PSYCHOLOGICAL CONSTRUCTS, DIETARY CHANGE, AND WEIGHT LOSS IN OLDER WOMEN FOLLOWING A SIX MONTH INTERVENTION

by

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(Under the Direction of Mary Ann Johnson)

ABSTRACT

As evidence amasses for the benefits of intentional weight loss in obese older adults, identifying feasible and appropriate intervention strategies for this population is warranted. This dissertation identifies changes in diet and psychological factors that are related to intentional weight loss in overweight and obese older women following intervention. Two studies were conducted and focused on: 1) identifying dietary changes that occur when older women (65 – 80 y) are counseled to consume an energy-restricted higher protein diet for weight loss, and 2) exploring the relationship of eating behaviors (Three Factor Eating Questionnaire, Stunkard and Messick, 1985) and depressive symptoms (Centers for Epidemiologic Studies Depression Scale, Radloff 1977) with intentional weight loss in overweight and obese older women. Overall, the major findings were that older women were able to make changes in their diet to promote weight loss, including significant reductions in energy and changes in macronutrient intakes. Participants who completed the intervention (n = 61) lost -9.2 ± 4.8% of initial body weight and 42.6% of those who completed the intervention met the weight loss goal of 10% of initial body weight. Compared to participants assigned to the conventional protein diet, those assigned to the higher protein diet consumed more protein, along with similar amounts of total fat, saturated, and

selected micronutrients, but less fiber. Also, measures of cognitive restraint, flexible restraint and rigid restraint, were consistent and independent predictors of percentage weight loss ($P < 0.01$), while other eating behaviors, depressive symptoms, and age were not associated with percentage weight loss. Together, these studies add to our understanding of the feasibility of higher protein diets as strategies for weight loss in community-dwelling older women, and eating behaviors that might be targeted to improve weight loss success.

INDEX WORDS: Obesity, older adults, weight loss, protein, dietary intake, women, beef, eating behaviors, depression, flexible restraint

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DEDICATION

This dissertation is dedicated to the women that participated in the DIVAS Project.

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I would like to acknowledge the many people that have helped me get to this point, particularly Dr. Mary Ann Johnson. I appreciate all that you have done to support me returning to UGA for a PhD, to make this doctoral pursuit meaningful both personally and professionally, and for having confidence in me as I venture into this next stage of my academic career. You are one amazing mentor, and only those who have had the privilege to be guided by you will ever understand the depths of your commitment to your students.

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CHAPTER 1

INTRODUCTION

Obesity prevalence among older adults exceeds 30% and contributes to metabolic diseases, physical disability, and dependence (Ogden et al. 2014, Mathus-Vliegen et al. 2012, Johnson and Bales 2014). Obese older women are at greater risk for obesity-related functional decline than their male counterparts (Fakhouri et al. 2012, Jensen and Friedmann 2002, Johnson 2013, Rejeski et al. 2010). Current position statements regarding weight status in older adults advocate for weight loss to reduce risk for chronic conditions (Villareal et al. 2005). However, little is known about the implementation of such strategies in community-dwelling older women, an understudied group in need of effective interventions. Furthermore, evidence from younger people indicates that weight loss success is highly variable and is influenced by more than diet and exercise (Elfhag and Rossner 2005, Moroshko, Brennan, and O'Brien 2011). Eating behaviors, specifically cognitive restraint, disinhibition, and hunger and depressive symptoms have been related to weight loss in younger people, but little is known about these relationships in older adults (Dykes et al. 2004, Foster et al. 1998, Teixeira et al. 2005). Therefore, this dissertation study aims to 1) explore the changes in diet that occur when older women are counseled to restrict energy and increase protein intake to promote weight loss, and 2) determine whether eating behaviors and depressive symptoms are related to weight loss in this population.

Chapter II is a review of the literature that provides a foundation for this dissertation research. The review emphasizes the demographics of aging, older women as a specific population for public health concern, and obesity and weight loss in older adults. Also reviewed

are psychological constructs (eating behaviors and depressive symptoms) that are related to obesity and weight loss. This dissertation study was conducted within a larger parent project funded, in part, by a grant from the National Cattleman's Beef Association entitled, Effects of a Higher Protein Weight Loss Diet and Exercise on Body Composition, Physical Function, and Fatigue in Overweight Older Women (Principal Investigator: Ellen M. Evans, PhD, Co-investigators: Mary Ann Johnson, Kevin M. McCully, PhD, Patrick J. O'Connor, PhD).

Chapter III is a manuscript to be submitted to a peer-reviewed journal that investigates the changes in diet that occur when older women are counseled to restrict energy and consume higher protein to promote weight loss. Changes in energy, macronutrients, and selected micronutrients are discussed.

Chapter IV is a manuscript to be submitted to a peer-reviewed journal. This chapter focuses on the relationships of psychological constructs, particularly eating behaviors and depression, with weight loss in older women following weight loss intervention. The eating behaviors assessed were cognitive restraint and its exploratory subscales, flexible and rigid restraint, disinhibition, and susceptibility to hunger, and these were measured using the Three Factor Eating Questionnaire developed by Stunkard and Messick (1985). Depressive symptoms were assessed using the Centers for Epidemiologic Studies Depression Scale developed by Radloff and the National Institute of Mental Health (1977).

Chapter V summarizes the findings in Chapters III and IV and provides general conclusions and directions for future research. The primary findings are that older women are able to make changes in their diet to promote weight loss, including energy restriction and consuming more protein. However, the amount of protein currently being suggested by researchers for older adults during intentional weight loss (~30% energy from protein, 1.6 g/kg)

may be more protein than is feasible for many older adults to consume daily and may result in inadequate fiber intake. In addition to changes in diet, eating behaviors, including flexible and rigid restraint, may be important intervention targets for overweight or obese older women trying to lose weight. Thus, interventions to achieve intentional weight loss in older women through energy-restriction and exercise should include counseling from a registered dietitian or other health professional knowledgeable in nutritional needs for older women to ensure nutrient needs, including fiber, are met, and should encourage a more flexible approach to restrained eating behavior.

CHAPTER II

LITERATURE REVIEW

Introduction

The older adult population (≥ 65 y) in the United States is growing rapidly and is expected to reach approximately 72 million, or 20% of the population, by 2030 (Federal Interagency Forum on Aging-Related Statistics 2012). As more middle aged adults enter older age with overweight and obesity (BMI ≥ 25 kg/m^2), the prevalence of obesity (BMI ≥ 30 kg/m^2) is increasing among older adults (Fakhouri et al. 2012). Obesity in older adults is associated with nursing home admission, exacerbation of obesity-related co-morbidities, and functional limitations, and obese older women are at greater risk for obesity-related functional decline than their male counterparts (Fakhouri et al. 2012, Jensen and Friedmann 2002, Johnson and Bales 2014, Rejeski et al. 2010). Evidence is increasingly strong for the benefits of weight loss interventions that combine energy restriction, higher protein, and exercise to preserve lean mass in obese and overweight older adults (Rejeski et al. 2010, Johnson 2013, Vincent, Raiser, and Vincent 2012, McTigue, Hess, and Ziouras 2006). However, as support for these strategies to promote healthy weight loss in obese older people grows, it is important to determine the feasibility of implementing recommendations to consume higher protein during energy restriction in independently living, community-dwelling older adults and how the diet changes when individuals try to adhere to such recommendations. Furthermore, weight loss research in younger people indicates weight loss success is highly variable and not explained by diet and exercise alone. Emerging evidence suggests that psychological constructs, particularly eating

behaviors and depressive symptoms, may be valuable pretreatment predictors of attrition and/or weight loss success in younger people, but little is known about these relationships in older adults (Stubbs et al. 2011, Teixeira et al. 2005, Teixeira et al. 2010, McTigue, Hess, and Ziouras 2006, Moroshko, Brennan, and O'Brien 2011, Warziski et al. 2008). Therefore, the primary purposes of this study are to 1) examine the changes in diet that occur when older women are counseled to consume an energy restricted, higher protein (~30% of energy from protein) or conventional protein diet (~18% of energy), and 2) to determine whether eating behaviors and depressive symptoms are related to dietary adherence and intentional weight loss in overweight and obese older women.

To provide a practical and theoretical foundation for this dissertation research, the following literature review focuses on the demographics of aging, older women as a specific population for public health concern, obesity in older women, assessment of obesity, weight loss in older adults, dietary change during weight loss, psychological constructs (eating behaviors and depressive symptoms) and obesity, and psychological constructs and weight loss.

Older Adults

The older adult population in the United States is increasing rapidly, such that in 2011, 13.3% of the population was aged 65 or older (Federal Interagency Forum on Aging-Related Statistics 2012). The proportion of older adults is expected to continue to grow to approximately 20% in 2030, when the last of the "Baby Boomers" (those born between 1946 and 1964) reach age 65 (Federal Interagency Forum on Aging-Related Statistics 2012). With the aging of the Baby Boom generation, the absolute number of "oldest old" (adults ≥ 85 y) is projected to increase more than 350% from 5.5 million in 2010 to 19 million by 2050 (Federal Interagency Forum on Aging-Related Statistics 2012). The older adult population is also becoming more

racially and ethnically diverse. In 2010, 80% of the older adult population was non-Hispanic white, 9% was black, and 7% was Hispanic (of any race, Federal Interagency Forum on Aging-Related Statistics 2012). In 2050, projections indicate that the older adult population will be 58% non-Hispanic white, 12% black, and 20% Hispanic (Federal Interagency Forum on Aging-Related Statistics 2012).

The growth and diversification of the older adult population will have vast effects, particularly with regard to health care use and cost. Older Americans (≥65 y) use more health care per capita than younger Americans, and the health care costs for the oldest old are nearly twice that of adults aged 65 to 74 y (Federal Interagency Forum on Aging-Related Statistics 2012). In 2013, more black and Hispanic older adults (≥65 y) reported their health as "fair/poor" than did white older adults: black (37.2%), Hispanic (35.6%), white (22.0%, CDC 2015). Furthermore, in 2013, 12.2% of non-Hispanic blacks and 11.5% of Hispanics reported needing assistance with at least one activity of daily living (ADL), compared to only 6.6% of non-Hispanic whites (CDC 2015). Costs also vary by health status, such that older adults with five or more chronic health conditions incurred an average of $24,658 in health care costs while those with no chronic conditions incurred an average of $5,520 annually (Federal Interagency Forum on Aging-Related Statistics 2012). Most older people (80%) have at least one chronic condition, while 50% have two or more (CDC 2011). Considering the concern over the sustainability of Medicare and Social Security, the US economy will certainly face challenges with the changing demographics of aging.

Older Women

Older women are of particular public health concern for a variety of reasons. Women in the US have longer life expectancies than men at age 65 (20.3 y for females and 17.7 y for males,

NCHS 2014), and women comprise more than 55% of the older adult population and more than 65% of the oldest old (Federal Interagency Forum on Aging-Related Statistics 2012). Older women are less likely than older men to live with a spouse (Federal Interagency Forum on Aging-Related Statistics 2012). Older non-Hispanic white and black women were more likely to live alone than Asian or Hispanic older women, and 46% of all women aged 75 and older were living alone in 2011(Federal Interagency Forum on Aging-Related Statistics 2012). Women, especially women over 85 y, report needing more help with ADLs than men of the same age, and needing assistance with ADLs is associated with nursing home admission (CDC 2015). Some studies have indicated that individuals living alone enter nursing home care with fewer limitations in ADLs than do individuals not living alone (Egleston, Rudberg, and Brody 1999). Health care costs for individuals living in long-term care are more than four times that of those living in the community (Federal Interagency Forum on Aging-Related Statistics 2012). Thus, older women, who live longer, are more likely to live alone, and more likely to need help with ADLs, are of particular public health interest (Federal Interagency Forum on Aging-Related Statistics 2012).

Obesity in Older Adults

According to 2011 – 2012 NHANES data, more than two-thirds of US adults are overweight or obese, the prevalence of obesity among adults (≥20 y) was 35.4%, and these numbers are quite similar to those of a decade ago (Ogden et al. 2014). Overweight and obesity in adults are associated with increased risk for numerous diseases and conditions, including, but not limited to, coronary heart disease, type 2 diabetes, breast cancer, colon cancer, hypertension, dyslipidemia, stroke, osteoarthritis, and sleep apnea (NHLBI 1998). The prevalence of most obesity-related medical complications, including diabetes, hypertension, cardiovascular disease,

and osteoarthritis, increases with increasing age (Villareal et al. 2005). Obesity is also associated with increased risk for mortality among adults (Flegal et al. 2013).

As more middle-aged adults enter older adulthood as overweight or obese, the prevalence of overweight and obesity in the older cohorts is increasing (Fakhouri et al. 2012). According to data from 2011 – 2012 NHANES, the prevalence of obesity in older adults (≥60 y) is approximately 35%, and more than two thirds of older adults were overweight or obese in 2010 (Ogden et al. 2013). Obesity prevalence is higher among adults aged 65 – 74 y (40.8%) than adults aged 75 y and older (27.8%, Fakhouri et al. 2012). Obesity prevalence is highest among non-Hispanic black women (aged 65 to 74 y 53.9%, 75 y and over: 49.4%, Fakhouri et al. 2012). In 2009 – 2010, 45% of women aged 65 – 74 y and 30% of women aged 75 and over were obese, while 43% of men aged 65 – 74 y and 27% of men aged 75 y and over were obese (Federal Interagency Forum on Aging-Related Statistics 2012). A recent report of 2011–2012 NHANES data indicates older women may be the only age and gender subgroup to experience an increase in obesity prevalence from 2003—2004 to 2011—2012, 31.5% to 38%, respectively (Ogden et al. 2014).

Among younger adults, the relative risk of mortality increases with increasing BMI (NIH, NHLBI 2000). However, in older adults, the relationship between obesity and mortality is less clear. After approximately age 65 y, the relative risk of mortality associated with increasing BMI diminishes (Johnson and Bales 2014). The absolute mortality risk associated with increasing BMI continues to increase up to age 75 y after which the relationship is unclear (Villareal et al. 2005, Johnson and Bales 2014). Furthermore, in their review, Bales and Buhr (2008) noted that obesity which developed later in life (after age 65 y) is not associated with

increased mortality risk. Therefore, obesity treatment in older adults controversial (Waters, Ward, and Villareal 2013, Bales and Buhr 2008, Johnson and Bales 2014).

Nonetheless, as with younger and middle-aged adults, obesity in older adults exacerbates chronic conditions, such as hypertension, diabetes, cardiovascular disease, osteoarthritis, and metabolic syndrome (Vincent, Raiser, and Vincent 2012, Waters, Ward, and Villareal 2013). Metabolic syndrome is an independent risk factor for type 2 diabetes, cardiovascular disease, and stroke and the prevalence of the metabolic syndrome increases with age reaching a peak in women aged 60 – 80 y and men aged 50 – 70 y (Mathus-Vliegen et al. 2012, Villareal et al. 2005, Jensen et al. 2014). Emerging evidence indicates that metabolic syndrome may also be associated with increased risk for cognitive decline, falls, and mortality in older adults (Mathus-Vliegen et al. 2012, McEvoy et al. 2012).

In addition to increasing the risk for metabolic disease, the risk of functional decline and limitation is a well-established adverse effect of obesity in older adults (Bernstein and Munoz 2012, Mathus-Vliegen et al. 2012, Vincent, Raiser, and Vincent 2012, Vincent, Vincent, and Lamb 2010, Zamboni et al. 2008). Body composition changes occur with normal aging that result in decreased fat free mass (FFM) and increased fat mass (FM), particularly in the abdominal region and within the muscle and liver (Zamboni et al. 2008, Mathus-Vliegen et al. 2012, Vincent, Raiser, and Vincent 2012). Obesity exacerbates these changes resulting in a disproportion of excess body fat, reduced lean mass (muscle and bone), and reduced strength, otherwise known as sarcopenic obesity (Bernstein and Munoz 2012, Vincent, Raiser, and Vincent 2012, Roubenoff 2004, Zamboni et al. 2008), which further increases the risk for functional limitation, frailty, disability, and nursing home admission (Villareal et al. 2005, Villareal et al. 2006). Increased fat deposition in the muscle decreases muscle quality and

performance (Mathus-Vliegen et al. 2012, Zamboni et al. 2008). These changes, in addition to increases in joint dysfunction, arthritis, and reductions in physical activity, increase the risk for functional decline in older adults (Mathus-Vliegen et al. 2012, Villareal 2013, Vincent, Raiser, and Vincent 2012). In a study by Villareal et al. (2004), obese older adults with poor muscle quality that exhibited similar functional status, aerobic capacity, strength and walking speed to non-obese frail elderly (Villareal et al. 2004). Visser et al. (1998) demonstrated that high fat mass at baseline, but not low fat free mass, was a predictor of physical disability 3 y later in older men and women. Moreover, body fatness was independently associated with disability when controlling for sarcopenia in older men and women (Visser et al. 1998). Therefore, sarcopenic obesity is more strongly related to functional decline and disability than obesity or sarcopenia alone (Cesari et al. 2005, Mathus-Vliegen et al. 2012, Visser et al. 1998).

Obese older women are of particular public health concern because women are more strongly impacted by these changes in body composition than their older adult male counterparts (Bernstein and Munoz 2012, Valentine et al. 2009). Greater fat mass is associated with significant decrements in physical function among older women, and women are already at greater risk for physical disability with aging than men, independent of obesity (Valentine et al. 2009, Bernstein and Munoz 2012, Rejeski et al. 2010, Visser et al. 1998). Launer et al. (1994) demonstrated that young-old (60 – 75 y) women with a history of obesity (BMI >27) had a two-fold greater risk for physical disability than young-old women with a history of normal weight. In addition, evidence is emerging that adiposity is more strongly associated with not only physical, but also mental fatigue in older women compared to older men (Valentine et al. 2009).

Although a milieu of adverse effects of obesity have been documented in older adults, some research indicates obesity provides protection against mortality in older adults (Bales and

Buhr 2008, Johnson and Bales 2014). As unintentional weight loss is associated with increased mortality in older adults (Bernstein and Munoz 2012, Mathus-Vliegen et al. 2012), adipose stores may be beneficial in protecting against wasting in end stage diseases, such as congestive heart failure, chronic obstructive pulmonary disease (COPD), some cancers, and end stage renal disease (Bales and Buhr 2008, Bernstein and Munoz 2012, Mathus-Vliegen et al. 2012). Furthermore, evidence indicates that in the event of a fall, fat may be protective against hip fracture, but the optimal amount of fat is unknown (Mathus-Vliegen et al. 2012, Bales and Buhr 2008). Thus, debates over the optimal BMI and controversy over weight loss in older people ensues (Johnson and Bales 2014).

Assessment of Obesity in Older Adults

Body mass index (BMI), which relates body weight to stature, is commonly used to assess adiposity and monitor change in body weight in community and clinical practice (Bales and Buhr 2008, Shah and Braverman 2012). BMI is calculated as weight in kg / (height in m^2) [weight in pounds/(height in squared inches) x 703] and is therefore a fairly simple measure to obtain with few resources (Shah and Braverman 2012, NHLBI 2000). BMI is significantly correlated with total body fat percentage in young and middle-aged persons, but the BMI calculation does not consider distribution of body fat or body composition changes which are common with aging and can influence risk for disease and disability (NHLBI 2000, Kyle et al. 2001). As aging is associated with increases in total fat mass, a redistribution of fat, and decreases in height due to kyphosis (Bales and Buhr 2008), other measurements of adiposity in addition to BMI may improve identification and evaluation of obesity in older adults (Bales and Buhr 2008, Shah and Braverman 2012). Results from a study by Shah and Braverman (2012) indicated that 39% of all older adults, and 48% of female older adults, were misclassified as non-

obese by BMI, when they were obese according to body fat percentages obtained from DXA and as defined by the American Society of Bariatric Physicians (ASBP), an American Medical Association (AMA) specialty board (≥ 25% for men, ≥ 30% for women) (Shah and Braverman 2012). Further, misclassification of women increased with age such that 59% of women aged 70 y and older were misclassified as non-obese by BMI when body fat percentage obtained from DXA classified them as obese (Shah and Braverman 2012). Therefore, BMI alone may not be the best measure for classifying older adults as overweight or obese and further, for assessing adiposity-associated risk status, particularly in women (Shah and Braverman 2012). Nonetheless, BMI remains relevant as one measure for assessing obesity due to its ease of assessment in community settings.

The 2013 *Guidelines for the Management of Overweight and Obesity in Adults* (2013) issued through a collaboration between the American College of Cardiology (ACC), and the American Heart Association (AHA), and The Obesity Society (TOS) recommend that physicians and other health practitioners use BMI to assess overweight and obesity in adults annually. However, these guidelines recommend using waist circumference (WC) in addition to BMI to assess overall health risk in all adults (Jensen et al. 2014). Waist circumference is positively correlated with abdominal fat and is an independent risk factor for chronic and metabolic disease (NHLBI 2000,Villareal et al. 2005). Women and men with a waist circumference greater than 35 in (88 cm) and 40 in (102 cm), respectively, are at greater risk for a number of diseases, including heart disease, type 2 diabetes, and some cancers (Jensen et al. 2014, NHLBI 1998) even if their BMI classification is in the normal weight category. WC above these thresholds is also associated with increased risks of functional limitation and physical disability and increased risk for mortality in older adults (Bernstein and Munoz 2012). Data from Arden et al. (2004)

indicate that a single WC cutoff may be inadequate for predicting disease risk across BMI. Furthermore, Arden et al. (2004) suggest that WC cut-offs associated with increased disease risk are greater for older adults than younger adults. Due to age-related changes in body composition, a combination of measurements, both WC and BMI, is preferred for assessing risk in older adults rather than BMI alone (Bernstein and Munoz 2012).

When available, dual X-ray absorptiometry (DXA) is a useful method for assessing body composition (Salamone et al. 2000, Toombs et al. 2012). Although DXA was initially designed for the purpose of assessing areal bone mineral density, the increased availability, limited participant burden when compared to other methods of body composition (under-water weighing, computed tomography, magnetic resonance imaging), low radiation dose, and recent improvements in the quality of images produced, have made it a popular research tool for the measurements of bone mineral content and bone free lean mass, and the estimation of body composition, including fat mass (Toombs et al. 2012). Recent technological advances have improved the precision of DXA, in particular the GE Lunar iDXA, such that it is widely used for the measurement of body composition for cross-sectional analyses and also for monitoring changes in body composition, such as that which would occur with weight loss treatment (Salamone et al. 2000, Toombs et al. 2012) Current research concludes that DXA is a valid measure for assessing body composition in older adults (Toombs et al. 2012, Salamone et al. 2000, Snijder et al. 2002), and emerging evidence indicates DXA may be an acceptable measure and alternative to computed tomography (CT) for assessing visceral fat in older adults (Snijder et al. 2002). Nonetheless, some researchers still caution against the use of DXA for estimating fat mass, as it has not been validated against direct measurement of fat mass in human cadavers (Clasey et al. 1997, Toombs et al. 2012).

Obesity Classifications

Adiposity can be assessed using a variety of methods including, but not limited to, CT, magnetic resonance imaging, DXA, bioelectrical impedance analysis, hydrostatic weighing, and air displacement plethysmography (Santesso et al. 2012). In the absence of such sophisticated measurements, and thus, in most clinical and community settings, BMI and WC are recommended for assessing obesity due to their practicality of use (NHLBI 2000, Jensen et al. 2014). The 2013 AHA/ACC/TOS *Guidelines* recommend classifying obesity according to BMI using the following categories for all adults, regardless of gender or age: underweight (BMI <18.5), normal (BMI 18.5 – 24.9), overweight (BMI 25.0 – 29.9), obese (BMI ≥ 30). Obesity is then further classified into obesity class I (BMI 30 – 34.9), obesity class II (BMI 35 – 39.9) and obesity class III or extreme obesity (BMI ≥ 40Jensen et al. 2014). The relative risk for disease is generally greater in the overweight and obese categories, and this risk varies by individual (NHLBI 2000, Jensen et al. 2014). The 2013 AHA/ACC/TOS *Guidelines* recommend using WC cut-offs of >35 inches (88 cm) for women and >40 inches (102 cm) for men to assess abdominal obesity and risk for disease independent of BMI, such that an individual in the normal BMI category can be classified as high risk if he/she has a WC greater than the aforementioned cut-off values (Jensen et al. 2014). Arden et al. (2004) proposed varying WC thresholds within the BMI categories and demonstrated improved specificity and sensitivity to risk for coronary events in men and women. However, as these thresholds have not been sufficiently validated, the proposed study will employ the guidelines recommended by the AHA/ACC/TOS *Guidelines* for assessing obesity and defining risk categories using BMI and WC (Jensen et al. 2014).

Weight Loss in Older Adults

Weight loss for obesity treatment in older adults remains controversial (Bernstein and Munoz 2012, Houston, Nicklas, and Zizza 2009, Waters, Ward, and Villareal 2013), primarily because unintentional weight loss in older adults is associated with increased mortality risk (Bernstein and Munoz 2012, Houston et al. 2009, Mathus-Vliegen et al. 2012). Current treatment guidelines for obesity in older adults reflect the scientific debate that exists over the appropriateness of weight loss for older people (Jensen et al. 2014, Villareal et al. 2005). The recently released AHA/ACC/TOS *Guideline*s (Jensen et al. 2014) do not include a recommendation regarding treatment of obesity in older adults due to what they note as insufficient evidence on the benefits of weight loss in this population. The AHA/ACC/TOS Guidelines do, however, note that aging demographics call for more research in the area of weight loss for older adults (Jensen et al. 2014). Therefore, practitioners must still rely on the joint position statement issued by the American Society for Nutrition (ASN) and the Obesity Society (TOS, formerly NAASO) issued in 2005 that recommends weight loss for obese older persons with functional impairments and/or medical complications that can benefit from weight loss (Villareal et al. 2005). Evidence is increasingly strong, however, for the benefits of intentional weight loss in obese older adults, and a number of research groups with expertise in gerontology have published excellent reviews of the evidence (Bernstein and Munoz 2012, Mathus-Vliegen et al. 2012, Felix and West 2013, Vincent, Raiser, and Vincent 2012, Waters, Ward, and Villareal 2013).

Recent reviews and the ASN/TOS (2005) position statement indicate that intentional weight loss in obese older adults is associated with improved glycemic control, reduction in inflammatory markers (e.g., C-reactive protein, IL-6), improved physical function, reduced joint

pain, and improved cardiovascular endpoints (cardiovascular events, blood pressure control, hypertensive medication use) (Bales and Buhr 2008, Mathus-Vliegen et al. 2012, McTigue, Hess, and Ziouras 2006, Villarealet al. 2005, Waters, Ward, and Villareal 2013). In the Diabetes Prevention Program, every kilogram of weight lost reduced the incidence of diabetes by 16% over a period of 3.2 y in adults aged 65-80 y (Mathus-Vliegen et al. 2012). In the Arthritis, Diet, and Activity Promotion Trial (ADAPT), obese older adults who lost weight via energy restriction only or a combination of energy restriction and physical activity reported improved pain scores (6-30%) and improvements in physical function (Mathus-Vliegen et al. 2012, Messier et al. 2004).

A primary concern cited by individuals who oppose weight loss in older people is the loss of lean mass that occurs with any loss of body weight (intentional or unintentional) and the potential for this loss to exacerbate the natural declines in fat free mass that are observed with aging (sarcopenia) (Houston, Nicklas, and Zizza 2009, Vincent, Raiser, and Vincent 2012, Weinheimer, Sands, and Campbell 2010). A number of studies have recently assessed the relationships between changes in lean body mass and changes in weight among older adults (Beavers et al. 2014, Mojtahedi et al. 2011a). In their review, Weinheimer et al. (2010) note that weight lost during energy restriction without exercise was approximately 25% fat free mass (FFM), but estimate that when exercise was added, the loss was only 11%. One of the largest observational studies to assess these relationships is the Dynamics of Health, Aging, and Body Composition (Health ABC) funded by the National Institute on Aging and is currently ongoing. Several longitudinal analyses of this data confirm reductions in lean mass with weight loss (Lee et al. 2010, Murphy et al. 2014, Newman et al. 2005). Concern lies in the potential for these changes in body composition to exacerbate sarcopenic obesity, which occurs when the

proportion of fat mass increases greatly relative to the decline in fat free mass (Vincent, Raiser, and Vincent 2012). While this concern is warranted, more research is needed on the clinical significance of the declines in fat free mass.

One way to explore clinical significance of changes in body composition is to evaluate changes in physical function. Intuitively, if fat free mass is declining at a rate which is cause for concern, then physical function should also decline. Results from previous observational studies of weight loss in older adults have yielded mixed results with regard to changes in physical function. Jensen and Friedmann (2002) reported that weight loss of 10 pounds was associated with functional decline. However, weight gain of 20 pounds or more was also associated with functional decline. This study did not indicate whether weight change was unintentional or intentional. Similarly, Launer et al. (1994) reported that at 5 year follow-up, women who were older (mean age 76 years at baseline and 80 y at follow-up) that had lost 5% or more of their initial body weight had an increased risk for functional decline and disability than their weight stable counterparts. However, it was not discernable whether weight loss was intentional or not, and this relationship was not discernable in the younger women (mean age 60 y at baseline and 65 y at follow-up, Launer et al. 1994).

Studies of intentional weight loss in obese older adults, however, consistently indicate improvements in physical function (Villareal et al. 2011, Avila et al. 2010, Rejeski et al. 2011, Messier et al. 2013). In a study by Villareal et al. (2011), obese older adults with mild-to-moderate frailty improved physical performance, aerobic capacity (peak oxygen consumption), and functional status in diet-only, exercise-only, and diet plus exercise intervention groups compared to controls. While all three groups in the Villareal study alleviated some markers of frailty, the combination of diet and exercise for weight loss resulted in the best outcomes

(Villareal et al. 2011). In their review, Weinheimer et al. (2010) note that weight lost during energy restriction without exercise was approximately 25% fat free mass (FFM), but estimate that when exercise was added, the loss was only 11%.

Miller et al. (2006) analyzed relationships between changes in body weight and composition and changes in distance walked during six minutes. For all participants combined ($n = 68$), there was a significant association ($P < 0.001$) between the change in physical function as measured by 6-minute walk distance and the change in body weight (kg) ($r = -0.528$). Similarly, there was a significant association ($P < 0.01$) between change in physical function as measured by the stair climb time (sec) ($r = 0.332$) and the change in body weight (kg) ($r = 0.332$). These relationships indicate that as body weight decreased, physical function improved for both outcome measures. Interestingly, there was a significant association between a change in fat free mass (kg) and physical function as measured by 6 min walk, such that 6 min walk distance increased with a decrease in fat free mass ($r = -0.343$, $P < 0.01$). This relationship, however, was not observed with the stair climb task. These changes indicate that although fat free mass (kg) may be lost during weight loss in older adults, the clinical significance may be minimal if physical function improves.

Additional reviews by Vincent et al. (2012), Mathus-Vliegan et al. (2012), Felix and West (2013), and Waters et al. (2013) resonated similar results and thus, provided support for the older ASN/TOS position statement (2005) to recommend weight loss that minimizes the loss of muscle and bone for obese older adults to improve functional status and obesity associated medical complications. These reviews indicate that behavioral interventions incorporating dietary counseling and exercise (aerobic and resistance/muscle strengthening) are effective in producing modest weight loss in older adults with few adverse events (Vincent, Raiser, and

Vincent 2012, Felix and West 2013, McTigue, Hess, and Ziouras 2006, Waters, Ward, and Villareal 2013, Mathus-Vliegen et al. 2012).

Higher Protein Diets, Weight Loss, and Older Adults

Researchers are increasingly investigating the potential for higher protein diets (>1.0 g/kg body weight/d) to attenuate loss of lean mass in older adults due to both normal aging and during intentional weight loss (Mathus-Vliegen et al. 2012, Paddon-Jones et al. 2008, Mojtahedi et al. 2011, Waters, Ward, and Villareal 2013). The Academy of Nutrition and Dietetics currently endorses IOM's Recommended Dietary Allowance of 0.8 g/kg body weight daily for older adults noting that nitrogen balance studies support this recommendation (Bernstein and Munoz 2012, IOM 2005). The Academy also notes, however, that the role of dietary protein in the prevention of sarcopenia remains unclear, some older adults may have difficulty consuming the recommended amount of protein, and that recent data indicates protein intake declines with advancing age (Bernstein and Munoz 2012). A longitudinal study by Houston et al. (2008) demonstrated older adults (70–79 y) in the highest quintile of protein intake lost approximately 40% less lean mass over 3 y compared to those in the lowest quintile of protein intake. Thus, the Academy notes that intakes moderately above the current 0.8 g/kg/d recommendation are safe and may be beneficial for all older adults as one strategy to attenuate sarcopenia (Bernstein and Munoz 2012).

Evidence is increasingly strong for recommending protein above the RDA for older adults engaged in a weight loss intervention (Felix and West 2013, Mathus-Vliegen et al. 2012, Mojtahedi et al. 2011a, Waters, Ward, and Villareal 2013, Paddon-Jones et al. 2008). Evidence from middle-aged adults indicates that higher protein intakes (~1.2–1.6 g/kg/d, or ~30% energy from protein) during weight loss are associated with attenuation of lean mass loss and

improvement in cardiovascular disease risk factors (e.g., triglycerides, LDL cholesterol, total cholesterol) and glycemic control (Lasker, Evans, and Layman 2008, Layman et al. 2009, Noakes et al. 2005, Wycherley et al. 2012). In a study of overweight or obese post-menopausal women (n = 31, mean age ± SD: 65.2 ± 4.6 y), higher protein intake (1.20 ± 0.14 g/kg/d protein) compared with moderate protein (0.86 ± 0.20 g/kg/d protein) was associated with greater weight loss following intervention (-8.0% ± 6.2%, -4.1% ± 2.6%, P = 0.059), and significant ($P < 0.05$) improvement in physical function as measured by up and go, transfer test, and balance (Mojtahedi et al. 2011a).

Further investigation is warranted to investigate the role of increased dietary protein, timing of dietary protein, and increased intake of specific amino acids, such as leucine, with weight loss and attenuation of lean mass loss in older adults (Casperson et al. 2012, Layman et al. 2009, Mathus-Vliegen et al. 2012). Nevertheless, recent reviews by Felix and West (2013), Mathus-Vliegan et al. (2012), and the Academy of Nutrition and Dietetics Position Paper by Bernstein and Munoz (2012) recommend considering increased protein (~1.2–1.6 g/kg/d, or ~30% energy from protein) during energy restriction for older adults with adequate renal function who are engaging in intentional weight loss.

As evidence builds for higher protein weight loss diets for older adults, it is important to explore whether such recommendations can be reasonably achieved by older adults who live independently in the community procuring and preparing their own food, and what changes in the diet occur to accommodate higher protein intake during energy restriction in these individuals. Much of the evidence for increasing dietary protein is from controlled feeding trials and intervention studies where protein or protein-containing food was supplied by the research team in either food or supplement form (Mojtahedi et al. 2011, Paddon-Jones et al. 2008,

Campbell et al. 2001). A recent analysis of NHANES 2005–2006 data indicates mean protein intake in community-dwelling older men and women (≥ 51 y) is 15 to 16% of energy and 0.8 to 1.1 g/kg of body weight (Berner et al. 2013), which is much lower than what is provided experimentally or currently being investigated for older adults involved in intentional weight loss (1.2 – 1.6 g/kg or up to 30% energy from protein, Felix and West 2013, Bernstein and Munoz 2012). Given that many women fail to meet the RDA for protein, and some even fail to meet the more conservative EAR for protein 0.6 g/kg, high intakes of protein suggested by these intervention studies are likely a departure from normal dietary patterns for older women (Berner et al. 2013). Therefore, the ability of community-dwelling older women to achieve such high intakes of protein without food or supplements provided by the research teams is unknown.

Given concern over reductions in lean mass that occur with weight loss of any type (intentional or unintentional) it will be important to note whether important nutrients involved in bone health, such as calcium and vitamin D are consumed in sufficient quantities during energy restriction with higher protein. Additionally, as animal products are good sources of high quality protein, but can also be higher in saturated fat, it is important to determine whether older women consuming an energy restricted diet that is higher in protein can meet individual and public health recommendations for limiting saturated fat intake (<10% energy from saturated fat, USDA and USDHHS 2010). Thus, there is much to be learned from interventions involving community-dwelling older women asked to consume an energy restricted diet that is higher in protein to promote weight loss and attenuate the loss of lean mass, particularly when that protein is not provided to the participants by the research team.

