (p < .001) reductions in mean BMI were found in the RYGB group (50.0 kg/m\(^2\) to 42.20 kg/m\(^2\)) and the SG group (50.9 kg/m\(^2\) to 42.23 kg/m\(^2\)) in the current study at three months, indicating an eight point reduction in BMI. Karamanakos et al. (2008) reported similar reductions in BMI (46.6 kg/m\(^2\) to 38.0 kg/m\(^2\)) in the RYGB group and (45.1 kg/m\(^2\) to 36.8 kg/m\(^2\)) in the SG group at three months. However Schauer et al. (2012) reported smaller within group differences in BMI (37.0 kg/m\(^2\) to 31.8 kg/m\(^2\)) in the RYGB group and (36.1 kg/m\(^2\) to 31.3 kg/m\(^2\)) in the SG group at three months.

%EBMIL. Percent Excess Body Mass Index Loss for the current study was 32.8% for the entire group, 33.62% for the RYGB group, and 33.74% for the SG group at three months. In comparison, Yip et al. (2012) reported a slightly higher %EBMIL of 40.6% after three months, and these results were 69% after one year in a sample of RYGB patients. Robert et al. (2015) reported a %EBMIL...
of 66.7% at one year in a group of RYGB patients, while Gehrer et al. (2010) reported a %EBMIL of 65% in a group of SG patients at one year.

**Limitations**

Limitations of the current study include the lack of random sampling and assignment, and the use of self-report measures. The current study initially proposed that three groups of bariatric surgery patients (RYGB, SG, and LB) be compared, however not enough LB participants could be recruited due to a low number of LB surgeries being performed. Generalizability is limited due to the fact that the sample was primarily Caucasian women at one site in the Midwest.

**Implications of the Results**

The current study produced new knowledge related to body image in the three most frequently performed bariatric surgeries in the United States, in the early three month postoperative phase. The current study is the first of its kind to examine the construct of body image in postoperative bariatric surgery patients using the BCQ, the PBIA, and the Topographic Device. Furthermore, a modified version of the original conceptual model emerged from this work, thus establishing groundwork for future body image theory construction in the bariatric surgery patient (see Figure 3).

Body image in the bariatric surgery patient is a multifaceted psychological construct that consists of six concepts measured in the current study (see Table 10). Body attitude consists of the dimensions lack of familiarity with one’s own body, negative appreciation of body size, body satisfaction, and body dissatisfaction. Appearance Evaluation is satisfaction or dissatisfaction with one’s
looks. Body checking consists of the dimension over evaluation of weight and shape. Perceived body space is the amount of space an individual perceives their body to occupy and its dimension is body cylinder. Perceived body size is body size estimation and its dimension is a body profile. Appearance Orientation is the extent of investment in one’s appearance, and its dimension is self-focus on one’s appearance or grooming.

Some of the measures used in this study could be developed further. For example, the BAT consisted of items that were difficult for men to interpret. Two items that male participants in the current study struggled with were: “I think my breasts are too large” and “My belly looks as if I’m pregnant”. Future work may include collaborating with the author to revise these items to improve its use in men. Another measure, the MBSRQ-AS Overweight Preoccupation subscale, had a low Cronbach’s alpha \( \alpha = 0.47 \) in the current study and has only four items. Additional work with the instruments’ author could be done to add items to this subscale.

The significant negative correlation between BMI and body checking in the current study indicates that as a patient loses weight body checking increases. Body checking refers to compulsive self-monitoring, or the repeated scrutiny of one’s body parts, body size, shape, and weight. It includes actions such as examining oneself in the mirror, using the fit of clothes to judge whether size has changed, and comparing one’s appearance to other people. Clinically it is not unusual to see these types of behavior in people as rapid weight loss takes
place. Further research must be conducted to determine if this behavior leads to weight regain over time.

**Rethinking Body Image**

The definition of body image at the start of this study was body image is a multifaceted psychological construct, one that forms in our mind as the picture of our own body, or the way the body appears to ourselves; the components of which are body image concern, Appearance Orientation, global body satisfaction, body image avoidance, body checking, perceived body space, and body percept (Ben-Tovim & Walker, 1991; Brown, Cash, & Mikulka 1990; Cash & Pruzinsky, 2002; Collins et al., 1983; Cuzzolaro et al., 2006; Fairburn et al., 3003; Reas et al., 2002; Schilder, 1950; Schlachter, 1971; Thompson & Van den Berg, 2002).

A new definition of body image in the bariatric surgery patient has been developed following this work. Body image is a multifaceted psychological construct, one that forms in our mind as the picture of our own body, or the way the body appears to ourselves; the components of which are body attitude, appearance evaluation, body checking, perceived body space, perceived body size, Appearance Orientation, and body percept (Ben-Tovim & Walker, 1991; Brown, Cash, & Mikulka 1990; Cash & Pruzinsky, 2002; Collins et al., 1983; Fairburn et al., 3003; Reas et al., 2002; Schilder, 1950; Schlachter, 1971; Thompson & Van den Berg, 2002).

Body percept is defined as the internal visual image of body space and size (Collins, McCabe, & Jupp, 1983). It is important to include the concept of body percept given that qualitative research on bariatric surgery patients reveals
that individuals often consider themselves obese years later, despite massive weight loss. Body percept is operationalized by researchers with the use of computer programs (Gardner & Boice, 2004), 3D video cameras, and adjustable laser light beams (Guardia et al., 2013). These techniques require special training and were too expensive to incorporate into the current study. Only one case study examining body percept in bariatric surgery patients was found in the literature and it included one participant (Guardia et al., 2013).

**Recommendations for Future Research**

Future studies should include more males, and more diverse ethnic groups. Additional data are needed exploring body image, especially in sleeve gastrectomy patients. Future studies should examine body image longitudinally exploring the three most popular bariatric surgeries and the effect of weight gain on body image. A better understanding is needed of the behavior patterns that occur related to a rapid change in weight in this population. Psychometric studies of the most frequently used body image measures are needed in this population, especially the Body Checking Questionnaire. Test-retest reliability studies are needed on the PBIA and Topographic in bariatric surgery patients. The techniques used to examine body percept require further study and comparison to both the PBIA and the Topographic Device.

Future work should include the development of body image measures that contain items examining feelings about loose, hanging, redundant skin, and the resulting dermatologic skin infections that occur following bariatric surgery (Zouridaki et al., 2013).
Conclusions

This study has presented clinically significant results regarding body image and anthropometric measurement in bariatric surgery patients at three months postoperative, and illustrated the process of body image theory construction. Those findings that were statistically significant (p ≤ .05) are summarized below.

The following evidence indicates an improved body image after bariatric surgery:

- Significant decrease in the BAT Total Score (Body Attitude)
- Significant increase in the MBSRQ-AS Appearance Evaluation Subscale (Body Attitude)
- Significant decrease on the Topographic Device (Perceived body space)
- Significant decrease on the PBIA (Perceived body size)

The following evidence indicates a reduction in BMI:

- Significant decrease in BMI three months following surgery compared to before surgery

The following correlational evidence was found:

- Significant negative correlation between the mean change in body mass index and the mean change in the Body Checking Questionnaire (Body Checking)

The following evidence indicates an improved body image within the two surgery groups after bariatric surgery at three months:

- Significant decrease on the BAT total score within the RYGB and the SG
• Significant decrease on the PBIA within the RYGB and the SG
• Significant decrease on the Topographic Device within the RYGB and the SG
• Significant increase on the MBSRQ-AS Appearance Evaluation Subscale within the RYGB and the SG

The following evidence indicates a reduced BMI within the two surgery groups after bariatric surgery at three months:
• Significant decrease in BMI within the RYGB and the SG

The following evidence indicates no significant difference in body image between the two surgery groups after bariatric surgery at three months:
• No significant difference in any of the body image measures between the RYGB and the SG groups

The following evidence indicates no difference in BMI between the two surgery groups after bariatric surgery at three months:
• No significant differences in BMI between the RYGB and the SG groups.

Bariatric surgery provides many physiologic benefits, but patients who undergo the procedure may not realize that the surgery can lead to drastic changes in body image. These reductions in BMI and body image occur so rapidly that patients may have difficulty adjusting to their new shape and size. Furthermore, loose hanging skin can lead patients to loath their bodies over time (Gilmartin, 2012). Measuring body image before and after surgery can help clinicians identify individuals most vulnerable to body image difficulties. Support and counseling can be offered to these individuals, perhaps impacting long-term
weight loss maintenance. Body image not just BMI, should be measured clinically before and three months after bariatric surgery.
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the Brazilian Metabolic Syndrome Study. *Clinical Endocrinology, 78*(6),
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### Definitions of Body Image

<table>
<thead>
<tr>
<th>Definition</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The picture of our own body which we form in our mind, that is to say the way in which the body appears to ourselves”</td>
<td>Schilder (1950)</td>
</tr>
<tr>
<td>“A highly complex egocentric system of attitudes and feelings to one’s body”</td>
<td>Cassell (1964)</td>
</tr>
<tr>
<td>“The body as a psychological experience, and focuses on the individual’s feelings and attitudes toward his own body. The body image is literally an image of his own body which the individual has evolved through experience”</td>
<td>Fisher &amp; Cleveland (1968)</td>
</tr>
<tr>
<td>“The body image is part of our relationship with our surroundings or life space as well as with our inner somatic self.”</td>
<td>Askevold (1975)</td>
</tr>
<tr>
<td>“Our perception of our function, sensation, and mobility. Body image is only part of our true self-concept in combination with our ego identity, (our social self) which includes our moods, social beliefs, values, goals, and other people’s opinion of us, our perception of our physical self shapes what we feel about ourselves as a person. Our body image constantly changes.”</td>
<td>McCloskey (1976)</td>
</tr>
<tr>
<td>“The multifaceted psychological experience of embodiment, especially but not exclusively one’s physical appearance”</td>
<td>Cash (1990)</td>
</tr>
<tr>
<td>“A loose mental representation of body shape, size, and form which is influenced by a variety of historical, cultural and social, individual, and biological factors, which operate over varying time spans”</td>
<td>Slade (1994)</td>
</tr>
<tr>
<td>“One’s perception of current body size”</td>
<td>Flynn &amp; Fitzgibbon (1996)</td>
</tr>
<tr>
<td>“How people think, feel, and behave with regard to their own physical attributes”</td>
<td>Muth &amp; Cash (1997)</td>
</tr>
<tr>
<td>“A subjective evaluation of your outward appearance contrasted with an objective evaluation.”</td>
<td>Thompson et al. (1999)</td>
</tr>
</tbody>
</table>
“A multidimensional psychological construct, which includes perceptual, cognitive, emotional, relational, and behavioral components”

Cash & Pruzinsky (2002)

“A system of perceptions, attitudes, and beliefs pertaining to one’s own body”

Gallagher (2005)

“A person’s perception, thoughts, and feelings about his or her body”

Grogan (2008)
Table 2

*Terms Used for Body Image*

<table>
<thead>
<tr>
<th>Body image term</th>
<th>Definition</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body size perception</td>
<td>“The subjective estimation of total body girth or area.”</td>
<td>Glucksman &amp; Hirsch (1969)</td>
</tr>
<tr>
<td>Perceptual body image</td>
<td>“The accuracy of individuals’ judgment of their size, shape, and weight relative to their actual proportions”</td>
<td>Slade (1994)</td>
</tr>
<tr>
<td>Body image boundary</td>
<td>“How one perceives their body boundaries to be. One may view his body as clearly and sharply bounded, with a high degree of differentiation from non-self-objects, or he may regard his body as lacking demarcation from what is out there”</td>
<td>Fisher (1963)</td>
</tr>
<tr>
<td>Perceptual body size distortion</td>
<td>“Inaccurate judgments of one’s body size”</td>
<td>Gardner &amp; Boice (2004)</td>
</tr>
<tr>
<td>Body ownership</td>
<td>“refers to the feeling that our physical body is our own and part of one psychological self”</td>
<td>Gallagher (2000)</td>
</tr>
<tr>
<td>Body schema</td>
<td>“The body schema is not a visual image. It results from previous postures and movements and possesses information about the last posture. Therefore, it changes constantly. The schema is plastic.”</td>
<td>Head &amp; Holmes (1911)</td>
</tr>
<tr>
<td>Body awareness</td>
<td>“The perception of bodily states, processes, and actions that is presumed to originate from sensory proprioceptive and interoceptive afferents and that an individual has the capacity to be aware of”</td>
<td>Mehling et al. (2009)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
<td>Source</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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<tr>
<td>Body catheisis</td>
<td>“The degree of feeling of satisfaction or dissatisfaction with the various parts or processes of the body”</td>
<td>Secord &amp; Jourard (1953)</td>
</tr>
<tr>
<td>Body image ideal</td>
<td>“One’s desired body size”</td>
<td>Flynn &amp; Fitzgibbon (1996)</td>
</tr>
<tr>
<td>Body esteem</td>
<td>“Self-evaluation of one’s body or appearance”</td>
<td>Mendelson et al. (2001)</td>
</tr>
<tr>
<td>The body self</td>
<td>“Constantly updated by sensations, perceptions, and cognitions which evolve directly from bodily experiences in concrete situations and which reach the consciousness via the organs of senses, via proprioceptors and via the vestibular system. The formation of the body self is based on intentionality and is manifested by the unity between perception and movement. The body self is a construction constituted in the dialogue between the subject and the environment.”</td>
<td>Stelter (1998)</td>
</tr>
<tr>
<td>Body image disturbance</td>
<td>“A persistent report of dissatisfaction, concern, and distress that is related to an aspect of appearance and some degree of impairment in social relations, social activities or occupational functioning”</td>
<td>Thompson et al. (1999)</td>
</tr>
<tr>
<td>Body dysmorphic disorder</td>
<td>“A preoccupation with an imagined defect in physical appearance”</td>
<td>Phillips (1991)</td>
</tr>
<tr>
<td>Body integrity identity disorder</td>
<td>A disorder whereby patients describe “a feeling of alienation and over-completeness for a particular limb, and wish for amputation of a perfectly healthy body part(s)”</td>
<td>van Dijk et al. (2012)</td>
</tr>
<tr>
<td>Instrument/author</td>
<td>Type</td>
<td>Sample</td>
</tr>
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<tr>
<td><strong>The Body Shape</strong></td>
<td>Self-report</td>
<td>GBP</td>
</tr>
<tr>
<td>Questionnaire (BSQ; Cooper, P., Taylor, M., Cooper, Z., &amp; Fairburn, C. 1987)</td>
<td></td>
<td>GBP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>GBP</td>
</tr>
<tr>
<td><strong>Body Attitude Test</strong></td>
<td>Self-report</td>
<td>VBG</td>
</tr>
<tr>
<td>(BAT; Probst et al., 1995)</td>
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</tbody>
</table>
BODY IMAGE AND ANTHROPOMETRIC MEASURES

BAT: all correlations > r = .40
(Probst et al., 1995)

The Multidimensional Body Self-Relations Questionnaire—appearance scales (MBSRQ-AS; Brown et al., 1990)

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Type</th>
<th>Scale</th>
<th>N</th>
<th>IC</th>
<th>TRT</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBSRQ-AS</td>
<td>Self-report</td>
<td>LAGB</td>
<td>n = 322</td>
<td>(AE) IC: α = .88</td>
<td>(AO) IC: α = .84</td>
<td>for females</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(AE) TRT: r = .91</td>
<td>(AO) TRT: r = .90</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(Brown et al., 1990)</td>
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</tbody>
</table>

34-items used to assess body image attitudes. Four subscales: Appearance Evaluation (AE), which measures overall feelings of attractiveness or unattractiveness; Appearance Orientation (AO), which assesses investment in, and importance of, appearance; Body Areas Satisfaction, which measures dissatisfaction with certain body areas and attributes; and Overweight Preoccupation, which assesses weight vigilance and eating restraint. This study used 2 subscales (AO) (12 items) & (AE) (7 items). Responses rated on 5 pt. Likert scale that assesses level of agreement from (1) definitely disagree to (5) definitely agree. High scorers feel positive & satisfied with their appearance. Low scorers are unhappy with their physical appearance.

Dixon et al. (2002)

Body Attitude Questionnaire (BAQ; Ben-Tovim & Walker, 1991)

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Type</th>
<th>Scale</th>
<th>N</th>
<th>IC</th>
<th>TRT</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAQ</td>
<td>Self-report</td>
<td>BPD</td>
<td>n = 30</td>
<td>IC Total: α = .87, Total TRT: r = .83</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TRT's for subscales: Feeling fat: r = .90, body disparagement: r = .76, strength &amp; fit: r = .79, weight &amp; shape: r = .64, attractiveness: r = .65, lower body fatness: r = .91. BAQ feeling fat subscale correlates well with the body dissatisfaction subscale of the EDI: r = .83 p &lt; .01. and the global score from the BSQ: r = .81 (Ben-Tovim &amp; Walker, 1991)</td>
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</tbody>
</table>

44-items used to measure a woman's attitude towards her own body. Six subscales include: 1) feeling fat, 2) body disparagement, 3) strength & fitness, 4) salience of weight & shape, 5) attractiveness 6) lower body fatness. Items rated on a 5 pt. Likert scale that assesses level of agreement from (1) strongly agree to (5) strongly disagree. Nine items are reverse-scored. For subscale totals add corresponding item scores. Scores can range from 44 to 220.

Adami et al. (1999)

Neven et al. (2002)
196

**Body Uneasiness Test (BUT; Cuzzolaro et al., 2006)**

Self-report BPD n=20  
IC WP: α = .85, TRT: r = .92  
BIC: α = .89, TRT: r = .88  
Avoidance: α = .84, TRT: r = .83, CSM: α = .75, TRT: r = .80  
Depersonalization: α = .84, TRT: r = .94, GSI: TRT: r = .90  
TRT for BUT-B subscales:  
r = .68-.92, WP and BIC subscales correlate with the EDI subscales drive for thinness, body dissatisfaction, compulsive monitoring, avoidance, depersonalization (p < .05) (Cuzzolaro et al., 2006). CFA in large obese sample (BMI > 30) confirmed factor structure of both scales (Marano et al., 2007).

**Body Checking Questionnaire (BCQ; Reas et al., 2002)**

Self-report GBP n=260  
IC overall appearance: α = .88, body parts: α = .92  
Idiosyncratic checking: α = .83  
Total TRT: r = .94  
Positive correlation between the BCQ and the BSQ r = .86 (p < .01)  
23-items that assess the desire to lose weight, body dissatisfaction, & feelings of low self-esteem associated with body weight & shape. Three subscales: 1) overall appearance, 2) specific body parts & 3) idiosyncratic checking. Rated on a 5-pt. Likert scale ranging from (1) never to (5) very often. Easy to administer

**Body Image States Scale (BISS; Cash et al., 2002)**

Self-report GBP n =106  
IC: α = .77 for women, α = .72 for men  
TRT: r = .69  
Correlates with the body area satisfaction scale (BASS) of the MBRSQ  
r = .78 p < .001 for women and r = .65 p < for men  
6-items which measure an individuals’ evaluation and affect about their physical appearance at a particular moment in time. Responses based on 9-point bipolar Likert-type scale semantically anchored at each point. Assesses 1) dissatisfaction—satisfaction with overall physical appearance 2) dissatisfaction with weight 3) evaluation of one’s appearance

71-items used to evaluate concern for physical appearance. Results of Part A expressed both in a combined Global severity index (GSI): average rating of all 34 items, and in scores of five subscales: 1) weight phobia (WP), 2) body image concerns (BIC), 3) avoidance, 4) compulsive self-monitoring (CSM), and 5) depersonalization or detachment feelings toward the body (34 items). Part B measures specific worries about particular body parts or functions (37 items). Scores of Part B are arranged into a Positive Symptom Total (BUT-PST, the number of one’s body parts that are disliked) and into a Positive Symptom Distress Index (BUT-PSDI, the strength of one’s body dislike). Items rated on a 6-pt. Likert-type scale ranging from (0) never to (5) always. Higher rates indicate greater body uneasiness.