Psychological Constructs and Weight Loss

Although behavioral weight loss interventions that involve energy-restriction, macronutrient distributions within acceptable ranges such as those defined by the Institutes of Medicine in the Dietary Reference Intakes (IOM 2005) and discussed in the previous sections, and exercise have sound empirical support, predicting which individuals will be successful in achieving desired weight loss goals is difficult (Stubbs et al. 2011, Elfhag and Rossner 2005, Teixeira et al. 2005). Both obesity and weight loss are multifactorial with genetic, personal, behavioral, and environmental factors influencing outcomes. High attrition rates, participant non-compliance, previous weight loss attempts, and differing definitions of success between practitioner (researcher) and client (participant) are just a few factors that could potentially limit these results (Teixeira et al. 2005, Stubbs et al. 2011). Emerging evidence suggests that interventions may need to be more individually targeted and that psychological constructs may be potential predictors of weight loss outcomes (AbuSabha and Achterberg 1997, Annesi and Whitaker 2010, Clark et al. 1991, Elfhag and Rossner 2005, Teixeira et al. 2005, Stubbs et al. 2011). In particular eating behaviors and depressive symptoms may be associated with increased risk for attrition and poor weight loss intervention outcomes (McTigue, Hess, and Ziouras 2006, Moroshko, Brennan, and O'Brien 2011, Teixeira et al. 2005).

In their review, Teixeira et al. (2005) summarized the current evidence for the utility of pre-treatment psychological factors (e.g., self-efficacy, eating behaviors, depression/mood) for predicting weight loss outcomes and provided recommendations for homogeneity in future research. Teixeira et al. (2005) recommend future studies use consistent psychometric instruments to explore the relationship of both pre-treatment and changes in psychological constructs and weight loss, as well as the potential interaction between pre-treatment individual

psychosocial measures and intervention characteristics (e.g., caloric-restriction, dietary pattern, counseling modality, physical activity). The authors suggest these studies may improve weight loss outcomes through better matching of individuals to intervention types.

Eating Behaviors and Weight Loss

Cognitive control over eating behavior has been of interest to psychologists and health professionals for more than 50 years (Stunkard and Messick 1985, Bruch 1948, Stubbs et al. 2011, Johnson, Pratt, and Wardle 2012, Teixeira et al. 2004). An individual's eating style or eating behaviors may influence his/her ability to lose weight or adhere to an assigned weight loss diet. Eating behaviors, such as conscious restriction of food intake as a means to control weight, emotional eating, and binge eating, may influence how an individual reacts to dieting and food restriction, and thus, may help or hinder one's ability to adhere to an assigned weight loss diet (Stunkard and Messick 1985). A large body of research exists examining the eating behaviors assessed by the Three Factor Eating Questionnaire (TFEQ, cognitive restraint, disinhibition, and hunger) and their relationships to obesity and weight loss (Cappelleri et al. 2009, Foster et al. 1998, Karlsson et al. 2000, Stunkard and Messick 1985). The Three Factor Eating Questionnaire was developed by Stunkard and Messick (1985) to improve upon two questionnaires, the Restraint Scale and the Latent Obesity questionnaire. These two scales were designed to operationalize the theory of restrained eating that states cognitive efforts to restrain eating as a measure to control body weight result in desensitization to physiological signals of hunger and fullness and dysregulation of eating behavior, specifically overeating and often eating at a rapid pace (Stunkard and Messick 1985). The restraint scale distinguished between obese and normal weight individuals in several studies, but was confounded by social desirability and weight fluctuation (Stunkard and Messick 1985). Meyer and Pudel developed the latent obesity

questionnaire which was able to distinguish a group of non-obese individuals that experienced similar dysregulation of eating behavior, but remained normal weight due to their ability to cognitively control their eating (Meyer and Pudel 1977). However, the latent obesity questionnaire was confounded by an inability to identify obese individuals who practiced restraint, but didn't experience dysregulation of eating behavior, specifically rapid eating pace following restraint (Meyer and Pudel 1977, Stunkard and Messick 1985). Thus, Stunkard and Messick (1985) developed the Three Factor Eating questionnaire through a series of experiments resulting in the final 51-item TFEQ to measure cognitive restraint, disinhibition, and hunger (Stunkard and Messick 1985). Since the development of this questionnaire, many abbreviated versions of the questionnaire have been developed for use in specific populations, but the original 51-item TFEQ remains relevant due to strong psychometric properties (Konttinen et al. 2015, Cappelleri et al. 2009), including satisfactory test-retest reliability (0.80 – 0.93), good internal consistency (Cronbach's alpha: 0.70 – 0.92), discriminant validity for selected groups (dieters, binge eaters, obese), and an acceptable three-factor structure (Foster et al. 1998, Karlsson et al. 2000, Stunkard and Messick 1985, Williamson et al. 2007).

As described by Stunkard and Messick (1985), and as assessed by the original 51-item TFEQ, cognitive restraint refers to an individual's behavior to consciously control or limit food intake as a means to control body weight. Disinhibition refers to the inability to restrict or control eating in certain circumstances (social situations, feelings of depression/anxiety) despite absence of physiological hunger (Stunkard and Messick 1985). Disinhibition has been associated with both obesity and binge eating severity and reductions in disinhibition have been associated with weight loss (Foster et al. 1998). Perceived hunger or susceptibility to hunger refers to

subjective feelings of hunger and food cravings and an individual's likelihood to consume food in response to those subjective feelings (Stunkard and Messick 1985).

Results from research examining the association of eating behaviors (cognitive restraint, disinhibited eating, and susceptibility to hunger) and degree of adiposity and weight loss consistently reveal significant associations, but in varying directions (Dykes et al. 2004, Foster et al. 1998, Teixeira et al. 2005). Among middle-aged women, higher baseline cognitive restraint scores have been associated with lower BMI in some, but not all studies (Foster et al. 1998, Dykes et al. 2004). Higher scores at baseline for disinhibition and hunger have been more consistently associated with obesity, but the relationships were fairly modest in strength ($r < 0.20$) (Dykes et al. 2004, Foster et al. 1998, Lindroos et al. 1997, Urbanek et al. 2015). Recently, Porter and Johnson (2011) identified cognitive restraint and disinhibition as potential targets for intervention due to their significant associations with obesity in a sample of community-dwelling older adults (Porter and Johnson 2011).

As pretreatment predictors of weight loss following intervention, baseline eating behavior scores have provided mixed results. Foster et al. (1998) found that higher baseline restraint was associated with greater weight loss ($r = -0.15$, $P = 0.03$) in overweight and obese women (mean age: 41 ± 8.8 y, mean BMI: 37.2 ± 5.6). Conversely, Urbanek et al. (2015) found that baseline cognitive restraint was positively associated with weight change ($r = 0.33$, $P < 0.01$) in middle-aged, overweight and obese women (mean age 35.9 ± 5.8 y, mean BMI: 31.0 ± 4.3). Both Foster et al. (1998) and Urbanek et al. (2015) found no association between baseline hunger or disinhibition scores and subsequent weight change. Batra et al. (2013), however, found that neither baseline restraint nor disinhibition scores were related to weight loss, but higher baseline hunger scores predicted greater weight change ($R^2 = 0.39$, $P = 0.01$) in middle aged, overweight

and obese older women (mean age: 49.09 ± 10.12, mean BMI: 33.5 ± 6.47). Thus, as indicated in reviews of eating behaviors and other psychological constructs as predictors of weight control, the value of cognitive restraint, disinhibiton, and hunger as pretreatment predictors of weight loss following intervention may be limited (Teixeira et al. 2005)

Although previous research yields mixed results regarding the relationship of initial eating behavior scores and intentional weight loss, changes in eating behavior scores have been more consistently associated with weight change (Foster et al. 1998, Karlsson et al. 2000). Increases in cognitive restraint have been associated with weight loss in a number of studies involving middle-aged adults seeking obesity treatment (Foster et al. 1998, Urbanek et al. 2015, Savage, Hoffman, and Birch 2009). In their recent review, Johnson et al. (2012) note that increases in cognitive restraint during behavioral weight loss intervention are consistently associated with greater weight loss following intervention and better weight loss maintenance (lower BMI, less weight regain, Konttinen et al. 2015, Foster et al. 1998, Karlsson et al. 2000). Reductions in disinhibition and hunger have been associated with better weight loss in overweight and obese adults following both behavioral and surgical treatment for weight loss (Konttinen et al. 2015, Batra et al. 2013)

The flexible and rigid restraint subscales of cognitive restraint (Westenhoefer 1991), have been proposed as potential refinements of the cognitive restraint scale that are differentially related to cognitive control over eating behavior and may better predict responsiveness to weight loss intervention (Riesco et al. 2009, Westenhoefer, Stunkard, and Pudel 1999). Westenhoefer et al. (1991) proposed using a subset of 14 questions (7 for each scale) from the TFEQ and summary scores be calculated for each subscale (range, 0 – 7): one for flexible and one for rigid restraint. Flexible restraint is characterized by a general consciousness of eating behavior to

control weight that allows for the occasional higher calorie food to be consumed without guilt. Following consumption of a higher calorie food item, an individual practicing flexible restraint would return to dieting by making reasonable accommodations in eating behavior, such as taking a smaller portion at a subsequent meal (Westenhoefer 1991a). In contrast, rigid control is characterized by avoidance of higher calorie foods and an "all or nothing" approach to dieting. When an individual who practices rigid control consumes a higher calorie food, he or she experiences considerable guilt. Following consumption of the higher calorie food, an individual practicing rigid control would be more likely to continue to overeat, since he/she feels they have already sabotaged themselves (Westenhoefer 1991a). Westenhoefer et al. (1991) proposed that flexible restraint may be more conducive to weight loss and long-term weight management, while rigid control may be more likely to lead to disinhibition and weight gain. Emerging evidence suggests that flexible control is associated with lower energy intakes, greater weight loss following intervention, and greater maintenance of weight loss 8 to 9 months following intervention (Westenhoefer, Stunkard, and Pudel 1999, Westenhoefer et al. 2013, Sairanen et al. 2014). Higher rigid restraint has been associated with higher BMI, higher energy intake, and poorer weight loss following intervention (Sairanen et al. 2014, Westenhoefer, Stunkard, and Pudel 1999, Westenhoefer et al. 2013). As Johnson et al. (2015) note in their recent review, further defining cognitive restraint into flexible and rigid control may help better explain who is successful during weight loss intervention and in long-term weight management (maintenance), but additional investigation is warranted, including further defining the psychometric properties of these two scales. Also, while these results are promising, the majority of these data are derived from samples including primarily middle-aged and younger adults, and little is known about these eating behaviors in older people.

Depressive Symptoms, Obesity, and Weight Loss

Obesity is associated with increased risk for depression ($P < 0.05$), and, to a lesser extent, depressive symptoms ($P = 0.05$) (de Wit et al. 2010, Luppino et al. 2010). Although not a normal part of aging, depression is prevalent in older adults, and more older women report clinically relevant depressive symptoms than older men (Federal Interagency Forum on Aging Related Statistics 2012). In 2008, 16% of older women and 11% of older men reported depressive symptoms and this is reflective of the trend that has endured since 1998 (Federal Interagency Forum on Aging-Related Statistics 2012). In men only, the prevalence of depression increases with age, such that the oldest old (≥85 y) report more depressive symptoms than the younger old (65 – 74 y, Federal Interagency Forum on Aging-Related Statistics 2012). The prevalence of depressive symptoms among older women (≥65 y) does not increase significantly with age (Federal Interagency Forum on Aging-Related Statistics 2012). Still, the National Institutes of Mental Health indicate that depression is likely under-diagnosed and undertreated in older people due to incorrect assumptions by both older people and their health care providers that depression is a normal part of aging and/or response to illness associated with aging (NIMH 2007).

In a recent review, Payne (2010) notes that late-life depression (depression in individuals ≥60 y) is the fourth leading cause of disease burden, is associated with increased health care costs, and is associated with risk for vascular diseases, hip fracture, dementia, and mortality in older adults (Payne 2009). Fiske et al. (2009) note that suicide is more closely associated with depression in older adults and that suicide rates are higher in older adults than in younger adults. Furthermore, Payne (2010) notes that late life depression is more susceptible to remission than younger life depression.

The etiology of late life depression is yet to be fully elucidated, however there is evidence that some nutritional factors including vitamin B12, folate, omega-3 fatty acids and obesity may play a role in depression (Payne 2009, Faulconbridge et al. 2012, Forman-Hoffman et al. 2007). Although researchers generally agree that obesity and depression are related across the life span, the directional influences of obesity and depression remain to be clarified (Forman-Hoffman et al. 2007, Fabricatore et al. 2011, Luppino et al. 2010, Payne 2009).

Studies in older adults report conflicting relationships between depressive symptoms, obesity, and weight loss following intervention (Forman-Hoffman et al. 2007, Forman-Hoffman et al. 2008, de Wit et al. 2010, Porter and Johnson 2011). In one study by Forman-Hoffman et al. (2007) baseline depressive symptoms predicted both weight gain and weight loss in older people, as did increased functional limitations and medical illness. The risk of depression in older adults increases with declines in physical function and obesity increases the risk for functional limitations, suggesting that all factors (depression, functional limitations, and obesity) need to be addressed to improve the health of older adults (Houston, Nicklas, and Zizza 2009, Houston et al. 2009, Jensen and Friedmann 2002, Launer et al. 1994, Vincent, Raiser, and Vincent 2012).

In their review, Fabricatore et al. (2011) report that weight loss following lifestyle intervention is associated with a reduction in depressive symptoms in middle-aged adults and that interventions including both diet and exercise were superior to diet or exercise alone or control (Fabricatore et al. 2011). Furthermore, Faulconbridge et al. (2012) report that incidence of depressive symptoms was significantly lower (RR = 0.66, 95% CI 0.5 – 0.8; $P < 0.001$) in older adults assigned to a lifestyle intervention designed to induce weight loss through energy restriction and increased physical activity compared to a control group. The authors concluded

that intentional and significant weight loss may be protective against depressive symptoms in overweight/obese older adults with type 2 diabetes (Faulconbridge et al. 2012). More research is needed to elucidate the relationship between depressive symptoms and degree of adiposity and weight loss in older adults.

Assessment of Depression in Older Adults

Many self-report questionnaires are available to assess depression and depressive symptoms in older adults in community, research, and clinical settings including, but not limited to, the Beck Depression Inventory (Hadziabdic et al. 2015, Beck et al. 1961), the Beck Depression Inventory-II (BDI-II, Beck and Steer 1996), the Geriatric Depression Scale (GDS, Yesavage et al. 1983), the Hospital Anxiety and Depression Scale (HADS, Zigmond 1983), the Patient Health Questionnaire-9 (PHQ-9, Snaith et al. 1994), and the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff 1977). The CES-D was chosen for use in this study due to recommendation by experts in the field of late life depression (Martha E. Payne, PhD, MPH, Associate Professor in the Department of Behavioral Sciences at Duke University, Senior Fellow, Duke Center for Aging and Human Development), sound psychometric properties (Naughton and Wiklund 1993, Radloff 1977, Smarr and Keefer 2011), and validation in community-dwelling older adult samples (Smarr and Keefer 2011, Lewinsohn et al. 1997).

The original CES-D is a 20 item self-report questionnaire that can be completed by the participant by hand, be interviewer administered and recorded, mailed, or conducted over the telephone (Radloff 1977, Smarr and Keefer 2011). Although the original CES-D has been revised and republished in various forms (e.g., short form 5-item, for children, for multiple chronic conditions), the original questionnaire developed by Radloff at the National Institutes of Health in 1977 is still widely used. The questions assess perceived mood and level of

functioning during the past week that are reflective of depressive symptomology (Radloff 1977, Smarr and Keefer 2011). Although no subscales exist, four factors are represented: depressed affect, positive affect, somatic problems, and retarded activity (Radloff 1977, Smarr and Keefer 2011). The questions are answered on a four point scale from 0, "rarely or none of the time" (< 1 day), to 3, "most or all of the time" (5 – 7 days). Items 4, 8, 12, and 16 are worded positively and thus are reverse scored: if a participant answers "0", then that answer is awarded three points and vice versa (Radloff 1977, Smarr and Keefer 2011). The remaining items are scored as indicated, from zero to three. The items scores are summed and the total score ranges from 0 to 60 (Radloff 1977, Smarr and Keefer 2011). Higher scores represent greater presence and persistence of depressive symptoms (Smarr and Keefer 2011, Naughton and Wiklund 1993, Radloff 1977). A cut-off score of ≥ 16 is generally considered indicative of possible depression (Smarr and Keefer 2011, Naughton and Wiklund 1993, Radloff 1977). Internal consistency reliability (Chronbach's alpha) is high and ranges from ~0.83 in the general population to ~0.91 in the patient population (Smarr and Keefer 2011, Naughton and Wiklund 1993, Radloff 1977). Test-retest reliability is acceptable (0.40 – 0.71, Smarr and Keefer 2011) with better test-retest reliability over shorter intervals. Several forms of validity have been established for the CES-D including, content (items developed from guidance from previously validated depression measures) and concurrent (correlations with other measures of depression and anxiety within acceptable ranges). Discriminant validity in certain populations has been questioned (high school students, schizophrenic patients), but has been demonstrated as valid for screening for depression in healthy community-dwelling older adults (Hertzog et al. 1990, Lewinsohn et al. 1997). Lastly, the CES-D is sensitive to change following treatment for depressive symptoms (Smarr and Keefer 2011, Naughton and Wiklund 1993, Radloff 1977).

Dietary Assessment Methodology

As this dissertation will assess changes in diet and the relationships of diet, psychological constructs, and weight loss, the following section provides a brief review of the literature regarding dietary assessment in weight loss research. There are many methods of collecting dietary data that are used in nutrition research, including, but not limited to, 24-hour dietary recalls, dietary records, food frequency questionnaires, and food disappearance data (Thompson and Subar 2013) and these vary in their appropriateness for a particular research question and target population. For studies in which individual level dietary data is of interest, methods such as the 24 hour dietary recall and dietary record are appropriate, because they are designed to collect data on an individual's total dietary intake over a specified time period, typically one meal to several days. When information about consumption of a particular food group or groups or dietary patterns for large samples of people are of interest, food frequency questionnaires or food disappearance data may be more appropriate (Thompson and Subar 2013). The dietary record approach can be particularly useful for assessing individual diets of participants in a weight loss study because it is possible to obtain sufficient detail over several days, and then to compare individuals and groups based on participant or intervention characteristics (Thompson and Subar 2013).

As summarized by Thomas and Subar (2013), when completing a dietary record, the respondent records all foods and beverages eaten, ideally at the time items are consumed, over several days. The participant must be trained in the level of detail required, such that recording is as accurate as possible. The participant is asked to record the food or beverage consumed, the time and location of consumption, the brand name, if available, cooking methods, and ingredients in a recipe or mixture or added to the item, i.e., condiments, sauces, sugar, salt

(Thompson and Subar 2013). Participants are also asked to record the amount, or portion size, of foods and beverages consumed (Thompson and Subar 2013). Portion sizes can be determined by estimation, weighing and measuring with measuring spoons, cups, or a food scale, photos taken of the food, and/or comparison to pictures or food models (Thompson and Subar 2013). Upon completion of the dietary record, a trained interviewer should review the record with the participant and probe for forgotten foods, additional detail, and omitted items, such as preparation methods or brand names (Thompson and Subar 2013).

There are several advantages to using the dietary record in weight loss research. By asking the participant to record foods at the time or close to when they are consumed and to measure the foods and beverages, recall bias is minimized and accuracy can be enhanced (Thompson and Subar 2013). By obtaining dietary intake data from more than one day and for full 24 hour periods, dietary intake from several eating locations and occasions can be obtained. The number of days involved can vary, but three days is common, as recording more than four days is associated with decreasing validity, and three days minimizes participant and researcher burden (Thompson and Subar 2013).

In one study by Bingham et al. (1997) of middle-aged women (50 – 65 y), dietary nitrogen intake (a proxy for protein) from estimated records was highly correlated with that obtained by 24-hour urinary nitrogen excretion ($r = 0.60 – 0.70$). Furthermore, Bingham et al. (1997) found that compared to a food frequency questionnaire or 24-hour dietary recall, the participant-recorded dietary record in which portions were estimated resulted in the fewest misclassifications by quartile for most nutrients, including protein, carbohydrate, fiber, calcium, and vitamin C, and was better than the 24-hour recall for classifying individuals by quartile for energy (Bingham et al. 1997).

The three day dietary record has been validated for use in older adults (Luhrmann et al. 1999, Thompson and Subar 2013). In the study by Luhrmann et al. (1999) of German older adults (≥60 y), there were no significant differences in calculated nitrogen intake from dietary records and urinary nitrogen excretion, men were more likely to underreport energy intake than women, and underreporting was associated with higher BMI. Suggested considerations when using dietary records with older adults include accommodations for visual limitations, probing for foods consumed via alternate methods due to dentition issues, e.g., pureed foods, smoothies, and shakes, and assessment of cognitive function to ensure there are no cognitive impairments that would impair the ability to recall and record daily food intake (Luhrmann et al. 1999, Thompson and Subar 2013). Nonetheless, for independently-living, community-dwelling older adults with adequate cognition and free of physical or mental disability, such as the sample in this dissertation research, limitations of the dietary record for assessment of food and beverage intake are similar to those in younger people (Thompson and Subar 2013, Luhrmann et al. 1999).

There are several limitations to consider when using dietary records for weight loss research in middle-aged and older adults. Previous studies comparing dietary records to doubly-labeled water indicate that women and individuals with a higher BMI are more likely to underreport intake (Thompson and Subar 2013). Underreporting can result from poor estimation of portion sizes, unintentional or intentional omission of foods and beverages, or intentional omission for social desirability purposes (Thompson and Subar 2013, Bingham et al. 1997). In the context of dietary records in nutrition research, social desirability may cause an individual to consume a diet that he or she thinks the interventionists want them to consume, and thus, this diet would not be typical of this individual (Thompson and Subar 2013). However, in a weight loss study, actively changing intake may be viewed as an advantage if it encourages the

participant to follow the dietary protocol and create better awareness of food consumption practices to promote weight loss (Thompson and Subar 2013). Another limitation of studies utilizing dietary records is that they may not be generalizable to low literacy or individuals who are not highly motivated, as a minimum level of literacy and motivation are required for completion of written dietary records, and potentially more so for electronically captured dietary records (Thompson and Subar 2013). Despite its limitations, the three day dietary record remains a widely used methodology for obtaining dietary intake data, particularly in weight loss intervention studies, due to adequate validity, feasibility of implementation, and ability to provide individual level data that can be used with sophisticated nutrition software (Thompson and Subar 2013).

Rationale, Specific Aims, and Hypothesis

This dissertation focuses on identifying changes in diet and psychological constructs that are associated with intentional weight loss in overweight and obese, community-dwelling older women (65 – 80 y). Studies are needed in this population, because obesity affects more than one third of older adults, particularly women (38.1%), and contributes to metabolic diseases, physical disability, and dependence (Mathus-Vliegen et al. 2012, Villareal et al. 2011, Villareal et al. 2005, Ogden et al. 2014). As evidence is increasingly strong for intentional weight loss that combines energy-restriction, higher protein, and exercise, it is important to determine the feasibility of implementing dietary recommendations for weight loss in this population and whether specific psychological factors may help or hinder weight loss in this group.

The purpose of the studies in this dissertation is to answer the research questions: 1) what dietary changes occur when older women (65 – 80 y) are counseled to consume energy-restricted, higher protein diets to promote intentional weight loss, and 2) how are eating

behaviors and depression related to intentional weight loss among older women (65 – 80 y) following intervention? The overall hypotheses are that 1) older women are able to reasonably adhere to recommendations to restrict energy and consume higher protein to promote weight loss without adverse changes in diet, and that 2) eating behaviors, such as higher cognitive restraint and higher flexible restraint, and lower depressive symptoms are associated with greater weight loss in older women following intervention. The overall hypotheses were tested in older women (65 – 80 y) enrolled in a supervised weight loss intervention in a university setting (University of Georgia, Athens, GA). This dissertation study comes from a larger parent project funded, in part, by a grant from the National Cattleman's Beef Association entitled, Effects of a Higher Protein Weight Loss Diet and Exercise on Body Composition, Physical Function, and Fatigue in Overweight Older Women (Principal Investigator: Ellen M. Evans, PhD, Co-investigators: Mary Ann Johnson, Kevin M. McCully, PhD, Patrick J. O'Connor, PhD), as well as additional funding from the UGA Department of Foods and Nutrition for a doctoral assistantship (ACB) and from the USDA National Institute of Food and Agriculture (MAJ).

The first specific aim is to determine changes in diet that occur among older women (65 – 80 y) participating in a six month weight loss intervention counseled to consume a higher protein (~30% of energy) or conventional protein (~18% of energy) energy-restricted diet with or without exercise. It was hypothesized that the older women in this study would be able to meet energy restriction goals by post-intervention, protein intake among those counseled to consume higher protein would be less than the study goal of 30%, and intake of selected micronutrients would not be compromised by energy restriction and/or protein assignment. The dissertation addresses this specific aim in Chapter III.

The second specific aim is to determine the relationships of eating behaviors (Stunkard and Messick 1985) and depressive symptoms (Radloff 1977) with weight loss following intervention. It was hypothesized that eating behaviors, particularly higher cognitive restraint and higher flexible restraint, but lower disinhibition, hunger, and depressive symptoms would be associated with greater weight loss following intervention in older women. The dissertation addresses this specific aim in Chapter IV.

CHAPTER III

CHANGES IN DIETARY INTAKE FOLLOWING A HIGHER PROTEIN WEIGHT LOSS INTERVENTION IN OVERWEIGHT AND OBESE OLDER WOMEN

[1]Berg, A.C., Evans, E.M., and Johnson M.A. To be submitted to *Medical Research Archives.*

Abstract

Background: There is considerable interest whether a higher protein intake during energy restriction along with exercise may help attenuate the loss of lean mass and promote weight loss during intentional weight loss in obese older adults. However, little is known about the feasibility of increasing protein for the community dwelling-older adult, or what changes are made in the diet to accommodate higher protein intake during energy restriction. This study examined the changes in diet made by overweight and obese community-dwelling older women enrolled in a weight loss trial and randomly assigned to experimental groups that varied in dietary protein and exercise. *Methods:* Older women (65 – 80 y) enrolled in a supervised weight loss study (n = 61) were counseled by a dietitian to consume an energy restricted diet including either higher protein (~30% energy from protein, HP) or conventional protein (~18% energy from protein, CP) without or with supervised exercise (EX) and completed 3 day diet records at baseline and post-intervention (6 months). Changes in energy intake, macronutrients and selected micronutrients were assessed. *Results:* Participants' intake of energy (-506 ± 447 kcal/d), total fat (-28.7 ± 25.2 g/d), and saturated fat (-9.81 ± 9.4 g/d) decreased significantly ($P < 0.05$) and similarly across groups. Compared to the conventional protein groups, those assigned to the higher protein group consumed more protein (29.1 ± 5.6% v. 19.1 ± 2.4% of energy from protein), similar amounts of selected micronutrients (calcium, vitamin C), but less fiber ($P < 0.05$). *Conclusions:* With dietary counseling, community-dwelling older women can adhere to dietary recommendations to promote weight loss, but many women still exceed public health limits (<10% of energy) for saturated fat intake. Furthermore, consuming higher protein during energy restriction may result in inadequate intake of fiber, an important nutrient for cardiovascular and digestive health.

Introduction

The older adult population in the US is growing rapidly, and older women have a longer life expectancy than men (West et al. 2014). Preliminary data from NHANES 2011–2012 suggest that older women (>60 y) were the only age and gender subgroup to experience a statistically significant increase in obesity from 2003–2004 to 2011–2012 from 31.5% to 38.1% (Ogden et al. 2014). As evidence is increasingly strong for beneficial effects of intentional weight loss in overweight and obese older adults, determining appropriate intervention strategies, particularly for older women, is warranted (Villareal 2013, Johnson and Bales 2014, Weinheimer, Sands, and Campbell 2010).

Because intentional weight loss may exacerbate the natural age related declines in lean mass (sarcopenia) which increases the risk for physical disability and mortality, strategies that help to attenuate this effect are of interest (Weinheimer, Sands, and Campbell 2010). Adding exercise, particularly resistance training, to energy restriction in obese older adults is associated with better lean mass retention and improved physical function (Lasker, Evans, and Layman 2008 Noakes et al. 2005, Wycherley et al. 2012). Researchers are increasingly interested whether dietary strategies, such as higher protein intakes (>1.0 g/kg), could have independent or synergistic benefits with exercise during weight loss in older people (Felix and West 2013, Paddon-Jones et al. 2008, Volpi et al. 2013, Mojtahedi et al. 2011). Studies in middle-aged adults indicate that 27 to 35% of daily energy from protein or approximately 1.2–2.0 g/kg/d may result in the best body composition outcomes for older adults (Paddon-Jones et al. 2008, Valentine et al. 2009, Wycherley et al. 2012). Furthermore, some experts suggest that this level of protein intake may be necessary for all older adults, even those in energy balance, to combat sarcopenia

and age related declines in the ability to stimulate muscle protein synthesis (Paddon-Jones et al. 2008, Bauer et al. 2013, Wycherley et al. 2012, Volpi et al. 2013).

Much of this evidence is from controlled feeding trials and intervention studies where protein or protein-containing food was supplied by the research team in either food or supplement form (Paddon-Jones and Leidy 2014). A recent analysis of NHANES 2005–2006 data indicates mean protein intake in community-dwelling older men and women (≥ 51 y) is 15 to 16% of energy and 0.8 to 1.1 g/kg (Berner et al. 2013), which is much lower than what is provided experimentally. Additionally, women were less likely than men to meet the RDA for protein (0.8 g/kg). Approximately 20% of the women failed to meet the more conservative estimated average requirement (EAR) for protein (0.66 g/kg), and intake of animal protein declined with age (Berner et al. 2013). Thus, high intakes of protein suggested by these intervention studies are likely a departure from normal intake for older women, and the ability of community-dwelling women to achieve such intakes without food or supplements provided by the research teams is unknown.

As evidence builds for higher protein weight loss diets for older adults, it is important to explore whether such recommendations can be reasonably achieved by community-dwelling older adults and what changes in diet occur to accommodate higher protein intake during energy restriction in community-dwelling individuals. Therefore, the purpose of this study is to explore the dietary changes that occur among older women (65 – 80 y) participating in a six month weight loss intervention assigned to a higher protein (~30% of energy) or conventional protein (~18% of energy) diet with or without exercise. It was hypothesized that the older women in this study would be able to make changes to their diet by post-intervention according to energy restriction goals, but that mean energy intake from protein would be less than the intervention

goal of 30%, and their intake of selected micronutrients would not be compromised by energy restriction and/or protein assignment.

Methods

Participants

Data for these analyses come from a study originally designed to assess the effectiveness of a higher protein weight loss diet and exercise for improvements in body composition, physical functional performance, and feelings of fatigue and vitality. All materials and methods were approved by the Institutional Review Board at the University of Georgia. Participants were recruited from the Athens, Georgia community and surrounding areas for participation in a weight loss intervention through word of mouth, flyers, email to listservs, and paid newspaper advertisements. Inclusion criteria were postmenopausal female, age 65 to 80 y, all races, BMI ≥25, and self-reported as weight stable within 2 kg and sedentary (<1 hour per week of physical activity or less than 2 exercise sessions per week) over the past 6 months. Exclusion criteria were: smoking; dietary restrictions that precluded adherence to the dietary protocol; history of unstable CVD; self-report of active cancer or treatment within previous five years; mini-mental state exam score less than 25 (Folstein et al. 2013); self-report or clinician report of clinical depression, other psychiatric or cognitive disorder that precluded ability to adhere to study protocols, severe arthritis, asthma or other pulmonary condition that precludes adherence to exercise prescription, or current diagnosis of balance disorders. Inclusion and exclusion criteria were determined through a series of phone calls and in-person visits. After participants were determined to meet the inclusion criteria and expressed interest in participating in the study, participants were randomized using an internet application (randomnumbergenerator.org) to one of three treatments: high protein diet with exercise (HP-EX), high protein without exercise (HP) or conventional protein with exercise (CP-EX). All participants were required to obtain personal

physician clearance to participate (Appendix E). Those who were randomized to the exercise interventions were required to complete a graded exercise test administered by the study physician to ensure safety when performing moderate intensity exercise. Any abnormalities or concerns from the graded exercise test were shared with the participant's personal physician to determine appropriateness to participate.

Measurements

Measurements were conducted at baseline (0 months), midpoint (3 months), and post-intervention (6 months). All baseline assessments were conducted after randomization and before the participant began the intervention. All post-intervention testing visits occurred immediately following completion of the intervention (within 1 to 2 weeks). All testing visits and intervention sessions occurred on the University of Georgia campus and were conducted by trained graduate students and/or supervised undergraduate students in the Departments of Kinesiology and Foods and Nutrition. All questionnaires, except dietary records, were completed by the participant with the interventionists present to provide instructions for completion and any clarification necessary.

Demographics

Demographic information, including age, race, income, education, employment status, place/type of residence, and number of individuals living in the household, were obtained via interviewer administered questionnaires over two screening visits: initial phone interview and in-person follow-up.

Anthropometrics

Barefoot standing height was measured to the nearest 0.1 cm with a stadiometer with the participant wearing light clothing and no shoes. Body weight was measured to the nearest 0.1 kg

at baseline and throughout the study with a digital scale with the participant wearing light clothing. Body mass index (BMI, kg/m^2) was calculated from weight and standing height at baseline and post-intervention, (NHLBI 2000). Waist circumference (WC) was assessed by three measurements of the natural waist. As per NHLBI guidelines, greater than of 88 cm (35 inches) for women will be considered abdominally obese (NHLBI and National Institutes of Health (NIH) National Heart 2000). Whole body fat mass, lean mass, and bone mass was assessed with dual-energy X-ray absorptiometry (DXA, GE Lunar-iDXA^{TM}, enCORE 2007, version 11.30.062, Madison, WI).

Dietary assessment

Participants completed diet records for three days, including two weekdays and one weekend day at baseline and post-intervention. Participants were asked to record all food and beverages consumed during those 24 hour periods, including preparation method, brand names when available, and portion sizes. Participants were provided a National Science Foundation (NSF) certified digital food service scale (Escali 136KP Alimento Pro, Burnsville, MN) to weigh their food, and interventionists provided instructions on proper use (zeroing, subtracting the weight of cups or plate, notating whether the measurement was before or after cooking). Participants were asked to use measuring cups and spoons to measure their food and were provided a reference sheet for estimating portion sizes when these tools were not available. After each reporting period, a registered dietitian nutritionist (RDN) or trained interviewer reviewed the record with the participant to clarify information provided and allow the participant multiple opportunities to recall forgotten foods and detailed information about food and beverage intake. Food models were used as needed to verify portion sizes. Dietary intake data was assessed using the Nutrition Data System for Research (NDSR 2013, Minneapolis, MN) to

determine three day average energy intake and diet composition at each data collection time. For the two participants missing midpoint dietary data, baseline values were substituted for midpoint values.

Dietary Intervention

Participants met with a registered dietitian nutritionist (RDN) or supervised nutrition graduate student and were provided individual diet goals based on a reduction of approximately 500 kcal from calculated energy needs (Mifflin St. Jeor equation using baseline body weight; activity factor 1.3, Seagle et al. 2009) to promote loss of 0.23 kg (0.5 pounds) to 0.91 kg (2 pounds) per week (NHLBI 2000, Pi-Sunyer et al. 1998, Seagle et al. 2009). No adjustment was made for additional energy expended during the exercise intervention. The RDN monitored participants for weight change throughout the study, and made adjustments to energy goals as necessary to promote continued weight loss. The minimum energy intake goal for a participant was 1200 kcal/d. The recommended higher protein diet (HP) was designed to provide 30% of energy from protein (~1.6g/kg/d) and the recommended conventional protein (CP) diet was designed to provide 18% of energy from protein (~0.8g/kg/d). Both diets were designed to provide 30% of energy from fat, and the remainder of energy from carbohydrate (HP: 40%, CP: 52%). Participants in the higher protein diet intervention groups were instructed to consume at least one serving of cooked lean beef (3 oz) per day as part of the primary study investigation. The research team did not provide beef or any other foods to the participants. Lean beef was defined as cuts with less than or equal to 4.5 g saturated fat, less than 10 g total fat, and less than 95 mg cholesterol per 3.5 oz serving. Participants were provided cards, handouts, and other materials regarding lean beef retail cuts and preparation methods that minimized the use of added fat. Participants completed compliance logs daily to indicate amount of beef consumed, cut, and

preparation method. These logs were reviewed weekly by the interventionists and participants not following protocol were counseled on ways to achieve the protocol intake.