Grilo et al. (2005)
Pecori et al. (2007)
De Panfilis et al. (2007)
| **Eating Disorders Inventory (EDI; Garner et al., 1983)** | Self-report | BPD n=239 | body dissatisfaction: IC: α = .91, TRT: r = .94 drive for thinness: α = .85, TRT: r = .91, perfectionism: α = .73, TRT: r = .87. Total TRT: r = .94. All items loaded significantly at .40 or above with orthogonal rotation (Welch et al., 1990) |
| **Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994)** | Self-report | GBP n=174 | Global score: IC: α = .90 SC: α = .83, WC: α = .72 (bulimics) (Peterson et al., 2007). TRT: SC: r = .94 WC: r = .92, (college students) (Luce et al., 1999). Validated in bariatric surgical candidates. SC subscale correlated with BSQ r = .80 and WC subscale r = .72 (p < .001) (Hrabosky et al., 2006) |
| **Silhouette Figure Rating Scale (SFRS; Stunkard et al., 1983)** | Figural | GBP n=57 | Concurrent validity: r = .99 Convergent validity: r = .05-.62 TRT for females: Ideal: r = .71, think: r = .89, Feel: r = .83, PM: r = .60, PW: r = .64, OS: r = .55 Figure ratings were transformed into discrepancy measures: feel minus ideal |

and 4) feelings of attractiveness/unattractiveness. Subjects are asked to check the box beside the statement that best describes how they feel right now at this very moment. Higher scores indicate more positive body image reactions to contextual challenges.

91-items used to assess psychological and behavioral traits common in anorexia nervosa & bulimia. Consists of 11 subscales. Common subscales used with bariatric patients: 1) body dissatisfaction (9 items), 2) drive for thinness (7 items), & 3) perfectionism (6 items). Subjects are asked to rate items on a scale from always to never.

(F-I) & think minus ideal (T-I). The (F-I) correlates with the EDI-DT subscale: $r = .54$, and (T-I): $r = .45$ (p< .001). EDI-BD subscale correlates with the (F-I): $r = .60$, (T-I): $r = .62$ (p< .001) (Thompson & Altabe, 1991). This score is calculated by subtracting ideal shape from their current shape. This score is referred to as body image dissatisfaction (BID). This is the score most often utilized in the bariatric literature.

*Note. GBP = gastric bypass surgery BPD= biliopancreatic diversion VBG = vertical banded gastroplasty LAGB = laparoscopic adjustable gastric banding TRT = test-retest reliability IC = internal consistency*
## Table 4

### Body Image Accuracy Techniques

<table>
<thead>
<tr>
<th>Instrument/author</th>
<th>Type</th>
<th>Sample</th>
<th>Reliability and validity</th>
<th>Comments</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topographic Device (Schlachter, 1971)</td>
<td>Self-report</td>
<td>n = 45</td>
<td>TRT: $r = .89$ (3 hours)</td>
<td>7 ft. square covered with concentric circles ranging from 11-72 inches in diameter. Each circle 1 in. larger, with a two digit random number assigned, unrelated to size or distance. Subject asked to position self in center circle &amp; identify circle that represents space body occupies. Subjects were asked to imagine they were encased in a transparent cylinder whose base was one of the circles. The random number code is converted to inches to obtain the measurement of perceived body space.</td>
<td>Schlachter (1971)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>n = 100</td>
<td>TRT: $r = .74 \text{ (1 week)}$ (Fawcett, 1977)</td>
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<td>Morin et al. (2002)</td>
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<td></td>
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<td></td>
<td>Fawcett (1977)</td>
</tr>
<tr>
<td>Image marking method (Askevold, 1975)</td>
<td>Self-report</td>
<td>n = 110 (normal weight females, 55 with bulimia)</td>
<td>TRT: $r = .72-.92$ (Gleghorn, Penner &amp; Powers, &amp; Schulman, 1987)</td>
<td>Subjects asked to draw specific marks on paper attached to wall. They are asked to identify specified body parts while imaging self in mirror (body height, acromio-clavicular joints, narrowest waist width, femoral trochanter bones)</td>
<td>Gleghorn et al. (1987)</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Askevold (1975)</td>
</tr>
<tr>
<td>Method</td>
<td>Self-Report</td>
<td>n</td>
<td>IC: α</td>
<td>TRT: r</td>
<td>Note</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------</td>
<td>-------------</td>
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<td>--------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Adjustable light beam method (Thompson &amp; Spana, 1988)</td>
<td>Self-report</td>
<td>159</td>
<td>.83</td>
<td>.75</td>
<td>With use of overhead projector patient adjusts 4 beams of light to be projected onto an adjacent wall to match his/her own estimation of width of a particular body site. Estimated width of body site is divided by actual width. Resulting ratio is multiplied by 100 to arrive at a percentage estimate of over or underestimation.</td>
</tr>
<tr>
<td>Video camera technique (Collins, 1986)</td>
<td>Self-report</td>
<td>21</td>
<td>.91</td>
<td>.52-.95</td>
<td>Video technique: polaroid picture of patient distorted by video camera provides a range of samples from thin to obese. Patients are asked to change image on TV screen with adjustable dial to match image of their own body. Judgment of body size is expressed in percent over or underestimation.</td>
</tr>
<tr>
<td>Direct measurement of perceived body size with use of wooden movable beams (Dillon, 1962)</td>
<td>Self-report</td>
<td>42</td>
<td>.85-.95</td>
<td></td>
<td>Device directly measures visually perceived body height, width, depth. Wood beams are adjusted by patient with instructions to form a doorway they can just fit thru. Ten sessions occur making for vertical, horizontal, descending and ascending estimations.</td>
</tr>
</tbody>
</table>

Note: IC = Internal consistency, TRT = Test-retest reliability
TABLE 5

**Body Image Concepts, Theoretical and Operational Definitions**

<table>
<thead>
<tr>
<th>Concept</th>
<th>Theoretical definition</th>
<th>Operational definition</th>
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<tbody>
<tr>
<td>Body image concern</td>
<td>Affective distress regarding one’s appearance characterized by preoccupation or over concern about issues related to weight and shape, and evaluation of self-worth largely in terms of weight and shape or the control of weight and shape. Includes emotions such as uneasiness, weight phobia (fear of being or becoming fat), body depersonalization (detachment) and body disparagement (Ben-Tovim &amp; Walker, 1991; Cuzzolaro et al., 2006; Fairburn et al., 2003; Thompson &amp; Van den Berg, 2002).</td>
<td>Body Attitude Test (BAT) Total score (Probst et al., 1995)</td>
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<tr>
<td></td>
<td></td>
<td>Body Uneasiness Test (BUT) Part A: Body image concern subscale, weight phobia subscale, body depersonalization or detachment feelings toward the body subscale, body disparagement subscale (Cuzzolaro et al., 2006)</td>
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<td></td>
<td></td>
<td>The multidimensional body self-relations questionnaire (MBSRQ-AS): Overweight preoccupation subscale (Brown et al., 1990)</td>
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<td>Body Checking Questionnaire (BCQ) Overall Appearance subscale (Reas et al., 2002)</td>
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<tr>
<td>Appearance Orientation</td>
<td>The degree of cognitive importance (salience) of and attention to physical appearance, physical fitness and strength. Cognitive aspects refer to investment in one’s appearance and may be exhibited by extensive grooming behaviors (Brown et al., 1990; Cash 2000; Thompson &amp; Van den Berg, 2002).</td>
<td>The multidimensional body self-relations questionnaire (MBSRQ-AS): Appearance Orientation (AO) subscale (Brown et al., 1990)</td>
</tr>
<tr>
<td>Global body satisfaction</td>
<td>Evaluative thoughts and beliefs about one’s physical body, such as figure, weight, and shape. Refers to overall satisfaction-dissatisfaction with one’s appearance (Brown et al., 1990; Thompson &amp; Van den Berg, 2002).</td>
<td>Body Attitude Test (BAT) Total score (Probst et al., 1995)</td>
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<td>The multidimensional body self-relations questionnaire (MBSRQ-AS): Appearance Evaluation (AE) subscale (Brown et al., 1990)</td>
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<tr>
<td>Measure</td>
<td>Description</td>
<td>Reference(s)</td>
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<tr>
<td>Body image avoidance</td>
<td>“Behavioral avoidance reflective of dissatisfaction with appearance—refers to avoidance of situations or objects due to their elicitation of body image concerns” (Thompson &amp; Van den Berg, 2002, p. 142).</td>
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<tr>
<td>Body checking</td>
<td>Compulsive self-monitoring, idiosyncratic checking or the repeated scrutiny of one’s body parts, body size, shape and weight. Can include personal mannerisms unique or peculiar to an individual. “Examples of this behavior include examining oneself in mirror, using the fit of clothes to judge whether size has changed, comparing one’s appearance to other people, and asking others for reassurance” (Cuzzolaro et al., 2006; Shafran et al., 2007; Reas et al., 2002)</td>
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<tr>
<td>Perceived body space</td>
<td>“The amount of space individuals perceive their bodies to occupy, and indicates perception of the limits of body boundaries” (Schlachter, 1971).</td>
<td>Topographic Device Total score (Schlachter, 1971)</td>
</tr>
<tr>
<td>Body percept</td>
<td>The internal visual image of body shape and size (Collins, 1986)</td>
<td>Video camera technique (Collins, 1986)</td>
</tr>
</tbody>
</table>

Note: MBRSQ-AS (AO), BAT, MBRSQ-AS (AE), PBIA, BUT (Part A), BCQ, and Topographic Device will be used.
# Table 6

## Anthropometric Measures

<table>
<thead>
<tr>
<th>Measure</th>
<th>Use and definition</th>
<th>Rationale for use</th>
<th>Advantages/ disadvantages</th>
<th>Reproducibility/correlation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quetelet’s Index (BMI)</strong></td>
<td>- A measure of weight adjusted for height. - Allows comparison of weight status to that of the general population - Calculated as weight in kilograms divided by the square of height in meters (kg/m²).</td>
<td>- Provides information about body volume and mass. - Surrogate measure of body fatness.</td>
<td>- Advantages: simple, inexpensive, practical, noninvasive - Disadvantages: does not reflect body shape; does not distinguish between excess fat, muscle, or bone mass; age, sex, and ethnicity can influence relationship between BMI and body fat</td>
<td>- Correlates to direct measures of body fat. - Correlation for BMI vs % body fat in black women: r = 0.75, for white women: r = 0.72, for black men: r = 0.63, for white men: r = .58 (p &lt; 0.001) - Correlates with WC: r = 0.80 - 0.95 - ICC: 0.99 in overweight</td>
<td>(Centers for Disease Control and Prevention, 2013; Ford, Mokdad, &amp; Giles, 2003; Gallagher et al., 1996; Klein et al., 2007; Nordhamn et al., 2000; Prentice &amp; Jebb, 2001)</td>
</tr>
<tr>
<td><strong>Percent Excess Weight Loss</strong></td>
<td>- A measure that indicates the percentage of excess weight that a person has lost or gained relative to 1983 Metropolitan Height &amp; Weight Tables for a person of medium frame</td>
<td>- Used to report weight loss following bariatric surgery</td>
<td>- Advantages: recommended by ASMBS as calculation follow-up following surgery - Disadvantages: % EWL based on outdated weight table, % EWL may vary in the super obese</td>
<td>- %- EWL correlates with % fat mass r = 0.67 (p &lt; 0.001) and WC: r = 0.50 (p &lt; 0.01)</td>
<td>(American Society for Bariatric Surgery Standards Committee, 1997; Carrasco et al., 2007; Júnior, Campos, &amp; Nonino, 2012; Oria et al., 2005)</td>
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<tr>
<td><strong>Mid upper arm circumference</strong></td>
<td>- A measure of the mid non-dominant upper arm circumference at the mid-point between the tip of</td>
<td>- Used to assess nutritional status in individuals - Recommended as an alternative to</td>
<td>- Advantages: easy to measure, less intrusive, does not require expensive equipment, measurement technique easy to learn</td>
<td>- Correlates with BMI in obese nondiabetics: r = 0.52, and obese diabetics: r = 0.66 (p &lt; 0.01) - ICC: 0.98-0.99</td>
<td>(Burden et al., 2005; Haboubi, Kennedy, Sheriff, &amp; Haboubi, 2010; Powell-Tuck &amp; Hennessy, 2003;</td>
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</tbody>
</table>
BODY IMAGE AND ANTHROPOMETRIC MEASURES

Waist circumference

- A perimeter that provides an estimate of body girth at the level of the abdomen
- A marker of abdominal fat mass
- Measured in the midpoint between lowest rib and the iliac crest at end of expiration

Advantages: simple, precision of the measurement is high at any given landmark
- Disadvantages: may be time-consuming, no standardized approach, different anatomical landmarks, as many as five different cut-off values have been published, does not adjust for body stature
- Correlates with subcutaneous and intra-abdominal fat mass
- Intraobserver reliability coefficient = 0.987
- Interobserver correlation coefficient = 0.988
- ICC: 0.996-0.999 for all sites
- ICC in overweight: 0.85

(Alberti et al., 2009; Chen et al., 2001; Klein et al., 2007; Nordhamn et al., 2000; Wang et al., 2003)

Neck circumference

- A measure of central obesity. Measured in the midway of the neck between mid-cervical spine and mid-anterior neck, if palpable below the laryngeal prominence

Advantages: low cost, quick and easy, clothing and respiratory movement do not affect outcome
- Disadvantages: no established guideline for measurement, different positions for measurement, cut-off values to establish overweight and obesity vary among studies
- Correlates with factors of the metabolic syndrome
- Changes in NC in both men and women correlate with changes in: BMI, WC, TC, LDL, TG, and glucose
- Correlates with WC: r = 0.78 for women, r = 0.75 for men.
- Correlates with BMI: r = 0.80 in women, r = 0.79 in men (p < 0.0001)

- Interobserver reliability coefficient = 0.961
- ICC = 0.832

(Adamus et al., 2011; Ben-Noun, Sohar, & Laor, 2001; Ben-Noun & Laor, 2006; Kouchi et al., 1999; Preis et al., 2010; Sjöström, Lissner, & Sjöström, 1997; Stabe et al., 2013; Yang et al., 2010)
<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Correlates with WC: ( r = 0.73 ) in men, ( r = 0.77 ) in women (( p &lt; 0.001 )); WHR: ( r = 0.58 ) in men, ( r = 0.72 ) in women; BMI: ( r = 0.61 - 0.72 ) in both men and women.</th>
<th>Interobserver correlation coefficient = 0.99 (( p &lt; 0.001 ))</th>
<th>ICC in overweight: 0.92 (with legs bent), 0.89 (with legs stretched)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sagittal Abdominal Diameter</td>
<td>A supine measure of abdominal height. Direct reading from Holtain Khan sliding calipers: distance between the subject's back and the front of the abdomen.</td>
<td>-Used to estimate abdominal obesity</td>
<td>-Advantages: high reliability in both lean and obese subjects, supine measures may be more accurate, as subcutaneous fat can overlap abdominal fat when standing</td>
<td>-Correlates with WC: ( r = 0.73 ) in men, ( r = 0.77 ) in women (( p &lt; 0.001 )); WHR: ( r = 0.58 ) in men, ( r = 0.72 ) in women; BMI: ( r = 0.61 - 0.72 ) in both men and women.</td>
<td>-Disadvantages: sliding caliper costly, needs to be standardized and validated, normal thresholds need to be identified</td>
<td>-ICC in overweight: 0.92 (with legs bent), 0.89 (with legs stretched)</td>
<td>(Cornier et al., 2011; Maurovich-Horvat et al., 2007; Mukedden-Peterson et al., 2006; Nordhamn et al., 2000; Sampaio, Simões, Assis, &amp; Ramos, 2007; Zamboni et al., 1998)</td>
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<tr>
<td>Waist-to-hip ratio</td>
<td>A measure obtained by dividing WC by hip circumference (widest area over the buttocks).</td>
<td>-Advantages: preferred measure by some to predict all cause CVD and mortality</td>
<td>-Disadvantages: poses a technical problem in the severely obese, easier to measure and interpret WC rather than both waist and hips</td>
<td>-Correlates to amount of intra-abdominal fat: ( r = 0.75 ) in men, ( r = 0.55 ) in women</td>
<td>-ICC: 0.69 men, 0.78 women</td>
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<td>Rimm et al., 1990; Seidell et al., 1987; Welborn &amp; Dhaliwal, 2007</td>
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<tr>
<td>Waist-to-height ratio also referred to as waist-stature ratio</td>
<td>A measure obtained by dividing WC (in cm) by height (in cm)</td>
<td>-Advantages: cheap and easy to calculate, could be more useful than BMI as an early warning of health risks, indicates risk for both sexes as well as different ethnic groups, same values can be used across all age groups</td>
<td>-Disadvantages: cut off points for increased risk have not been established</td>
<td>-Correlates with BMI: ( r = 0.79 ), WHR: ( r = 0.90 ), (( p &lt; 0.0001 ))</td>
<td>-ICC in overweight: 0.78</td>
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<td>(Ashwell &amp; Hsieh, 2005; Hsieh, &amp; Yoshinaga, 1995)</td>
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</tbody>
</table>
Note: ASMBS = American Society for Metabolic and Bariatric Surgery, BMI = Body mass index, CVD = Cardiovascular disease, NC = Neck circumference, WC = Waist circumference, % EWL = Percent excess weight loss, ICC = Intraclass correlation coefficient, LDL = Low density lipoprotein, SAD = Sagittal abdominal diameter, TG = triglycerides, TC = total cholesterol
Table 7

*Studies Using Anthropometric Measures Following Three Types of Bariatric Surgery*