To ensure participants were meeting micronutrient needs during the intervention, all participants were provided with a multivitamin mineral supplement formulated for older women (Centrum® Silver® Women, Pfizer, Inc., Madison, NJ) that provided 800 IU of vitamin D (RDA for women 51—70 y is 600 IU or 15 mcg, for women ≥71 y is 800 IU or 20 mcg/d), 500 mg of calcium (RDA for women >50 y is 1200 mg), and more than 100% of the RDA for several nutrients, including vitamin C (RDA for women >50 y is 75mg) (IOM 2006, IOM 2011). Additional calcium supplements (Regular Strength TUMS®, 200 mg elemental calcium, GlaxoSmithKilne, St. Louis, MO) were recommended on an individual basis to meet the RDA (1200 mg/d) considering the participant's usual dietary intake of calcium-rich foods according to the following method: TUMS per day rounded to nearest 0.5 tablet = [1200 mg (RDA for calcium for older women) – 500 mg (Centrum® Silver® Women) – 300mg (approximate dietary calcium from non-dairy sources) – (daily servings dairy food × 300 mg/serving)] ÷ 200 mg Ca/TUMS. Compliance with supplementation was monitored via paper logs and through oral confirmation at visits.

At the beginning of the intervention, participants attended a minimum of two individual sessions with the registered dietitian nutritionist (RDN) or nutrition graduate student under supervision of the RDN for instruction regarding energy restriction, macronutrient distribution of the intervention diet, self-monitoring methods, and participant-centered goal setting. Although a minimum of two individual visits was required, most participants had a total of four individual weekly visits during their first month of the intervention. For the remainder of the study, participants attended weekly educational/motivational group sessions (45 – 60 minutes) with the

RDN or supervised graduate student, and individual sessions as necessary to meet weight loss goals. The group session curriculum was based on Social Cognitive Theory (Bandura 2004) and topics included general nutrition education and behavioral strategies for weight management. All participants attended one individual session at the midpoint of the intervention to assess progress toward weight loss and dietary goals.

Participants were instructed to use a free online dietary intake monitoring application (MyFitnessPal.com). The RDN or supervised graduate student registered the participant for an account with MyFitnessPal.com and then entered the individualized energy-restriction goal and macronutrient distribution per the intervention protocol. The RDN or supervised graduate student instructed the participants on how to use the application in the series of individual vists and through additional emails or phone calls. All participants were able to access the program through their home computers or smart phones, and one participant chose to use the computer at the public library. During times of technical difficulties, participants used paper food diary or paper logs with the exchange system to record daily food intake. Participants were asked to enter all foods and beverages, except water, daily. Food diaries were monitored weekly by the RDN or supervised nutrition graduate student and participants were provided individualized feedback to help meet weight loss, intervention, and nutrient goals.

Exercise intervention

Participants randomized to an exercise intervention group (HP-EX, CP-EX) completed three exercise sessions per week on non-consecutive days (~75 min/session) for six months. Participants assigned to the higher protein diet with no exercise sessions were asked to maintain current activity levels for the duration of the study (defined as <1 h/wk of physical activity or less than 2 exercise sessions per week per the inclusion criteria). All exercise sessions were

conducted by trained graduate students in the Department of Kinesiology. The exercise intervention was a multicomponent program that integrated cardiorespiratory training, resistance training, balance, flexibility and functional activities. Cardiorespiratory training included 30 minutes of continuous exercise (walking on a treadmill, cycling or using an elliptical) at 70-80% of age-predicted maximal heart rate. Resistance training included upper body, lower body, and abdominal exercises in two sets of 8 to 10 repetitions at 65% of four-repetition maximum (1-RM). Each session included 5 to 10 minutes of flexibility and balance, and two 30-second sets of functional activities (chair rises, wall push-ups, lift-and-carry, and transfer task). Further details of the exercise intervention are described elsewhere (Straight 2015, forthcoming).

Dietary Adherence

Two measures of adherence to energy restriction and protein (percent of energy) recommendations were calculated following the methods of Warziski et al. (2008). Participants were assigned a daily energy intake goal based on their calculated needs at baseline less 500 calories to produce a half pound to two pounds weight loss per week (Jensen et al. 2014, Seagle et al. 2009, Waters, Ward, and Villareal 2013). Baseline energy needs were calculated using the Mifflin St. Jeor equation with an activity factor of 1.3 as per the Academy of Nutrition and Dietetics recommendations for estimating energy needs for overweight and obese adults (Seagle et al. 2009). The activity factor 1.3 was chosen to represent sedentary behavior, which was expected based on the inclusion criteria for the study. If calculated needs for weight loss were less than 1200 kcal/d, participants were recommended to consume 1200 kcal/d to ensure nutrient adequacy. If calculated needs for weight loss were greater than 1200, then needs were rounded to the nearest 50 kcal for ease of participant implementation. Protein recommendation was

determined by intervention group assignment (HP-EX, HP: 30% of energy, CP-EX: 18% of energy).

Following Warziski et al. (2008), energy adherence was calculated as actual intake estimated via 3 day dietary record (kcal/d) divided by the energy recommendation (kcal/d) multiplied by 100. Protein adherence was calculated as actual intake (percent of energy from protein) estimated via 3 day dietary record divided by the protein recommendation (HP-EX, HP: 30% of energy, CP-EX: 18% of energy) multiplied by 100. For both protein and energy adherence, a score between 85% and 115% of the goal was considered adherent (Warziski et al. 2008). Greater than 115% or less than 85% was considered non-adherent. An example of the dietary adherence calculations are provided in Appendix A.

Statistical analysis

All statistical analyses were performed using SAS version 9.4, Cary, NC. Differences between intervention groups at baseline were assessed with one-way ANOVA and Kruskal Wallis tests for nonparametric data. To explore differences between completers and non-completers, one-way ANOVA (normally distributed dependent variable), and Wilcoxon-Mann-Whitney tests (non-normally distributed dependent variables) were used for continuous variables, and for categorical variables, Fisher's exact test was used due to small cell frequencies (< 5).

To explore within group changes in diet from baseline to post-intervention, paired t-tests and Wilcoxon signed rank sum tests for non-parametric data were used. To explore differences in dietary changes between groups, comparisons were determined *a priori* as per the research protocol. Four contrasts were tested: higher protein diet groups (HP-EX + HP) vs. conventional protein diet (CP-EX), exercise intervention (HP-EX + CP-EX) vs. no exercise intervention (HP),

higher protein and exercise (HP-EX) vs. higher protein alone and conventional protein and exercise (HP + CP-EX), and higher protein with exercise (HP-EX) vs. conventional protein with exercise (CP-EX). No adjustment was made for multiple comparisons. Differences between groups in meeting established nutrient intake recommendations were explored at baseline and post-intervention using Chi-square tests and logistic regression. All statistical tests were considered significant at a P value < 0.05.

Results

Characteristics of participants who completed baseline testing and enrolled in the study (n = 72) are reported in Table 3.1. Baseline demographic and anthropometric characteristics were similar across intervention groups, with the exception of BMI. Baseline BMI of the conventional protein diet and exercise (CP-EX) group (29.2 ± 3.1) was lower than the other two groups (HP-EX: 32.2 ± 6.1, HP: 32.4 ± 4.57, $P < 0.05$). Attrition was 15% (n = 11) with the primary reasons including time constraints, non-study related illness or injury, and non-compliance with participant reporting or attendance responsibilities (Figure 3.1). There were no differences in BMI or demographic characteristics between the completers and participants who withdrew from the study (non-completers, n = 11). Non-completers had greater total number of medical conditions (completers: 1.4 ± 1.0, non-completers: 2.2 ± 1.2, $P < .05$). Non-completers reported more depressive symptoms, which is discussed in Chapter 4.

Participants who completed the intervention (completers: n = 61) lost $-9.2 \pm 4.8\%$ of initial body weight and 42.6% of those who completed the intervention met the weight loss goal of 10% of initial body weight. The percent of participants who met the weight loss goal of 10% in the higher protein-with exercise group (HP-EX), higher protein (HP) and conventional protein with exercise group (CP-EX) was 31.6%, 45.0% and 50.0%, respectively, and the difference

between groups was not significant (Chi-Square: 1.48, P = 0.48) as is discussed in more detail in Chapter 4.

Overall, completers made changes to the diet as per intervention recommendations. Changes in diet in the total sample are shown in Table 3.2. Changes in diet by intervention group are shown in Tables 3.3 and 3.4.

As shown in table 3.2, total daily energy intake decreased by -506 ± 447 kcal (median, -476, range, -2042, 692). At the end of the intervention (post-intervention, 6 months), participants were consuming 73.4 ± 13.7% (median, 72.2, range, 49.7, 113) of the energy needed to maintain their current weight. By the end of the intervention, 59.1% of the CP-EX group and 61.54% of the groups assigned to higher protein diets (HP and HP-EX) were adherent to energy recommendations (85 – 115% of individual energy recommendation), and there was no difference between diet intervention groups (HP and HP-EX v. CP-EX, Chi-Square 0.38, df=2, P = 0.8282) or between exercise intervention groups (HP-EX and CP-EX v. HP, Chi-Square 1.42, df 2, P = 0.49, Tables 3.3 and 3.4). When the midpoint values were included in the repeated measures mixed model, all groups made changes in energy intake over the course of the intervention, and there was no group by time interaction (Appendix B, P-values for mixed model).

Macronutrients

As shown in Table 3.2, total intake from carbohydrate, protein, and fat decreased by 60.4 ± 57.8 g/d, 3.7 ± 23.6 g/d, and 28.7 ± 25.2 g/d, respectively in the total sample. As per intervention protocol and shown in Table 3.3, participants in the two intervention groups assigned to the higher protein diet (HP-EX, HP, n = 39) reported intakes of 29.1% ± 5.6 of energy from protein, 39.6% ± 4.6 from carbohydrate, and 30.21% ± 5.3 of energy from fat. The

participants assigned to the conventional protein diet (CP-EX, n =22) reported consuming 19.1% ± 2.42 of energy from protein, 49.5% ± 6.48 of energy from carbohydrate, and 28.8% ± 4.93 of energy from fat. Changes in macronutrients over time and by group were consistent with the intervention protocol (Appendix B, P-values for mixed model).

As shown in Table 3.4, by the end of the intervention, 43.7% of the CP-EX group and 56.2% of the groups assigned to higher protein diets (HP and HP-EX) were adherent to protein (as percentage of energy needs, CP-EX: 18% of energy, HP and HP-EX: 30% of energy) recommendations (85 – 115% of protein recommendation), and there was no difference between diet intervention groups (HP and HP-EX v. CP-EX, Chi-Square 3.80, df=2, P = 0.15) or between exercise intervention groups (HP-EX and CP-EX v. HP) (Chi-Square 1.88, df 2, P = 0.39).

Reported total saturated fat intake decreased in the total sample -9.8 ± 9.4 g/d (median,-8.16, range, -41.0, 9.6) as did percent of energy from saturated fat, mean -2.05% ± 2.9 (median, -2.5, range, -7.5, 4.1, Table 3.2). At the end of the intervention, 57.4% of the participants (n = 35) were meeting public health guidelines of less than 10% of energy intake from saturated fat (USDA and USDHHS 2010, data not shown), and participants assigned to the higher protein diets with beef were not more likely to exceed these guidelines (0.491, 95% CI: 0.164 – 1.469) than their counterparts in the conventional protein group (Table 3.4).

Total fiber intake (g/d) decreased during the intervention in the total sample and within all groups (Tables 3.2 and 3.3). At post-intervention, mean intake of fiber was 18.1 ± 5.8 g/d (median 17.8, range 8.2, 41.6) and 19.7% of participants (n = 12) were meeting the AI for fiber (21 g/d). However, the adequate intake for fiber is based on energy intake (14 g/1000 kcal), and grams of fiber consumed per thousand calories increased from baseline to post-intervention in all groups with 55.7% of participants (n = 34) consuming at least 14 g/1000 kcal at post-

intervention (Table 3.2). Additional planned comparisons between intervention groups showed that fiber intake per thousand calories increased more in the group assigned to the conventional protein diet (CP-EX, Table 3.3). Accordingly, participants in the higher protein diet groups (HP-EX, HP) were less likely to meet the recommendation of 14g/1000 kcal (OR 0.32, 95% CI: 0.104, 0.995, Table 3.4).

Micronutrients

As discussed in the methods section, all participants were provided with a multivitamin mineral supplement formulated for older women to supplement micronutrient intake during energy restriction. The multivitamin mineral supplement provided 500 mg of calcium, and the participants were provided additional supplemental calcium to meet individual needs. Dietary intakes of selected micronutrients (calcium, vitamin D, and vitamin C) remained relatively unchanged over the intervention, despite statistically significant decreases in energy intake in all groups, with the exception of calcium (Table 3.3). There was a statistically significant decrease in calcium intake from baseline to post-intervention within the group assigned to the conventional-protein diet ($P < 0.01$, Table 3.3). Still, mean calcium intake from food was 666 ± 254 mg/d (median 639, range 243, 1754) at post-intervention, and mean intakes were not different between groups. Only 3.3% of participants met the RDA for calcium through food intake, and there was no difference between groups. One participant met the RDA for vitamin D from food (51 – 70 y: ≥ 15 mcg/d; 70 y and older: ≥ 20 mcg/d). Mean intake of vitamin C at post-intervention was 83.6 ± 44.7 mg/d, but less than half of the participants met the RDA for vitamin C (75 mg/d), and there were no differences between groups (Tables 3.2 – 3.4).

Beef

Participants in the higher protein diet groups (HP-EX, HP) had a mean intake of 2.3 ± 1.2 oz equivalents of beef per day, and of this, 1.7 ± 1.2 ounce equivalents was lean beef. Participants in the higher protein diets consumed a mean of 0.67 ± 0.92 ounce equivalents and 0.13 ± 0.27 ounce equivalents per day of lean cold cuts and regular cold cuts per day, respectively, that could have included roast beef and are not included in the aforementioned beef servings. If it is assumed that these cold cuts were regular or lean roast beef (as was recommended by the interventionists), then mean intake of beef per day in the higher protein diet groups would be 3.1 ±1.3, of which 2.4 ± 1.2 oz equivalents would be lean beef.

Discussion

The purpose of this study was to identify changes in diet among older women enrolled in a supervised weight loss intervention. The major findings were that older women were able to make changes in their diet to promote weight loss, including significant changes in both energy and macronutrient intakes. Compared to participants assigned to the conventional protein diet, those assigned to the higher protein diet consumed more protein, along with similar amounts of total fat, saturated fat, and selected micronutrients, but less fiber. Also, exercise did not influence the participants' ability to adhere to the diet. As discussed in detail elsewhere (Berg, Chapter 4 and Evans et al., 2015), women consuming the higher protein diet and the conventional protein diets lost similar amounts of weight.

There has been much discussion recently about recommending higher protein intake for older adults as part of interventions for sarcopenia. Furthermore, as evidence is increasingly strong for the benefits of weight loss for overweight and obese older adults, researchers are investigating the effects of higher protein intakes during energy restriction to attenuate loss of

lean mass, but the ability of older adults to adhere to such recommendations and what other changes in the diet occur is unknown. In the current study, women assigned to the higher protein diet (30% of energy from protein) increased their intakes of protein from a mean of approximately 17% of energy from protein at baseline to 29.1 ± 5.6% (median 29.0, range 19.6, 40.1) at post-intervention (84.7 ± 15.4 g/d, 1.13 ± 0.27 g/kg). Still, more than 50% of the women assigned to higher protein diets did not meet the goal of 30% despite the intensity of the counseling and social support provided by the intervention. As a result, although these older women were successful at increasing their protein to a percent of energy greater than their counterparts in the conventional protein diet, 30% may not be a reasonably achievable for many women.

Participants were counseled to consume one serving (3 oz) of cooked lean beef per day as part of the primary goals of the study. At post-intervention, daily intake of beef was less than this recommendation. By the end of the study, many participants refused to consume beef daily stating they had grown weary of it. Thus, older women may be able to increase their protein intake, but doing so via a variety of food sources may be a better recommendation than the same source daily, and this should be explored in future studies.

Because many high protein foods can also be significant sources of saturated fat, particularly regular fat dairy products and non-lean meat, it is noteworthy that the intakes of saturated fat declined in all groups during the intervention and the mean intake of saturated fat at the end of the study was not greater in the higher protein diet groups compared to the conventional protein diet group. Nevertheless, more than 40% of the participants were not meeting the public health goals set by the Dietary Guidelines for Americans (USDA and USDHHS 2010) of less than 10% of energy from saturated fat. This is concerning in light of the

American Heart Association's current recommendation that saturated fat intake be limited to less than 7% of total energy intake for healthy Americans age two and older, and between 5 and 6% of energy for Americans who would benefit from lowering their LDL-cholesterol (Eckel et al. 2013, Stone et al. 2014) Many of the older women in this study are included in the latter group that could benefit from LDL-cholesterol lowering given their advanced age, statin use (>30% at baseline), reported high blood pressure (47.1%), established cardiovascular disease (4.2%), diabetes (9.7%), and overweight and obese BMI (Eckel et al. 2013, Stone et al. 2014). Still, less than 5% of the participants in our study met these more conservative intakes of saturated fat intake. Previous research by Roussel et al. (2011) indicated that it is possible for an individual to consume a higher protein diet (~27% protein) with one serving of lean beef (~ 3 oz) and less than 7% of energy in the diet be from saturated fat. However, in the BOLD study (Roussell et al. 2012), all food was supplied to the participants by the research team and all beef was lean (per 3.5 oz beef: saturated fat ≤ 4.5 g, total fat < 10 g, cholesterol < 95 mg, http://beefretail.org/whatdoesleanmean.aspx, (Roussell et al. 2012). Despite intensive counseling, the participants in the current study reported regularly consuming beef that was not lean (>1 oz per day). Thus, participants living in a community setting and procuring their own foods and meals, even with the help of an RDN, may be unlikely to adhere to such recommendations when beef is consumed daily as part of a higher protein diet (30% energy from protein). In agreement, the recent Report of the Dietary Guidelines Advisory Committee (2015) notes that in order to meet the saturated fat guidelines suggested by AHA, Americans would have to consume little, if any, meat and dairy products, which could make consuming a higher protein diet difficult, since these are important sources of protein.

Not only is saturated fat intake a concern for primary and secondary prevention of cardiovascular disease, but fiber is also an important nutrient related to cardiovascular health (IOM 2005, Slavin et al. 2008). Notably, data from this sample indicates that when women adhere to energy restriction and higher protein recommendations, it may be at the expense of intake of fiber-containing foods. In this sample, less than 20% of all participants met the AI of dietary fiber of 21 g/d, and 55.7% met the AI of 14 g/1000 kcal at post-intervention. Individuals in the higher protein group were less likely to consume at least 14 g fiber/1000 kcal. Furthermore, fiber intake in this group was lower than in the studies that demonstrated reductions in LDL-cholesterol with a high beef, higher protein diet (mean fiber intake ~14 g/1000 kcal compared with ~18 g/1000 kcal, Roussell et al. 2012). Given that reduction of risk for coronary heart disease is the primary endpoint used for establishing the adequate intake (AI) of fiber (IOM and Medicine 2006) (put the reference here), the inadequate intakes of fiber in this group are of concern. Also, available evidence indicates higher intakes of dietary fiber from food are associated with lower risk of colon cancer, while higher intakes of red meat are associated with increased risk of colon cancer (Perera, Thompson, and Wiseman 2012). Therefore, more research is needed to determine whether higher protein diets can be achieved without a reduction in dietary fiber. Furthermore, if future recommendations are to have older adults consume more protein (~30% of energy), careful monitoring of fiber to ensure adequate intakes probably should also be recommended.

Although participants were not meeting many of the recommended intakes for micronutrients from food alone, participants were taking a multivitamin mineral supplement and additional calcium to meet their nutritional needs. The participants' mean intakes of calcium from food at post-intervention (666 ± 254 mg/d, Table 3.2) were lower than those of women age

60 and older living in the US (calcium: ~842 mg/d, NHANES 2009 – 2010, Hoy and Goldman September 2014). However, when adjusted for energy intake, participant's mean calcium intake at post-intervention (562 ± 190 mg/1000 kcal/d) was similar to mean intakes of older women in the US (~531 mg/1000 kcal/d, Hoy and Goldman September 2014). Additionally, despite energy restriction, the participants' mean intakes of vitamin D and vitamin C from food at post-intervention (vitamin D: 4.4 ± 4.0 mcg/d, vitamin C: 83.6 ± 44.7 mg/d, Table 3.2) were similar to a nationally representative sample of older women from NHANES 2009-2010 data (vitamin D: ~4.6 mcg/d, vitamin C: ~80 mg/d). Thus, although participants were consuming an energy-restricted diet, their micronutrient intakes were similar to a nationally representative sample (USDA, 2012).

Strengths and limitations

The current study was conducted in a university setting and participants' education (72% Bachelor's degree or more) exceeded that of the older adult women in the US (18% Bachelor's degree or more, Federal Interagency Forum on Aging-Related Statistics 2012). Thus, the women in this study may have been better able to understand the nutrition goals of the study and implement the interventionists' recommendations, which may not be generalizable to the older American population. However, participants' baseline level of education and the intensity of the counseling likely contributed to the success of the intervention in encouraging energy restriction and adherence to macronutrient recommendations. Furthermore, as education is strongly correlated with income, the results of this study may not be generalizable to lower income populations. Notably, protein foods are relatively expensive and require refrigeration, and, consequently, reliable transportation to refrigeration. Further research will be needed to explore whether higher protein intakes are feasible for lower education and/or lower-income individuals.

There are many ways to assess dietary adherence, and this study employed the methods of Warziski et al. (2008). Although adherence to the energy restriction recommendation as per this method was not associated with meeting weight loss goals, adherence within 90 to 100% of the individual energy restriction goal was associated with meeting the weight loss goal of the intervention (10% of initial body weight). As implementing higher protein diets may be important for all older adults regardless of weight goals, the feasibility of adherence to macronutrient recommendations during both weight loss and weight maintenance is important to understand. Lastly, some research indicates the timing of protein intake is as much important to stimulating muscle protein synthesis as is the total protein consumed (Paddon-Jones et al. 2008), and this was not assessed in these analyses. Still, this study adds to our understanding of the feasibility of increasing total protein intake in the diet.

Conclusions

This study provides important information regarding changes in diet that occur when older women are asked to reduce their energy intake and increase protein intake during a supervised weight loss intervention with exercise. Notably, the older women in this study were able to make changes in their diet to promote weight loss and adhere reasonably well to macronutrient intake recommendations. Their total intake of saturated fat and as a percent of energy decreased despite recommendations to consume higher protein, and specifically, lean beef daily. However, when older women increase their percent of energy from protein, it may be at the expense of fiber. Considering the important role of both protein and fiber in human health, and specifically older adult health, more research is needed to understand these changes and if counseling to increase the intake of fiber-containing foods might be beneficial under conditions of increased protein. Lastly, it is important to note that intake of essential micronutrients from

food, namely calcium and vitamin D, were inadequate before and during energy restriction. Thus, supplementation of these nutrients should continue to be strongly encouraged for older women to support optimal bone health, especially during weight loss.

Table 3.1
Selected participant characteristics before weight loss treatment for total sample and by intervention group. Mean ± SD, percent, and/or median [range]

Variable	Total Sample (n = 72)	HP-EX[a] (n = 23)	HP[b] (n = 24)	CP-EX[c] (n = 25)
Age (years)	69.4 ± 3.59	70.0 ± 4.4	69.5 ± 2.3	68.8 ± 3.8
Race/ethnicity				
Non-Hispanic white	96%	96%	100%	92%
Black	1%	-	-	4%
Hispanic	1%	4%	-	-
Native American	4%	-	4%	8%
Married (%)	60%	48%	58%	72%
Work status				
Full-time	7%	4%	13%	4%
Part-time	31%	35%	21%	36%
Not currently working	63%	61%	67%	60%
Education – Highest degree achieved (%)				
High school	18%	13%	25%	16%
Vocational or technical school	3%	-	4%	4%
2 year college	7%	17%	-	4%
Undergraduate	29%	22%	21%	44%
Master's degree	38%	48%	46%	20%
Doctoral degree/professional school	6%	-	4%	12%
Household income				
$15,000 – $29,999	7%	9%	4%	8%
$30,000 – $44,999	14%	17%	17%	8%
$45,000 – $59,999	10%	17%	8%	4%
$60,000 – $74,999	8%	4%	4%	16%
$75,000 – $90,000	15%	17%	17%	12%
More than $90,000	12%	4%	25%	8%
Prefer not to answer	33%	30%	25%	44%
Weight (kg)	82.5 ± 12.3	84.4 ± 13.6	85.1 ± 12.6	78.3 ± 9.8
BMI (kg/m^2)*	31.2 ± 4.9	32.2 ± 6.1	32.4 ± 4.6	29.2 ± 3.1[*]
Waist circumference (cm)	94.5 ± 11.1	96.8 ± 13.4	96.8 ± 10.2	90.3 ± 8.4
Body fat (% total mass)	48.2 ± 3. 9	49.1 ± 3.6	48.6 ± 4.1	47.0 ± 3.8
Total medications	4.4 ± 2.6 4[0 – 11]	4.2 ± 2.6 4 [0 – 10]	5.2 ± 2.4 5 [1 – 11]	3.8 ± 2.7[d] 4 [0 – 9]
Total medical conditions	1.6 ± 1.1 2 [0 – 5]	1.6 ± 1.3 1 [1 – 5]	2.0 ± 0.9 2 [1 – 5]	1.0 ± 0.2 1 [0 – 3]
Medical conditions				
Diabetes	10%	13%	17%	-
Hypertension	47%	45%	5%	42%
Cardiovascular disease	4%	4%	4%	4%
Pulmonary disease	19%	22.%	25%	12%
Thyroid disorder	25%	35%	29%	12%
Sleep apnea	22%	17%	29%	20%

Table 3.1

Selected participant characteristics before weight loss treatment for total sample and by intervention group. Mean ± SD, percent, and/or median [range]

Variable	Total Sample (n = 72)	HP-EX[a] (n = 23)	HP[b] (n = 24)	CP-EX[c] (n = 25)
Physical activity (steps/day)	4966 ± 2080	5002 ± 2232[f]	4699 ± 2184[g]	5176 ± 1893[h]
Physical activity (min MVPA/day)[f]	9.5 ± 8.9	10.6 ± 11[g]	9.3 ± 8.2[h]	8.6 ± 7.7[i]
Physical function				
6 min walk (m)	108 ± 23.6	110 ± 27	106 ± 22	107 ± 23
Gait speed (m/s)	0.30 ± 0.06	0.31 ± 0.08	0.29 ± 0.06	0.30 ± 0.06

a. HP-EX: Higher protein diet (30% energy from protein) and supervised exercise intervention
b. HP: Higher protein diet (30% energy from protein); no exercise intervention
c. CP-EX: Conventional protein diet (18% energy from protein) and supervised exercise intervention
d. N = 24
e. Reported energy intake (average caloric intake per day) as a percentage of energy needs for weight maintenance; % energy needs = baseline kcal/d ÷ estimated energy needs: [((10*body weight (kg)) + (6.25*height (cm)) – (5*age(y) - 161)] × [activity factor, 1.3]
f. MVPA is moderate to vigorous physical activity
g. N = 22
h. N = 21
i. N = 23

* P < 0.05 for difference between groups

Table 3.2

Overall changes in diet for completers; all groups combined. Mean ± SD (n = 61)[a]

Variable	**Baseline**	**Midpoint** (3 months)	**Post-intervention** (6 months)	**Change**[b]
	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]
Energy (kcal/d)[c]	1698 ± 427 1655 [879 – 3105]	1258 ± 284 1241 [689 – 2504]	1192 ± 224 1167 [805 – 1836]	-506 ± 447 -476 [-2042 – 693]****
Energy (percent of calculated need) [c, d]	98.5 ± 23.9 94.4 [53.6 – 170.5]	75.5 ± 15.6 75.0 [50.0 – 140.4]	73.4 ± 13.7 72.2 [49 – 113]	-25.1 ± 25.3 -23.5 [-107.8 – 37.1]****
Carbohydrate (g/d) [c]	195 ± 56.0 187 [103 – 355]	142 ± 37.2 135 [85.7 – 284.4]	134 ± 29.1 131 [79.2 – 199.8]	-60 ± 57.8**** -57.4 [-228 – 40.3]
Carbohydrate (g/1000 kcal/d) [c]	115 ± 20.2 116 [75.0 – 163]	113 ± 19.5 110 [78.8 – 158]	114 ± 18.5 109 [75.5 – 157.7]	-1.6 ± 8.8, -1.9 [-18.4 – 26.1]
Carbohydrate (% Energy)	44.7 ± 7.80 44.8 [28.8 – 61.3]	43.3 ± 7.4 42.3 [29.8 – 59.4]	43.2 ± 7.15 42.0 [28.9 – 60.3]	-1.6 ± 8.79 1.9 [-26.1 – 18.4]
Protein (g/d)	70.3 ± 18.8 67.0 [36 – 117]	73.5 ± 21.4 69.1 [36.5 – 126]	74.0 ± 19.6 71.0 [40.7 – 117]	3.73 ± 23.6 -0.4, [-35.1 – 63.8]
Protein (g/1000 kcal/d) [c]	42.1 ± 9.0 40.8 [27.1 – 67.8]	59.1 ± 14.1 62.1 [28.7 – 82.3]	62.7 ± 15.2 60.2 [35.1 – 96.7]	20.6 ± 16.5 17.7 [-9.8 – 61.9]****
Protein (percent of energy) [c]	17.0 ± 3.9 16.6 [10.4 – 28.5]	23.9 ± 6.1 25.0 [11.1 – 35.1]	25.5 ± 6.7 24.3 [14.4 – 40.1]	8.5 ± 7.3 6.5 [-5.8 – 26.4]****
Protein (g/kg/d) [c,e]	0.87 ± 0.2 0.86 [0.39 – 1.3]	0.95 ± 0.26 0.91 [0.43 – 1.7]	1.00 ± 0.28 0.96 [0.58 – 2.0]	0.13 ± 0.3 0.08, [-0.36 – 1.1]***
Total fat (g/d) [c]	69.7 ± 23.3 64.2 [21.8 – 139]	44.9 ± 16.0 41.2 [16.6 – 104]	41.0 ± 12.9 39.5 [22.6 – 83.5]	-28.7 ± 25.2 -28.1 [-114 – 45.9]****

Table 3.2

Overall changes in diet for completers; all groups combined. Mean ± SD (n = 61)[a]

Variable	**Baseline**	**Midpoint** (3 months)	**Post-intervention** (6 months)	**Change**[b]
	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]
Total fat (g/1000 kcal/d)	40.6 ± 6.6 41.6 [24.8 – 56.1]	35.1 ± 6.5 35.4 [22.9 – 46.9]	34.1 ± 5.9 33.2 [18.3 – 46.7]	-6.6 ± 7.9 -6.8 [-23.5 – 12.6]****
Total fat (% energy) [c]	35.3 ± 6.0 35.8 [22.2 – 47.9]	30.1 ± 5.7 30.2 [19.3 – 40.4]	29.7 ± 5.2 29.2 [16.5 – 41.0]	-5.6 ± 7.0 -5.6 [-21.2 – 12.6]****
Saturated fat (g/d) [c]	22.9 ± 9.0 21.9 [7.7 – 57.0]	14.2 ± 5.8 12.7 [5.1 – 34.0]	13.1 ± 4.7 12.4 [6.1 – 30.2]	-9.8 ± 9.4 -8.2 [-41.0 – 9.4]****
Saturated fat (g/1000 kcal/d) [c]	13.3 ± 3.1 13.1 [7.6 – 23.0]	11.0 ± 2.7 10.8 [6.30 – 19.7]	10.8 ± 2.6 10.9 [5.7 – 17.6]	-2.5 ± 3.4 -2.9 [-9.3 – 4.4]****
Saturated fat (% energy)	11.6 ± 2.7 11.5 [6.6 – 19.8]	9.6 ± 2.3 9.4 [5.7 – 16.7]	9.5 ± 2.2 9.3 [5.0 – 15.4]	-2.1 ± 2.9 -2.5 [-7.5 – 4.1]****
Alcohol (g/d) [c]	7.6 ± 11.4 0.08 [0.0 – 37.1]	3.9 ± 7.2 0.01 [0.0 – 27.8]	3.1 ± 5.6 0.01 [0.0 – 20.8]	-4.5 ± 8.4 -0.03 [-29.0 – 13.3]****
Alcohol (% energy) [c]	3.0 ± 4.5 0.04 [0.0 – 16.8]	2.1 ± 3.8 0.01 [0.0 – 15.3]	1.7 ± 3.1 0.01 [0.0 – 11.2]	-1.3 ± 3.3 -0.01 [-9.8 – 6.1]**
Fiber (g/d) [c]	20.5 ± 6.6 19.8 [8.0 – 45.5]	18.8 ± 5.7 18.3 [10.3 – 40.5]	18.1 ± 5.8 17.8 [8.2 – 41.6]	-2.3 ± 6.3 -1.6 [-18.8 – 11.7]**
Fiber (g/1000 kcal/d) [c]	12.4 ± 4.2 12.0 [6.0 – 29.7]	15.2 ± 4.6 14.3 [8.2 – 30.6]	15.5 ± 5.2 15.0 [8.6 – 36.7]	3.1 ± 4.6 3.0 [-6.1 – 12.7]****
Calcium (mg/d)[c]	782 ± 252 751 [390 – 1395]	698 ± 257 655 [292 – 1510]	666 ± 254 639 [243 – 1754]	-115 ± 284 -90 [-798 – 568]**

Table 3.2

Overall changes in diet for completers; all groups combined. Mean ± SD (n = 61)[a]

Variable	**Baseline**	**Midpoint** (3 months)	**Post-intervention** (6 months)	**Change**[b]
	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]	Mean ± SD Median [Range]
Vitamin D (μg/d)[c]	4. 6 ± 3.2 3.6 [0.5 – 16.0]	4.4 ± 3.6 3.0 [0.6 – 19.6]	4.4 ± 4.0 3.4 [0.4 – 20.5]	-0.1 ± 4.7 -0.9 [-11.8 – 13.8]
Vitamin C (mg/d)	81.8 ± 45.3 69.4 [13.4 – 184]	87.8 ± 34.3 84.9 [17.8 – 154]	83.6 ± 44.7 71.6 [17.7 – 252]	1.9 ± 56.2 -1.0 [-109 – 174]

a. Nutrient from food and beverage intake; does not include supplements

b. Change from baseline (0 months) to post-intervention (6 months); Paired t-test for normally distributed variables, Wilcoxon-sign-ranked-sum test for non-normally distributed variables, McNemar's Chi-square for categorical variables

c. Variable with non-normal distribution

d. Energy intake as a percent of energy needs to maintain body weight at that measurement time; Mifflin St. Jeor Equation: [((10*Body Weight (kg)) + (6.25*Height (cm)) – (5*Age(y) - 161)]*1.3 (activity factor);

e. Grams per kilogram current body weight

* P < 0.05, **P < 0.01, ***P < 0.001, ****P < 0.0001

Table 3.3

Changes in daily dietary intake over 6 month weight loss trial by intervention group. Mean ± SD or percent (%)

Variable	HP-EX[a] (n = 19)	HP[b] (n = 20)	CP-EX[c] (n = 22)	P value for planned comparisons[d]			
				(HP-EX + HP) vs. CP-EX	(HP-EX + CP-EX) vs. HP	HP-EX vs. (HP + CP-EX)	HP-EX vs. CP-EX
Energy (kcal/d)							
Baseline	1744 ± 527	1675 ± 398	1679 ± 370				
Post-intervention	1256 ± 259	1182 ±254	1145 ± 196				
Change	-488.5 ± 653**	-493 ± 329****	-534 ± 327****	0.72	0.89	0.84	0.75
Energy (percent of calculated need[e])							
Baseline	101 ± 31.1	95.0 ± 20.6	99.4 ± 20.0				
Post-intervention	76.2 ± 11.3	71.8 ± 16.5	72.6 ± 13.0				
Change	-25.0 ± 36.8**	-23.2 ± 17.3****	-26.8 ± 19.6****	0.69	0.70	0.99	0.82
Carbohydrate (g/d)							
Baseline	200 ± 64.2	185 ± 50.8	199.5 ± 54.2				
Post-intervention	132 ± 32.1	123 ± 34.2	147 ± 26.2				
Change	-68.4 ± 68.1***	-61.5 ± 50.1***	-52.6 ±56.3***	0.43	0.95	0.48	0.39
Carbohydrate (% Energy)							
Baseline	44.9 ± 6.2	42.9 ±7.5	46.2 ± 9.2				
Post-intervention	40.4 ± 4.5	38.9 ± 4.7	49.5 ± 6.5				
Change	-4.5 ± 7.8*	-4.0 ± 8.2*	3.2 ± 8.4	0.001	0.13	0.071	0.003
Protein (g/d)							
Baseline	73.8 ± 22.8	70.0 ± 19.1	67.5 ± 14.6				
Post-intervention	85.4 ± 16.7	84.0 ± 14.6	55.1 ± 8.9				
Change	11.6 ± 28.8	14.0 ±17.8**	-12.4 ± 12.7****	<0.0001	0.012	0.061	<0.001
Protein (percent of energy)							
Baseline	17.4 ± 4.4	17.0 ± 3.6	16.7 ± 4.0				
Post-intervention	27.8 ±4.4	30.3 ± 6.4	19.1 ± 2.4				
Change	10.4 ± 5.0****	13.3 ±7.5****	2.4 ± 4.2**	<0.0001	<0.0001	0.11	<0.0001
Protein (g/kg/d)							
Baseline	0.90 ± 0.29	0.83 ± 0.24	0.87 ± 0.19				
Post-intervention	1.14 ± 0.24	1.12 ± 0.30	0.78 ± 0.11				
Change	0.23 ±0.36*	0.28 ±0.27***	-0.08 ±0.16*	<0.0001	0.006	0.086	<0.001