<table>
<thead>
<tr>
<th>Type of surgery/author</th>
<th>Sample</th>
<th>Weight in kg (mean)</th>
<th>BMI in kg/m² (mean)</th>
<th>%EWL (mean)</th>
<th>Waist circumference in cm (mean)</th>
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<tr>
<td>RYGB randomized</td>
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<tr>
<td>Ikramuddin et al. (2013)</td>
<td>Type 2 diabetics with BMI between 30-39.9 (12 mos)</td>
<td>RYGB: 98.9 73.0 25.8 18</td>
<td>RYGB: 34.9 25.8 -9.1 6.4</td>
<td>RYGB: 68.08%</td>
<td>RYGB: 114 90 -24 16</td>
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<tr>
<td></td>
<td>Lifestyle and medical management with diet, exercise, weight loss, and medication</td>
<td>RYGB: 97.9 90.1 -7.8</td>
<td>Control: 34.3 31.6 -2.7</td>
<td>Control: 9.29%</td>
<td>Control: 113 105 -8</td>
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<td>Mingrone et al. (2012)</td>
<td>Type 2 diabetics with a BMI of ≥ 35 (24 mos)</td>
<td>RYGB: 129.8 84.3 45.5 37.1</td>
<td>RYGB: 44.9 29.3 -15.6 13.1</td>
<td>RYGB: 58.79%</td>
<td>RYGB: 125.4 98.6 -26.8 16.1</td>
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<td>Medical therapy including treatment by a team of doctors, dietician and nurses</td>
<td>RYGB: 136.4 128 -8.4</td>
<td>Control: 45.6 43.1 -2.5</td>
<td>Control: 8.01%</td>
<td>Control: 127 116.3 -10.7</td>
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<tr>
<td>Schauer et al. (2012)</td>
<td>Type 2 diabetics with BMI 27-43 (3, 6, 9, 12 mos)</td>
<td>RYGB: n = 50</td>
<td>Control: n = 41</td>
<td>3 mos</td>
<td>RYGB: 106.7</td>
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<td>RYGB: 37.0</td>
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<td>BGP: p &lt; 0.001</td>
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<td>BGP: p &lt; 0.001</td>
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<td>BGP: p &lt; 0.001</td>
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LSG randomized

<table>
<thead>
<tr>
<th>Schauer et al. (2012)</th>
<th>Type 2 diabetics with BMI 27-43 (12 mos)</th>
<th>LSG: n = 49</th>
<th>Control: n = 41</th>
<th>3 mos</th>
<th>LSG: 100.6</th>
<th>75.5</th>
<th>-25.5</th>
<th>19.7</th>
<th>Control: 104.4</th>
<th>99.0</th>
<th>-5.4</th>
<th>WGP &lt; 0.05</th>
<th>BGP &lt; 0.001</th>
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<td></td>
<td>LSG: 36.1</td>
<td>31.3</td>
<td>-4.8</td>
<td>3.9</td>
<td>Control: 36.3</td>
<td>35.4</td>
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<td>6 mos</td>
<td>LSG: 36.1</td>
<td>28.3</td>
<td>-7.8</td>
<td>6.3</td>
<td>Control: 36.3</td>
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<td>LSG: 36.1</td>
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<td>-8.8</td>
<td>7.0</td>
<td>Control: 36.3</td>
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<td>LSG: 36.1</td>
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<td>-7.8</td>
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<td>Control: 36.3</td>
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BODY IMAGE AND ANTHROPOMETRIC MEASURES

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<tr>
<th></th>
<th>LAGB</th>
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<th>Control</th>
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<tbody>
<tr>
<td><strong>LSG</strong></td>
<td>36.1</td>
<td>27.2</td>
<td>8.9</td>
<td>7.0</td>
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<tr>
<td><strong>BGp</strong></td>
<td>&lt; 0.001</td>
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**LAGB randomized**

**Dixon et al. (2008)**
Conventional Therapy: treatment, follow-up and open access to physician, dietician, nurse, and diabetes educator

Obese adults with Type 2 diabetes diagnosed in the previous 2 years and a BMI >30 and < 40 (24 mos)
LAGB: n = 30
Control: n = 30

\[
\begin{array}{cccc}
\hat{a} & \hat{p} & \text{WGD} & \text{BDG} \\
\text{LAGB:} & 105.6 & 84.6 & -21 & 19.9 \\
\text{Control:} & 105.9 & 104.8 & -1.1 & \text{BGp < 0.001} \\
\end{array}
\]

**O'Brien et al. (2006)**
Nonsurgical group: very low calorie diet, pharmaco-therapy, education and support on eating and exercise

Obese adults BMI 30-35 (6, 12, 18, 24 mos)
LAGB: n = 40
Control: n = 40

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<th>6 mos</th>
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<th>12 mos</th>
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6 mos
LAGB: 57.2%
Control: 57.4%
BGD: 57.4%
BGp = 0.98

12 mos
LAGB: 78.6%
Control: 41.1%
BGD: 37.5%
BGp = p < 0.001

18 mos
LAGB: 83.6%
Control: 29%
BGD: 54.6%
BGp = p < 0.001

24 mos
LAGB: 87.2%
Control: 21.8%
<table>
<thead>
<tr>
<th>Study</th>
<th>Population Characteristics</th>
<th>1.5 mos</th>
<th>7.5 mos</th>
<th>1.5 mos</th>
<th>7.5 mos</th>
<th>1.5 mos</th>
<th>7.5 mos</th>
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</thead>
<tbody>
<tr>
<td>del Genio et al. (2009)</td>
<td>Obese adults with BMI 49.76 ± 5.8 (1.5 mos and 7.5 mos) n = 28</td>
<td>137.6 103.9</td>
<td>137.6 103.9</td>
<td>49.8 37.4</td>
<td>49.8 37.4</td>
<td>141.3 132.5</td>
<td>141.3 132.5</td>
</tr>
<tr>
<td>Kulovitz, Kolkmeyer, Conn, Cohen, &amp; Ferraro (2014) Medical and behavioral treatment including dietary meal plans, counseling, support groups, and medications</td>
<td>Obese adults with BMI &gt; 35 n = 24</td>
<td>126.6 103</td>
<td>120.6 100</td>
<td>46.6 38.1</td>
<td>45.3 37.5</td>
<td>131.2 116</td>
<td>123.7 110.5</td>
</tr>
<tr>
<td>Lima Filho, Ganem, &amp; de Cerqueira (2011)</td>
<td>Obese adults with BMI &gt; 35 (24 mos) n = 42</td>
<td>113.6 75.5</td>
<td>116.3 73.8</td>
<td>40.7 27.2</td>
<td>40.6 27.2</td>
<td>116.3 73.8</td>
<td>116.3 73.8</td>
</tr>
<tr>
<td>Karamanakos et al. (2008)</td>
<td>Obese adults with BMI ≥ 36.8</td>
<td>46.6 41.9</td>
<td>46.6 41.9</td>
<td>46.6 41.9</td>
<td>46.6 41.9</td>
<td>46.6 41.9</td>
<td>46.6 41.9</td>
</tr>
<tr>
<td>Study</td>
<td>Group Description</td>
<td>3 mos</td>
<td>6 mos</td>
<td>12 mos</td>
<td>12 mos</td>
<td>24 mos</td>
<td>3 mos</td>
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<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Sammour et al. (2010)</td>
<td>Obese and super obese adults with a mean preoperative BMI of 50.3 - 140.8 (12 mos)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>LSG: n = 100</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>BMI &lt; 50: 50.3 38.5 -11.8</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>BMI ≥ 50: 140.8 44.3 -96.5</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>WGP = 0.037 for both groups</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fuks et al. (2009)</td>
<td>Obese adults with a BMI &gt; 40 or &gt; 35 with severe comorbidity (12 mos)</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>LSG: n = 135</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LSG: 48.8 39.8 -9.0</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>p &lt; 0.001</td>
<td></td>
<td></td>
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<tr>
<td>Zachariah et al. (2013)</td>
<td>Obese adults with a BMI of 32 and obesity-related comorbidities, or a BMI &gt; 37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>irrespective of comorbidities</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LSG: n = 120</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>LSG: 37.42 25.86 -11.56</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>WGP &lt; 0.001 for both groups</td>
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</tr>
</tbody>
</table>

LSG nonrandomized

WGP < 0.001 for all comparisons

BGp < 0.001 for all comparisons

WGP (1 and 12 mo) = p < 0.001

WGp (BMI < 50 ≥ 50) = not significant
<table>
<thead>
<tr>
<th>Study</th>
<th>Group Details</th>
<th>36 mos</th>
<th>72 mos</th>
<th>72 mos</th>
<th>36 mos</th>
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</thead>
<tbody>
<tr>
<td>Himpens, Dobbeleir, &amp; Peeters (2010)</td>
<td>Obese adults with BMI between 31-57 (36 and 72 mos) LSG: n = 228</td>
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<tr>
<td></td>
<td>LSG: n = 30</td>
<td>39.9</td>
<td>39.9</td>
<td>31.1</td>
<td>39.9</td>
</tr>
<tr>
<td></td>
<td>WGD: ā 26.6 ā -13.3</td>
<td>26.6</td>
<td>31.1</td>
<td>8.8</td>
<td>26.6</td>
</tr>
<tr>
<td></td>
<td>ā p WGD</td>
<td>26.6</td>
<td>31.1</td>
<td>8.8</td>
<td>26.6</td>
</tr>
<tr>
<td></td>
<td>WGD: LSG</td>
<td>26.6</td>
<td>31.1</td>
<td>8.8</td>
<td>26.6</td>
</tr>
<tr>
<td></td>
<td>LSG: 77.5%</td>
<td>77.5%</td>
<td>77.5%</td>
<td>77.5%</td>
<td>77.5%</td>
</tr>
<tr>
<td></td>
<td>BGp &lt; 0.0001 for both groups</td>
<td></td>
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<tr>
<td>Karamanakos et al. (2008)</td>
<td>Obese adults with BMI ≥ 36.8 (1,3,6,12 mos) LSG: n = 16 Control: n = 16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LSG: n = 16</td>
<td>45.1</td>
<td>45.1</td>
<td>36.8</td>
<td>45.1</td>
</tr>
<tr>
<td></td>
<td>WGD: ā 41 ā -4.1</td>
<td>41</td>
<td>41</td>
<td>8.3</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>ā p WGD</td>
<td>41</td>
<td>41</td>
<td>8.3</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>WGD: LSG</td>
<td>41</td>
<td>41</td>
<td>8.3</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>LSG: 18.2%</td>
<td>18.2%</td>
<td>18.2%</td>
<td>18.2%</td>
<td>18.2%</td>
</tr>
<tr>
<td></td>
<td>BGp (1 and 12 mo) ā p &lt; 0.001</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Note:** ADA = American Diabetes Association, RYGB = Roux-en-Y gastric Bypass, LRYGB = Laparoscopic Roux-en-Y gastric Bypass, LSG = Laparoscopic sleeve gastrectomy, LAGB = Laparoscopic adjustable gastric banding, kg = kilograms, BMI = Body mass index, %EWL = Percent excess weight loss, cm = centimeters, ā = before, ā p = after, WGD = within group difference, BGD = between group difference
Table 8
Demographic and Clinical Variables of Bariatric Surgery Patients at Baseline

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (n = 67)</th>
<th>RYGB (n = 35)</th>
<th>SG (n = 28)</th>
<th>LAGB (n = 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean years (SD)</td>
<td>48.8 (11.4)</td>
<td>49.3 (11.1)</td>
<td>47.6 (12.4)</td>
<td>52.2 (6.7)</td>
</tr>
<tr>
<td>Range</td>
<td>24 - 71</td>
<td>30 - 67</td>
<td>24 - 71</td>
<td>43 - 59</td>
</tr>
<tr>
<td>Missing</td>
<td>1 (1%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (24%)</td>
<td>8 (22.9%)</td>
<td>6 (21.4%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Female</td>
<td>51 (76%)</td>
<td>27 (77.1%)</td>
<td>22 (78.6%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>47 (70.1%)</td>
<td>26 (74.3%)</td>
<td>8 (28.6%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>African American</td>
<td>19 (28.4%)</td>
<td>9 (25.7%)</td>
<td>19 (67.9%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1 (1.5%)</td>
<td></td>
<td>1 (3.6%)</td>
<td></td>
</tr>
<tr>
<td>Marital Status, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>10 (15.2%)</td>
<td>5 (14.3%)</td>
<td>5 (17.9%)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>44 (66.7%)</td>
<td>24 (68.6%)</td>
<td>16 (57.1%)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Widowed</td>
<td>1 (1.5%)</td>
<td>1 (2.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced or Separated</td>
<td>11 (16.7%)</td>
<td>5 (14.3%)</td>
<td>6 (21.4%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td></td>
<td></td>
<td>1 (3.6%)</td>
<td></td>
</tr>
<tr>
<td>Education, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than High school</td>
<td>1 (1.5%)</td>
<td>1 (2.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school or GED</td>
<td>9 (13.4%)</td>
<td>6 (17.1%)</td>
<td>3 (10.7%)</td>
<td></td>
</tr>
<tr>
<td>Associate’s or some college</td>
<td>35 (52.2%)</td>
<td>15 (42.9%)</td>
<td>18 (64.3%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>13 (19.4%)</td>
<td>8 (22.9%)</td>
<td>3 (10.7%)</td>
<td>2 (50%)</td>
</tr>
<tr>
<td>Graduate degree</td>
<td>8 (11.9%)</td>
<td>5 (14.3%)</td>
<td>3 (10.7%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>1 (1.5%)</td>
<td></td>
<td>1 (3.6%)</td>
<td></td>
</tr>
<tr>
<td>Employment, n (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>49 (73%)</td>
<td>26 (74.2%)</td>
<td>20 (71.5%)</td>
<td>3 (75%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>2 (3.0%)</td>
<td>1 (2.9%)</td>
<td></td>
<td>1 (25%)</td>
</tr>
<tr>
<td>Retired</td>
<td>5 (7.5%)</td>
<td>3 (8.6%)</td>
<td>2 (7.1%)</td>
<td></td>
</tr>
<tr>
<td>Disabled</td>
<td>6 (9.0%)</td>
<td>4 (11.4%)</td>
<td>2 (7.1%)</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>5 (7.5%)</td>
<td>1 (2.9%)</td>
<td>4 (14.3%)</td>
<td></td>
</tr>
<tr>
<td>Age Weight Problem First Noticed, mean years</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, (SD)</td>
<td>21.1 (12.3)</td>
<td>21.5 (13.4)</td>
<td>20.4 (9.9)</td>
<td>23.0 (18.1)</td>
</tr>
<tr>
<td>Age, range</td>
<td>5-56</td>
<td>5-56</td>
<td>7-40</td>
<td>8-45</td>
</tr>
<tr>
<td>Weight (pounds; SD)</td>
<td>307.0 (71.2)</td>
<td>306.7 (61.2)</td>
<td>310.1 (80.9)</td>
<td>302.6 (55.5)</td>
</tr>
<tr>
<td>Minimum weight (pounds)</td>
<td>185.6</td>
<td>185.6</td>
<td>189.2</td>
<td>259.8</td>
</tr>
<tr>
<td>Maximum weight (pounds)</td>
<td>573.8</td>
<td>463.0</td>
<td>573.8</td>
<td>365.0</td>
</tr>
<tr>
<td>Neck Circumference</td>
<td>16.6 (1.9)</td>
<td>16.4 (1.5)</td>
<td>16.6 (2.2)</td>
<td>18.1 (2.8)</td>
</tr>
<tr>
<td>Waist Circumference</td>
<td>54.2 (7.0)</td>
<td>53.6 (7.1)</td>
<td>55.0 (7.3)</td>
<td>55.0 (6.5)</td>
</tr>
</tbody>
</table>

Note: RYGB = Roux-en-Y gastric bypass, SG = Sleeve gastrectomy, LAGB = Laparoscopic adjustable gastric banding, SD = standard deviation
### Table 9

**Argument for Inclusion or Exclusion of Scales and Subscales in Current Study (n=67)**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Change in Scores in My Study</th>
<th>Correlation with named variable is</th>
<th>Correlation with named variable is</th>
<th>Conceptually Same with Other Measures</th>
<th>Use in the Literature ‡: (+) indicates supports my using it vs. (-) indicates not support my using it</th>
<th>Regarding this Instrument, I plan to:</th>
<th>Cronbach’s Alpha in My Study at Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body Attitude Test (BAT)</strong></td>
<td></td>
<td>None</td>
<td>None</td>
<td>MBSRQ-OWPreOc subscale (body image concern)</td>
<td>+VanHout et al. (2008) found significant improvement in body image in bariatric surgery patients from baseline to 6 months on the BAT total score with large effect sizes.</td>
<td>Include</td>
<td>.89</td>
</tr>
<tr>
<td><strong>BAT (General body dissatisfaction)</strong> subscale</td>
<td>Significant decrease in scores noted</td>
<td>-Negatively with MBSRQ-OWPreOc subscale</td>
<td>-BAT-negative appreciation of body size subscale †</td>
<td>MBSRQ-AE (general body dissatisfaction)</td>
<td>-VanHout et al. (2008) found significant improvement in the General body dissatisfaction subscale from baseline to 6 months.</td>
<td>Exclude †</td>
<td>.87</td>
</tr>
<tr>
<td><strong>BAT (lack of familiarity with one’s own body)</strong> subscale</td>
<td>Significant decrease in scores noted</td>
<td>-BAT General body dissatisfaction</td>
<td>-BAT Negative Appreciation of body size subscale †</td>
<td>-MBSRQ-OWPreOc subscale (body image concern)</td>
<td>-VanHout et al. (2008) found significant improvement in the Lack of familiarity with one’s own body subscale from baseline to 6 months.</td>
<td>Exclude †</td>
<td>.70</td>
</tr>
<tr>
<td>Measure</td>
<td>NS change in scores noted</td>
<td>Significant increase in scores noted</td>
<td>None</td>
<td>BAT-lack of familiarity with one's own body †</td>
<td>None</td>
<td>- VanHout et al. (2008) found significant improvement in the Negative Appreciation of body size subscale from baseline to 6 months. Exclude † .80</td>
<td></td>
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<td>-------------------------------</td>
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</tr>
<tr>
<td><strong>BAT (Neg. appreciation of body size) subscale</strong></td>
<td></td>
<td></td>
<td></td>
<td>-BAT general body dissatisfaction subscale †</td>
<td></td>
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<td></td>
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<tr>
<td><strong>Body Checking Questionnaire (BCQ) Total Score</strong></td>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td>+Cross-sectional study found significant associations between body checking and overvaluation of weight and shape Grilo et al. (2005). Include .92</td>
<td></td>
</tr>
<tr>
<td><strong>MBSRQ-AE (Appearance Evaluation) subscale</strong></td>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td>+Appearance Evaluation (AE) mean scores increased significantly from baseline and remained for 4 years after bariatric surgery (Dixon et al., 2002). Include .79</td>
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</tr>
<tr>
<td><strong>MBSRQ-AO (Appearance Orientation) subscale</strong></td>
<td></td>
<td></td>
<td></td>
<td>None</td>
<td></td>
<td>+Appearance Orientation (AO) did not change at 1-4 years after surgery (Dixon et al., 2002). Include .84</td>
<td></td>
</tr>
<tr>
<td><strong>MBSRQ-OWPreOc (Overweight Preoccupation) subscale</strong></td>
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<td></td>
<td></td>
<td>None</td>
<td></td>
<td>-Significant decrease in scores noted in one cross-sectional study of bariatric surgery patients (de Zwaan et al., 2014) Exclude † .47 †</td>
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</tr>
<tr>
<td>subscales</td>
<td>-MBRSQ-AO</td>
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<td></td>
<td>Topographic Device</td>
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<tr>
<td>BAT total score</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>-BCQ total score</td>
<td>None (perceived body space)</td>
<td></td>
<td></td>
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<tr>
<td>-Negatively with AE</td>
<td>Include</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Pictorial Body Image Assessment</td>
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<td>None</td>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>BAT (general body dissatisfaction)</td>
<td>Include</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Note: ‡There is no published literature at 3 months, † Either measure correlates ≥ .70 with total score or subscale score, or Cronbach’s Alpha was too low, Bold = instruments excluded from analysis
Table 10