Table 3.3

Changes in daily dietary intake over 6 month weight loss trial by intervention group. Mean ± SD or percent (%)

Variable	HP-EX[a] (n = 19)	HP[b] (n = 20)	CP-EX[c] (n = 22)	P value for planned comparisons[d]			
				(HP-EX + HP) vs. CP-EX	(HP-EX + CP-EX) vs. HP	HP-EX vs. (HP + CP-EX)	HP-EX vs. CP-EX
Total fat (g/d)							
Baseline	74.5 ± 27.8	71.0 ±21.8	64.4 ± 20.3				
Post-intervention	44.7 ±13.0	40.4 ± 14.0	38.3 ± 11.5				
Change	-29.6 ± 35.7**	-30.6 ±20.3****	-26.2 ±18.4****	0.56	0.71	0.86	0.66
Total fat (% energy)							
Baseline	36.7 ±5.5	36.7 ± 5.2	33.0 ± 6.5				
Post-intervention	30.9 ± 4.7	29.5 ± 5.8	28.8 ± 4.9				
Change	-5.8 ±7.5**	-7.2 ± 6.9***	-4.1 ±6.7*	0.22	0.25	0.95	0.46
Saturated fat (g/d)							
Baseline	25.1 ± 12.0	22.7 ± 7.4	21.0 ± 6.9				
Post-intervention	13.3 ± 3.4	13.8 ± 5.6	12.2 ± 4.9				
Change	-11.8 ±13.5***	-8.9 ±7.3****	-8.8 ±6.5****	0.54	0.59	0.26	0.31
Saturated fat (% energy)							
Baseline	12.3 ± 3.2	11.7 ±2.5	10.7 ± 2.3				
Post-intervention	10.3 ± 2.6	10.1 ± 2.5	9.1 ± 2.2				
Change	-3.0 ± 3.0**	-1.7 ± 3.0*	-1.6 ± 2.7*	0.36	0.42	0.096	0.13
Alcohol (g/d)							
Baseline	2.6 ± 4.5	8.73 ± 11.7	10.8 ± 14.1				
Post-intervention	2.0 ± 5.4	2.4 ± 4.1	4.7 ±6.8				
Change[f]	-0.6 ±5.7	-6.4 ±8.6**	-6.1 ±9.4**	0.36	0.28	0.041	0.091
Alcohol (% energy)							
Baseline	1.2 ± 2.1	3.5 ± 4.5	4.2 ±5.6				
Post-intervention	1.0 ± 2.6	1.4 ± 2.4	2.6 ±3.8				
Change[f]	-0.2 ± 2.8	-2.1 ±2.8**	-1.6 ±3.8*	0.74	0.24	0.12	0.30
Fiber (g/d)							
Baseline	19.8 ± 5.2	19.8 ± 6.3	21.6 ±7.9				
Post-intervention	17.5 ± 4.4	15.9 ± 4.6	20.7 ±6.9				
Change	-2.2 ±5.7	-4.0 ± 6.7*	-0.9 ± 6.3	0.20	0.17	0.91	0.50

Table 3.3

Changes in daily dietary intake over 6 month weight loss trial by intervention group. Mean ± SD or percent (%)

Variable	HP-EX[a] (n = 19)	HP[b] (n = 20)	CP-EX[c] (n = 22)	P value for planned comparisons[d]			
				(HP-EX + HP) vs. CP-EX	(HP-EX + CP-EX) vs. HP	HP-EX vs. (HP + CP-EX)	HP-EX vs. CP-EX
Fiber (g/1000 kcal/d)							
Baseline	11.8 ± 3.4	12.1 ± 3.6	13.2 ± 5.2				
Post-intervention	14.1 ± 3.4	13.6 ± 3.6	18.4 ±6.4				
Change	2.2 ± 4.6	1.5 ± 4.7	5.2 ± 3.8****	0.004	0.17	0.33	0.016
Calcium (mg/d)							
Baseline	768 ± 280	791 ± 252	785 ± 238				
Post-intervention	645 ± 205	764 ± 312	596 ± 213				
Change[f]	-123 ± 303	-26.9 ± 267	-189 ± 272**	0.120	0.20	0.76	0.30
Vitamin D (µg/d)							
Baseline	4.8 ± 4.1	5.4 ± 3.2	3.6 ± 1.7				
Post-intervention	4.2 ± 3.1	4.8 ± 5.2	4.3 ± 3.7				
Change[f]	-0.6 ± 5.2	-0.6 ± 4.8	0.7 ± 4.3	0.26	0.45	0.69	0.42
Vitamin C (mg/d)							
Baseline	88.6 ± 46.7	71.3 ± 41.1	85.3 ± 48.1				
Post-intervention	89.2 ± 51.9	76.5 ± 44.2	85.2 ± 39.6				
Change[f]	0.6 ± 63.5	5.2 ± 58.4	-0.1 ± 49.9	0.96	0.61	0.56	0.65

a. HP-EX: Higher protein diet (30% energy from protein) and supervised exercise intervention
b. HP: Higher protein diet (30% energy from protein); no exercise intervention
c. CP-EX: Conventional protein diet (18% energy from protein) and supervised exercise intervention
d. P value for planned comparisons of changes over the intervention; simple contrasts for parametric data and Wilcoxon-Mann-Whitney test for non-parametric data.
e. Percent of energy needs = [energy intake (kcal/d) ÷ energy needed to maintain current body weight (kcal/d)] × 100; energy needed to maintain current body weight = Mifflin St. Jeor Equation: [((10*Body Weight (kg)) + (6.25*Height (cm)) – (5*Age(y) - 161)]*1.3 (activity factor)
f. Non-normal distribution
*P < 0.05; ** P < 0.01; *** P < 0.001; **** P < 0.0001 for difference within intervention group over time; paired t-test for normally distributed variables. Wilcoxon signed rank sum test for non-parametric data

Table 3.4

Adherence to dietary recommendations by intervention group[a] (n = 61). Percent (%)

Variable	HP-EX[b] (n = 19)	HP[c] (n = 20)	CP-EX[d] (n = 22)	Difference between intervention groups	
				Chi-Square Statistic	P-Value
Meeting RDA[e] protein (≥46 g/d, %)					
Baseline	89.5	85.0	100	3.33	0.19
Post-intervention	100	100	81.8	7.59	0.02
Meeting DGA[f] 2010 goal for saturated fat (<10% energy)					
Baseline	26.3	25.0	36.4	0.78	0.68
Post-intervention	52.6	50.0	68.2	1.67	0.43
Meeting fiber AI (21 g/d) [g]					
Baseline	42.1	35.0	50.0	0.97	0.62
Post-intervention	15.8	15.0	27.3	1.26	0.54
Meeting AI fiber per 1000 kcal[g]					
Baseline	21.0	25.0	31.8	0.63	0.73
Post-intervention	42.1	50.0	72.7	4.27	0.12
Meeting RDA calcium (≥ 1200 mg/d, %)					
Baseline	15.8	10.0	4.55	1.45	0.48
Post-intervention	5.26	5.00	0.00	1.17	0.56
Meeting RDA Vitamin D (51 – 70 y: ≥ 15 mcg/d; 70 y and older: ≥ 20 mcg/d, %)					
Baseline	0.00	0.00	0.00	-	-
Post-intervention	0.00	5.00	0.00	2.21	0.35
Meeting RDA vitamin C (≥ 75 mg/d, %)					
Baseline	63.2	35.0	45.4	3.16	0.21
Post-intervention	52.6	30.0	50.0	2.48	0.29
Energy recommendation (kcal/d) adherence at post-intervention (%)[h]					
Under consumers (<85% of recommendation)	15.8	35.0	31.8	2.74	0.60
Adherers (85 – 115% of recommendation)	73.7	50.0	59.1		
Over consumers (>85% of recommendation)	10.5	15.0	9.1		

Protein recommendation (% of energy) adherence at post-intervention (%)[i]					
Under consumers (<85% of recommendation)	31.6	30.0	9.1	4.91	0.30
Adherers (85 – 115% of recommendation)	52.6	40.0	63.6		
Over consumers (>85% of recommendation)	15.8	30.0	27.3		

a. All participants received multivitamin mineral supplement formulated for older women and additional calcium to meet nutrient needs during energy-restriction
b. HP-EX: Higher protein diet (30% energy from protein) and supervised exercise intervention
c. HP: Higher protein diet (30% energy from protein); no exercise intervention
d. CP-EX: Conventional protein diet (18% energy from protein) and supervised exercise intervention
e. RDA is Recommended Dietary Allowance (Dietary Reference Intakes, Institute of Medicine)
f. DGA is Dietary Guidelines for Americans, 2010
g. AI is Adequate Intake (Dietary Reference Intakes, Institute of Medicine)
h. Energy adherence = (mean energy intake at post-intervention ÷ individual energy recommendation) ×100; Energy recommendation based on needs to maintain current weight less 500 kcal/d for weight loss; see methods for details
i. Energy adherence = (mean protein intake at post-intervention ÷ protein recommendation) ×100; protein recommendation is 30% energy for HP-EX, HP or 18% energy for CP-EX

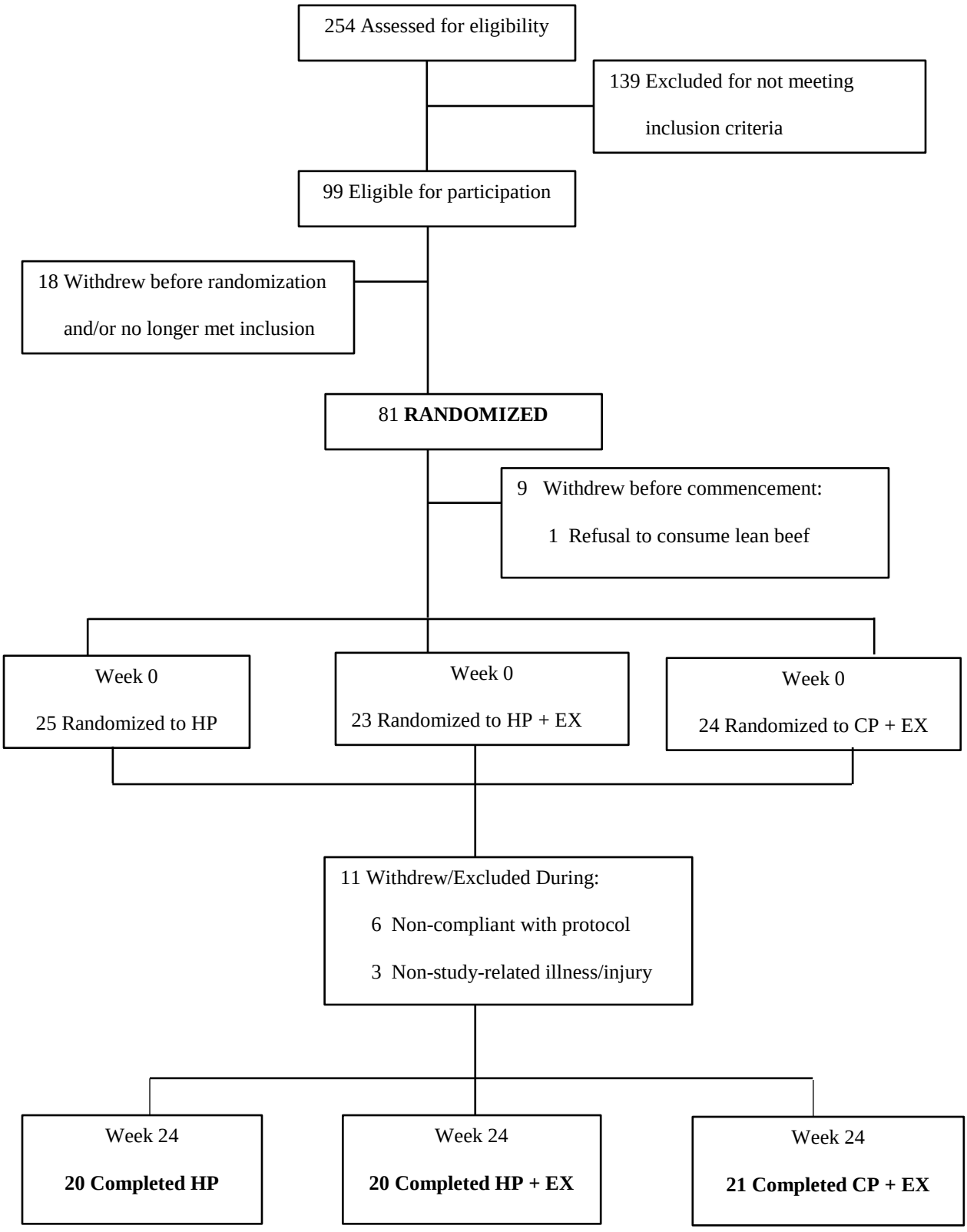


Figure 3.1 Participant Flowchart

CHAPTER IV

CHANGES IN EATING BEHAVIORS ARE ASSOCIATED WITH INTENTIONAL WEIGHT LOSS FOLLOWING INTERVENTION IN OLDER WOMEN[1]

[1]Berg, A.C., Evans, E.M., and Johnson M.A. To be submitted to *Appetite.*

Abstract

Background: Obesity in older women (≥ 60 y) exceeds 35% and evidence is increasingly strong for the benefits of weight loss to improve chronic conditions and physical function in this group. However, studies in younger people indicate that many dieters don't achieve weight loss goals, and that psychological constructs, particularly eating behaviors and depressive symptoms, may play a role. This study examined the relationships of eating behaviors, depression, and weight loss in overweight and obese older women enrolled in a weight loss study. *Methods:* Older women (65 – 80 y) enrolled in a supervised weight loss study (n = 61) completed assessments of eating behaviors (Three Factor Eating Questionnaire) and depression (Centers for Epidemiologic Studies Depression Scale) at baseline and post-intervention (6 months). *Results:* Weight loss was -9.2 ± 4.8 % of initial body weight. Measures of restraint increased significantly ($P < 0.0001$) from baseline to post-intervention, and effect sizes were large (> 1.2). Increases in flexible restraint and decreases in rigid restraint of eating behavior were associated with better weight loss ($P < 0.01$). Depressive symptoms were not related to weight loss, but were more prevalent in individuals who withdrew from the study after baseline testing ($P < 0.001$, n = 11). *Conclusions:* Encouraging a flexible approach to eating behavior and dieting and discouraging guilt in response to the occasional high calorie food may lead to better weight loss outcomes for overweight and obese older women trying to lose weight. Symptoms of depression in older overweight or obese women may be a risk factor for withdrawing from weight loss studies, so this should be explored further to determine the appropriate role for mental health services during weight loss interventions.

Introduction

Obesity in older adults is associated with functional limitations, nursing home admission, and exacerbation of obesity-related co-morbidities (Vincent, Vincent, and Lamb 2010, Mathus-Vliegen et al. 2012, Vincent, Raiser, and Vincent 2012, Johnson and Bales 2014). Older women (>60 y) are of particular public health interest because they are at greater risk for obesity-related functional decline, have longer life expectancies, and higher prevalence of obesity than their male older adult counterparts (women: 38.1% obese, men: 32.0% obese, Ogden et al. 2013, Valentine et al. 2009, Federal Interagency Forum on Aging-Related Statistics 2012). In recent years, evidence has become increasingly strong for the benefits of weight loss that combines energy restriction and exercise in obese and overweight older adults (Johnson and Bales 2014, Vincent et al. 2012, Villareal 2013, McTigue, Hess, and Ziouras 2006). However, evidence from younger people indicates that weight loss success is highly variable and may be moderated by other factors that influence diet and exercise (Elfhag and Rossner 2005, Moroshko, Brennan, and O'Brien 2011, Teixeira et al. 2015).

For more than 50 years, researchers have explored psychological factors for their potential to explain some of the individual variation in obesity and weight loss, and much of this research has focused on cognitive control over eating behavior (Stunkard and Messick 1985a, Teixeira et al. 2002, Bruch 1948, Johnson, Pratt, and Wardle 2012). The eating behaviors assessed by the 51 item Three Factor Eating Questionnaire (TFEQ-51, cognitive restraint, disinhibition, and hunger,Stunkard and Messick 1985a) have been widely studied as potential psychological predictors of BMI and weight loss (Teixeira et al. 2005), but most of these studies have focused on younger and middle-aged adults. As described by Stunkard and Messick (1985), cognitive restraint refers to an individual's self-reported behavior to consciously control

or limit food intake as a means to control body weight. Disinhibition refers to the self-reported inability to restrict or control eating in certain circumstances (social situations, feelings of depression or anxiety) despite absence of physiological hunger (Stunkard and Messick 1985a). Perceived hunger or susceptibility to hunger refers to subjective feelings of hunger and food cravings and an individual's self-reported likelihood to consume food in response to those subjective feelings (Stunkard and Messick 1985a). Studies of middle-aged women indicate that low cognitive restraint and high disinhibition are associated with higher weight and BMI, but results for hunger are varied (Foster et al. 1998, Dykes et al. 2004, Konttinen et al. 2015).

The flexible and rigid control subscales of cognitive restraint (Westenhoefer 1991c), have been proposed as potential refinements of the cognitive restraint scale that are differentially related to cognitive control over eating and may better predict responsiveness to weight loss intervention (Riesco et al. 2009, Westenhoefer, Stunkard, and Pudel 1999). Westenhoefer et al. (1991) proposed that flexible restraint may be more conducive to weight loss and long-term weight management, while rigid control may be more likely to lead to disinhibition and weight gain.

In addition to eating behaviors, depression is another psychological factor that has been associated with obesity and weight loss (de Wit, van Straten, and Cuijpers 2008, Luppino et al. 2010, Fabricatore et al. 2011). Although researchers generally agree that obesity and depression are related across the life span, the directional influences of obesity and depression remain to be clarified (Fabricatore et al. 2011, Forman-Hoffman et al. 2007, Luppino et al. 2010, Payne 2009). Studies in older adults report conflicting relationships between depressive symptoms, obesity and weight loss following intervention (Forman-Hoffman et al. 2007, Fabricatore et al. 2011). In a prospective cohort study by Forman-Hoffman et al. (2007) baseline depressive

symptoms predicted both weight gain and weight loss in older people (intentionality of weight change was not reported), as did increased functional limitations and medical illness. In their review, Fabricatore et al. (2011) report that intentional weight loss following lifestyle intervention is associated with a reduction in depressive symptoms in middle-aged adults and that interventions including both diet and exercise were superior to diet or exercise alone or control (Fabricatore et al. 2011). More research is needed to elucidate the relationship between depressive symptoms, obesity, and weight loss in older adults.

Because evidence from younger people suggests that the variability in weight loss is not fully explained by diet and exercise alone and that psychological factors may play an important role as both predictors of obesity and weight loss and intervention targets, further research into the relationships of these psychological constructs with obesity and weight loss in older women is warranted. Therefore, the purpose of this study was to assess the relationships of self-reported eating behaviors and depression with intentional weight loss in older women. The sample was overweight and obese older women (≥65 y) enrolled in a 6 month behavioral weight-loss intervention and the psychological variables of interested were measured by the Three Factor Eating Questionnaire (TFEQ) and the Centers for Epidemiologic Studies Depression Scale (CES-D) spell out if not already done so in this chapter (). It was hypothesized that following the intervention, improvements in cognitive restraint and flexible restraint along with reductions in disinhibition, hunger and depression would be associated with greater weight loss.

Methods

Participants

Data for these analyses come from a study originally designed to assess the effectiveness of a higher protein weight loss diet and exercise for improvements in body composition, physical

functional performance, and feelings of fatigue and energy. All materials and methods were approved by the Institutional Review Board at the University of Georgia. Participants were recruited from the Athens, Georgia community and surrounding areas for participation in a weight loss intervention through word of mouth, flyers, email to listservs, and paid newspaper advertisements. Inclusion criteria were postmenopausal female, age 65 to 80 y, all races, BMI ≥25, and weight stable within 2 kg and sedentary (<1 hour per week of physical activity or less than 2 exercise sessions per week) over the past 6 months. Exclusion criteria were: smoking; dietary restrictions that preclude adherence to the dietary protocol; history of unstable CVD; self-report of active cancer or treatment within previous five years; mini-mental state exam score less than 25 (Folstein et al. 2013); self-report or clinician report of clinical depression, other psychiatric or cognitive disorder that precludes ability to adhere to study protocols, severe arthritis, asthma or other pulmonary condition that precludes adherence to exercise prescription, or current diagnosis of balance disorders. Inclusion and exclusion criteria were determined through a series of phone calls and in-person visits. After participants were determined to meet the inclusion criteria and expressed interest in participating in the study, participants were randomized using an internet application (randomnumbergenerator.org) to one of three treatments: high protein diet with exercise (HP-EX), high protein without exercise (HP), or conventional protein with exercise (CP-EX). All participants were required to obtain personal physician clearance to participate. Those who were randomized to the exercise interventions were required to complete a graded exercise test administered by the study physician to ensure safety when performing moderate intensity exercise. Any abnormalities or concerns from the graded exercise test were shared with the participant's personal physician to determine appropriateness to participate.

Measurements

Measurements were conducted at baseline (0 months), midpoint (3 months), and post-intervention (6 months). All baseline assessments were conducted after randomization and before the participant began the intervention. All post-intervention testing visits occurred immediately following completion of the intervention. All testing visits occurred on the University of Georgia campus and were conducted by trained graduate students in Departments of Kinesiology and Foods and Nutrition, and/or supervised undergraduate students. All questionnaires were completed by the participant with the interventionists present to provide instructions for completion and any clarification necessary.

Demographics

Demographic information, including age, gender, race, income, education, employment status, place of residence, and number of individuals living in the household, were obtained via interviewer administered questionnaire over two screening visits: initial phone interview, in-person follow-up.

Anthropometrics

Barefoot standing height was measured to the nearest 0.1 cm with a stadiometer with the participant wearing light clothing and no shoes. Body weight was measured to the nearest 0.1 kg at baseline and throughout the study with a digital scale with the participant wearing light clothing. Body mass index (BMI, kg/m^2) was calculated from weight and standing height at baseline and post-intervention, (NHLBI, 2000). Waist circumference (WC) was assessed by three measurements of the natural waist. As per NHLBI guidelines, greater than of 88 cm (35 inches) for women will be considered abdominally obese (NHLBI, 2000). Whole body fat mass,

lean mass, and bone mass was assessed with dual-energy X-ray absorptiometry (DXA, GE Lunar-iDXA^{TM}, enCORE 2007, version 11.30.062, Madison, WI).

Psychological assessment

Psychological constructs were assessed via participant completed questionnaires at baseline (0 months), midpoint (3 months) and post-intervention (6 months), but for the purposes of this study only the baesline and post-intervention measures were used. Eating behaviors (cognitive restraint, disinhibition, and susceptibility to hunger) were assessed with the Three Factor Eating Questionnaire (TFEQ, Stunkard and Messick 1985a), and scores were calculated by the study investigators according to the original guidelines (Stunkard and Messick 1985). Ranges for each eating behavior are indicated in Table 4.1. For missing item data, a score was imputed by substituting the average value from completed questions for that eating behavior in that section, (4 participants were missing one question each at baseline and 1 participant was missing 1 question at post-intervention). Questionnaires with multiple missing items were not included in this analysis. The flexible and rigid restraint subscales of cognitive restraint were measured with a subset of 14 questions (7 for each scale) identified by Westenhoefer (1991) from the TFEQ and summary scores (range, 0 – 7) were calculated for each subscale (Westenhoefer 1991).

Depressive symptoms were assessed with the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff 1977). The CES-D includes 20 questions about depressive symptoms answered on a four point scale from 0, “rarely or none of the time” (< 1 day), to 3, “most or all of the time” (5 – 7 days). Four items are worded positively and reverse scored (Radloff 1977, Smarr and Keefer 2011). The remaining items are scored as indicated, from zero to three. The items scores are summed and the total score ranges from 0 to 60 (Radloff 1977).

Higher scores represent greater presence and persistence of depressive symptoms (Naughton and Wiklund 1993b, Radloff 1977, Smarr and Keefer 2011). A cut-off score of $\geq$16 is generally considered indicative of possible depression, while a score of 20 or greater is indicative of probable depression (Naughton and Wiklund 1993a, Radloff 1977).

Dietary assessment

Participants completed diet records for three days, including two weekdays and one weekend day at baseline, midpoint, and post-intervention. Participants were asked to record all food and beverages consumed during those 24 hour periods, including preparation method, brand names when available, and portion sizes. Participants were provided a National Science Foundation (NSF) certified digital food service scale (Escali 136KP Alimento Pro, Burnsville, MN) to weigh their food, and interventionists provided instructions on proper use (zeroing, subtracting the weight of cups or plate, notating whether the measurement was before or after cooking). Participants were asked to use measuring cups and spoons to measure their food and were provided a reference sheet for estimating portion sizes when these tools were not available. After each reporting period, the research dietitian or trained interviewer reviewed the record with the participant to clarify information provided and allow the participant multiple opportunities to recall forgotten foods and detailed information about food and beverage intake. Food models were used as needed to verify portion sizes. Dietary intake data was assessed using the Nutrition Data System for Research (NDSR 2013, Minneapolis, MN) to determine three day average energy intake and diet composition. For the two participants missing midpoint dietary data, baseline values were substituted for midpoint values, but only baseline and post-intervention were used for the current analyses.

Dietary Intervention

Participants met with a registered dietitian nutritionist (RDN) and were provided individual diet goals based on a reduction of approximately 500 kcal from calculated energy needs: Mifflin St. Jeor equation using baseline body weight; activity factor 1.3, (Seagle et al. 2009) to promote loss of 0.23 kg (0.5 pounds) to 0.91 kg (2 pounds) per week (NHLBI, 2000, Pi-Sunyer et al. 1998, Seagle et al. 2009, Jensen et al. 2014). No adjustment was made for additional energy expended during the exercise intervention. The RDN monitored participants for weight change throughout the study, and made adjustments to energy goals as necessary to promote continued weight loss. The RDN also counseled participants to meet specific percentages of macronutrients, including recommendations for protein. The recommended higher protein diet was designed to provide 30% of energy from protein (~1.6g/kg/d) and the recommended conventional protein (CP) diet was designed to provide 18% of energy from protein (0.8g/kg/d). Both diets were designed to provide 30% of energy from fat, and the remainder of energy from carbohydrate (HP: 40%, CP: 52%). Participants in the higher protein diet intervention groups were instructed to consume at least one serving of cooked lean beef (3 oz) per day as part of the primary investigation, and this was discussed in greater detail in chapter 3. Participants in all groups self-selected and procured their foods and beef was not provided as part of the study.

At the beginning of the intervention, participants attended a minimum of two individual sessions with the RDN or supervised nutrition graduate student for instruction regarding energy restriction, macronutrient distribution of the intervention diet, and self-monitoring methods. For the remainder of the study, participants attended weekly educational/motivational group sessions (45 – 60 minutes) with the RDN or supervised graduate student, and individual sessions as

necessary to meet weight loss goals. Participants' dietary records were monitored weekly, and individual written feedback from the RDN or supervised graduate student was provided at each group session. The group session curriculum was based on Social Cognitive Theory (Bandura 2004) and topics included general nutrition education and behavioral strategies for weight management. All participants attended one individual session at the midpoint of the intervention to assess progress toward weight loss and dietary goals. For further information about the dietary intervention, see Appendix B.

Exercise intervention

Participants randomized to an exercise intervention group (HP-EX, CP-EX) completed three exercise sessions per week on non-consecutive days) (~75 min/session) for six months. Participants assigned to the higher protein diet with no exercise sessions were asked to maintain current activity levels for the duration of the study. Activity levels of the higher protein no exercise (HP) intervention group were monitored through verbal communication with the participants.All exercise sessions were conducted by trained graduate students in the University of Georgia, Department of Kinesiology. The exercise intervention was a multicomponent program that integrated cardiorespiratory training, resistance training, balance, flexibility and functional activities. Cardiorespiratory training included 30 minutes of continuous exercise (walking on a treadmill, cycling or using an elliptical) at 70-80% of age-predicted maximal heart rate. Resistance training included upper body, lower body, and abdominal exercises in two sets of 8 to 10 repetitions at 65% of one-repetition maximum (1-RM). Each session included 5 to 10 minutes of flexibility and balance, and two 30-second sets of functional activities (chair rises, wall push-ups, lift-and-carry, and transfer task). Further details of the exercise intervention are described elsewhere (Evans et al. 2015).

Statistical analysis

All statistical analyses were performed using SAS version 9.4, Cary, NC. Differences between intervention groups at all data collection times were assessed with one-way ANOVA (normally distributed dependent variable), t-tests and chi-square tests. Paired T-tests and Wilcoxon-rank sum tests (non-parametric data) were used to explore differences between completers and non-completers for continuous variables. For categorical variables, the non-completers and non-completers were compared via Fisher's exact test due to small cell frequencies (< 5). Changes in anthropometrics, diet, and the psychological measures from baseline to post-intervention were assessed with paired t-tests and Wilcoxon-rank sum tests (non-parametric data). There are many ways to calculate effect sizes. To provide a more conservative estimate of effect size, the standard deviation at baseline was chosen, as it was larger than post-intervention for all measures. Effect sizes for changes from baseline to post-intervention in anthropometrics, energy intake (kcal/d and % of needs), disinhibition, hunger, and depressive symptoms (CES-D total score) were calculated by subtracting the mean at post-intervention from the mean at baseline and dividing by the standard deviation at baseline. Similarly to indicate change in the measure, effect size for cognitive restraint, flexible and rigid restraint, the mean at baseline was subtracted from the mean at post-intervention and then divided by the standard deviation at baseline (Kazis et al. 1989).

To explore the relationships between psychological factors and obesity, correlations were performed with baseline weight (kg), BMI, eating behaviors, and related change variables (Tables 4.2 and 4.4). Spearman correlations were performed due to non-normal distribution of outcome data (change in energy intake, psychological variables). Variables with significant correlations were then used in a series of linear regression analyses to explore the predictive and

independent ability of the psychological variables of interest above and beyond variables known to influence weight loss (change in energy intake in kcal and baseline degree of obesity as assessed by dietary records and BMI).

Results

Characteristics of participants who completed baseline testing and enrolled in the study (n = 72) are reported in Table 4.1. Baseline demographic and anthropometric characteristics were similar across intervention groups, with the exception of BMI. Baseline BMI of the conventional protein diet and exercise (CP-EX) group (29.2 ± 3.1) was lower than the other two groups (HP-EX: 32.2 ± 6.1, HP: 32.4 ± 4.57, $P < 0.05$). Psychological variables were similar across groups, with the exception of baseline disinhibition. Baseline disinhibition of the higher protein diet group (HP: 10.1 ± 2.4) was higher than baseline disinhibition of the standard protein and exercise group (CP-EX: 7.48 ± 3.6, $P < 0.05$). Baseline disinhibition of higher protein and exercise group (HP-EX: 8.44 ± 3.0) was not significantly different than the other two groups ($P > 0.05$, Table 4.1). There were no differences between groups with regard to the primary outcome of this analysis (percent weight loss). However, there may be differences between the three intervention groups with regard to the outcomes of the primary study, such as body composition and physical function, which will be explored in future analyses (Evans et al. 2015).

Attrition was 15% (n = 11, non-completers) with the primary reasons including time constraints, non-study related illness or injury, and non-compliance with participant reporting or attendance responsibilities (Figure 4.1). There were no differences in initial body weight, BMI or demographic characteristics between the completers and non-completers. Non-completers had greater total number of medical conditions (completers: median 1, range 0, 5; non-completers: median 2, range 1, 5, $P < 0.05$). Eating behavior scores were similar between

completers and non-completers. Median total score on the CES-D was greater in the non-completers than completers, (non-completers: median 16, range 3, 31; completers: median 6, range 0, 27, $P < 0.05$), and accordingly, more non-completers met screening criteria for possible depression (CESD ≥16: 63.6% of non-completers versus 11.5% of completers, $P < 0.001$; Fisher's Exact Test). There was no difference between non-completers and completers in self-reported psychoactive medication use.

Changes in body weight, eating behaviors, and depression

Among the completers of the intervention (n = 61) mean weight change was -9.2 ± 4.8% of initial body weight (range -23.1% to +2.0%) and mean change in BMI was -2.9 ± 1.6 kg/m^2 ($P < 0.0001$, Table 4.2), and there were no differences between intervention groups (HP-EX, CP-EX, HP, data not shown). Energy intake among participants decreased significantly from baseline to post-intervention (-506 ± 447 kcal/d, $P < 0.0001$), and mean energy intake was 1192 ± 224 calories per day at post-intervention.

All eating behaviors and depressive symptoms changed in the expected direction during the intervention (Table 4.2, all $P < 0.01$). Cognitive restraint increased (5.5 ± 3.9 points), while disinhibition and hunger decreased, -2.4 ± 3.1 and -1.7 ± 3.2 points, respectively (all $P < 0.0001$). Flexible and rigid restraint also increased with treatment (flexible: 1.9 ± 2.6 points, rigid: 2.0 ± 1.6 points). Calculated effect sizes indicate moderate (at least 0.50) to large effects (at least 0.80) for anthropometrics, energy intake, and measures of eating behaviors. Although statistically significant, the effect size for depression was small (< 0.50, Cohen 1988, Table 4.2). Total score on the CES-D decreased from baseline to post-intervention (median -1, range -12, 5, $P < 0.01$), but the percentage of individuals with possible depression (CES-D ≥ 16) did not change significantly.

At baseline, the primary factors of the Three Factor Eating Questionnaire had adequate internal consistency (Cronbach's $\alpha > 0.7$, Nunnally 1978). While disinhibition ($\alpha = 0.80$) and susceptibility to hunger ($\alpha = 0.81$) were internally consistent at post-intervention, cognitive restraint dropped below conventional standards for acceptability ($\alpha = 0.57$, Nunnally 1978), which will be discussed further in the limitations. The exploratory factors were less reliable both at baseline and post-intervention (flexible restraint: baseline $\alpha = 0.44$, post $\alpha = 0.33$, rigid restraint: baseline, $\alpha = 0.47$, post-intervention, $\alpha = 0.35$). As expected, the two subscales of cognitive restraint, flexible and rigid control were correlated with overall cognitive restraint and with each other (Table 4.3)

Baseline relationships of eating behaviors, body weight, and depression

Spearman correlations were conducted to determine baseline relationships among age, psychological factors, weight (kg), BMI, and related variables at baseline (Table 4.3). Higher cognitive restraint, flexible restraint, and rigid restraint were correlated with lower body weight (kg) and BMI baseline ($P < 0.05 - 0.10$), except that BMI and rigid restraint were not correlated ($P > 0.10$). Higher baseline disinhibition and hunger were associated with higher BMI and body weight (kg, $P < 0.01 – 0.10$). Depressive symptoms were not significantly associated with weight (kg) or BMI.

Predictors of weight change

Predictors of percent weight loss were identified through a series of steps that included correlation analyses and regression analyses. Correlational analyses revealed no relationship of age, baseline body weight or BMI or any of the baseline psychological measures with percent weight lost (Table 4.4). Change in flexible restraint was significantly associated with weight loss

(*rho* = -0.41, P = 0.0009), and there was a trend for change in cognitive restraint (*rho* = -.24, P = 0.07).

Similar to other investigators (Urbanek et al. 2015, Foster et al. 1998), correlation analyses were used to identify potential control variables. Both baseline and change variables were considered. Because baseline energy intake showed a trend for a relationship with weight loss (*rho* = 0.19, P = 0.14) and change in energy intake was significantly associated with baseline energy intake, these variables were analyzed for potential as control variables for regression analyses exploring the relationships of eating behaviors with weight loss. Together, baseline energy intake as a percentage of energy needs (% EER) and change in energy intake from baseline to post-intervention were predictive of weight loss in this sample, $F(2, 58) = 3.52$, $P < 0.05$, and thus, these variables were retained as control variables. Similar to other investigators (Urbanek et al. 2015, Foster et al. 1998), baseline BMI and age were then explored in the regression models independently and together as possible control variables. Age and BMI were not significant predictors of weight loss ($P > 0.05$) and did not increase the percent variance explained in these models. Thus, to find a parsimonious yet meaningful model, only the variables with significant influence on percent weight loss (energy intake at baseline and change in energy intake) were retained as control variables.