*Body Image Measures Kept for Data Analysis, Including: Concepts, Theoretical Definitions, and Dimensions*

<table>
<thead>
<tr>
<th>Concept</th>
<th>Theoretical definition</th>
<th>Body Image Measures Kept For Data Analysis</th>
<th>Dimension Measured</th>
</tr>
</thead>
</table>
| Body Attitude      | Affective distress or worries related to one's appearance characterized by issues related to weight, shape, body size and fatness. Includes emotions such as dissatisfaction, weight phobia (fear of being or becoming fat), body depersonalization (detachment) and body disparagement (Ben-Tovim & Walker, 1991; Brown et al., 1990; Cuzzolaro et al., 2006; Fairburn et al., 2003; Thompson & Van den Berg, 2002). | Body Attitude Test (BAT) Total Score (Probst et al., 1995) | -Lack of Familiarity with One's Own Body
                          |                                                                                                                                                                                                                 |                                           | -Negative Appreciation of Body Size
                          |                                                                                                                                                                                                                 |                                           | -Dissatisfaction
                          |                                                                                                                                                                                                                 |                                           | -Satisfaction                      |
| Body Checking      | Compulsive self-monitoring, idiosyncratic checking or the repeated scrutiny of one's body parts, body size, shape and weight. Can include personal mannerisms unique or peculiar to an individual. “Examples of this behavior include examining oneself in mirror, using the fit of clothes to judge whether size has changed, comparing one's appearance to other people, and asking others for reassurance” (Cuzzolaro et al., 2006; Shafran et al., 2007; Reas et al., 2002) | Body Checking Questionnaire (BCQ) Total Score (Reas et al., 2002) | -Preoccupation with Weight and Shape    |
| Perceived Body Space | “The amount of space individuals perceive their bodies to occupy, and                                                                                                                                               | Topographic Device Total score (Schlachter, 1971)               | -Body Cylinder                         |
Body size estimation or perceived body size (Stunkard, Sorenson, & Schulsinger, 1983)

**Pictorial Body Image Assessment (PBIA; Song et al., 2006)**

**Perceived Body Size**

**Appearance Orientation**

The degree of cognitive importance and attention to physical appearance. Extent of investment in one’s appearance and may be exhibited by extensive grooming behaviors (Brown et al., 1990; Cash, 2000; Thompson & Van den Berg, 2002)

**The Multidimensional Body Self-Relations Questionnaire (MBSRQ-AS)**

**Appearance Orientation Subscale**

**-Self focus on One’s Appearance**

The Multidimensional Body Self-Relations Questionnaire (MBSRQ-AS) Appearance Orientation Subscale
Table 11

Body Image and Anthropometric Measurements Over Three Months in Bariatric Surgery Patients in the Overall Sample

<table>
<thead>
<tr>
<th>Body Image Measures</th>
<th>Baseline (n = 67)</th>
<th>3 Months after Surgery (n = 67)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Attitude Test (BAT) Total Score</td>
<td>60.0 ± 17.65</td>
<td>45.81 ± 16.36</td>
<td>.001</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Evaluation Subscale</td>
<td>1.23 ± 0.76</td>
<td>1.73 ± 0.85</td>
<td>.001</td>
</tr>
<tr>
<td>Body Checking Questionnaire (BCQ)Total Score</td>
<td>24.47 (15.1)</td>
<td>25.01 (16.6)</td>
<td>.718</td>
</tr>
<tr>
<td>Topographic Device</td>
<td>21.78 ± 4.52</td>
<td>18.64 ± 3.91</td>
<td>.001</td>
</tr>
<tr>
<td>Pictorial Body Image Assessment (PBIA)</td>
<td>9.19 ± 4.10</td>
<td>6.78 ± 1.93</td>
<td>.001</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Orientation Subscale</td>
<td>2.62 ± 0.72</td>
<td>2.62 ± 0.66</td>
<td>.882</td>
</tr>
</tbody>
</table>

Anthropometric Measures

<table>
<thead>
<tr>
<th></th>
<th>Baseline (n = 67)</th>
<th>3 Months after Surgery (n = 67)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index (kg/m^2)</td>
<td>50.30 (9.24)</td>
<td>42.64 (8.33)</td>
<td>.001</td>
</tr>
<tr>
<td>Percentage Excess Body Mass Index Loss (%EBMIL)</td>
<td>_____</td>
<td>32.82 (11.2)</td>
<td>_____</td>
</tr>
</tbody>
</table>

Note: Measures reported as mean ± SD, (MBSRQ-AS) = Multidimensional Body-Self Relations Questionnaire Appearance Scale, %EBMIL is a post measure only
### Table 12

*Correlation Between the Change in Body Mass Index and the Change in Body Image Over Three Months*

<table>
<thead>
<tr>
<th>Change</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Image</td>
<td></td>
</tr>
<tr>
<td>Body Attitude Test (BAT) Total Score</td>
<td>.152</td>
</tr>
<tr>
<td><em>(MBSRQ-AS)</em> Appearance Evaluation Subscale</td>
<td>.080</td>
</tr>
<tr>
<td>Body Checking Questionnaire <em>(BCQ)</em> Total Score</td>
<td>-.290*</td>
</tr>
<tr>
<td>Topographic Device</td>
<td>.042</td>
</tr>
<tr>
<td>Pictorial Body Image Assessment (PBIA)</td>
<td>-.041</td>
</tr>
<tr>
<td><em>(MBSRQ-AS)</em> Appearance Orientation Subscale</td>
<td>-.206</td>
</tr>
</tbody>
</table>

**Note:** *Significant at p < 0.05, *(MBSRQ-AS)* = Multidimensional Body-Self Relations Questionnaire Appearance Scale*
Table 13

*Body Image and Anthropometric Measurements Over Three Months According to Type of Bariatric Surgery*

<table>
<thead>
<tr>
<th>Body Image Measures</th>
<th>RYGB Baseline (n = 35)</th>
<th>RYGB 3 Months after Surgery (n = 35)</th>
<th>P-value</th>
<th>SG Baseline (n = 27)</th>
<th>SG 3 Months after Surgery (n = 27)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Attitude Test (BAT) Total Score</td>
<td>58.7 (18.2)</td>
<td>44.9 (17.4)</td>
<td>.001</td>
<td>61.8 (16.5)</td>
<td>46.0 (15.01)</td>
<td>.001</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Evaluation Subscale</td>
<td>1.16 (0.74)</td>
<td>1.67 (0.94)</td>
<td>.001</td>
<td>1.34 (0.80)</td>
<td>1.80 (0.76)</td>
<td>.003</td>
</tr>
<tr>
<td>Body Checking Questionnaire (BCQ) Total Score</td>
<td>23.0 (14.4)</td>
<td>24.5 (17.7)</td>
<td>.458</td>
<td>25.3 (15.0)</td>
<td>25.7 (16.5)</td>
<td>.810</td>
</tr>
<tr>
<td>Topographic Device</td>
<td>21.66 (4.24)</td>
<td>18.26 (3.01)</td>
<td>.001</td>
<td>21.96 (5.13)</td>
<td>18.93 (5.0)</td>
<td>.001</td>
</tr>
<tr>
<td>Pictorial body Image Assessment (PBIA)</td>
<td>8.71 (1.60)</td>
<td>7.06 (2.20)</td>
<td>.001</td>
<td>9.96 (6.05)</td>
<td>6.46 (1.58)</td>
<td>.006</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Orientation Subscale</td>
<td>2.61 (0.83)</td>
<td>2.61 (0.82)</td>
<td>.992</td>
<td>2.60 (0.60)</td>
<td>2.68 (0.57)</td>
<td>.518</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anthropometric Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index (kg/m²)</td>
</tr>
<tr>
<td>% EBMIL</td>
</tr>
</tbody>
</table>

Note: (MBSRQ-AS) = Multidimensional Body-Self Relations Questionnaire Appearance Scale, RYGB = Roux-en-Y Gastric Bypass, SG = Sleeve Gastrectomy, Measures reported as mean ± SD, %EBMIL is a post measure only, Lower scores on the BAT, BCQ, Topographic, and PBIA indicate improved body image, Higher scores on the MBSRQ-AE and MBSRQ-AO indicate improved body image.
Table 14

*Change in Body Image and Anthropometric Measure Over Three Months Between the Two Surgeries*