Next, a series of linear regression analyses was performed to identify independent contributions of eating behaviors on the main outcome of interest: percent weight change. In all models, the control variables (baseline energy intake, change in energy intake) were entered first. Then, each baseline, change, and post-intervention eating behavior was entered into the model separately, and then in combination with the other behaviors. As correlation analyses suggested, neither baseline nor changes in disinhibition and hunger were associated with weight loss in any

of the regression models. Models including post-intervention disinhibition and hunger scores did not predict weight loss above and beyond the control variables (data not shown, all models: P > 0.05). Therefore, the remainder of the results focuses on cognitive restraint, and the two exploratory factors, flexible restraint and rigid restraint.

Baseline and changes in restraint as predictors of weight loss

Baseline cognitive restraint and subscales (flexible restraint and rigid restraint) were not associated with percent weight change (data not shown). Changes in restraint (cognitive restraint, flexible restraint, rigid restraint) from baseline to post-intervention were analyzed for association with percent weight loss in models 1 through 4 (Table 4.5). Changes in cognitive restraint (model 1) and rigid restraint (model 3) were not significantly associated with weight loss, after controlling for baseline energy intake and change in energy intake. However, an increase in flexible restraint (model 2) was associated with greater weight loss, F (3, 57) = 4.63, P = 0.006. Overall, an increase in flexible restraint accompanied by a decrease in rigid restraint explained the most variance (26%) in percent weight change, F (4, 56) = 4.97, P = 0.002 (model 4). Because changes in restraint contributed to percent weight loss, we also explored post-intervention values of these measures (Table 4.5, models 5 – 8). Higher post-intervention scores of cognitive restraint (model 5) and flexible restraint (model 6) were associated with greater percent weight loss, while rigid restraint alone (model 7) was not predictive of weight loss. Similar to what was seen in model 4, the combination of higher post-intervention flexible restraint and lower rigid restraint (model 8) was related to greater weight loss, F (4, 56) = 3.29, P = 0.02.

When Models 1 to 8 included age, diet intervention group (conventional protein or higher protein), and exercise intervention group (exercise or no exercise), the relationships of cognitive

restraint, flexible restraint, and rigid restraint with percent weight loss were not changed (data not shown).

Discussion

The purpose of this study was to identify psychological predictors of weight loss among older women enrolled in a supervised weight loss intervention. The major findings were that specific measures of cognitive restraint, particularly flexible restraint and rigid restraint, were consistent and independent predictors of percentage weight loss, while disinhibition, hunger, depressive symptoms, and age were not associated with percentage weight loss. This study adds new knowledge to our understanding of eating behaviors and depression in older women trying to lose weight, a population in need of targeted interventions.

The finding that changes in flexible and rigid restraint, together, were the most salient predictors of weight loss in our sample of older women is novel. First, this result adds to an emerging body of evidence that supports the hypothesis that the cognitive restraint scale of the Three Factor Eating Questionnaire (Stunkard and Messick, 1985) may be measuring two distinct aspects of dietary restraint (flexible and rigid control), and that these two constructs have differential impacts on weight management (Johnson and Pratt 2012, Westenhoefer 1991). Second, our findings suggest that an individual who is conscious about what he or she is eating to manage weight, but anticipates and responds to the occasional deviation from the plan without stress (flexible restraint) may be more successful at weight loss than is someone who is focused on strictly controlling calorie intake and feels a strong sense of guilt when eating high calorie foods (rigid restraint). In their recent review of self-regulation mediators of weight control in overweight and obese adults, Texeira et al (2015) identified flexible restraint as a potential mediator of medium/long-term weight control in overweight and obese middle-aged adults, but

noted that this conclusion was derived from a limited number of studies. The results of the present analyses agree with those of Teixeira et al. (2015) and provide new evidence of this relationship in older adults.

It is possible that the interventionists for this study encouraged flexible restraint through the intentional use of social cognitive theory and emphasis on messages about self-efficacy for managing eating-related events. In particular, there were repeated discussions of how to manage situations in which an individual eats high calorie foods that are not typical of her weight loss diet, such as at a party or family gathering. Interventionists encouraged removing guilt from the situation and returning to the weight loss diet with moderate modifications in the following hours or day after the event, such as skipping dessert or forgoing a typically scheduled snack. Although self-efficacy was not directly measured in this study, this observation agrees with the review by Texeira et al. (2015) that both self-efficacy and flexible restraint may be part of a group of several self-regulation behaviors that together may be associated with improved weight loss outcomes. In light of these findings, health practitioners might consider focusing less on adherence to strict dietary recommendations for weight loss (rigid restraint), and focus more on increasing a person's self-efficacy for managing their eating behavior in a variety of situations. These results, however, should be interpreted with caution in light of the poor internal consistency of the flexible and rigid restraint scales in this sample.

As noted in several reviews and previous weight loss studies (Stubbs et al. 2011, Teixeira et al. 2004, Teixeira et al. 2005), neither total score for depressive symptoms nor meeting the screening criteria for possible depression (CES-D $\geq$16) was associated with weight loss. However, individuals who withdrew from the study (non-completers) had more depressive symptoms and were significantly more likely to meet the screening criteria for possible

depression (63.6% of non-completers versus 11.5% of completers), but taking psychoactive medication was not related to attrition. Other weight loss research studies have found a similar relationship between depression at baseline and attrition, but most of these studies are in younger people (Fabricatore et al. 2011, Teixeira et al. 2004, Zhang et al. 2012). These findings suggest that: 1) overweight and obese older women may be less likely to seek treatment and diagnosis for depressive symptoms, and 2) that depressive symptoms may need to be addressed before or concurrently with weight loss treatment for an individual to be able to fully engage in a weight loss intervention. The CES-D is a quick self-report tool that can be used to screen for possible depression. Future researchers and health practitioners might consider using the CES-D or a similar questionnaire to identify individuals for referral to mental health providers before and during weight loss treatment.

In addition to depression, the design elements of the intervention, the higher protein diet and supervised exercise were not related to weight loss. This agrees with previous studies indicating that the macronutrient composition of the diet is less important than is energy restriction for producing weight loss. Similarly, although exercise is an energy expending activity, exercise does not typically produce a caloric deficit sufficient enough to produce weight loss independent of energy intake restriction. Thus, our findings support previous research that during intentional weight loss, energy restriction is more important than macronutrient composition of the diet or exercise for weight loss. However, these analyses consider only one outcome: percent weight loss. Future analyses may show that assignment to the higher protein diet and/or exercise may positively influence body composition and other important health outcomes, such as physical function. Lastly, this analysis only considered intervention

assignment, and not adherence to the assigned protocol. Thus, further analyses conducted by other researchers on this team (Evans et al. 2015) are warranted to explore these relationships.

The lack of relationship between age and percent weight loss in these older women indicates that age does not influence an overweight or obese older woman's ability to safely lose weight with varying recommendations for protein, modest energy restriction, and with or without exercise. Given the recent evidence for improvements in physical function and obesity related comorbidities with weight loss in obese older adults, high prevalence of obesity in older women, and the long life expectancy of older women, this should encourage health professionals to discuss weight loss with their overweight and obese older female clients in the context of practice guidelines specifically for older people (Villareal et al. 2005).

Limitations and strengths

This study had several limitations. The intervention was intense with regard to frequency of contact with the interventionists (at least once per week) who were health professionals and/or health professionals in training, which may not be generalizable to typical weight loss settings (e.g., consumer weight loss programs, one-on-one counseling with a registered dietitian). However, the intensity of the intervention likely contributed to the success of the intervention in achieving the goal of loss of 10% of initial body weight (mean weight change 9.2 ± 4.8%; 43% ≥10% weight loss). Additionally, the level of education in this study (72% Bachelor's degree or more) was greater than that of older women in the US (18% Bachelor's degree or more, Federal Interagency Forum on Aging-Related Statistics 2012), and thus, results may not be generalizable to many older women in the US. Furthermore, as education is highly correlated with income, the results may not be generalizable to lower income audiences. The Three Factor Eating Questionnaire asks questions about "stocking up" on tempting foods, which may not be

applicable to lower income audiences. More research is needed to determine if these relationships are similar in older adults with lower income and lower education, and modifications to the eating behavior questionnaire may be necessary to further investigate these relationships.

Internal consistency of several of the measures of eating behaviors, particularly flexible and rigid restraint, was lower than is conventionally acceptable in social science research (Cronbach's alpha ≥ 0.70, Nunnally 1978). Nonetheless, the relationships between the measures of restraint and weight loss were consistent and highly significant. Further research is needed to refine the flexible and rigid restraint scales and improve the psychometric properties. To that end, both the flexible and rigid control scales include questions about self-monitoring behavior which may limit interpretation, and this study did not measure self-monitoring as a separate variable. Participants were, however, asked to use a free internet application to monitor their food intake daily. The dietitian monitored the participants' reported intake weekly and provided individual feedback suggesting changes that could be made to promote weight loss and improve dietary quality. Thus, compliance with self-monitoring was an important part of this intervention. Nonetheless, the addition of a self-monitoring variable to this analysis would have added to our understanding of the relationships of these psychological constructs, eating behaviors, and weight loss assessed in this study.

Conclusions

This study provides new insights into the relationship of eating behaviors, depression, and weight loss in older women seeking weight loss treatment: an understudied population in need of targeted interventions. Evidence that flexible restraint in eating behavior is associated with greater weight loss may be quite useful in designing interventions for overweight and obese

older women and tailoring messages to improve weight loss outcomes. Highly palatable, energy-dense food is available ubiquitously and conveniently in the US, and eating at social events is part of the American culture. Interventions designed to help participants develop an approach to dieting that is not overly restrictive and accommodates the occasional highly palatable energy dense food and empowers dieters to be confident in managing these events may be more appealing to dieters. Moreover, the message of flexible restraint may be particularly appealing to older adults, who might be more likely to otherwise say, "Life is too short to diet." Lastly, the fact that depressive symptoms were related to non-completion of the intervention highlights the importance of mental health as part of overall health and wellness, even for older people.

Table 4.1
Selected participant characteristics before weight loss treatment for total sample and by intervention group. Mean ± SD or percent

Variable	Total Sample (n = 72)	HP-EX[a] (n = 23)	HP[b] (n = 24)	CP-EX[c] (n = 25)
Age (years)	69.4 ± 3.6	70.0 ± 4.4	69.5 ± 2.3	68.8 ± 3.8
Race/ethnicity				
White	96%	96%	96%	92%
Black	1%	-	-	4%
Hispanic	1%	4%	-	-
Native American	4%	-	4%	8%
Married (%)	60%	48%	58%	72%
Work status				
Full-time	7%	4.4%	13%	4%
Part-time	31%	35%	21%	36%
Not currently working	62.%	61%	67%	60%
Total medications	4.4 ± 2.6	4.2 ± 2.6	5.2 ± 2.4	3.8 ± 2.7[d]
	4 [0 – 11]	4 [0 – 10]	5 [1 – 11]	4 [0 – 9]
Currently taking psychoactive medication (%)	45.1%	43.5%	58.3%	33.3% [d]
Education – Highest degree achieved (%)				
High School	18%	13%	25%	16%
Vocational/Technical School	3%	-	4%	4%
2 year College	7%	17%	-	4%
Undergraduate	29%	22%	21%	44%
Master's Degree	38%	48%	46%	20%
Doctoral Degree/Professional School	6%	-	4%	12%
Household income				
$15,000 – $29,999	7%	9%	4%	8%
$30,000 – $44,999	14%	17%	17%	8%
$45,000 – $59,999	10%	17%	8%	4%
$60,000 – $74,999	8%	4%	4%	16%
$75,000 – $90,000	15%	17%	17%	12%
More than $90,000	12%	4%	25%	8%
Prefer not to answer	33%	30%	25%	44%
Weight (kg)	82.5 ± 12	84.4 ± 14	85.1 ± 13	78.3 ± 9.8
BMI (kg/m^2)*	31.2 ±4.9	32.2 ± 6.1	32.4 ± 4.6	29.2 ± 3.1[*]
Waist circumference (cm)	94.5 ± 11	96.8 ± 13	96.8 ± 10	90.3 ± 8.4
Fat (percent of total mass)	48.2 ± 3.9	49.1 ± 3.6	48.6 ± 4.1	47.0 ± 3.8
Energy (kcal/d)	1726 ± 413	1744 ± 480	1731 ± 417	1705 ± 356
Energy (percent of calculated need[e])	99.9 ± 23	101 ± 29	98.1 ± 20	101 ± 19
Protein (g/d)	70.3 ± 18	72.4 ± 21	71.0 ± 19	67.6 ± 14
Protein (g/kg/d)	0.86 ± 0.23	0.88 ± 0.28	0.85 ± 0.24	0.87 ± 0.19
Protein (% of energy)	16.7 ± 3.8	17.1 ± 4.1	16.7 ± 3.6	16.4 ± 3.9
Meeting RDA Protein (≥46 g/d)	93%	91%	88%	100%
Carbohydrate (g/d)	197 ± 55	201 ± 58	187 ± 55	202 ± 53

Table 4.1

Selected participant characteristics before weight loss treatment for total sample and by intervention group. Mean ± SD or percent

Variable	Total Sample (n = 72)	HP-EX[a] (n = 23)	HP[b] (n = 24)	CP-EX[c] (n = 25)
Carbohydrate (% energy)	44.5 ± 7.9	45.2 ± 5.8	42.2 ± 7.9	46.0 ± 9.3
Fat (g/d)	72.3 ± 24	74.4 ± 26	75.5 ± 24	67.2 ± 23
Fat (% energy)	36.0 ± 6.3	36.7 ± 5.1	37.6 ± 5.5	33.8 ± 7.4
Fiber (g/1000 kcal/d)	12.1 ± 4.1	11.3 ± 3.5	11.8 ± 3.5	13.1 ± 5.1
Fiber (g/d)	20.3 ± 6.8	18.9 ± 5.3	20.2 ± 6.9	21.8 ± 7.8
Physical activity (steps/d)	4966 ± 2080	5002 ± 2232[f]	4699 ± 2184[g]	5176 ± 1893[h]
Physical activity (min MVPA/day)[i]	9.5 ± 8.9	10.6 ± 11[f]	9.3 ± 8.2[g]	8.6 ± 7.7[h]
Physical function				
6 min walk (m)	108 ± 24	110 ± 27	106 ± 22	107 ± 23
Gait speed (m/s)	0.30 ± 0.06	0.31 ± 0.08	0.29 ± 0.06	0.30 ± 0.06
Total medical conditions	1.6 ± 1.1	1.6 ± 1.3	2.0 ± 0.91	1.0 ± 0.22
	2 [0 – 5]	1 [1 – 5]	2 [1 – 5]	1 [0 – 3]
Medical conditions				
Diabetes	10%	13%	17%	-
Hypertension	47%	45%	54%	42%
Cardiovascular disease	4%	4%	4%	4%
Pulmonary disease	19%	22%	25%	12%
Thyroid disorder	25%	35%	29%	12%
Sleep apnea	22%	17%	29%	20%
Eating behaviors (TFEQ)[j]				
Cognitive restraint (0 – 21)	10.5 ± 3.9	10.9 ± 4.2	10.2 ± 3.2	10.5 ± 4.2
Flexible restraint (0 – 7)	3.4 ± 1.5	3.5 ± 1.5	3.1 ± 1.4	3.7 ± 1.6
Rigid restraint (0 – 7)	3.1 ± 1.5	3.1 ± 1.6	3.1 ± 1.1	3.0 ± 1.7
Disinhibition (0 – 16)[k]	8.7 ± 3.2	8.4 ± 3.0	10.1 ± 2.4[k]	7.5 ± 3.6[k]
Hunger (0 – 14)	5.4 ± 3.1	6.2 ± 3.2	5.7 ± 3.2	4.5 ± 2.7
Depression (CES-D)[j]				
Total score (0 – 60)	8.9 ± 7.2	11.3 ± 8.4[l]	8.1 ± 6.1	7.3 ± 6.5[l]
Possible depression (%)[m]	19.4%	21.7%	20.8%	16%

a. HP-EX: Higher protein diet (30% energy from protein) and supervised exercise intervention
b. HP: Higher protein diet (30% energy from protein); no exercise intervention
c. CP-EX: Conventional protein diet (18% energy from protein) and supervised exercise intervention
d. N = 24
e. Reported energy intake (average caloric intake per day) as a percentage of energy needs for weight maintenance; % energy needs = baseline kcal/d ÷ estimated energy needs: [((10*body weight (kg)) + (6.25*height (cm)) – (5*age(y) - 161)] × [activity factor, 1.3]
f. N = 22
g. N = 21
h. N = 23
i. MVPA is moderate to vigorous physical activity
j. Ranges for each scale and subscale, if applicable, are in parentheses
k. Higher scores for disnihbition in HP compared to CP-EX intervention group($P < 0.05$); Test for difference in three groups (Kuskal –Wallis) not significant ($P > 0.05$)
l. Higher CES-D scores for HP-EX compared to CP-EX ($P < 0.05$); Test for difference among all groups (Kruskal-Wallis) not significant ($P > 0.05$)
m. At or above cutoff (16) for possible depression

Table 4.2
Baseline, post-intervention, and change in adiposity and psychological measures among completers of the 6 month weight loss intervention (n = 61)

Variable	Baseline	Post-intervention	Change	Effect size[a]	P[b] <
	Mean ± SD, Median [Range]	Mean ± SD, Median [Range]	Mean ± SD, Median [Range]		
Weight (kg)	82.1 ±12.0, 81.5 [53.7 – 118.1]	74.5 ± 11.7, 71.8 [49.8 – 113.9]	-7.53 ± 4.05, -8.1 [-22 – 1.7]	0.63	0.0001
Weight change (%)	-	-	-9.17 ± 4.76, -9.2 [-23 – 2]		0.0001
BMI (kg/m^2)[c]	31.1 ± 5.05, 30.2 [24.9 – 47.9]	28.3 ± 4.9, 27.2[21.9 – 45.3]	-2.87 ± 1.56, -3.12 [-8.2 – 0.67]	0.55	0.0001
Waist circumference (cm)[c,d]	94.3 ± 11.6, 93 [75.7 – 134.7]	87.3 ± 11.3, 85.6 [66.4 – 121.1]	-6.67 ± 4.51, -6.25 [-18.6 – 7.7]	0.60	0.0001
Energy (kcal/d)[c]	1698 ± 427, 1655 [879 – 3104]	1192 ± 224, 1167 [805 – 1836]	-506 ± 447, -476 [-2042 – 693]	1.18	0.0001
Energy (% EER)[c,e]	98.5 ± 23.9, 94.4 [53.6 – 170.5]	73.4 ± 13.7, 72 [49 – 113]	-25.1 ± 25.3, -23.5 [-108 – 37.1]	1.05	0.0001
Eating behaviors[f]					
Cognitive restraint (0 – 21)[c]	10.9 ± 3.9, 11 [1 – 20]	16.4 ± 2.5, 16 [9 – 21]	5.51 ± 3.92, 5 [-3 – 17]	1.41	0.0001
Flexible restraint (0 – 7)[c]	3.6 ± 1.5, 4 [0 – 6]	5.5 ± 1.2, 6 [2 – 7]	1.9 ± 1.6, 2 [-2 – 6]	1.26	0.0001
Rigid restraint (0 – 7)[c]	3.1 ± 1.5, 3 [0 – 7]	5.1 ± 1.2, 5[2 – 7]	2.0 ± 1.6, 2 [-1 – 6]	1.33	0.0001

Table 4.2
Baseline, post-intervention, and change in adiposity and psychological measures among completers of the 6 month weight loss intervention (n = 61)

Variable	Baseline	Post-intervention	Change	Effect size[a]	P[b] <
	Mean ± SD, Median [Range]	Mean ± SD, Median [Range]	Mean ± SD, Median [Range]		
Disinhibition (0 – 16)[c]	8.7± 3.4, 9 [2 – 16]	6.3 ± 3.4, 5 [0 – 14]	-2.4 ± 3.1, -2.0 [-11 – 3]	0.70	0.0001
Hunger (0 – 14)[c]	5.6 ± 3.1, 5 [0 – 14]	3.8 ± 3.1, 3 [0 – 13]	-1.70 ± 3.16, -1 [-12 – 5]	0.58	0.0001
Depressive symptoms[f]:					
CES-D Total score (0 – 60)[c]	7.52 ± 5.84, 6 [0 – 27]	5.8 ± 5.7, 4 [0-27]	-1.68 ± 6.43, -1 [-20 – 23]	0.29	0.01
Possible depression (%)[g]	11.5%	8.2%	3.3%		0.10

a. Effect size = (Mean at baseline – mean at post-intervention) ÷ standard deviation at baseline; For cognitive restraint, flexible restraint, CES-D total score, (Mean at post-intervention – mean at baseline) ÷ standard deviation at baseline to indicate an improvement in the measure.
b. P-value from associated test: paired t-test for normally distributed variables, Wilcoxon sign rank sum test for non-parametric data, Fisher's exact for percent comparison due to small cell sizes (<5)
c. Non-parametric data
d. Post-intervention waist circumference (n = 58)
e. Baseline weight used to calculate percent of energy needs for ease of comparison between baseline and post-intervention in this table
f. Ranges for each scale and subscale, if applicable, are in parentheses
g. CES-D total score ≥ 16

Table 4.3

Bivariate correlations of body weight, BMI, and psychological measures at baseline (n = 72)[1]

Variable	Age	Weight (kg)	BMI[2] (kg/m^2)	Cognitive restraint	Flexible restraint	Rigid restraint	Disinhibition	Hunger	Depressive symptoms	Energy intake (% EER)[3]
Age	1.0	.15	.22*	-.15	-.10	-.12	.01	.02	.06	.11
Weight (kg)		1.0	.90****	-.29**	-.22*	-.22*	.26**	.20*	.18	-.12
BMI (kg/m^2)			1.0	-.28**	-.25**	-.13	.37***	.26**	.22*	-.09
Cognitive restraint				1.0	.81****	.76****	-.12	-.19	-.30***	-.07
Flexible restraint					1.0	.45****	-.12	-.13	-.13	-.04
Rigid restraint						1.0	.14	-.01	-.29**	-.06
Disinhibition							1.0	.45****	.32***	.01
Hunger								1.0	.10	-.01
Depressive symptoms									1.0	.18
Energy intake (% EER)[3]										1.0

1. Spearman correlations for non-normally distributed variables
2. BMI is body mass index: weight (kg) ÷ (height (m)^2)
3. Reported energy intake (average caloric intake per day) as a percentage of energy needs for weight maintenance; % energy needs = baseline kcal/d ÷ estimated energy needs: [((10*body weight (kg)) + (6.25*height (cm)) – (5*age(y) - 161)] × [activity factor, 1.3]

* P < 0.10; **P < 0.05; *** P < 0.01; **** P < 0.0001

Table 4.4

Bivariate correlations of baseline values and changes in body weight, BMI, and psychological measures for completers (n = 61)[1,2]

Variable	Δ Weight (%)	Δ BMI (kg/m^2)	Δ Cognitive restraint	Δ Flexible restraint	Δ Rigid restraint	Δ Disinhibition	Δ Hunger	Δ Depressive symptoms	Δ Energy Intake (kcal/d)
Age	-.10	-.19	.14	.10	.13	.02	.08	.10	.03
Baseline weight (kg)	-.03	-.28*	.29*	.02	.21^{+}	.09	.02	.04	-.16
Δ Weight (%)	1.0	.93****	-.24^{+}	-.41***	.12	.06	.09	-.00	-.05
Baseline BMI (kg/m^2)	-.11	-.39**	.24^{+}	.02	.14	-.03	.01	-.02	-.07
Baseline cognitive restraint	.11	.19	-.79****	-.55****	-.54****	.13	.26*	.18	.22^{+}
Baseline flexible restraint	.19	.23^{+}	-.64****	-.72****	-.29*	.12	.10	.11	.28*
Baseline rigid restraint	.00	.03	-.58****	-.34****	-.66****	-.02	.11	.20	.21
Baseline disinhibition	-.06	-.16	.16	.15	-.10	-.31*	-.09	-.11	-.04
Baseline hunger	.01	-.10	.28*	.09	.13	-.04	-.44****	-.04	.01
Baseline depressive symptoms	-.08	-.13	.21	-.02	.22^{+}	-.08	-.07	-.58****	-.20
Baseline energy intake (% EER)[3]	.19	.24^{+}	-.15	-.15	-.08	-.02	.17	-.06	-.77****

1. Spearman correlations for non-parametric data
2. Δ = change
3. Reported energy intake (average caloric intake per day) as a percentage of energy needs for weight maintenance; % energy needs = baseline kcal/d ÷ estimated energy needs: [((10*body weight (kg)) + (6.25*height (cm)) – (5*age(y) - 161)] × [activity factor, 1.3]

$^{+}$ 0.05 < P < 0.10 (trend); *P < 0.05; ** P < 0.01; ***P < 0.001,****P < 0.0001

Table 4.5

Relationships of restraint measures with percent weight change: regression analyses (n = 61)[a]

Variable	Regression coefficient (b)	Standard error	t	P-Value	Model R^2 (Adjusted R^2)
Model 1					0.12 (0.08)
Intercept	-16.3	3.80	-4.28	< 0.0001	
Baseline energy intake (% needs)[b]	0.10	0.04	2.30	0.03	
Change in energy intake (kcal/d)[c]	0.00	0.00	1.74	0.09	
Change in cognitive restraint	-0.16	0.16	-1.01	0.32	
Model 2					0.20 (0.15)**
Intercept	-14.1	3.60	-3.92	< 0.001	
Baseline energy intake (% needs)[b]	0.08	0.04	1.96	0.05	
Change in energy intake (kcal/d)[c]	0.00	0.00	1.39	0.17	
Change in flexible restraint	-1.21	0.38	-2.49	0.016	
Model 3					0.12 (0.08)
Intercept	-19.2	3.57	-5.37	< 0.001	
Baseline energy intake (% needs)[b]	0.12	0.04	2.73	0.01	
Change in energy intake (kcal/d)[c]	0.00	0.00	2.01	0.05	
Change in rigid restraint	0.40	0.38	1.05	0.30	
Model 4					0.26 (0.21)**
Intercept	-15.3	3.52	-4.35	< 0.001	
Baseline energy intake (% needs)[b]	0.08	0.04	2.0	0.05	
Change in energy intake (kcal/d)[c]	0.00	0.00	1.25	0.22	
Change in flexible restraint	-1.21	0.38	-3.22	< 0.01	
Change in rigid restraint	0.84	0.38	2.24	0.03	
Model 5					0.13 (0.09)*
Intercept	-12.1	5.86	-2.07	0.04	
Baseline energy intake (% needs)[b]	0.10	0.04	2.39	0.02	
Change in energy intake (kcal/d)[c]	0.00	0.00	2.00	0.05	
Post-intervention cognitive restraint	-0.30	0.24	-1.23	0.22	

Table 4.5

Relationships of restraint measures with percent weight change: regression analyses (n = 61)[a]

Variable	Regression coefficient (b)	Standard error	t	P-Value	Model R^2 (Adjusted R^2)
Model 6					0.16 (0.12)*
Intercept	-12.1	4.49	-2.70	< 0.01	
Baseline energy intake (% needs)[b]	0.11	0.04	2.59	0.01	
Change in energy intake (kcal/d)[c]	0.00	0.00	2.24	0.03	
Post-intervention flexible restraint	-0.95	0.49	-1.94	0.06	
Model 7					0.12 (0.07)
Intercept	-20.2	4.52	-4.48	< 0.0001	
Baseline energy intake (% needs)[b]	0.12	0.04	2.68	0.01	
Change in energy intake (kcal/d)[c]	0.00	0.01	1.93	0.06	
Post-intervention rigid restraint	0.37	0.50	0.75	0.46	
Model 8					0.19 (0.13)*
Intercept	-15.0	4.94	-3.04	0.01	
Baseline energy intake (% needs)[b]	0.11	0.04	2.70	0.01	
Change in energy intake (kcal/d)[c]	0.00	0.00	2.21	0.03	
Post-intervention flexible restraint	-1.14	0.51	-2.25	0.03	
Post-intervention rigid restraint	0.68	0.50	1.36	0.18	

1. Regression models of baseline restraint with percent weight change not shown (all P > 0.05)
2. Reported energy intake (average caloric intake per day) as a percentage of energy needs for weight maintenance; % energy needs = baseline kcal/d ÷ estimated energy needs: [((10*body weight (kg)) + (6.25*height (cm)) – (5*age(y) - 161)] × [activity factor, 1.3]
3. Change in energy intake (kcal/d) from baseline to post-intervention

* P < .05, ** P < .01

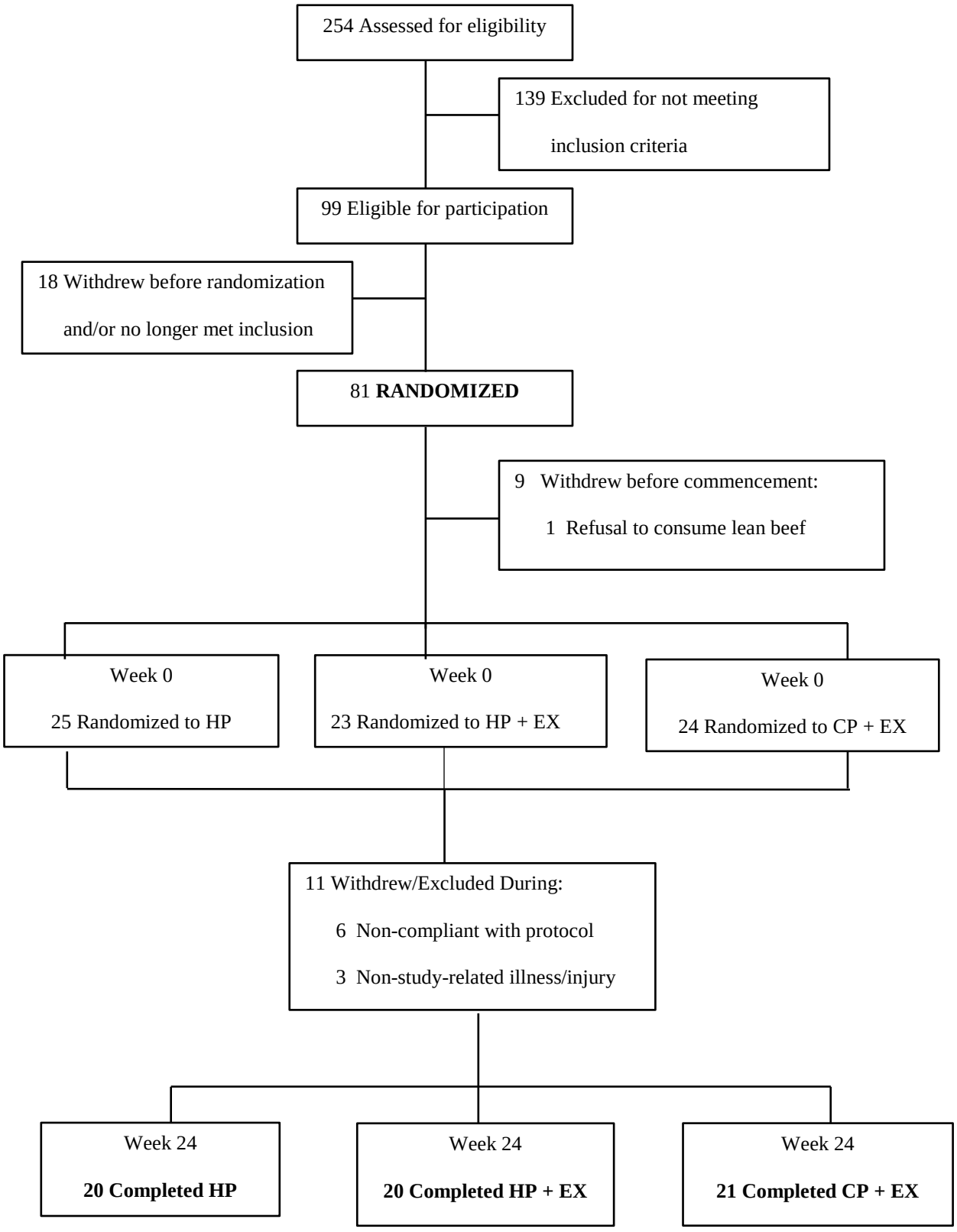


Figure 4.1 Participant flowchart

CHAPTER V

CONCLUSION

This dissertation adds to our understanding of intentional weight loss in older people (≥ 65 y). The continued growth in this segment of the population, the ever increasing health care costs in later life, and the growing obesity epidemic in all age groups, particularly older adults, demands our attention (Federal Interagency Forum on Aging-Related Statistics 2012, Ogden et al. 2014). More specifically, overweight and obese older adults are in need of evidence-based, targeted, and feasible intervention strategies to help maintain independence and improve health and health-related quality of life.

Although it is reasonable to assume that intentional weight loss in older people will be achieved by similar dietary and exercise interventions as younger people, older adults likely require special consideration due to changes in metabolism and multiple chronic conditions. It is well established that sarcopenia occurs with aging during both energy balance and weight change (Vincent, Raiser, and Vincent 2012, Zamboni et al. 2008). Moreover, sarcopenic obesity, or a disproportion of fat mass to lean mass, is becoming as much of a problem and resulting in many of the same consequences as frailty in older adults (Zamboni et al. 2008, Villareal et al. 2004). However, concern over loss of lean mass and potential for furthering functional limitations with intentional weight loss has fueled controversy over the appropriateness of recommending weight loss for overweight and obese older adults (Waters, Ward, and Villareal 2013, Johnson and Bales 2014). Still, evidence is increasingly strong for the benefits of weight loss in obese older adults, including, but not limited to, improved cardiometabolic health and physical function (Mathus-

Vliegen et al. 2012, Waters, Ward, and Villareal 2013). Higher protein diets are being investigated for both additive and independent contributions to attenuating the loss of lean mass during weight loss (Paddon-Jones et al. 2008, Mojtahedi et al. 2011, Bauer et al. 2013). While increasing protein intake sounds reasonably achievable, my work as a dietitian in research and community settings leads me to believe that increasing intakes to those studied experimentally would be difficult for the independently living, community-dwelling older person who must purchase, procure and prepare their own food. Furthermore, I know from working with individuals trying to lose weight that increasing any food when you are trying to decrease energy intake can seem both counterintuitive and challenging. These factors inspired me to study the dietary changes that occurred when we counseled older women to consume energy restricted diets of varying macronutrient content to promote weight loss.

In addition to addressing dietary change that promotes weight loss, evidence in younger people and my experiences as a dietitian encouraged me to explore psychological factors that may be related to weight loss in older adults. It is one thing to counsel someone to eat less and exercise more, but eating is more than just physiological need fulfillment. Eating is a behavior and is involved in many social activities, cultural traditions, and may be emotionally driven (Stunkard and Messick 1985, Green and Saenz 1995, Westenhoefer et al. 1994). Studies in younger people indicate that cognitive control over eating behavior and depressive symptoms may be related to obesity and weight loss (Teixeira et al. 2005, Teixeira et al. 2010, Fabricatore et al. 2011). Thus, the overall hypothesis for these studies was that the older women would be able to make changes to their diet to promote weight loss, and that eating behaviors and depressive symptoms would be related to weight loss in overweight and obese older women following intervention.

Changes in Dietary Intake Following a Higher Protein Weight Loss Intervention in Overweight and Obese Older Women (Chapter III)

Chapter III focused on exploring changes in diet when women are counseled to consume higher protein, including one serving of lean beef per day, and restrict energy for weight loss. This study was novel in that women were expected to plan and procure their own food, including protein sources to meet the study goals. The results suggest that women are able to restrict energy and increase protein, but most women were unable to meet the study goal of 30% energy from protein and fiber intake was lower in women counseled to consume more protein. Many of the women in the study expressed dislike of beef or consuming the animal products in quantities necessary to meet the study goals for protein intake. By the end of the study, many women reported that they had grown weary of eating beef daily, despite the fact that they typically enjoy beef. Therefore, future studies should consider a variety of protein sources, as most individuals with the ability to procure their own food from a variety of sources and with adequate financial resources likely prefer not to eat the same thing every day. Furthermore, it will be important to determine what level of protein intake is associated with clinically meaningful attenuation of loss of lean mass loss during weight loss. Perhaps a lower intake of protein would be sufficient to meet the needs of overweight and obese older adults during weight loss. Additionally, as protein intake increased and fiber intake decreased, many women reported gastrointestinal discomfort and constipation (although we did not record this information in a systematic way). Increasing consumption of high-fiber foods and water was recommended to these individuals, and in many cases alleviated constipation. This is a legitimate concern for the feasibility of adherence to increased protein intakes. Thus, if evidence supports higher protein intakes for older people

during energy balance and during weight loss, innovation from the food industry may be warranted to address these concurrent issues related to gastrointestinal discomfort and fiber intake.

Among the completers of the intervention (n = 61) mean weight change was -9.2 ± 4.8% of initial body weight (range -23.1% to +2.0%) and mean change in BMI was -2.9 ± 1.6 kg/m^2 ($P < 0.0001$, Table 4.2), and there were no differences between intervention groups (HP-EX, CP-EX, HP, data not shown). While only 42.6% of those who completed the intervention met the weight loss goal of 10% of initial body weight, 85.2% lost at least 5% of initial body weight. These results indicate that older women can make changes to diet and physical activity that result in clinically significant weight loss. Although loss of 10% of initial body weight is a commonly recommended goal with clinically meaningful health outcomes (improvements in hemoglobin A1c, blood-lipids, osteoarthritis pain), previous research has indicated clinically meaningful changes in diabetes outcomes (fasting glucose) with as little as 3% loss of initial body weight (Jensen et al. 2014, Miller et al. 2008). Notably, although less than 50% of the women met the weight loss goal of 10%, many women exceeded the goal. Lastly, it is possible that the rate at which weight is lost may be related to changes in lean mass, and this can be explored with other analyses from this data set. Overall, most of the women in the study experienced clinically meaningful weight loss.

Changes in Eating Behaviors are Associated with Intentional Weight Loss Following Intervention in Older Women (Chapter IV)

Chapter IV focused on exploring the relationship of eating behaviors and depressive symptoms in older women following weight loss intervention. The results of this study add to

literature regarding psychological aspects of weight loss in older people. The finding that individuals self-reporting higher levels of depressive symptoms may be at higher risk for withdrawing from weight loss intervention highlights the role of mental health in overall health, well-being, and the ability to commit large efforts toward weight loss. Future research that engages behavioral and mental health professionals with experts in behavioral weight loss including diet and exercise could add meaningful information about the risk factors for attrition in weight loss intervention and possible intervention strategies.

The finding that an increase in flexible restraint and a decrease in rigid restraint of eating behavior was associated with weight loss was particularly interesting to me as it resonates the message of moderation as key to overall health and wellness. In reflecting upon my experiences counseling the women in this intervention, participants repeatedly told me they were relieved when I wasn't upset with them for deviating from their diet. People, especially older people, do not want to be told what they are doing wrong all the time. My observation is that most people want to be empowered to make the decision that they know is best for their health on their own accord. Encouraging flexible restraint by helping people feel empowered to make food choices that support both their desire for pleasure and involvement in social and cultural traditions as well as their desire to improve their health could be a viable and appealing strategy for weight loss in all people, but especially older adults. Future research should compare messages of rigid and flexible control in weight loss intervention to determine if these study results are robust and reproducible, and thus, these eating behaviors are, in fact, modifiable.

Limitations and Opportunities for Future Research

This dissertation study had several limitations that could be explored in future research. First, there was no measure of social support. Anecdotally, it seemed as though participants with

family members or other individuals living in the household who were supportive of the participants' weight loss goals were more successful or at least appeared to be less emotionally distressed by participation in the intervention. Future research could explore the role of the family, partners, roommates, and friends in weight loss success. Of interest would be interventions aimed at improving diet and physical activity behaviors aimed at the whole family, couples, or roommates.

The length of the intervention (six months) can be viewed as both a limitation and a strength. Position statements recommend participation in behavioral weight management program of at least six months, but preferably at least one year (Jensen et al. 2014). While a shorter intervention might result in better outcomes for some due to an initial rapid weight loss phase followed by slower weight loss or even "plateau," some individuals take longer to adopt the behavior changes necessary for weight loss, and thus would be determined as "unsuccessful" in the shorter term intervention. Many differences observed in weight loss between experimental diets, e.g., low-carbohydrate, low-fat, at six months are no longer significant at 12 months, and thus a longer (> 6 months) intervention might be preferable. However, longer intervention length may have resulted in greater attrition and poorer compliance. It is also possible that by six months participant fatigue was already considerable, and a shorter (< 6 months) intervention would have resulted in better compliance and outcomes. Therefore, the six month time period may be more reflective of non-experimental conditions, because it is long enough for participant fatigue to occur and compliance to diminish, but short enough to achieve adequate participant retention. Thus, the length of the intervention can be viewed as both a strength and a weakness.

The lack of a self-monitoring variable is another important limitation. Self-monitoring of dietary intake is described as a cornerstone of behavioral weight loss and weight loss

maintenance methods (Jensen et al. 2014) and several reviews have concluded that greater frequency of self-monitoring of dietary intake is associated with greater weight loss and weight loss maintenance (Burke et al. 2011, Wing et al. 2003, Wing et al. 2005). One study by Kong et al. (2012) found that older women (~58 y) who self-monitored dietary intake approximately 70% of the time lost 3.7% more weight ($P < 0.0001$). Use of my-fitness pal or exchange system and paper food diaries was intensively monitored during the intervention but not intentionally measured, and perhaps, this may have contributed to the overall success of the intervention. The addition of this variable would be helpful in further understanding the relationships of weight loss and eating behaviors and of self-monitoring and dietary change. Future research should include self-monitoring variables for dietary intake, as well as physical activity and weighing oneself.

Overall Conclusions

With the rising prevalence of obesity in older people, impact of obesity on health of the individual and contribution to health care expenditures, and growing evidence for the beneficial effects of weight loss in older adults, research is needed to determine effective and feasible strategies for community dwelling overweight and obese older adults desiring to lose weight. This dissertation identifies changes in diet and psychological factors that are related to intentional weight loss in overweight and obese older women following intervention which may be useful in designing future research studies and community interventions for weight loss. Strategies to consider include counseling individuals to take a more flexible approach to eating behavior, encouraging the addition of mental health professionals to research teams exploring weight loss, and how to balance dietary intakes of important nutrients, such as fiber and protein, while undergoing energy-restriction to promote intentional weight loss. The food industry could

play an important role in providing healthy options for older individuals trying to meet both protein and fiber needs. The results of this study further emphasize that obesity is a multifactorial issue and interventions to help people live healthier lives will require multidisciplinary strategies for people of all ages.

REFERENCES

AbuSabha, R., & Achterberg, C. (1997). Review or self-efficacy and locus of control for nutrition- and health-related behavior. *Journal of the American Dietetic Association, 97*(10), 1122-1132. doi:10.1016/s0002-8223(97)00273-3

Alhassan, S., Kim, S., Bersamin, A., King, A. C., & Gardner, C. D. (2008). Dietary adherence and weight loss success among overweight women: results from the A TO Z weight loss study." *International Journal of Obesity* 32 (6):985-991. doi: 10.1038/ijo.2008.8

Annesi, J. J., & Whitaker, A. C. (2010). Psychological factors discriminating between successful and unsuccessful weight loss in a behavioral exercise and nutrition education treatment. *International Journal of Behavioral Medicine, 17*(3), 168-175. doi:10.1007/s12529-009-9056-2

Avila, J. J., Gutierres, J. A., Sheehy, M. E., Lofgren, I. E., & Delmonico, M. J. (2010). Effect of moderate intensity resistance training during weight loss on body composition and physical performance in overweight older adults. *European Journal of Applied Physiology, 109*(3), 517-525. doi:10.1007/s00421-010-1387-9

Bales, C. W., Fischer, J. G., & Orenduff, M. C. (2004). Nutritional interventions for age-related chronic disease. *Generations-Journal of the American Society on Aging, 28*(3), 54-60.

Bandura, A. (2004). Health promotion by social cognitive means. *Health Education & Behavior, 31*(2), 143-164. doi:10.1177/1090198104263660

Batra, P., Das, S. K., Salinardi, T., Robinson, L., Saltzman, E., Scott, T., . . . Roberts, S. B. (2013). Eating Behaviors as Predictors of Weight Loss in a 6 Month Weight Loss Intervention. *Obesity, 21*(11), 2256-2263. doi:10.1002/oby.20404

Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., . . . Boirie, Y. (2013). Evidence-Based Recommendations for Optimal Dietary Protein Intake in Older People: A Position Paper From the PROT-AGE Study Group. *Journal of the American Medical Directors Association, 14*(8), 542-559. doi:10.1016/j.jamda.2013.05.021

Beavers, D. P., Beavers, K. M., Loeser, R. F., Walton, N. R., Lyles, M. F., Nicklas, B. J., . . . Messier, S. P. (2014). The independent and combined effects of intensive weight loss and exercise training on bone mineral density in overweight and obese older adults with osteoarthritis.*Osteoarthritis and Cartilage, 22*(6), 726-733. doi:10.1016/j.joca.2014.04.002

Beck, A. T., Erbaugh, J., Ward, C. H., Mock, J., & Mendelsohn, M. (1961). An Inventory for Measuring Depression. *Archives of General Psychiatry, 4*(6), 561-71.

Beck, A.T, a& Steer, R.A. (1996). *Beck Depression Inventory--II., The Behavioral Measurement Letter, 3(2), 3-5. By: Behavioral Measurement Database Services.*

Berner, L. A., Becker, G., Wise, M., & Doi, J. (2013). Characterization of dietary protein among older adults in the United States: amount, animal sources, and meal patterns. *Journal of the Academy of Nutrition & Dietetics, 113*(6), 809-815.

Bernstein, M., & Munoz, N. (2012). Position of the Academy of Nutrition and Dietetics: Food and Nutrition for Older Adults: Promoting Health and Wellness. *Journal of the Academy of Nutrition and Dietetics, 112*(8), 1255-1277. doi:10.1016/j.jand.2012.06.015

Bingham, S. A., Gill, C., Welch, A., Cassidy, A., Runswick, S. A., Oakes, S., . . . Day, N. E. (1997). Validation of dietary assessment methods in the UK arm of EPIC using weighed records, and 24-hour urinary nitrogen and potassium and serum vitamin C and carotenoids as biomarkers.*International Journal of Epidemiology, 26*(suppl 1), S137. doi:10.1093/ije/26.suppl_1.S137

Bruch, H. (1948). Psychological aspects of obesity. *Bulletin of the New York Academy of Medicine,* 24 (2), 73-86.

Burke, L. E., Wang, J., & Sevick, M. A. (2011). Self-monitoring in weight loss: a systematic review of the literature. *Journal of the American Dietetic Association, 111*(1), 92-102.

Campbell, W. W., Trappe, T. A., Wolfe, R. R., & Evans, W. J. (2001). The recommended dietary allowance for protein may not be adequate for older people to maintain skeletal muscle.*Journals of Gerontology Series a-Biological Sciences and Medical Sciences, 56*(6), M373-M380.

Cappelleri, J. C., Bushmakin, A. G., Gerber, R. A., Leidy, N. K., Sexton, C. C., Lowe, M. R., & Karlsson, J. (2009). Psychometric analysis of the Three-Factor Eating Questionnaire-R21: results from a large diverse sample of obese and non-obese participants. *International Journal of Obesity, 33*(6), 611-620. doi:10.1038/ijo.2009.74

Casperson, S. L., Sheffield-Moore, M., Hewlings, S. J., & Paddon-Jones, D. (2012). Leucine supplementation chronically improves muscle protein synthesis in older adults consuming the RDA for protein. *Clinical Nutrition, 31*(4), 512-519. doi:10.1016/j.clnu.2012.01.005

Centers for Disease Control and Prevention (CDC). (2011). Healthy aging at a glance 2011. Retrieved from http://www.cdc.gov/chronicdisease/resources/publications/AAG/aging.htm

Centers for Disease Control and Prevention (CDC). (2015). Health and funcitonal status. *Health Data Interactive.* Retrieved from http://www.cdc.gov/nchs/hdi.htm

Centers for Disease Control and Prevention (CDC). (2015). Health care use and expenditures. *Health Data Interactive.* Retrieved from http://www.cdc.gov/nchs/hdi.htm

Cesari, M., Kritchevsky, S. B., Penninx, B., Nicklas, B. J., Simonsick, E. M., Newman, A. B., . . . Pahor, M. (2005). Prognostic value of usual gait speed in well-functioning older people-results from the health, aging and body composition study. *Journal of the American Geriatrics Society, 53*(10), 1675-1680. doi:10.1111/j.1532-5415.2005.53501.x

Clark, M. M., Abrams, D. B., Niaura, R. S., Eaton, C. A., & Rossi, J. S. (1991). Self-efficacy in Weight Management. *Journal of Consulting and Clinical Psychology, 59*(5), 739-744. doi:10.1037//0022-006x.59.5.739

Clasey, J. L., Hartman, M. L., Kanaley, J., Wideman, L., Teates, C. D., Bouchard, C., & Weltman, A. (1997). Body composition by DEXA in older adults: Accuracy and influence of scan mode.*Medicine and Science in Sports and Exercise, 29*(4), 560-567. doi:10.1097/00005768-199704000-00020

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.

de Wit, L., Luppino, F., van Straten, A., Penninx, B., Zitman, F., & Cuijpers, P. (2010). Depression and obesity: A meta-analysis of community-based studies. *Psychiatry Research, 178*(2), 230-235. doi:10.1016/j.psychres.2009.04.015

de Wit, L. M., van Straten, A., van Herten, M., Penninx, B. W. J. H., & Cuijpers, P. (2009). Depression and body mass index, a u-shaped association. *BMC Public Health, 9*. doi:10.1186/1471-2458-9-14

Dykes, J., Brunner, E. J., Martikainen, P. T., & Wardle, J. (2004). Socioeconomic gradient in body size and obesity among women: the role of dietary restraint, disinhibition and hunger in the Whitehall II study. *International Journal of Obesity, 28*(2), 262-268. doi:10.1038/sj.ijo.0802523

Eckel, R. H., Jakicic, J. M., Ard, J. D., Hubbard, V. S., de Jesus, J. M., Lee, I. M., . . . Yanovski, S. Z. (2013). 2013 AHA/ACC Guideline on lifestyle management to reduce cardiovascular risk: A report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *Circulation*. doi:10.1161/01.cir.0000437740.48606.d1

Egleston, B. L., Rudberg, M. A., & Brody, J. A. (1999). Prior living arrangements and nursing home resident admission ADL characteristics: a study of two states. *Journals of Gerontology Series B Psychological Sciences and Social Sciences, 54*(4), S202-206.

Elfhag, K., & Rossner, S. (2005). Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obesity Reviews, 6*(1), 67-85. doi:10.1111/j.1467-789X.2005.00170.x

Fabricatore, A. N., Wadden, T. A., Higginbotham, A. J., Faulconbridge, L. F., Nguyen, A. M., Heymsfield, S. B., & Faith, M. S. (2011). Intentional weight loss and changes in symptoms of depression: a systematic review and meta-analysis. *International Journal of Obesity, 35*(11), 1363-1376. doi:10.1038/ijo.2011.2

Fakhouri, T. H., Ogden C. L., Carroll M. D., Kit B. K., and Flegal K. M.. (2012). Prevalence of obesity among older adults in the United States, 2007-2010. *NCHS Data Brief* (106):1-8.

Faulconbridge, L. F., Wadden, T. A., Rubin, R. R., Wing, R. R., Walkup, M. P., Fabricatore, A. N., . . . Look, A. R. G. (2012). One-Year Changes in Symptoms of Depression and Weight in Overweight/Obese Individuals With Type 2 Diabetes in the Look AHEAD Study. *Obesity, 20*(4), 783-793. doi:10.1038/oby.2011.315

Federal Interagency Forum on Aging-Related Statistics. (2012). *Older Americans 2012: Key Indicators of Well-Being*. Washington, DC: U.S. Government Printing Office. Retrieved from http://www.agingstats.gov/agingstatsdotnet/Main_Site/Data/2012_Documents/Docs/EntireChartbook.pdf.

Felix, H. C., & West, D. S. (2013). Effectiveness of weight loss interventions for obese older adults.*American Journal of Health Promotion, 27*(3), 191-199.

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of all-cause mortality with overweight and obesity using standard body mass index categories a systematic review and meta-analysis. *Jama-Journal of the American Medical Association, 309*(1), 71-82. doi:10.1001/jama.2012.113905

Folstein, M. F., Folstein, S. E., McHugh, P. R., Hamrick, I., Hafiz, R., & Cummings, D. M. (2013). Mini-Mental State Examination. *Use of days of the week in a Modified Mini-Mental State Exam (M-MMSE) for detecting geriatric cognitive impairment, 26*, 429-435.

Felix, H. C., & West, D. S. (2013). Effectiveness of weight loss interventions for obese older adults..*American Journal of Health Promotion, 27*(3), 191-199.

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of all-cause mortality with overweight and obesity using standard body mass index categories a systematic review and meta-analysis. *JAMA-Journal of the American Medical Association, 309*(1), 71-82. doi:10.1001/jama.2012.113905

Folstein, M. F., Folstein, S. E., McHugh, P. R., Hamrick, I., Hafiz, R., & Cummings, D. M. (2013). Mini-Mental State Examination. Use of days of the week in a Modified Mini-Mental State Exam (M-MMSE) for detecting geriatric cognitive impairment. *Journal of the American Board of Family Medicine*, 26(4):429-435.

Foster, G. D., Wadden, T. A., Swain, R. M., Stunkard, A. J., Platte, P., & Vogt, R. A. (1998). The Eating Inventory in obese women: Clinical correlates and relationship to weight loss..*International Journal of Obesity, 22*(8), 778-785. doi:10.1038/sj.ijo.0800659

Green, B. L., & Saenz, D. S. (1995). Tests of a mediational model of restrained eating - the role of dieting self-efficacy and social comparisons. *Journal of Social and Clinical Psychology, 14*(1), 1-22. doi:10.1521/jscp.1995.14.1.1

Hadziabdic, M. O., Mucalo, I., Hrabac, P., Matic, T., Rahelic, D., & Bozikov, V. (2015). Factors predictive of drop-out and weight loss success in weight management of obese patients.*Journal of Human Nutrition and Dietetics, 28*, 24-32. doi:10.1111/jhn.12270

Houston, D. K., Nicklas, B. J., Ding, J., Harris, T. B., Tylavsky, F. A., Newman, A. B., . . . Study, H. A. (2008). Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. *American Journal of Clinical Nutrition, 87*(1), 150-155.

Houston, D. K., Nicklas, B. J., & Zizza, C. A. (2009). Weighty concerns: the growing prevalence of obesity among older adults. *Journal of the American Dietetic Association, 109*(11), 1886-1895. doi:10.1016/j.jada.2009.08.014

Houston, D. K., Ding, J., Nicklas, B. J., Harris, T. B., Lee, J. S., Nevitt, M. C., . . . Hlth, A. B. C. S. (2009). Overweight and obesity over the adult life course and incident mobility limitation in older adults. *American Journal of Epidemiology, 169*(8), 927-936. doi:10.1093/aje/kwp007

Hoy, M., & Goldman, J. (September 2014). *Calcium intake of the U.S. population: What We Eat in America, NHANES 2009- 2010*. Food Surveys Research Group Dietary Data Brief No. 13. Retrieved from http://www.ars.usda.gov/SP2UserFiles/Place/80400530/pdf/DBrief/13_calcium_intake_0910.pdf

Institute of Medicine (IOM). (2000). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington, DC: The National Academies Press.

Institute of Medicine (IOM). (2006). Fiber. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements* (pp. 110-121). Washington, DC: The National Academies Press.

Institute of Medicine (IOM). (2006). Vitamin C. *Dietary Reference Intakes: The Essential Guide to Nutrient Requirements* (pp. 202-210). Washington, DC: The National Academies Press.

Institute of Medicine (IOM). (2011). *Dietary Reference Intakes for Calcium and Vitamin D*. Washington, DC: The National Academies Press.

Jensen, G. L., & Friedmann, J. M. (2002). Obesity is associated with functional decline in community-dwelling rural older persons. *Journal of the American Geriatrics Society, 50*(5), 918-923. doi:10.1046/j.1532-5415.2002.50220.x

Jensen, M. D., Ryan, D. H., Apovian, C. M., Ard, J. D., Comuzzie, A. G., Donato, K. A., . . . Tomaselli, G. F. (2014). 2013 AHA/ACC/TOS guideline for the management of overweight and obesity in adults: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines and The Obesity Society. *Circulation, 129*(25 Suppl 2), S102-138. doi:10.1161/01.cir.0000437739.71477.ee

Johnson, F., Pratt, M., & Wardle, J. (2012). Dietary restraint and self-regulation in eating behavior..*International Journal of Obesity, 36*(5), 665-674. doi:10.1038/ijo.2011.156
Johnson, M. A. (2013). Strategies to improve diet in older adults. *Proceedings of the Nutrition Society, 72*(1), 166-172.

Johnson, M. A., & Bales, C. W. (2014). Is There a Best Body Mass Index for Older Adults? Moving Closer to Evidence-Based Recommendations Regarding "Overweight," Health, and Mortality.*Journal of Nutrition in Gerontology and Geriatrics, 33*(1), 1-9. doi:10.1080/21551197.2014.875817

Karlsson, J., Persson, L. O., Sjostrom, L., & Sullivan, M. (2000). Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. *International Journal of Obesity, 24*(12), 1715-1725. doi:10.1038/sj.ijo.0801442

Kazis, L.E., Anderson J.J., Meenan, R.F. (1989). Effect sizes for interpreting changes in health-status. *Medical Care* 27 (3):S178-S189. doi: 10.1097/00005650-198903001-00015

Kong, A., Beresford, S. A. A., Alfano, C. M., Schubert, K. E. F., Neuhouser, M. L., Johnson, D. B., . . . McTiernan, A. (2012). Self-Monitoring and Eating-Related Behaviors Are Associated with 12-Month Weight Loss in Postmenopausal Overweight-to-Obese Women. *Journal of the Academy of Nutrition and Dietetics, 112*(9), 1428-1435. doi:10.1016/j.jand.2012.05.014

Konttinen, H., Peltonen, M., Sjostrom, L., Carlsson, L., & Karlsson, J. (2015). Psychological aspects of eating behavior as predictors of 10-y weight changes after surgical and conventional treatment of severe obesity: results from the Swedish Obese Subjects intervention study. *American Journal of Clinical Nutrition, 101*(1), 16-24. doi:10.3945/ajcn.114.095182

Kyle, U. G., Genton, L., Hans, D., Karsegard, V. L., Michel, J. P., Slosman, D. O., & Pichard, C. (2001). Total body mass, fat mass, fat-free mass, and skeletal muscle in older people: Cross-sectional differences in 60-year-old persons. *Journal of the American Geriatrics Society, 49*(12), 1633-1640. doi:10.1046/j.1532-5415.2001.t01-1-49272.x

Lasker, D. A. W., Evans, E. M., & Layman, D. K. (2008). Moderate carbohydrate, moderate protein weight loss diet reduces cardiovascular disease risk compared to high carbohydrate, low protein diet in obese adults: A randomized clinical trial. *Nutrition & Metabolism, 5*. doi:10.1186/1743-7075-5-30

Launer, L. J., Harris T., Rumpel C., and Madans J. (1994). Body-mass index, weight change, and risk of mobility disability in middle-aged and older women - the epidemiologic follow-up-study of NHANES-i. *JAMA-Journal of the American Medical Association* 271 (14):1093-1098. doi: 10.1001/jama.271.14.1093

Layman, D., Evans, E., Erickson, D., Seyler, J., Weber, J., Bagshaw, D., . . . Kris-Etherton, P. (2009). A Moderate-Protein Diet Produces Sustained Weight Loss and Long-Term Changes in Body Composition and Blood Lipids in Obese Adults. *J Nutr, 139*(3), 514-521. doi:10.3945/jn.108.099440

Lee, J. S., Visser, M., Tylavsky, F. A., Kritchevsky, S. B., Schwartz, A. V., Sahyoun, N., . . . Hlth, A. B. C. S. (2010). Weight Loss and Regain and Effects on Body Composition: The Health, Aging, and Body Composition Study. *Journals of Gerontology Series A-Biological Sciences and Medical Sciences, 65*(1), 78-83. doi:10.1093/gerona/glp042

Lewinsohn, P. M., Seeley, J. R., Roberts, R. E., & Allen, N. B. (1997). Center for Epidemiologic Studies Depression Scale (CES-D) as a screening instrument for depression among community-residing older adults. *Psychology and Aging, 12*(2), 277. doi:10.1037/0882-7974.12.2.277

Lindroos, A. K., Lissner L., Mathiassen M. E., Karlsson J., Sullivan M., Bengtsson, C., Sjostrom, L. (1997). Dietary intake in relation to restrained eating, disinhibition, and hunger in obese and nonobese Swedish women. *Obesity Research* 5 (3):175-182.

Luhrmann, P. M., Herbert, B. M., Gaster, C., & Neuhauser-Berthold, M. (1999). Validation of a self administered 3-day estimated dietary record for use in the elderly. *European Journal of Nutrition, 38*(5), 235-240. doi:10.1007/s003940050066

Luppino, F. S., de Wit, L. M., Bouvy, P. F., Stijnen, T., Cuijpers, P., Penninx, B. W. J. H., & Zitman, F. G. (2010). Overweight, obesity, and depression a systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry, 67*(3), 220-229.

Mathus-Vliegen, E. M. H., Basdevant, A., Finer, N., Hainer, V., Hauner, H., Micic, D., . . . Easo. (2012). Prevalence, pathophysiology, health consequences and treatment options of obesity in the elderly: a guideline. *Obesity Facts, 5*(3), 460-483. doi:10.1159/000341193

McEvoy, L. K., Laughlin, G. A., Barrett-Connor, E., Bergstrom, J., Kritz-Silverstein, D., Der-Martirosian, C., & von Mühlen, D. (2012). Metabolic Syndrome and 16-Year Cognitive Decline in Community-Dwelling Older Adults. *Annals of Epidemiology, 22*(5), 310-317. doi:10.1016/j.annepidem.2011.12.003

McTigue, K. M., Hess, R., & Ziouras, J. (2006). Obesity in older adults: A systematic review of the evidence for diagnosis and treatment. *Obesity*, *14*(9), 1485-1497. doi:10.1038/oby.2006.171

Messier, S. P., Loeser, R. F., Miller, G. D., Morgan, T. M., Rejeski, W. J., Sevick, M. A., . . . Williamson, J. (2004). Exercise and dietary weight loss in overweight and obese older adults with knee osteoarthritis - The arthritis, diet, and activity promotion trial. *Arthritis and Rheumatism, 50*(5), 1501-1510. doi:10.1002/art.20256

Messier, S. P., Mihalko, S. L., Legault, C., Miller, G. D., Nicklas, B. J., DeVita, P., . . . Loeser, R. F. (2013). Effects of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis the idea randomized clinical trial. *JAMA-Journal of the American Medical Association, 310*(12), 1263-1273. doi:10.1001/jama.2013.277669

Meyer, J. E., & Pudel, V. E. (1977). Experimental feeding in man: a behavioral approach to obesity..*Psychosomatic Medicine, 39*(3), 153-157.

Mojtahedi, M.C., Thorpe, M.P., Karampinos, D.C., Johnson, C.L., Layman, D.K., Georgiadis, J.G., Evans, E.M. (2011). The effects of a higher protein intake during energy restriction on changes in body composition and physical function in older women. *Journals of Gerontology Series A-Biological Sciences and Medical Sciences* 66 (11):1218-1225. doi: 10.1093/gerona/glr120.

Moroshko, I., Brennan, L., & O'Brien, P. (2011). Predictors of dropout in weight loss interventions: a systematic review of the literature. *Obesity Reviews, 12*(11), 912-934. doi:10.1111/j.1467-789X.2011.00915.x

National Center for Health Statistics (NCHS). (2014). *Health, United States, 2013: With special feature on prescription drugs*. Hyattsville, MD: U.S. Government Printing Office Retrieved from http://www.cdc.gov/nchs/data/hus/hus13.pdf#018.

Naughton, M. J., & Wiklund, I. (1993). A critical-review of dimension specific measures of health-related quality-of-life in cross-cultural research. *Quality of Life Research* 2(6): 397-432. doi: 10.1007/bf00422216.

Newman, A. B., Lee, J. S., Visser, M., Goodpaster, B. H., Kritchevsky, S. B., Tylavsky, F. A., . . . Harris, T. B. (2005). Weight change and the conservation of lean mass in old age: the Health, Aging and Body Composition Study. *American Journal of Clinical Nutrition, 82*(4), 872-878.

National Institutes of Health (NIH) National Heart, Lung, and Blood Institute (NHLBI). (2000). The practical guide: identification, evaluation, and treatment of overweight and obesity in adults. In *NIH publication: no. 00-4084*. Bethesda, Md.

National Institutes of Health (NIH) National Heart, Lung, and Blood Institute (NHLBI) (1998). Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. *Obesity Research, 6 Suppl 2*, 51S-209S.

Noakes, M., Keogh, J. B., Foster, P. R., & Clifton, P. M. (2005). Effect of an energy-restricted, high-protein, low-fat diet relative to a conventional high-carbohydrate, low-fat diet on weight loss, body composition, nutritional status, and markers of cardiovascular health in obese women.*American Journal of Clinical Nutrition, 81*(6), 1298-1306.

Nunnally, J. C. (1978). *Psychometric theory*: New York : McGraw-Hill, c1978. 2nd ed.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2013). Prevalence of obesity among adults: United States, 2011-2012. *NCHS data brief*(131), 1-8.

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2014). Prevalence of childhood and adult obesity in the united states, 2011-2012. *JAMA, 311*(8), 806-814. doi:10.1001/jama.2014.732

Paddon-Jones, D., & Leidy, H. (2014). Dietary protein and muscle in older persons. *Curr Opin Clin Nutr Metab Care, 17*(1), 5-11. doi:10.1097/MCO.0000000000000011

Paddon-Jones, D., Short, K. R., Campbell, W. W., Volpi, E., & Wolfe, R. R. (2008). Role of dietary protein in the sarcopenia of aging. *American Journal of Clinical Nutrition, 87*(5), 1562S-1566S.

Payne, M. E. (2009). Nutrition and Late-Life Depression. *Handbook of Clinical Nutrition and Aging, Second Edition*, 523-535. doi:10.1007/978-1-60327-385-5_26

Perera, P., Thompson, R., & Wiseman, M. (2012). Recent Evidence for Colorectal Cancer Prevention Through Healthy Food, Nutrition, and Physical Activity: Implications for Recommendations.*Current Nutrition Reports, 1*(1), 44-54. doi:10.1007/s13668-011-0006-7

Pi-Sunyer, F. X., Becker, D. M., Bouchard, C., Carleton, R. A., Colditz, G. A., Dietz, W. H., . . . Expert Panel Identification, E. T. (1998). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: Executive summary. *American Journal of Clinical Nutrition, 68*(4), 899-917.

Porter, K. N., & Johnson, M. A. (2011). Obesity is more strongly associated with inappropriate eating behaviors than with mental health in older adults receiving congregate meals. *Journal of Nutrition in Gerontology and Geriatrics, 30*(4), 403-415. doi:10.1080/21551197.2011.623960

Radloff, Lenore Sawyer. 1977. "The CES-D Scale." *Applied Psychological Measurement* 1 (3):385.

Rejeski, W. J., Brubaker, P. H., Goff, D. C., Jr., Bearon, L. B., McClelland, J. W., Perri, M. G., & Ambrosius, W. T. (2011). Translating weight loss and physical activity programs into the community to preserve mobility in older, obese adults in poor cardiovascular health. *Archives of Internal Medicine, 171*(10), 880-886. doi:10.1001/archinternmed.2010.522

Rejeski, W. J., Marsh, A. P., Chmelo, E., & Rejeski, J. J. (2010). Obesity, intentional weight loss and physical disability in older adults. *Obesity Reviews, 11*(9), 671-685. doi:10.1111/j.1467-789X.2009.00679.x

Riesco, E., Rossel, N., Rusques, C., Mirepoix, M., Drapeau, V., Sanguignol, F., & Mauriege, P. (2009). Impact of weight reduction on eating behaviors and quality of life: influence of the obesity degree. *Obesity Facts, 2*(2), 87-95. doi:10.1159/000210692

Rimer B.K. & Glanz K. (2005). Theory at a glance: a guide for health promotion practice (Second edition). edited by National Institutes of Health (NIH). Bethesda Maryland: National Institutes of Health [NIH] National Cancer Institute.

Roubenoff, R. (2004). Sarcopenic obesity: The confluence of two epidemics. *Obesity Research, 12*(6), 887-888. doi:10.1038/oby.2004.107

Roussell, M. A., Hill, A. M., Gaugler, T. L., West, S. G., Vanden Heuvel, J. P., Alaupovic, P., . . . Kris-Etherton, P. M. (2012). Beef in an Optimal Lean Diet study: effects on lipids, lipoproteins, and apolipoproteins. *The American Journal of Clinical Nutrition*. doi:10.3945/ajcn.111.016261

Sairanen, E., Lappalainen, R., Lapveteläinen, A., Tolvanen, A., & Karhunen, L. (2014). Flexibility in weight management. *Eating Behaviors, 15*(2), 218-224. doi:http://dx.doi.org/10.1016/j.eatbeh.2014.01.008

Salamone, L. M., Fuerst, T., Visser, M., Kern, M., Lang, T., Dockrell, M., . . . Lohman, T. G. (2000). Measurement of fat mass using DEXA: a validation study in elderly adults. *Journal of Applied Physiology, 89*(1), 345-352.

Santesso, N., Akl, E. A., Bianchi, M., Mente, A., Mustafa, R., Heels-Ansdell, D., & Schunemann, H. J. (2012). Effects of higher- versus lower-protein diets on health outcomes: a systematic review and meta-analysis. *European Journal of Clinical Nutrition, 66*(7), 780-788. doi:10.1038/ejcn.2012.37

Savage, J. S., Hoffman, L., & Birch, L. L. (2009). Dieting, restraint, and disinhibition predict women's weight change over 6 y. *American Journal of Clinical Nutrition, 90*(1), 33-40. doi:10.3945/ajcn.2008.26558

Seagle, H. M., Strain, G. W., Makris, A., Reeves, R. S., & American Dietetic, A. (2009). Position of the American Dietetic Association: weight management. *Journal of the American Dietetic Association, 109*(2), 330-346.

Shah, N. R., & Braverman, E. R. (2012). Measuring Adiposity in Patients: The Utility of Body Mass Index (BMI), Percent Body Fat, and Leptin. *PLOS One, 7*(4). doi:10.1371/journal.pone.0033308

Shin, S., Valentine, R. J., Evans, E. M., & Sosnoff, J. J. (2012). Lower extremity muscle quality and gait variability in older adults. *Age and Ageing, 41*(5), 595-599. doi:10.1093/ageing/afs032

Slavin, J. L. (2008). Position of the American Dietetic Association: health implications of dietary fiber.*Journal of the American Dietetic Association, 108*(10), 1716-1731.

Smarr, K. L., Harry S. Truman Memorial Veterans' Hospital and University of Missouri School of Medicine, C., Harry S. Truman Memorial Veterans' Hospital, H. D., Research Service, Columbia, MO 65201, Keefer, A. L., & Harry S. Truman Memorial Veterans' Hospital, C., Missouri. (2015). Measures of depression and depressive symptoms: Beck Depression Inventory-II (BDI-II), Center for Epidemiologic Studies Depression Scale (CES-D), Geriatric Depression Scale (GDS), Hospital Anxiety and Depression Scale (HADS), and Patient Health Questionnaire-9 (PHQ-9). *Arthritis Care & Research, 63*(S11). doi:10.1002/acr.20556

Smarr, K. L., & Keefer, A. L. (2011). Measures of Depression and Depressive Symptoms. *Arthritis Care & Research, 63,* S454-S466. doi:10.1002/acr.20556

Snijder, M. B., Visser, M., Dekker, J. M., Seidell, J. C., Fuerst, T., Tylavsky, F., . . . Harris, T. B. (2002). The prediction of visceral fat by dual-energy X-ray absorptiometry in the elderly: a

comparison with computed tomography and anthropometry. *International Journal of Obesity and Related Metabolic Disorders, 26*(7), 984-993. doi:10.1038/sj.ijo.0801968

Stone, N. J., Robinson, J. G., Lichtenstein, A. H., Bairey Merz, C. N., Blum, C. B., Eckel, R. H., . . . Wilson, P. W. F. (2014). 2013 ACC/AHA Guideline on the treatment of blood cholesterol to reduce atherosclerotic cardiovascular risk in adults: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. *Circulation, 129*(25 suppl 2), S1-S45. doi:10.1161/01.cir.0000437738.63853.7a

Stubbs, J., Whybrow, S., Teixeira, P., Blundell, J., Lawton, C., Westenhoefer, J., . . . Raats, M. (2011). Problems in identifying predictors and correlates of weight loss and maintenance: implications for weight control therapies based on behaviour change. *Obesity Reviews, 12*(9), 688-708. doi:10.1111/j.1467-789X.2011.00883.x

Stunkard, A. J., & Messick, S. (1985). The Three-Factor Eating Questionnaire to measure dietary restraint, disinhibiiton, and hunger. *Journal of Psychosomatic Research, 29*(1), 71-83. doi:10.1016/0022-3999(85)90010-8

Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Metcalfe, L. L., Blew, R. M., . . . Lohman, T. G. (2004). Pretreatment predictors of attrition and successful weight management in women. *International Journal of Obesity, 28*(9), 1124-1133. doi:10.1038/sj.ijo.0802727

Teixeira, P. J., Silva, M. N., Coutinho, S. R., Palmeira, A. L., Mata, J., Vieira, P. N., . . . Sardinha, L. B. (2010). Mediators of weight loss and weight loss maintenance in middle-aged women..*Obesity, 18*(4), 725-735. doi:10.1038/oby.2009.281

Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Martin, C. J., Metcalfe, L. L., . . . Lohman, T. G. (2002). Weight loss readiness in middle-aged women: Psychosocial predictors of success for behavioral weight reduction. *Journal of Behavioral Medicine, 25*(6), 499-523. doi:10.1023/a:1020687832448

Teixeira, P. J., Carraca, E. V., Marques, M. M., Rutter, H., Oppert, J.-M., De Bourdeaudhuij, I., . . . Brug, J. (2015). Successful behavior change in obesity interventions in adults: a systematic review of self-regulation mediators. *BMC Medicine, 13*. doi:10.1186/s12916-015-0323-6

Thompson, F. E., & Subar, A. F. (2013). Chapter 1 - Dietary Assessment Methodology. In A. M. C. J. B. G. Ferruzzi (Ed.), *Nutrition in the Prevention and Treatment of Disease (Third Edition)* (pp. 5-46): Academic Press.