<table>
<thead>
<tr>
<th>Body Image Measures</th>
<th>RYGB (n = 35)</th>
<th>SG (n = 28)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Attitude Test (BAT) Total Score</td>
<td>-13.83 (15.9)</td>
<td>-15.79 (12.7)</td>
<td>.598</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Evaluation subscale</td>
<td>0.51 (.71)</td>
<td>0.46 (.74)</td>
<td>.782</td>
</tr>
<tr>
<td>Body Checking Questionnaire (BCQ) Total Score</td>
<td>1.6 (12.3)</td>
<td>0.46 (10.1)</td>
<td>.695</td>
</tr>
<tr>
<td>Topographic Device</td>
<td>-3.4 (3.12)</td>
<td>-3.04 (2.90)</td>
<td>.641</td>
</tr>
<tr>
<td>Pictorial Body Image Assessment (PBIA)</td>
<td>-1.66 (1.7)</td>
<td>-3.50 (6.3)</td>
<td>.10</td>
</tr>
<tr>
<td>(MBSRQ-AS) Appearance Orientation subscale</td>
<td>0.05 (.35)</td>
<td>0.01 (.33)</td>
<td>.633</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Anthropometric Measures</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index (kg/m$^2$)</td>
<td>-7.79 (2.3)</td>
<td>-7.85 (1.9)</td>
<td>.909</td>
</tr>
</tbody>
</table>

Note: (MBSRQ-AS) = Multidimensional Body-Self Relations Questionnaire Appearance Scale, RYGB = Roux-en-Y Gastric Bypass, SG = Sleeve Gastrectomy, Measures presented as mean ± S
Appendix B

Figure 2

Model of Body Image in the Bariatric Surgery Patient Before the Study

Body image is a multifaceted psychological construct, one that forms in our mind as the picture of our own body, or the way the body appears to ourselves; the components of which are body image concern, Appearance Orientation, global body satisfaction, body image avoidance, body checking, perceived body space, and body percept (Ben-Tovim & Walker, 1991; Brown, Cash, & Mikulka 1990; Cash & Pruzinsky, 2002; Collins et al., 1983; Cuzzolaro et al., 2006; Fairburn et al., 2003; Reas et al., 2002; Schilder, 1950; Schlachter, 1971; Thompson & Van den Berg, 2002).
Figure 3

Model of Body Image in the Bariatric Surgery Patient After the Study
THE MBSRQ-AS

INSTRUCTIONS—PLEASE READ CAREFULLY

The following pages contain a series of statements about how people might think, feel, or behave. You are asked to indicate the extent to which each statement pertains to you personally.

Your answers to the items in the questionnaire are anonymous, so please do not write your name on any of the materials. In order to complete the questionnaire, read each statement carefully and decide how much it pertains to you personally. Using a scale like the one below, indicate your answer by entering it to the left of the number of the statement.

EXAMPLE:

______ I am usually in a good mood.

In the blank space, enter a 1 if you definitely disagree with the statement; enter a 2 if you mostly disagree; enter a 3 if you neither agree nor disagree; enter a 4 if you mostly agree; or enter a 5 if you definitely agree with the statement.

There are no right or wrong answers. Just give the answer that is most accurate for you. Remember, your responses are confidential, so please be completely honest and answer all items.

(Duplication and use of the MBSRQ-AS only by permission of Thomas F. Cash, Ph.D., Department of Psychology, Old Dominion University, Norfolk, VA 23529)
<table>
<thead>
<tr>
<th></th>
<th>Definitely Disagree</th>
<th>Mostly Disagree</th>
<th>Neither Agree Nor Disagree</th>
<th>Mostly Agree</th>
<th>Definitely Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Before going out in public, I always notice how I look.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I am careful to buy clothes that will make me look my best.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>My body is sexually appealing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I constantly worry about being or becoming fat.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I like my looks just the way they are.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I check my appearance in a mirror whenever I can.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Before going out, I usually spend a lot of time getting ready.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I am very conscious of even small changes in my weight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Most people would consider me good-looking.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>It is important that I always look good.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I use very few grooming products.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>I like the way I look without my clothes on.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>I am self-conscious if my grooming isn't right.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>I usually wear whatever is handy without caring how it looks.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>I like the way my clothes fit me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>I don't care what people think about my appearance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>I take special care with my hair grooming.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>I dislike my physique.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*continued on the next page*
____ 19. I am physically unattractive.

____ 20. I never think about my appearance.

____ 21. I am always trying to improve my physical appearance.

____ 22. I am on a weight-loss diet.

For the remainder of the items use the response scale given with the item, and enter your answer in the space beside the item.

____ 23. I have tried to lose weight by fasting or going on crash diets.

1. Never
2. Rarely
3. Sometimes
4. Often
5. Very Often
Circle the point that represents what you look like right now.
Circle the point that represents what you would ideally like to be.
Circle the point that represents what you looked like before obesity surgery.
**BAT**

Circle the number that best describes how you feel.

<table>
<thead>
<tr>
<th>1. When I compare myself with my peers' bodies, I'm dissatisfied with my own.</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Usually</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. My body appears to be a numb thing.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. My hips seem too broad to me.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. I feel comfortable within my own body.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I have a strong desire to be thinner.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I think my breasts are too large.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. I'm inclined to hide my body (for example by loose clothing).</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. When I look at myself in the mirror, I'm dissatisfied with my own body.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. It's easy for me to relax physically.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I think I'm too thick.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. I feel my body as a burden.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. My body appears as if it's not mine.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. Some parts of my body look swollen.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. My body is a threat for me.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. My bodily appearance is very important to me.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>16. My belly looks as if I'm pregnant.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>17. I feel tense in my body.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>18. I envy others for their physical appearance.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>19. There are things going on in my body that frighten me.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>20. I observe my appearance in the mirror.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
**Mark with an X the answer which best expresses your experience at the moment**

<table>
<thead>
<tr>
<th>BUT</th>
<th>never</th>
<th>seldom</th>
<th>sometimes</th>
<th>often</th>
<th>always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I spend a lot of time in front of the mirror</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2. I don't trust my appearance: I'm afraid it will change suddenly</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3. I like those clothes which hide my body</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. I spend a lot of time thinking about some defects of my physical appearance</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5. When I undress, I avoid looking at myself</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6. I think my life would change significantly if I could correct some of my aesthetic defects</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7. Eating with others causes me anxiety</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8. The thought of some defects of my body torments me so much that it prevents me being with others</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9. I'm terrified of putting on weight</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10. I make detailed comparisons between my appearance and that of others</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11. If I begin to look at myself, I find it difficult to stop</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12. I would do anything to change some parts of my body</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13. I stay at home and avoid others seeing me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>14. I am ashamed of the physical needs of my body</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15. I feel I am laughed at because of my appearance</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16. The thought of some defects of my body torments me so much that it prevents me studying or working</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17. I look in the mirror for an image of myself which satisfies me and I continue to search until I am sure I have found it</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18. I feel I am fatter than others tell me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19. I avoid mirrors</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
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</tr>
<tr>
<td>20. I have the impression that my image is always different</td>
<td>0</td>
<td>1</td>
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<td>3</td>
<td>4</td>
</tr>
<tr>
<td>21. I would like to have a thin and bony body</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>22. I am dissatisfied with my appearance</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>23. My physical appearance is disappointing compared to my ideal image</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>24. I would like to undergo plastic surgery</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>25. I can't stand the idea of living with the appearance I have</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>26. I look at myself in the mirror and have a sensation of unattractiveness and strangeness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>27. I am afraid that my body will change against my will, in a way I don't like</td>
<td>0</td>
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<td>2</td>
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<td>4</td>
</tr>
<tr>
<td>28. I feel detached from my body</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>29. I have the sensation that my body does not belong to me</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>30. The thought of some defects of my body torments me so much that it prevents me having a sexual life</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>31. I observe myself in what I do and ask myself how I seem to others</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>32. I would like to decide what appearance to have</td>
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<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>33. I feel different to how others see me</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>34. I am ashamed of my body</td>
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<td>3</td>
<td>4</td>
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</tbody>
</table>
BCQ

Circle the number which best describes how often you engage in these behaviors at the present time.

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<tr>
<th></th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>23.</td>
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<td></td>
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</tbody>
</table>
Data Form

Thank you for taking the time to complete this survey. Please circle and/or fill in the answer that pertains to you.

<table>
<thead>
<tr>
<th></th>
<th>What is your gender?</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What is your age?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>What is your marital status?</td>
<td>Single</td>
<td>Married</td>
</tr>
<tr>
<td>3</td>
<td>What is your race?</td>
<td>African American</td>
<td>Asian</td>
</tr>
<tr>
<td>4</td>
<td>Hispanic</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>What is your occupation?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>What is the highest grade you completed in school?</td>
<td>Less than high school</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High school or GED</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some college or Associate’s Degree</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 year college degree</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Graduate degree</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>At what age did you first notice a weight problem?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
AMENDED ATTACHMENT A

IRB Authorization Agreement
Between
Washington University
And
University of Missouri - St. Louis
(Protocols Reviewed and Approved by WU IRB)
(Revision Date 6/4/14)

19. myIRB Protocol Number: 201405132
    WU Principal Investigator: J. Chris Eagon, MD, MS
    Department: Surgery-chairman's Cp
    Name of Research Project: Body Image and Anthropometric Measurements in Bariatric Surgery Patients
    Source of Funding: N/A
    Faculty/Agency Sponsor: N/A
    Grant Number: N/A
    Collaborators: The individuals participating in a project are documented in the myIRB approved project for the study.
    WU IRB Registration Numbers: IRB00005594, IRB00009237

UNIVERSITY OF MISSOURI - ST. LOUIS

-Institutional Official Signature-

Nasser Arshadi, Ph.D.
Name (please print)
Vice Provost for Research
Title
ora@umsl.edu / 314-516-5897
E-mail Address/Phone Number

Date: 7/15/14

WASHINGTON UNIVERSITY

-Institutional Official Signature-

Margaret Jones, MA, CRA
Executive Director
Human Research Protection Office
Washington University
jonesm@wumsl.wustl.edu
(314) 632-7455

Date: 9-15-2014

Designee Signature

Designee Name (please print)

Designee Title

Designee E-mail Address/Phone Number

As new projects are added to an agreement, a new signature will be obtained.