Toombs, R. J., Ducher, G., Shepherd, J. A., & De Souza, M. J. (2012). The impact of recent technological advances on the trueness and precision of DXA to assess body composition. *Obesity, 20*(1), 30-39. doi:10.1038/oby.2011.211

United States Department of Agriculture (USDA), Agricultural Research Service (ARS). 2012. Nutrient intakes from food: Mean amounts consumed per individual, by gender and age, What We Eat in America, NHANES 2009-2010. Available: www.ars.usda.gov/ba/bhnrc/fsrg.

United States Department of Agriculture (USDA), and United States Department of Health and Human Services (USDHHS). 2010. Dietary guidelines for americans, 2010. edited by US Department of Agriculture and US Department of Health and Human Services. Washington, DC: U.S. Government Printing Office.

Urbanek, J. K., Metzgar, C. J., Hsiao, P. Y., Piehowski, K. E., & Nickols-Richardson, S. M. (2015). Increase in cognitive eating restraint predicts weight loss and change in other anthropometric measurements in overweight/obese premenopausal women. *Appetite, 87*, 244-250. doi:10.1016/j.appet.2014.12.230

Valentine, R. J., Misic, M. M., Rosengren, K. S., Woods, J. A., & Evans, E. M. (2009). Sex impacts the relation between body composition and physical function in older adults. *Menopause-the Journal of the North American Menopause Society, 16*(3), 518-523. doi:10.1097/gme.0b013e31818c931f

Villareal, D. (2013). Weight loss therapies to decrease frailty in obese older adults. *Gerontologist, 53*, 352-352.

Villareal, D. T., Apovian, C. M., Kushner, R. F., Klein, S., Nutrition, A. S. f., & NAASO, T. e. O. S. (2005). Obesity in older adults: technical review and position statement of the American Society for Nutrition and NAASO, The Obesity Society. *Obesity Research, 13*(11), 1849-1863. doi:10.1038/oby.2005.228

Villareal, D. T., Banks, M., Siener, C., Sinacore, D. R., & Klein, S. (2004). Physical frailty and body composition in obese elderly men and women. *Obesity Research, 12*(6), 913-920. doi:10.1038/oby.2004.111

Villareal, D. T., Banks, M., Sinacore, D. R., Siener, C., & Klein, S. (2006). Effect of weight loss and exercise on frailty in obese older adults. *Archives of Internal Medicine, 166*(8), 860-866. doi:10.1001/archinte.166.8.860

Villareal, D. T., Chode, S., Parimi, N., Sinacore, D. R., Hilton, T., Armamento-Villareal, R., Shah, K. (2011). Weight loss, exercise, or both and physical function in obese older adults. *New England Journal of Medicine, 364*(13), 1218-1229.

Vincent, H. K., Heywood, K., Connelly, J., & Hurley, R. W. (2012). Obesity and weight loss in the treatment and prevention of osteoarthritis. *Pm&R, 4*(5), S59-S67.

Vincent, H. K., Raiser, S. N., & Vincent, K. R. (2012). The aging musculoskeletal system and obesity-related considerations with exercise. *Ageing Research Reviews, 11*(3), 361-373. doi:10.1016/j.arr.2012.03.002

Vincent, H.K., Vincent, K.R., & Lamb, K. (2010). Obesity and mobility disability in the older adult. *Obesity Reviews, 11*(8), 568-579. doi:10.1111/j.1467-789X.2009.00703.x

Visser, M., Langlois, J., Guralnik, J. M., Cauley, J. A., Kronmal, R. A., Robbins, J., . . . Harris, T. B. (1998). High body fatness, but not low fat-free mass, predicts disability in older men and women: the Cardiovascular Health Study. *American Journal of Clinical Nutrition, 68*(3), 584-590.

Volpi, E., Campbell, W. W., Dwyer, J. T., Johnson, M. A., Jensen, G. L., Morley, J. E., & Wolfe, R. R. (2013). Is the optimal level of protein intake for older adults greater than the Recommended Dietary Allowance? *Journals of Gerontology Series a-Biological Sciences and Medical Sciences, 68*(6), 677-681. doi:10.1093/gerona/gls229

Warziski, M. T., Sereika, S. M., Styn, M. A., Music, E., & Burke, L. E. (2008). Changes in self-efficacy and dietary adherence: the impact on weight loss in the PREFER study. *Journal of Behavioral Medicine, 31*(1), 81-92. doi:10.1007/s10865-007-9135-2

Waters, D., Ward, A., & Villareal, D. (2013). Weight loss in obese adults 65years and older: A review of the controversy. *Experimental Gerontology, S0531-5565*(13), 36-33. doi:10.1016/j.exger.2013.02.005

Weinheimer, E. M., Sands, L. P., & Campbell, W. W. (2010). A systematic review of the separate and combined effects of energy restriction and exercise on fat-free mass in middle-aged and older adults: implications for sarcopenic obesity. *Nutrition Reviews, 68*(7), 375-388. doi:10.1111/j.1753-4887.2010.00298.x

West, L. A., Cole, S., Goodkind, D., & He, W. (2014). *65+ in the United States: 2010*. Washington, DC: U.S. Government Printing Office.

Westenhoefer, J. (1991). Dietary restraint and disinhibition- Is restraint a homogeneous construct..*Appetite, 16*(1), 45-55. doi:10.1016/0195-6663(91)90110-e

Westenhoefer, J., Broeckmann, P., Munch, A. K., & Pudel, V. (1994). Cognitive control of eating behavior and the disinhibition effect. *Appetite, 23*(1), 27-41. doi:10.1006/appe.1994.1032

Westenhoefer, J., Engel, D., Holst, C., Lorenz, J., Peacock, M., Stubbs, J., . . . Raats, M. (2013). Cognitive and weight-related correlates of flexible and rigid restrained eating behaviour. *Eating Behaviors, 14*(1), 69-72. doi:10.1016/j.eatbeh.2012.10.015

Westenhoefer, J., Stunkard, A. J., & Pudel, V. (1999). Validation of the flexible and rigid control dimensions of dietary restraint. *International Journal of Eating Disorders,* 26:53-64.

Williamson, D. A., Martin, C. K., York-Crowe, E., Anton, S. D., Redman, L. M., Han, H., & Ravussin, E. (2007). Measurement of dietary restraint: Validity tests of four questionnaires. *Appetite, 48*(2), 183-192. doi:10.1016/j.appet.2006.08.066

Wing, R. R. (2003). Behavioral interventions for obesity: Recognizing our progress and future challenges. *Obesity Research, 11*, 3S-6S. doi:10.1038/oby.2003.219

Wycherley, T. P., Moran, L. J., Clifton, P. M., Noakes, M., & Brinkworth, G. D. (2012). Effects of energy-restricted high-protein, low-fat compared with standard-protein, low-fat diets: a meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition, 96*(6), 1281-1298. doi:10.3945/ajcn.112.044321

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale - a preliminary-report. *Journal of Psychiatric Research, 17*(1), 37-49. doi:10.1016/0022-3956(82)90033-4

Zamboni, M., Mazzali, G., Fantin, F., Rossi, A., & Di Francesco, V. (2008). Sarcopenic obesity: A new category of obesity in the elderly. *Nutrition Metabolism and Cardiovascular Diseases, 18*(5), 388-395. doi:10.1016/j.numecd.2007.10.002

Zhang, J.-P., Weiss, J. J., McCardle, M., Klopchin, H., Rosendahl, E., Maayan, L., . . . Correll, C. U. (2012). Effectiveness of a cognitive behavioral weight management intervention in obese patients with psychotic disorders compared to patients with nonpsychotic disorders or no psychiatric disorders results from a 12-month, real-world study. *Journal of Clinical Psychopharmacology, 32*(4), 458-464. doi:10.1097/JCP.0b013e31825cccd2

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta psychiatrica Scandinavica, 67*(6), 361-370.

APPENDIX A

SAMPLE DIETARY ADHERENCE CALCULATION

Sample Dietary Adherence Calculation

Participant	A	B
Intervention group	CP-EX	CP-EX
Energy recommendation	1200 kcal/d	1200 kcal/d
Macronutrient recommendation (percent of energy)	Carbohydrate: 52% Protein: 18% Fat: 30%	Carbohydrate: 52% Protein: 18% Fat: 30%
Actual energy intake at post-intervention (6 months)	1425 kcal/d	1225 kcal/d
Actual macronutrient intake (percent of energy) at post-intervention (6 months)	Carbohydrate: 63% Protein: 15% Fat: 23%	Carbohydrate: 54% Protein: 18% Fat: 28%
Energy adherence[1]	$\left({}^{1425}/_{1200}\right) \times 100 = 119$	$\left({}^{1225}/_{1200}\right) \times 100 = 102$
Protein adherence[1]	$\left({}^{15}/_{18}\right) \times 100 = 83$	$\left({}^{18}/_{18}\right) \times 100 = 100$
Energy adherence[1,2] (85 – 115% of recommendation)	Over consumer	Adherer
Protein adherence[1,2] (85 – 115% of recommendation	Under-consumer	Adherer

1. Warziski et al. 2008
2. Adherers: 85 – 115% of recommendation, under consumers <85% of recommendation, over consumers >85% of recommendation

APPENDIX B

CHANGES IN DIETARY INTAKE AND WEIGHT FOR COMPLETERS OF INTERVENTION BY GROUP OVER TIME

Changes in dietary intake and weight for completers of intervention by group over time. Mean ± SD or percent (%)

Variable	HP-EX[a] (n = 19)	HP[b] (n = 20)	CP-EX[c] (n = 22)	Differences in dietary change between groups[g]		P value for mixed model[d]		
				F or H	P	Group (G)	Time (T)	G x T
Energy (kcal)						0.4598	<.0001	0.5513
Baseline	1744 ± 527	1675 ± 398	1679 ± 370					
Post-intervention	1256 ± 259	1182 ±254	1145 ± 196					
Change	-488.5 ± 653**	-493 ± 329****	-534 ± 327****	0.06	0.9393			
Energy (percent of calculated need[e])						0.6924	<.0001	0.5407
Baseline	101 ± 31.1	95.0 ± 20.6	99.4 ± 20.0					
Post-intervention	76.2 ± 11.3	71.8 ± 16.5	72.6 ± 13.0					
Change	-25.0 ± 36.8**	-23.2 ± 17.3****	-26.8 ± 19.6****	0.10	0.9009			
Carbohydrate (g/d)						0.1455	<.0001	0.6581
Baseline	200 ± 64.2	185 ± 50.8	199.5 ± 54.2					
Post-intervention	132 ± 32.1	123 ± 34.2	147 ± 26.2					
Change	-68.4 ± 68.1***	-61.5 ± 50.1***	-52.6 ±56.3***	0.38	0.6835			
Carbohydrate (% energy)						<.0001	0.1810	0.0032
Baseline	44.9 ± 6.22	42.9 ±7.46	46.2 ± 9.19					
Post-intervention	40.4 ± 4.52	38.9 ± 4.72	49.5 ± 6.49					
Change	-4.54 ± 7.76*	-4.04 ± 8.20*	3.23 ± 8.38	6.03	0.0042			
Protein (g/d)						<.0001	0.1966	0.0001
Baseline	73.8 ± 22.8	70.0 ± 19.1	67.5 ± 14.6					
Post-intervention	85.4 ± 16.7	84.0 ± 14.6	55.1 ± 8.86					
Change	11.6 ± 28.8	14.0 ±17.8**	-12.4 ± 12.7****	10.80	0.0001			
Protein (% energy)						<.0001	<.0001	<.0001
Baseline	17.4 ± 4.36	17.0 ± 3.58	16.7 ± 4.02					
Post-intervention	27.8 ±4.40	30.3 ± 6.4	19.1 ± 2.42					
Change	10.4 ± 5.04****	13.3 ±7.49****	2.45 ± 4.22**	20.43	<0.001			
Protein (g/kg)						0.0002	0.0005	0.0001
Baseline	0.90 ± 0.29	0.83 ± 0.24	0.87 ± 0.19					
Post-intervention	1.14 ± 0.24	1.12 ± 0.30	0.78 ± 0.11					
Change	0.23 ±0.36*	0.28 ±0.27***	-0.08 ±0.16*	11.39	<0.001			
Total fat (g/d)						0.0965	<.0001	0.6009
Baseline	74.5 ± 27.8	71.0 ±21.8	64.4 ± 20.3					
Post-intervention	44.7 ±13.0	40.4 ± 14.0	38.3 ± 11.5					

Change	-29.6 ± 35.7**	-30.6 ±20.3****	-26.2 ±18.4****	0.17	0.8411			
Total fat (% energy)						0.0297	<.0001	0.6609
Baseline	36.7 ±5.49	36.7 ± 5.23	33.0 ± 6.51					
Post-intervention	30.9 ± 4.71	29.5 ± 5.84	28.8 ± 4.93					
Change	-5.76 ±7.48**	-7.17 ± 6.88***	-4.14 ±6.74*	0.98	0.3820			
Saturated fat (g/d)						0.2087	<.0001	0.7047
Baseline	25.1 ± 12.0	22.7 ± 7.37	21.0 ± 6.88					
Post-intervention	13.3 ± 3.45	13.8 ± 5.55	12.2 ± 4.92					
Change	-11.8 ±13.5***	-8.93 ±7.35****	-8.83 ±6.48****	0.65	0.5277			
Saturated fat (% energy)						0.1758	<.0001	0.3047
Baseline	12.3 ± 3.22	11.7 ±2.49	10.7 ± 2.29					
Post-intervention	10.3 ± 2.59	10.1 ± 2.48	9.10 ± 2.21					
Change	-2.98 ± 3.00**	-1.66 ± 2.96*	-1.61 ± 2.67*	1.44	0.2455			
Alcohol (g/d)						0.1146	<.0001	0.0538
Baseline	2.65 ± 4.54	8.73 ± 11.7	10.8 ± 14.1					
Post-intervention	2.05 ± 5.36	2.37 ± 4.09	4.70 ±6.79					
Change[h]	-0.60 ±5.70	-6.35 ±8.60**	-6.10 ±9.45**	4.193[h]	0.1229			
Alcohol (% energy)						0.1438	0.0117	0.2828
Baseline	1.16 ± 2.10	3.47 ± 4.53	4.16 ±5.65					
Post-intervention	1.01 ± 2.59	1.42 ± 2.45	2.59 ±3.81					
Change[h]	-0.15 ± 2.79	-2.06 ±2.84**	-1.58 ±3.85*	2.6377[h]	0.2674			
Fiber (g/d)						0.0434	0.0100	0.1350
Baseline	19.8 ± 5.16	19.8 ± 6.34	21.6 ±7.94					
Post-intervention	17.5 ± 4.37	15.9 ± 4.64	20.7 ±6.86					
Change	-2.25 ±5.71	-3.96 ± 6.70*	-0.93 ± 6.29	1.23	0.2999			
Fiber (g/1000 kcal)								
Baseline	11.8 ± 3.42	12.1 ± 3.62	13.2 ± 5.22					
Post-intervention	14.1 ± 3.37	13.6 ± 3.55	18.4 ±6.38					
Change	2.20 ± 4.55	1.54 ± 4.70	5.23 ± 3.81****	4.34	0.0175			
Dietary macronutrient adherence score						0.0278	<0.001	0.0081
Baseline	9.86 ± 2.60	9.97 ± 2.37	6.79 ± 3.81					
Post-intervention	4.19 ± 2.04	5.15 ± 2.24	4.48 ±2.48					
Change	-5.67 ±3.18****	-4.82 ± 3.66****	-2.31 ± 3.60**	5.19	0.0085			
Calcium (mg/d) [h]						0.4366	0.0086	0.3520
Baseline	768 ± 280	791 ± 252	785 ± 238					

Post-intervention	645 ± 205	764 ± 312	596 ± 213					
Change [f]	-123 ± 303	-26.9 ± 267	-189 ± 272**	3.34 [h]	0.1878			
Vitamin D (µg/d) [h]						0.2140	0.9492	0.8320
Baseline	4.80 ± 4.12	5.38 ± 3.20	3.61 ± 1.72					
Post-intervention	4.18 ± 3.12	4.82 ± 5.18	4.28 ± 3.66					
Change	-0.62 ± 5.24	-0.57 ± 4.79	0.67 ± 4.29	2.76 [h]	0.2513			
Vitamin C (mg/d) [h]						0.2922	0.5780	0.8600
Baseline	88.6 ± 46.7	71.3 ± 41.1	85.3 ± 48.1					
Post-intervention	89.2 ± 51.9	76.5 ± 44.2	85.2 ± 39.6					
Change	0.56 ± 63.5	5.21 ± 58.4	-0.06 ± 49.9	1.55 [h]	0.4596			

a. HP-EX: Higher protein diet (30% energy from protein) and supervised exercise intervention
b. HP: Higher protein diet (30% energy from protein); no exercise intervention
c. CP-EX: Conventional protein diet (18% energy from protein) and supervised exercise intervention
d. P value for difference between groups at post-intervention????
e. Mifflin St. Jeor Equation: [((10*Body Weight (kg)) + (6.25*Height (cm)) – (5*Age(y) - 161)]*1.3 (activity factor);
f. Depressive symptoms is CES-D total score greater than or equal to 16.
g. ANOVA (F) for normally distributed variables, Kruskal-Wallis Test (H), for non-normally distributed variables
h. Non-normal distribution
i. Hunger score lower ($P < 0.05$) in CP-EX than HP-EX and HP at baseline

*$P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; **** $P < 0.0001$, difference within intervention group over time. T-test for normally distributed variables. Wilcoxon Signed Rank Sum for non-normally distributed variables.

APPENDIX C

ADDITIONAL DIETARY INTERVENTION MATERIALS AND METHODS

Social Cognitive Theory

As noted in Chapter 3, the dietary intervention was based on Social Cognitive Theory. Human behavior is complex, and whether or not an individual successfully engages in behaviors necessary to lose weight and why he/she engages in those behaviors remains the focus of inquiry of many health behavior researchers. Bandura (1977) notes that research indicates that "cognitive processes play a prominent role in both the acquisition and retention of new behavior patterns" (Bandura, 1977, p. 192). Specifically, Bandura's Social Cognitive Theory (SCT) indicates that human behavior is determined by social and cognitive determinants that are an interaction of personal, behavioral, and environmental factors, known as reciprocal determinism (Bandura 2004, Rimer and Glanz 2005). Social Cognitive Theory evolved from Social Learning Theory in which Bandura posited that individuals learn behavior not only from their own experiences but from observing the actions and consequences of the actions of others (Rimer and Glanz 2005). Core determinants include knowledge, self-efficacy, outcome expectancies, goals, and perceived facilitators and barriers to engaging in health behavior (Bandura 2004, Rimer and Glanz 2005).

In the case of Social Cognitive Theory, knowledge is self-evident to mean the knowledge of the risks and benefits of engaging in a health behavior. Thus, whether or not someone would engage in weight loss behavior is partly determined by their knowledge of the risks and consequences of overweight and obesity. Outcome expectancies are what an individual believes the results will be of a particular behavior (Bandura 2004). For example, in the context of weight loss behavior, losing a certain amount of weight is the outcome expectancy of consuming energy-restricted diet, e.g., 1200 kcal/d goal. In this case, an individual believes that the behavior of meeting the energy restriction goals will result in an outcome of weight loss.

However, the outcome expectancy of weight loss in response to consuming an energy-restricted diet and knowledge that obesity adversely affects health do not fully predict whether or not an individual will engage in the desired health behavior of consuming the energy-restricted diet. According to Social Cognitive Theory, the individual must also believe that she is capable of accomplishing the health behavior or have the task-specific self-confidence (self-efficacy) to accomplish the health behavior. In the example of consuming an energy-restricted diet, the individual must have "self-efficacy" for measuring energy intake to know she is consuming an energy-restricted diet and to resist the desire to eat in excess of her daily energy goal. According to Bandura (1977), efficacy expectation is "the conviction that one can successfully execute the behavior to produce the outcomes" (Bandura 1977, p. 193). Therefore, Social Cognitive Theory proposes that while the individual can believe consuming an energy-restricted diet will result in weight loss, she may have limited self-efficacy for consuming an energy-restricted diet, and thus may continue to consume a higher calorie diet. Self-efficacy influences both whether the individual will initiate the desired health behavior and whether the effort towards the health behavior will continue in the face of obstacle, barrier, or adversity (Bandura 2004, Clark et al. 1991). Thus, greater self-efficacy for a particular behavior is associated with increased likelihood of engaging in the health behavior and attempts at accomplishing or continuing the health behavior in the face of challenge (Bandura 1977, Clark et al. 1991, Condiotte and Lichtenstein 1981). Therefore, outcome expectations and self-efficacy influence the likelihood of initiating and accomplishing a behavior (Bandura 1977).

Other important aspects of Social Cognitive Theory include goal setting, skill development, modeling, stimulus control, and reinforcement. Goal-setting is important for enhancing motivation to engage in the health behavior (Rimer and Glanz 2005, Bandura 2004).

Modeling involves peer examples of successful engagement in the health behavior (Bandura 2004). Modeling can be especially important for providing evidence of success in the health behavior in the face of obstacle. Stimulus control involves modifying the environment, physical or social, to enhance the likelihood of engaging in the health behavior (Spahn et al. 2010). Reinforcement involves providing affirmation or reward for successfully engaging in a health behavior that encourage likelihood of engaging in the behavior again (Rimer and Glanz 2005).

Social Cognitive Theory in the Dietary Intervention

The group education curriculum utilized various elements of the theory. The interventionists were purposeful in including the elements of Social Cognitive Theory in the group educational lessons, such as including opportunities for goal setting, facilitating discussion about successes and barriers, and providing examples of how to modify the environment to enhance the likelihood of engaging in healthy eating behaviors. Furthermore, the group sessions allowed opportunity for skill development by providing examples of nutrition labels or choosing lower calorie substitutions. Self-efficacy for managing eating behavior and food choices was emphasized in most group sessions and individual visits.

The individual visits also utilized elements of Social Cognitive Theory. During the first visit, the participants were asked to identify what losing weight would allow them to do that fit within their broader personal values. From these conversations, participants were asked to set goals for themselves that did not include weight loss. For example, a common goal was: "I will be able to get up and down off the floor to play with my grandchildren." Social cognitive theory indicates that helping individuals see how, "habit changes are in their self-interest and the broader goals they highly value," will enhance motivation (Bandura 2004, p. 144). The participants were asked to set two to three goals that were then discussed at later visits.

During the first visit, the participants were taught how to use the food scale provided. Subsequent visits allowed for further skill development, as participants were asked to practice and/or demonstrate their ability to weigh foods using food models and dishes. Later individual visits involved skill development for self-monitoring, as the interventionists instructed the participants to use the free online internet application, myfitnesspal.com or the exchange system (reference). Instructing the participants on using myfitnesspal.com provided opportunities to practice making substitutions, choose foods that would better meet goals, and identify barriers to success. A minimum of two individual visits was required for goal setting and instruction regarding the recommended diet and self-monitoring methods. Most participants attended four individual visits with the RDN or supervised graduate student at the beginning of the intervention for additional assistance.

Therefore, although the theory was used to design the educational curriculum and the agenda for the initial visit, the interventionists were not intentional about implementing social cognitive theory during group visits and individual visits beyond the first visit. Group sessions were participant driven, such that the interventionist responded to participant inquiries and interests. The interventionists did, however, facilitate modeling during group intervention sessions by asking specific participants to share successes with other participants. Furthermore, participants frequently asked to discuss social situations where eating was involved and following their dietary plan was difficult. The interventionists encouraged strategies for managing eating related behavior in these situations, while at the same time encouraged being flexible in their approach to these situations. For example, if the participant decided to have a slice of cake at a birthday party, the interventionists suggested that they have the cake without guilt. In the following days, the participant should be conscious to return to his or her plan. The

interventionists emphasized moderation in favor of an all-or-nothing approach to weight management and dieting. Examples of checklists for the individual visits are found on the following pages.

Self-monitoring

Participants were asked to keep a daily food diary throughout the intervention. During the first week, participants were asked to record their food on paper logs to develop an awareness for food preferences, meal and snack timing, and potential areas for improvement. For the remainder of the study, participants tracked their food intake using the free internet application, myfitnesspal.com that can be accessed on any computer with internet, or through a free application on a smart phone. This application was chosen for its cost (free), ease of use, large database of foods using the USDA National Nutrient Database for Standard Reference and brand name foods, allowance for participant entered recipes and bar-code scanning. Participants were given the option to use the program or record food on paper logs using the exchange system. All participants chose to use the myfitnesspal.com application. However, a few participants intermittently experienced technical difficulties and paper logs were used when they were not able to access myfitnesspal.com or it was unavailable.

After permission was obtained from the participant, the interventionist registered the participant for a free account and manually entered energy (kcal/d) and macronutrient goals (percent of energy) based on aforementioned calculations and intervention group protocol (higher protein, conventional protein). Participants were instructed on how to enter their daily intake, methods for choosing the most representative entry, and how to enter recipes and foods. Each week before the group visits, the registered dietitian nutritionist (RDN) or trained and supervised nutrition graduate student reviewed the participant records, and for each participant,

weekly averages for energy and macronutrients were calculated. The RDN or student then provided the participant written individualized feedback based on the entries reviewed. Feedback included suggestions for substitutions, corrections to data entry errors, reinforcement of good choices and effort, recommendations for recipes or meal and snack ideas, etc. The individualized notes were distributed at the beginning of group education sessions to allow for participants to ask questions.

Myfitnesspal.com was also used as a method for enhancing self-efficacy. By logging their daily intake and monitoring their energy and macronutrient intake, participants were quickly exposed to the nutrient content of varied foods. The interventionists encouraged the participants to practice entering different foods to see food choices would influence progress toward their dietary goals. Because they could do this before they ate the food, it provided a low stakes opportunity to try to master meal planning skills and enhance self-efficacy for making healthy food choices.

A major limitation of this study is that self-monitoring was not measured specifically. However, because participants were monitored weekly for self-monitoring adherence, it is assumed that most participants were self-monitoring regularly. Nonetheless, an intentional measurement of this variable would add to these analyses.

Body Weight Monitoring

Participants in the exercise intervention groups (CP-EX, HP-EX) were weighed weekly on Wednesday before their exercise sessions on a digital scale in the exercise facility wearing light clothes and no shoes. The individuals in the higher protein intervention group without exercise were weighed before or after group nutrition education classes once per week on the same digital scale wearing light clothes and no shoes. Participant weight was recorded on data

collection sheets by the interventionists as well as by the participants on their own weight loss graphs provided by the RDN, but these weights were only used for monitoring and not research data analyses. The graphs illustrated the trajectory of weight loss necessary to achieve weight loss goals of 10%, 7.5%, and 5% of initial body weight over the six month intervention. The purposes of the graphs were participant self-monitoring and as a communication tool for the RDN assess the rate of weight loss in relation to self-reported energy adherence so that adjustments could be made in energy goals to ensure weight was lost at a moderate rate (0.5 - 2 lbs per week), depending on initial body weight. An example of a weight loss graph is provided in the subsequent pages of Appendix C titled, “Sample Weight Loss Graph.”

ugaDIVAS Session 1 Checklist

Individual Session 1: (1 hour for session)

Prior to Individual Session:

- ☐ Create Excel File and Weight Loss Graph
- ☐ Complete the Nutrition-related Demographics and Health History notes
- ☐ Analyze baseline 3 day food diary and make notes in diet visit folder
- ☐ Print appropriate sample menus
- ☐ Organize food scale and supplements (sign scale out)
- ☐ Get Plate Method tear sheet
- ☐ Gather Beef Pamphlet, Lean beef cuts card, and beef cookery brochure
- ☐ Fill in NCBA Participant Calendar
- ☐ Label first week of food logs
- ☐ Prepare Diet Contract

Individual Session 1 Timeline:

- Part 1: Introduction and Expectations (30 minutes)
  - ☐ Establish Rapport: Introduce yourself, and ask them about themselves.
    - Why are they choosing to participate in the study?
  - ☐ Explain individual vs. group visits
  - ☐ PRO only -Do first weigh in.
  - ☐ Review weight loss graph.
    - Expectation: participants track their weight weekly on their weight graph.
    - When participants are not able to come to a class meeting they will still weigh themselves, record it, and report their weight to their instructor.

- Part 2: Individual Diet Plan
  - ☐ Review Nutrition Related Demographics and Health Hx
  - ☐ Provide TUMS and MVM (Ask about dairy consumption)
  - ☐ Review Mifflin-St. Jeor Calculation & Complete "How much should I eat?" handout with participant
    - Explain difference between calculated needs and prescribed kcal goal
  - ☐ Review Basic Diet Goals
  - ☐ PRO and PRO-EX only: Review Beef Pamphlet and lean beef cuts
  - ☐ Sample menus

Individual Session 1 Timeline (Continued):

- ☐ Plate method
- ☐ Food Scale

- **Part 3:** Assignment #1: (Diet Records) Keeping track (30 minutes)
  - ☐ (Have them record 7 days for first week) Food journal & Beef compliance log
  - ☐ Eating & Coping Lifestyle Patterns Mini Quiz
  - ☐ Go over worksheets (with Introduction to Portions Sheet, beef materials)
  - ☐ Think about goals
  - ☐ Ask about interest in website and App tracking of diet (My Fitness Pal)
    - Email address to use: _____

- Wrap up
  - ☐ Diet Contract
  - ☐ Set expectations for the week:
    - Maintain food journal daily
    - Note where difficulties arise
    - Be prepared for goal setting at next meeting.
  - ☐ What's the best way to contact you?
    - Phone, email, text, etc.=_____

ugaDIVAS Session 2 Checklist

Individual Session 2: (1 hour for session)

Prior to Individual Session:

- ☐ Update Weight Loss Graph
- ☐ Analyze 3 day food diary and make notes in diet visit folder
- ☐ Fill in NCBA Participant Calendar
- ☐ Create Myfitnesspal account

Individual Session 2 Timeline:

- Part 1: (30 minutes)
  - ☐ PRO only: Weigh-in
  - ☐ Review 7-d food log
  - ☐ Review beef compliance log – ensure understanding
  - ☐ Ask about how the client approached reaching the calorie goals
  - ☐ Ask about any concerns or issues the client had this week
    - Notes:

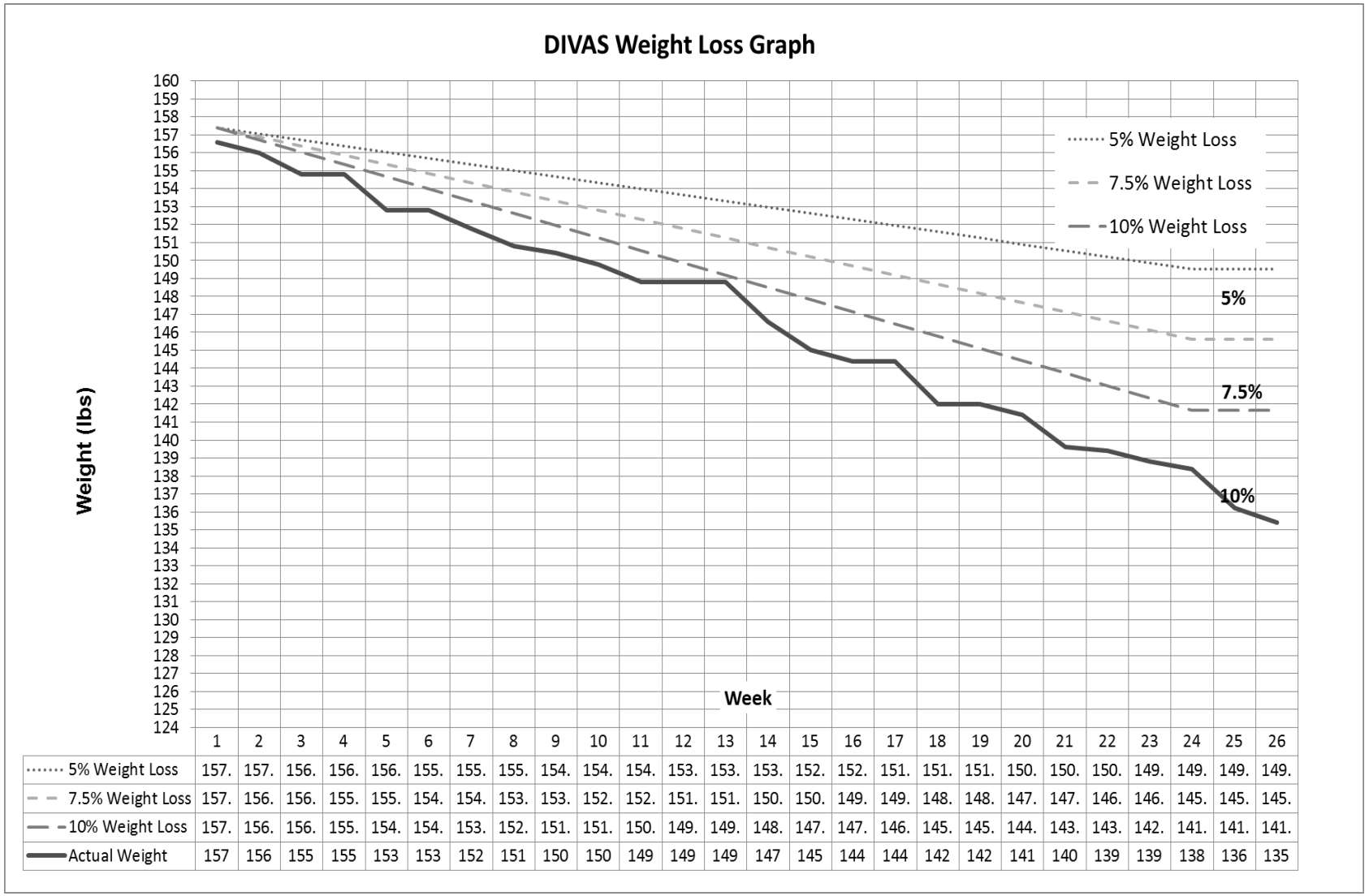
      _____
    - _____
  - ☐ Record and Discuss client developed goals
    - _____
    - _____
    - _____
  - ☐ Take Mini-Quizzes from client
  - ☐ Provide Myfitnesspal login info
  - ☐ Enter one day of food record in myfitnesspal or discuss ways to look up calorie information

- Wrap up
  - Set expectations for the week:
    - Maintain food journal daily (myfitnesspal OR paper journal)
    - Note where difficulties arise
    - Take bigger goals and break them in to smaller goals

ugaDIVAS Session 3 Checklist

✓	Task	Notes
Previsit		
	Update Weight Loss Graph	
	Analyze 3 day food diary and make notes in diet visit folder **OR** check on myfitnesspal progress	
	Fill in NCBA Participant Calendar	
	Check Mini-Quiz results and print out appropriate Eating Lifestyle Pattern handout	Handout provided:_____
During		
	Ask about how the client approached reaching the calorie goals	
	Ask about any concerns or issues the client had this week	
	Review 7-d food log OR Myfitnesspal.com; does participant have any questions about myfitnesspal?	
	Review beef compliance log – ensure understanding	
	Provide Eating Lifestyle Pattern Handout	
	Discuss client developed goals - inform client that we will start breaking these goals into mini goals in one of the first few classes.	
For next visit		
	Continue with myfitness pal and logs	
	Note where difficulties arise	
	Review the Eating Lifestyle Handout and apply wherever possible; be prepared to report back next week!	

Sample Weight Loss Graph



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
5% Weight Loss	157.	157.	156.	156.	156.	155.	155.	155.	154.	154.	154.	153.	153.	153.	152.	152.	151.	151.	151.	150.	150.	150.	149.	149.	149.	149.
7.5% Weight Loss	157.	156.	156.	155.	155.	154.	154.	153.	153.	152.	152.	151.	151.	150.	150.	149.	149.	148.	148.	147.	147.	146.	146.	145.	145.	145.
10% Weight Loss	157.	156.	156.	155.	154.	154.	153.	152.	151.	151.	150.	149.	149.	148.	147.	147.	146.	145.	145.	144.	143.	143.	142.	141.	141.	141.
Actual Weight	157	156	155	155	153	153	152	151	150	150	149	149	149	147	145	144	144	142	142	141	140	139	139	138	136	135

APPENDIX D

PARTICIPANT INFORMED CONSENT DOCUMENT

Consent to Participate in a Research Study

Title of Study: Effects of a Higher Protein Weight Loss Diet and Exercise on Body Composition, Physical Function and Fatigue in Overweight Older Women

Principal Investigators: Dr. Ellen M. Evans (706-542-4395; emevans@uga.edu)

UGA Department: Kinesiology

Purpose of this Research Study: This research, sponsored by the National Cattleman's Beef Association, is being conducted by the responsible principal investigator listed above. The purpose of this study is to compare the effectiveness of a higher-protein, reduced-carbohydrate (PRO) diet including beef combined with exercise, a standard higher carbohydrate (CARB) diet combined with exercise and PRO diet including beef without exercise on weight loss, body composition, muscular strength and quality and feelings of energy and fatigue.

Major Activities of Your Involvement:

1. Time: Your participation in the study will last approximately 7 months with multiple visits to our research sites. *These visits will last from approximately 0.5 hour to 3 hours in length for a total of approximately 40-130 hours depending on the study group to which you are randomly assigned*. This equates to roughly 5 hours a week for the 7 months. Research visits, diet education classes and exercise sessions will occur in our laboratories on the first floor of the Ramsey Student Center. MRI scanning will take place in the Coverdell Building, and screening blood work will be done at the University Health Center.

2. Screening: Because of the nature of this study, you will undergo screening to insure that it is safe for you to participate. This will involve evaluation of your medical history, obtaining a blood sample, and for those assigned to an exercise group, clearance from your personal physician, and completion of stress test administered by the study physician to determine that your cardiovascular system is healthy for exercise.

3. Treatment Groups: Upon successful screening, you will be randomly placed into one of the following three groups:

1) higher-protein, reduced-carbohydrate diet (PRO) plus exercise group (130 hour time commitment)
2) conventional higher carbohydrate diet (CARB) plus exercise group (130 hour time commitment)
3) PRO without exercise group (40 hour time commitment)

Dietary Prescriptions: You must discontinue all dietary supplements except those recommended by your physician or provided to you by this study (multivitamin-mineral supplement and calcium supplements will be provided to you during this study). All diet recommendations will be designed to reduce your caloric intake by 500 calories per day to induce a 10% weight loss from your initial body weight over the course of the intervention. The different diet plans are described on the attached hand-out which you can keep for your records. If you are assigned to one of the PRO diet plans, you will be asked to incorporate one serving of beef per day. The cost of food to meet these respective dietary prescriptions will be your responsibility. All participants will have an individual meeting with the dietetics counselor for initial prescriptions and will also attend weekly (first 1 to 2 months) or bi-weekly (remainder of the study) educational meetings in small groups. These meetings will last from half an hour to an hour, depending on the topic. You will be asked to follow the prescribed diet for the duration of the study. If you are unable to continue following the prescribed diet, you should discuss this with the dietetics counselor who will help you determine if you should continue with the study.

Exercise Intervention: Both of the exercise groups will be required to attend 3 exercise sessions per week. If you do not attend at least 75% of exercise session (54 sessions over the 6 months), you may be asked to withdraw from the study. Exercise sessions will be held on Monday, Wednesday and Friday mornings in the UGA Department of Kinesiology Fitness Center. The exercise sessions will include walking, lifting weights with your arms, abdominals, back and legs, stretching and balance exercises. Each session will last one hour and 15 minutes. If you are assigned to the PRO diet only group, you will be asked to maintain your current physical activity patterns for the duration of the intervention.

Details of Study Involvement:

Screening Visit #1 (S1) [~ 1 hour]

In the Ramsey Center lab, you will go over your phone screening information with study staff and if you are eligible to continue, the staff will go over information about the dual energy x-ray absorptiometry (DEXA) scan to determine your body composition and bone density, and the MRI scanning procedures. We will measure your height, weight and waist circumferences and you will provide information about your medical history, cognitive status, physical activity habits, and dietary intake. You will be given instructions for the screening blood draw at the University Health Center (see S2 below)

and forms to take to your personal physician to get medical clearance for study participation.

Screening Visit #2 (S2) [~0.5 hour]
You will visit the Laboratory at the University Health Center for a fasting blood draw. A small sample size of approximately two teaspoons will be taken at this visit by a trained nurse.

Randomization: At this point in the study, you will now be randomized (equal chance of assignment) to one of the three treatment groups described above. If you are assigned to the exercise group, you will be asked to complete Screening Visit #3, described below.

Screening Visit #3 (S3) [~0.75 hour]
Once the research team receives clearance from your personal physician allowing you to participate in the study, you will be scheduled for a stress test in the Ramsey Center Lab which will be conducted under the supervision of Jonathan Murrow, MD. This standard clinical test is used to determine safety for exercise participation and involves walking a treadmill while your heart rate and blood pressure are monitored..

If the results of the screening visits indicate that you are eligible for continued participation, you will complete 4 baseline testing visits, 2 midpoint visits, and 4 post-intervention testing visits.

Baseline Visits [~7 hours]: Before beginning the 6-month exercise and/or diet intervention, you will be scheduled to complete the 4 baseline testing visits outlined below.

Baseline Visit #1 (B1) [~ 2 hours]
You will be asked to arrive at our laboratory (Ramsey Center, Room 101A) in a fasted state to provide us with another fasting blood sample (about 3 teaspoons). We will provide you with a snack once this has been completed. Then you will have a complete a DXA scan. DXA technology uses a low-dose X-ray beam to determine body composition. You will fill out questionnaires that ask you about how you have been feeling over the past week and the past month and about your physical activity and eating behaviors. You will be provided with an activity monitor that we will ask you to wear for 7 days during waking hours. You will be provided with forms to record what you eat and drink for 3 days.

Baseline Visit #2 (B2) [~ 1 hours]
After arriving at the Ramsey Center Lab, you will be accompanied by a member of the research team to the Coverdell building to undergo MRI scanning. The scanner is a small enclosed space. MRI uses radio waves and magnetic fields to make images of your muscle, fat and bone tissue.

Baseline Visit #3 (B3) [~ 2 hours]
In the Ramsey Center Lab, you will complete assessments of your muscular strength and endurance. The strength testing will involve measuring the maximum amount of weight you are able to lift when extending and bending your knee.

Baseline Visit #4 (B4) [~ 2 hours]
In the Ramsey Center Lab, you will complete physical function tasks that mimic activities of daily living like standing up from a chair, getting off the floor from a sitting position, walking, and carrying small items. You should return your activity monitor and forms and the food records given to you in the B1 visit.

Mid-Point Visits [~4.5 hours]: After 3 months of your exercise and/or diet intervention, you will be scheduled to complete two mid-point testing visits as outlined below.

Mid-Point Visit #1 (M1) [~ 3 hours]
In the Ramsey Center Lab, you will have another DXA scan, complete additional questionnaires, and do the same functional tasks that you did in visit B4. You will be provided with an activity monitor and you will be asked to wear it for another 7 days. You will also be given another 3 day food record form.

Mid-Point Visit #2 (M2) [~ 1.5 hours]
In the Ramsey Center Lab, you will do the same strength testing as the B2 visit. A member of the research team will collect your activity monitor and forms that you filled out.

Post-Intervention Visits [~7 hours]: After completing all 6 months of your exercise and/or diet intervention, you will be scheduled for 4 post-intervention testing visits. These 4 visits include the same baseline testing visits outlined above and a one-hour focus group with other participants about what you thought about participating in our study.

Benefits: After the study, you will be provided with information about your body composition, the results of your blood work, and data collected during your stress test. You are encouraged to share this information with your personal physician. The results of this study may increase understanding of additional health benefits of weight loss using a high-protein diet alone, a high protein diet combined with exercise or a standard reduced calorie diet combined with exercise. The results may have important implications for improving overall cardiovascular and metabolic health for postmenopausal women.

Incentives: You will be provided $100 total upon successful completion of the research study, and monetary compensation is pro-rated as follows: $25 for successful completion of baseline testing, $25 for successful completion of mid-point testing, $25 for successful completion of post-intervention testing, and $25 for successful completion of the intervention. Successful completion of the intervention is defined as completing

75% of exercises per session and attending 80% of sessions offered. Successful completion of mid-point and post-testing sessions is defined as completing all required assessments including DEXA scan, questionnaires, accelerometry, diet records, functional testing, muscular strength and endurance testing, blood work, and attendance at the focus group meeting. Additionally, participants randomized into the PRO will be offered a complimentary free, 6-month trial membership to the Kinesiology Department's Fitness Center upon successful completion of the study.

Potential risks/discomforts from participation in the study: The primary risks in this study are (1) the performance of strenuous exercise which may make you fatigued, give you sore muscles or make you experience discomfort in breathing or your muscles, (2) possible but unlikely pooling of blood in the lower extremities after strenuous exercise, (3) possibility of fainting, development of a small bruise, or infection with the blood draw, (4) exposure to radiation during the DXA scans, (5) claustrophobia (feeling closed in) and loud noise during the MRI scan and the risk that the magnet could attract certain kinds of metal, (6) possible but unlikely negative long-term health effects of consuming red meat.

We will reduce risks to you by doing the following:

1. Carefully screening you for safety to exercise with a physician administered stress test and obtaining clearance from your personal physician.
2. You will warm-up prior to the muscle strength testing to reduce potential muscle soreness.
3. During the exercise training sessions, an individual will monitor your heart rate and look for signs of distress. If signs of illness such as headache, nausea, mental disorientation, lack of coordination, or dizziness occur, the training session will stop and you will be assessed by the study team. All testing will be carefully supervised by CPR/AED trained personnel to reduce possible risk. 4. The risks involved in drawing blood will be minimized by using only qualified and experienced staff to draw blood. These individuals will follow standard sterile techniques and procedures, will observe the subject after the needle is withdrawn, and will apply pressure to the blood-draw site to stop bleeding.
5. The radiation exposure from a DXA scan is typically 1-5 mrem. A comparable exposure is equivalent to less than one day's amount of natural background radiation exposure persons in the United States receive each year. The risk from radiation exposure of this magnitude is too small to be measured directly and is considered to be low when compared with other everyday risks.
6. There have been no ill effects reported from exposure to the magnetism or radio waves used in MRI. However, it is possible that harmful effects could be recognized in the future. Therefore, you will be asked about metal in or on your body (this includes certain dyes found in tattoos). If there is any question about potentially hazardous metal within your body, you may be withdrawn from the study. The examining room is locked during use so that no one carrying metal objects can enter while you are in the scanner. You will be in visual and verbal contact with the experimenter throughout the scan through an observation window, headphones, and a microphone and the test can be stopped quickly at any time if you feel uncomfortable. To minimize any discomfort

caused by noise, you will be provided with earplugs, and the headphones used for communication with the experimenter will further reduce the generated noise. The MRI results will be explained to you and may be clinically relevant, but for diagnosis and health questions, you should consult a qualified physician.
7. Although the risks of long-term consumption of red meat are not well established, especially when consumed as part of a high quality diet, public health guidelines caution against consuming too much red meat in the diet. At the completion of the study you will meet with our Registered Dietitian (RD) who will provide nutritional counseling for you as you transition out of our study and provide recommendations regarding other high quality protein sources such as chicken. We will also provide to you an informational sheet describing the potential risks and alternatives for your diet.

If you are injured: The researchers involved in this study will exercise all reasonable care to protect you from harm as a result of your participation. In the event of an injury as an immediate and direct result of your participation in this study, the researchers' sole responsibility is to arrange transportation to an appropriate facility if additional care is required. In the event that you suffer a research-related injury, your medical expenses will be your responsibility or that of your third-party payer, although you are not precluded from seeking to collect compensation for injury related to malpractice, fault, or blame on the part of those involved in the research.

Confidentiality and Privacy Protection: All information that can identify you will be kept strictly confidential unless required by law or necessary to protect your welfare (for example, if you were injured and needed physician care). Your name will not appear on any data relating to you except for the Informed Consent Document for the study, DXA, and MRI informed consent document. These items will be kept in a locked cabinet in a locked office separate from your other study information. Upon entrance in the study, you will be assigned a code number. Only the investigators will have access to the list of names and corresponding code numbers. All codes and identifiers will be destroyed one year following the completion of all data collection. This study will be performed, in part, at the University Health Center (UHC). Refusal to participate or decision to stop participating at any time will not compromise your access to care, treatment, and UHC services not related to the research, if you otherwise have such access. If you have a health record at UHC, your participation in this project will be noted on the summary list unless you specifically request that it not be added.

Voluntary participation and withdrawal from the study: Your participation in this study is voluntary. You can refuse to participate or withdraw from the study at any time without penalty or loss of benefits to which you are otherwise entitled. Also, the researchers will terminate your participation in the study at any time as a result of you having an unexpected response during the study, failing to follow instructions, or because the study has been stopped. It is important for you to know, however, that information collected from or about you up to the point of your withdrawal or termination by the researcher will be kept as part of the study data and may continue to be analyzed.

Questions: If you have any questions at any time throughout the study, you have a right to ask and are encouraged to contact the principal investigator Dr. Ellen M. Evans at emevans@uga.edu or by phone at 706-542-4395.

Participant's agreement:
I have read the information provided on the preceding pages. The researchers have answered all of my questions to my satisfaction, and I voluntarily agree to participate in this study.

_____
_____
Signature of Research Participant Date

_____
Printed Name of Research Participant

_____
_____
Signature of Researcher Date

_____
Printed Name of Researcher

Please sign three copies of this informed consent document. One will be stored in a locked cabinet separate from all of your other study materials. One will be provided to the University Health Center and you will keep one for your records.

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson, Institutional Review Board, University of Georgia, 629 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address IRB@uga.edu

THE UNIVERSITY OF GEORGIA
College of Education
Kinesiology

Body Composition and Metabolism Lab
UGA DIVAS Project

Breakdown of Treatment Groups

The Informed Consent Document for this research study explains that, if you are eligible to be enrolled in the study, you will be randomly assigned to one of three different treatment groups. **You have an equal chance of being randomized into each group**, and these groups are illustrated in the chart below.

**All diet recommendations will be designed to reduce your caloric intake by 500 calories per day to induce a 10% weight loss from your initial body weight over the course of the intervention.*

	PRO	**PRO + EX**	**CARB + EX**
Where will my calories come from?	30% Protein 30% Fat 40% Carbohydrates	30% Protein 30% Fat 40% Carbohydrates	18% Protein 30% Fat 52% Carbohydrates
Will I be required to eat beef?	 YES: Consume 3-3.5 ounces/day	 YES: Consume 3-3.5 ounces/day	NO: Maintain baseline level of beef consumption
Will I be required to exercise?	NO: Maintain baseline level of exercise	 YES: 3 mornings per week in the Ramsey Center	 YES: 3 mornings per week in the Ramsey Center
How often will I meet with the dietetics counselor?	Individual meetings weekly for the first month; group lessons bi-weekly for remainder of intervention	Individual meetings weekly for the first month; group lessons bi-weekly for remainder of intervention	Individual meetings weekly for the first month; group lessons bi-weekly for remainder of intervention

If you ever have questions about the three treatment groups, please feel free to contact our study team at ugadivasproject@gmail.com!

APPENDIX E

PHYSICIAN CLEARANCE FORM

Effects of a Higher Protein Weight Loss Diet and Exercise on Body Composition, Physical Function, and Fatigue in Overweight Women

Body Composition and Metabolism Laboratory
Phone: 706-542-6872 Fax: 706-542-3148

To the Attending Physician of Ms. _____
Patient Name *Phone Number*

Patient will be a new enrollee in the above listed study through the Department of Kinesiology at the University of Georgia.

*Patient understands that a medical examination is required before participation is permitted.

-
****
****

To be completed by the attending physician

The above named individual has asked to be included in a weight loss intervention. She will be randomly assigned to a diet + exercise group or a diet only group. The dietary intervention be aimed at participants losing 10% of initial body weight. The exercise program involves mild to moderate exercise in the form of stretching, walking and weight training, 3 days per week, ~ 75 minutes total in duration.

Applicant's Name _____ Date _____

Age _____ DOB _____Date of last complete physical examination _____

Please supply the following information, if available:

1. Height:_____ Weight:_____
2. Resting Blood pressure:_____ Resting Heart Rate:_____
3. Cholesterol:_____ mg/dL LDL _____ HDL _____ Triglycerides _____
4. 12-lead supine EKG (**Please attach a copy if available**)
   Date recorded _____ Normal _____ Abnormal ____

5. Most recent Graded Exercise Test (**Please attach a copy if available**)

   Date administered _____ Positive _____ Negative _____ Equivocal _____

6. DXA (**Please attach a copy if available**)

   Date administered _____Normal _____ Osteopenia ____

   Osteoporosis_____

7. **Cardiovascular Disease Risk Factors**

   _____Age (Men ≥ 45; Women ≥ 55)

   _____Family History (MI, coronary revascularization, or sudden death in first-degree family member)

   _____Smoking (Current or quit within last 6 months)

   _____Sedentary (Less than 30 min of moderate intensity exercise, 3 days/week for the past 3 months)

   _____Obesity (BMI ≥ 30)

   _____Hypertension (SBP ≥ 140 mm Hg and/or DBP ≥ 90 mm Hg; currently on hypertensive medications)

   _____Dyslipidemia (LDL-C ≥ 130 mg/dL and/or HDL-C < 40 mg/dL; TC ≥ 200 mg/dL; or on lipid lowering medication)

   _____Pre-diabetes (100 mg/dL ≤ IFG < 126 mg/dL; 140 mg/dL ≤ OGTT < 200 mg/dL)

   _____High-serum HDL-C (HDL-C ≥ 60 mg/dL)

8. **Known Disease**

   _____Known Cardiovascular Disease: _____

   _____Known Metabolic Disease:_____

   _____Known Pulmonary Disease:_____

9. **Contraindications**

   _____Unstable Angina

   _____Uncontrolled Symptomatic Heart Failure

   _____Significant EKG Abnormality

   _____Syncope

   _____Significant Cognitive or Emotional Disorder

   _____Weight Loss Surgery and/or drugs

   _____Uncontrolled Cardiac Dysrhythmia

   _____Significant Valvular Disease

   _____Severe/Uncontrolled Hypertension

   _____Significant Musculoskeletal Disorder

   _____Other Uncontrolled Disease

10. Please list any other chronic conditions or abnormalities that you are aware of:
    _____

    _____

    _____

11. Orthopedic Surgeries
    (Location/When):_____
    __
    _____

    _____

12. Exercise
    Limitations:_____
    _____
    ____

Please list any medications the applicant is currently taking:

MEDICATION	DOSAGE	FREQUENCY	CONDITION / SPECIAL NOTES

I have examined the above applicant and approve his/her participation in a weight loss intervention at the University of Georgia.

Print Physician's Name:

_____

Physician's Signature:

_____

Date:_____

MD Address:

_____

Phone: _____

RETURN APPLICATION TO:

Body Composition and Metabolism Laboratory
University of Georgia Department of Kinesiology
Suite 101 Ramsey Student Center
330 River Road
Athens, GA 30602-6554

E-mail: bcmluga@gmail.com
Phone: 706-542-4230
Fax: 706-542-3148

APPENDIX F

ANTHROPOMETRIC DATA COLLECTION PROTOCOL

Project NCBA Anthropometric Protocol & Script

Measuring Body Weight Protocol:
Make sure that the scale is plugged into the wall. Zero the scale.

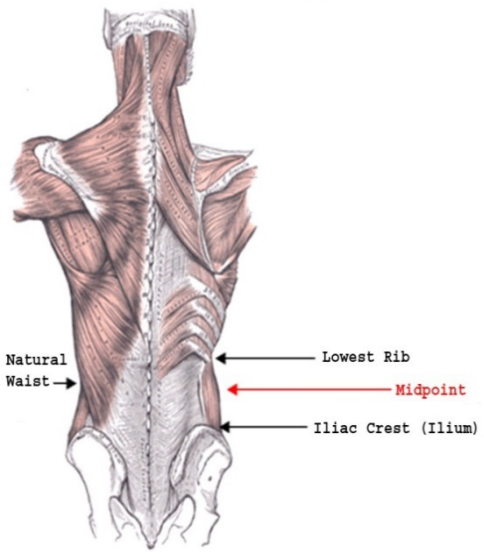
Measuring Body Weight Script:
Please step up on the scale when it reads 00.0 and hold still. Once I record your weight, you can step down off the scale.

Measuring Height Protocol:
Make sure the participant has removed shoes or any hat/headwear. Hold the head piece of the stadiometer well above her head so that she can stand underneath the headpiece and against the wall with her back to the wall. Make sure the participant is standing against the wall, with feet together and as close the wall as possible. Once she is standing in the appropriate position and has taken in a breath, lower the head piece so that it rests on the top of her head. Be sure the head piece is flat and perfectly horizontal on her head and is not obstructed by a hair-do, etc. Read the measurement and record to the nearest 0.1 cm.

Measuring Height Script:
We are going to measure how tall you are using this stadiometer. Please remove your shoes. Once you have removed your shoes, please stand with your back against the stadiometer with your feet together and as close to the wall as possible. Stand up as straight as possible, fix your eyes forward, put your hands on your hips, take a deep breath and slowly blow it out. We will move the stadiometer head piece so that it touches the top of your head lightly. Allow us to record the measurement, move the head piece off of the top of your head and then you can step out from the stadiometer. Record the measurement to the nearest 0.1 cm.

Measuring Waist Circumference Protocol:
Measure the natural waist circumference 3 times and the umbilicus waist circumference 3 times alternating between the two different measurement points.

As follows in this order:
Natural--#1, Umbilicus-#1, Natural-#2, Umbilicus-#2, Natural-#3, Umbilicus-#3



Natural waist circumference:
The natural waist is the narrowest part of the waist above the iliac crest and below the sub-sternal notch/ribs (see picture). Be sure the subject has removed her shirt and (is wearing a sports-bra) and the measurement is taken on bare skin. Hold the tape in both

hands and wrap it around the subject's waist or have them wrap it around their waist. Be sure the tape is not twisted and you have each end of the tape in each hand. Be sure the subject has both arms hanging loosely from her sides. Be sure the tape measure is completely horizontal around her natural waist (narrowest point) and at the end of the subject's normal expiration pull the tape tight but not so tight that you are pinching skin and read the measurement. Record the measurements to the nearest 0.1 cm and write the number on the anthropometric measurement form (example below).

Umbilicus waist circumference protocol:
The waist circumference is the horizontal plane centered on the umbilicus (belly-button) of the participant.

Be sure the subject has removed her shirt and (is wearing a sports-bra) and the measurement is taken on bare skin. Hold the tape in both hands and wrap it around the subject's waist or have them wrap it around their waist. Be sure the tape is not twisted and you have each end of the tape in each hand. Be sure the subject has both arms hanging loosely from her sides. Be sure the tape measure is completely horizontal around her waist at the same level of her umbilicus (belly button). At the end of the subject's normal expiration pull the tape tight but not so tight that you are pinching skin and read the measurement. Record the measurements to the nearest 0.1 cm and write the number on the anthropometric measurement form (example below). Repeat natural waist circumference then umbilicus waist circumference twice more, in that order.

Measuring Waist Circumference Script:
We are going to take 2 measurements of your waist. One will be at your natural waist, the narrowest part of your torso, and the other will be right at your belly button. We are going to take 3 measurements at each of these locations in rotating order. If you are uncomfortable at any time, please let us know and we will stop the measurements immediately.

Are you wearing a sports bra? Please remove your shirt. We will keep the door closed for privacy.

For each measurement, please stand up straight with your abdomen relaxed and with your arms at your sides and your feet together. Take in a breath and exhale. We'll measure your circumference at the end of your normal expiration.

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Anthropometric Measures

Date of Birth: MM DD YYYY

Time Point (please circle): Baseline Midpoint Post

Measures	Measurement	Comments
Body Weight (kg)		
Natural Waist Circumference 1 (cm)		
Natural Waist Circumference 2 (cm)		
Natural Waist Circumference 3 (cm)		
Natural Waist Circumference Average (cm)		
Umbilicus Waist Circumference 1 (cm)		
Umbilicus Waist Circumference 2 (cm)		
Umbilicus Waist Circumference 3 (cm)		
Umbilicus Waist Circumference Average (cm)		

BMI Measurements

Body Mass	kg	lbs
Height	cm	inches
BMI	**Kg/m²**	

DXA Information

Whole Body DXA Scan Completed by Investigator of Record: _____

Hand Position: $_1$☐ **Flat** $_0$☐ **Upright** **Artifacts present?** $_1$☐ **Yes** $_0$☐ **No**

APPENDIX G

QUESTIONNAIRES

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Demographics & Health History

Demographics

Date of Birth: MM DD YYYY Age:

Are you currently married?	1 ☐ Yes 0 ☐ No *If no, please specify:* 1 ☐ Never married 4 ☐ Separated 2 ☐ Living with partner 5 ☐ Divorced 3 ☐ Widowed 6 ☐ Other
What is your race? *(Please specify all categories that apply.)*	1 ☐ Asian/Pacific Islander 2 ☐ Black 3 ☐ Hispanic 4 ☐ Native American/Alaskan 5 ☐ White

How many years of education have you completed?

	# of years attended	Degree?	Specify the major area of study
Elementary (grades 1-8)	years	1☐Yes 0☐ No	
High school (grades 9-12)	years	1☐Yes 0☐ No	
Vocational/Technical School	years	1☐Yes 0☐ No	
2-year College	years	1☐Yes 0☐ No	
4 –year College	years	1☐Yes 0☐ No	
Graduate School	years	1☐Yes 0☐ No	

Professional School	☐☐ years	1☐Yes 0☐ No	

What is your current employment status?

☐ 1	Full time – working at least 35 hours/week
☐ 2	Part time – working less than 35 hours/week
☐ 3	Laid-off or unemployed, but looking for work
☐ 4	Laid-off or unemployed, but not looking for work
☐ 5	Retired, not working at all
☐ 6	Retired, working part-time
☐ 7	Disabled
☐ 8	Full time homemaker
☐ 9	Other, *please specify:* _____

What is your primary occupation (the one you work most hours a week)?

If you are retired and not working, what WAS your primary occupation?

Do you have any children?	1☐ Yes 0☐ No *If yes, please specify how many:* ☐☐
How many people live in your household including yourself?	☐☐ adults (at least 18 years of age) ☐☐ children (less than 18 years of age)

Other than yourself and your spouse or significant other, please describe any additional household members:

Children	Age(s)
Grandchildren	Age(s)
Other relatives	Age(s)
Other non-relatives	Age(s)

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

What is your total gross household annual income (before taxes and deductions)?

0 ☐ $0-$14,999	1 ☐ $15,000-$29,999	2 ☐ $30,000-$44,999	3 ☐ $45,000-$59,999
4 ☐ $60,000-$74,999	5 ☐ $75,000-$89,999	6 ☐ $90,000 and above	7 ☐ I choose not to answer

Health History

Do you have any of the following:

Have you been diagnosed with a past or present cardiovascular disease?	1 ☐ Yes 0 ☐ No
Do you have any significant heart rhythm disorders?	1 ☐ Yes 0 ☐ No
Is it a chronic disorder?	1 ☐ Yes 0 ☐ No
Have you been diagnosed with hypertension (high blood pressure)?	1 ☐ Yes 0 ☐ No
Have you been diagnosed with peripheral vascular disease?	1 ☐ Yes 0 ☐ No
Have you ever been diagnosed with a pulmonary disease such as asthma or emphysema?	1 ☐ Yes 0 ☐ No
Do you have obstructive sleep apnea?	1 ☐ Yes 0 ☐ No

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Are you epileptic?	1 ☐ Yes 0 ☐ No
Do you have arthritis? If so please describe where and severity (i.e., left knee, moderate pain):	1 ☐ Yes 0 ☐ No
Are you diabetic? If so please explain:	1 ☐ Yes 0 ☐ No
Have you been diagnosed with any kind of cancer? If so, please explain:	1 ☐ Yes 0 ☐ No
Do you have hyper or hypothyroidism? If so, please explain:	1 ☐ Yes 0 ☐ No
Have you recently been hospitalized? If so please explain why and for how long:	1 ☐ Yes 0 ☐ No
Have you had any recent illnesses or recently received antibiotics? If so, please explain:	1 ☐ Yes 0 ☐ No

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Medications: *Please indicate if you take the following medicine or drugs (circle all that you take),* ***and*** *list all other medicines or drugs you presently take and include the amount taken (dosage) and how often. Please include over-the-counter medicines as well as prescription medicine.*

Medicine/Drug/Supplement Name	Dosage (strength, i.e. mg, units, etc.)	Frequency Taken (i.e., times per day, week, etc.)
Anti-inflammatory drugs (e.g. aspirin, ibuprofen)		
Statins (e.g. Lipitor, Crestor, Mevacor, Vytorin)		
Hypothyroidism drugs (e.g. Synthroid)		
Any Other Medications:		

How much sleep did you get last night? How much sleep do you typically get each night?	☐☐ Hours last night ☐☐ Hours each night
Have you ever smoked in the past? If yes, How many years did you smoke? Approximately how much did you smoke each day? How long ago did you quit smoking?	1 ☐ Yes 0 ☐ No ☐☐ Years smoked ☐☐ Cigarettes/day ☐☐ Years ago

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
☐☐☐☐	☐☐ ☐☐ ☐☐☐☐ (MM DD YYYY)	☐☐	☐☐☐	☐☐☐

How many cups of caffeinated coffee do you have daily? *(If none, please write "0")*	☐☐ cups of caffeinated coffee/day
How many caffeinated soft drinks do you have daily?	☐☐ soft drinks/day
How many cups of tea do you have daily?	☐☐ cups of tea/week
How many cans of beer do you have weekly?	☐☐ cans of beer/week
How many glasses of wine do you have weekly?	☐☐ glasses/week
How many ounces of liquor do you have weekly?	☐☐ ounces/week
How many cigars or pipes do you smoke daily?	☐☐ cigars or pipes/day
How often would you rate your stress level as high?	0 ☐ Occasionally 1 ☐ Frequently 2 ☐ Constantly
Is there **anything** else you feel we should know about you or your current/past health? If yes, please explain:	1 ☐ Yes 0 ☐ No

Beef Consumption History

Do you regularly consume beef?	1 ☐ Yes 0 ☐ No *If yes, please specify how many days per week you consume beef:* _____ *How many serving of beef do you eat per week?* _____

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Three Factor Eating Questionnaire

Directions: For items 1-36, please respond by circling True or False.

Part I

		Please circle your answer
1.	When I smell a sizzling steak, I find it very difficult to keep from eating, even if I have just finished a meal.	True False
2.	I usually eat too much at social occasions, like parties and picnics.	True False
3.	I am usually so hungry that I eat more than three times a day.	True False
4.	When I have eaten my quota of calories, I am usually good about not eating any more.	True False
5.	Dieting is so hard for me because I just get too hungry.	True False
6.	I deliberately take small helpings as a means of controlling my weight.	True False
7.	Sometimes things just taste so good that I keep on eating even when I am no longer hungry.	True False
8.	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat.	True False
9.	When I feel anxious, I find myself eating.	True False
10.	Life is too short to worry about dieting.	True False
11.	Since my weight goes up and down, I have gone on reducing diets more than once.	True False
12.	I often feel so hungry that I just have to eat something.	True False
13.	When I am with someone who is overeating, I usually overeat too.	True False
14.	I have a pretty good idea of the number of calories in common food.	True False
15.	Sometimes when I start eating, I just can't seem to stop.	True False
16.	It is not difficult for me to leave something on my plate.	True False
17.	At certain times of the day, I get hungry because I have gotten used to eating then.	True False
18.	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.	True False
19.	Being with someone who is eating often makes me hungry enough to eat also.	True False
20.	When I feel blue, I often overeat.	True False
21.	I enjoy eating too much to spoil it by counting calories or watching my weight.	True False
22.	When I see a real delicacy, I often get so hungry that I have to eat right away.	True False

23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.	True	False
24. I get so hungry that my stomach often seems like a bottomless pit.	True	False
25. My weight has hardly changed at all in the last ten years.	True	False
26. I am always hungry so it is hard for me to stop eating before I finish the food on my plate.	True	False
27. When I feel lonely, I console myself by eating.	True	False
28. I consciously hold back at meals in order not to gain weight.	True	False
29. I sometimes get very hungry late in the evening or at night.	True	False
30. I eat anything I want, any time I want.	True	False
31. Without even thinking about it, I take a long time to eat.	True	False
32. I count calories as a conscious means of controlling my weight.	True	False
33. I do not eat some foods because they make me fat.	True	False
34. I am always hungry enough to eat at any time.	True	False
35. I pay a great deal of attention to changes in my figure.	True	False
36. While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.	True	False

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Three Factor Eating Questionnaire
Part II

Directions: Please answer the following questions by circling your answers.

37. How often are you dieting in a conscious effort to control your weight?
A = rarely B = sometimes C = usually D = always

38. Would a weight fluctuation of five pounds affect the way you live your life?
A = rarely B = sometimes C = usually D = always

39. How often do you feel hungry?
A = rarely B = sometimes C = usually D = always

40. Do your feelings of guilt about overeating help you to control your food intake?
A = rarely B = sometimes C = usually D = always

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?
A = easy B = slightly difficult C = moderately difficult D = very difficult

42. How conscious are you of what you are eating?
A = not at all B = slightly C = moderately D = extremely

43. How frequently do you avoid "stocking up" on tempting foods?
A = almost never B = seldom C = usually D = almost always

44. How likely are you to shop for low calorie foods?
A = unlikely B = slightly unlikely C = moderately likely D = very likely

45. Do you eat sensibly in front of others and splurge alone?
A = never B = rarely C = often D = always

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?
A = unlikely B = slightly likely C = moderately likely D = very likely

47. How frequently do you skip dessert because you are no longer hungry?
1 = almost never 2 = seldom 3 = at least once a week 4 = almost everyday

48. How likely are you to consciously eat less than you want?
A = unlikely B = slightly unlikely C = moderately likely D = very likely

49. Do you go on eating binges though you are not hungry?
A = never B = rarely C = sometimes D = at least once a week

50. On a scale of A to E, where A means no restraint in eating (eating whatever you want, whenever you want it) and E means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself? Circle your answer:
A = usually eat whatever you want, whenever you want it
B = often eat whatever you want, whenever you want it
C = often limit food intake, but often "give in"
D = usually limit food intake, rarely "give in"
E = constantly limiting food intake, never "giving in"

51. To what extent does this statement describe your eating behavior? “I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow.”

A = not like me
B = little like me
C = pretty good description of me
D = describes me perfectly

Subject No.	Date of Visit	Visit	Reviewed by:	Data entered by:
	MM DD YYYY			

Center for Epidemiologic Studies Depression Scale (CES-D), NIMH

Directions: Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the **past week**.

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by the things that usually don't bother me.	☐ 0	☐ 1	☐ 2	☐ 3
2. I did not feel like eating; my appetite was poor.	☐ 0	☐ 1	☐ 2	☐ 3
3. I felt that I could not shake off the blues even with help from my family or friends.	☐ 0	☐ 1	☐ 2	☐ 3
4. I felt I was just as good as other people.	☐ 0	☐ 1	☐ 2	☐ 3
5. I had trouble keeping my mind on what I was doing.	☐ 0	☐ 1	☐ 2	☐ 3
6. I felt depressed.	☐ 0	☐ 1	☐ 2	☐ 3
7. I felt that everything I did was an effort.	☐ 0	☐ 1	☐ 2	☐ 3
8. I felt hopeful about the future.	☐ 0	☐ 1	☐ 2	☐ 3
9. I thought my life had been a failure.	☐ 0	☐ 1	☐ 2	☐ 3
10. I felt fearful.	☐ 0	☐ 1	☐ 2	☐ 3
11. My sleep was restless.	☐ 0	☐ 1	☐ 2	☐ 3
12. I was happy.	☐ 0	☐ 1	☐ 2	☐ 3
13. I talked less than usual.	☐ 0	☐ 1	☐ 2	☐ 3
14. I felt lonely.	☐ 0	☐ 1	☐ 2	☐ 3
15. People were unfriendly.	☐ 0	☐ 1	☐ 2	☐ 3
16. I enjoyed life.	☐ 0	☐ 1	☐ 2	☐ 3
17. I had crying spells.	☐ 0	☐ 1	☐ 2	☐ 3
18. I felt sad.	☐ 0	☐ 1	☐ 2	☐ 3
19. I felt that people dislike me.	☐ 0	☐ 1	☐ 2	☐ 3
20. I could not get "going."	☐ 0	☐ 1	☐ 2	☐ 3