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Perceived Self-Efficacy and Financial Incentives: Factors Affecting Health Behavior and Body Weight in Individuals with Overweight and Obesity

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**Perceived Self-Efficacy and Financial Incentives: Factors Affecting Health Behavior and
Body Weight in Individuals with Overweight and Obesity**

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A Thesis

Submitted in Partial Fulfillment of the

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University of Connecticut

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APPROVAL PAGE

Masters of Science Thesis

**Perceived Self-Efficacy and Financial Incentives: Factors Affecting Health Behavior and
Body Weight in Individuals with Overweight and Obesity**

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This thesis will be presented in two chapters. Chapter 1 will examine self-efficacy as a predictor of health behavior and body weight. Chapter 2 will assess the role of self-efficacy and financial incentives in a weight-loss intervention.

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CHAPTER ONE

Perceived Self-Efficacy as a Cognitive Factor Affecting Health Behavior and Body Weight in Individuals with Overweight and Obesity and at Risk for Type II Diabetes

Abstract

Statement of the problem: Overweight (OW) and obesity (OB) is a major public health concern and contributes to escalating health care costs. Self-efficacy plays a significant role in health behavior (both exercise and diet) and lack of could contribute to OW and OB. **Design:** Exploratory and correlational. **Sample size and composition:** Ninety-nine middle aged OW and OB female nursing home employees of black and white ethnicities, with at least a high school diploma. **Measures:** Eating and exercise self-efficacy (Eat-SE, Ex-SE) were assessed using confidence-based questions and then transformed into qualitative scores for each efficacy scale. Healthy eating scores (HES) and exercise behavior were assessed using frequency-based questions. **Analysis:** Correlation, causal mediation, and regression analysis examined the influence of Eat-SE and Ex-SE on physical activity (PA), eating behavior, and BMI. **Results:** Higher HES predicted higher Eat-SE ($p= 0.02$) and in turn, a lower BMI ($p= 0.02$). Increased frequencies of moderate and vigorous PA predicted higher Ex-Se ($p= 0.01$, $p= 0.00$). Moderate PA further predicted a lower BMI ($p= 0.05$). **Conclusion:** Our models combining social cognitive variables (self-efficacy beliefs) and behavioral variables captured variations in BMI. Future obesity intervention may incorporate self-efficacy for overcoming barriers to weight management.

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Introduction

Obesity is a growing epidemic in the United States and is quickly becoming a global crisis. According to the Centers for Disease Control and Prevention (CDC), more than two-thirds of U.S. adults are overweight or obese, and over one-third worldwide.¹ Obesity leads to many comorbidities and other obesity-related disorders, including Type 2 Diabetes, cardiovascular disease, hypertension, and countless other detrimental health consequences.² This further contributes to increased morbidity, mortality and health care costs across the nation.

An individual is classified as overweight when his or her Body Mass Index (BMI) is greater than or equal to 25 kg/m², and classified as obese when his or her BMI is greater than or equal to 30 kg/m². Biological, behavioral, metabolic, psychological, psychosocial, sociocultural, socioeconomic and environmental factors all influence the etiology of obesity, a disease affecting individuals of every age, gender and race.³ Higher body weight and obesity result from an imbalance in the amount of energy consumed through dietary intake and expended energy through physical activity. Over the past few decades, the amount of calories consumed by the U.S. population has increased. Data from the U.S. Department of Agriculture (USDA) shows that between 1970 and 2010, the amount of calories consumed per individual has increased by nearly 500 calories per day. This increase in energy intake has been accompanied by a decrease in physical activity and an increase in sedentary behavior.⁴ Sedentary behavior, the time a person is sitting or lying down, is associated with a 147% increased risk of cardiovascular disease (CVD), a 90% increase in CVD mortality, and a 49% increase in the risk of all-cause mortality.⁴ Less than 4% of adults in North America complete recommended minimum amounts of physical activity, and most consume well in excess of their caloric needs.⁵ This shift in energy imbalance over the recent years has led to the significant increase in BMI across the nation. A study published in the

Journal of Preventive Medicine predicted that by 2030, 51% of the U.S. population will be obese, a 33% increase in obesity and 130% increase in severe obesity within the next two decades.⁶

Our current healthcare system is not equipped to manage these projected obesity trends. Obesity and its related health consequences are significant factors driving healthcare spending. In 2011, the CDC estimated that healthcare costs exceed \$8,600 annually (per capita).⁴ In 2008, obesity-related medical care costs were estimated to have risen to \$146 billion dollars per year, accounting for almost 10% of all medical spending.⁴ This total includes direct costs and indirect costs associated with absenteeism, disability, illness and premature death. If these trends continue, it is estimated that by 2030, the costs of obesity in the U.S. could reach 16% to 18% of all U.S. health expenditures annually.⁴ However, if obesity prevalence were to remain at the levels they were at in 2010, the combined savings in medical expenditures over the next two decades is estimated at \$5.5 billion dollars.⁶ The economic burden of obesity is not only a major public health concern for the U.S., but is also becoming a global health crisis.⁷ It is critical to identify ways to stop or slow the progression of this epidemic.

Obesity may be combatted though shifting the energy intake and expenditure back to an appropriate balance. Increasing physical activity and improving healthy eating habits can lower the risk of obesity, as well as its comorbidities such as Type 2 Diabetes, high blood pressure and CVD. Obese individuals who lose even relatively small amounts of weight are likely to experience health benefits, such as improvements in diabetes control, reduction of CVD risk factors, and improved psychosocial functioning.^{8,9} The ability to make positive lifestyle behavior changes is strongly rooted to intrinsic factors such as motivation, readiness to change, and confidence, all of which are involved in the construct of self-efficacy. Self-efficacy, as explained by Bandura, refers to “an individual’s belief in his or her capacity to execute behaviors necessary to produce specific

performance attainments”.¹⁰ An individual’s perceived self-efficacy reflects his or her confidence in the ability to exert control over their own behavior, motivation and environment. Current research states that higher levels of self-efficacy in certain health behaviors, including healthy eating and exercise, have been associated with lower BMI.¹¹

National and global populations facing the obesity epidemic are at significant risk for further weight gain if the current obesity trends continue. As obesity increases detrimental health risks to our society, it is pertinent that health professionals identify factors contributing to weight change in order to halt its alarming progression. To do so, it is essential to pinpoint which psychological factors play significant roles in health-related behaviors including dietary and physical activity habits.

Purpose:

The primary purpose of the present study was to evaluate the relationship between perceived self-efficacy, eating and exercise behaviors, and BMI in individuals with overweight and obesity, who are at risk for Type 2 Diabetes.

Specific Objectives:

1. Assess the relationship between perceived eating self-efficacy, healthy eating behavior, and BMI in individuals with overweight and obesity.

***Hypothesis 1a:** Higher healthy eating scores will be associated with higher eating self-efficacy and both will be associated with lower baseline BMI.*

***Hypothesis 1b:** Eat-SE will mediate the relationship between HES and BMI.*

2. Assess the relationship between perceived exercise self-efficacy, frequency of **mild** physical activity, and BMI in individuals with overweight and obesity.

Hypothesis 2a: *More frequent mild physical activity will be associated with higher exercise self-efficacy and both will be associated with lower baseline BMI.*

Hypothesis 2b: *Ex-SE will mediate the relationship between mild PA and BMI.*

3. Assess the relationship between perceived exercise self-efficacy, frequency of **moderate** physical activity, and BMI in individuals with overweight and obesity.

Hypothesis 3a: *More frequent moderate physical activity will be associated with higher exercise self-efficacy, and both will be associated with lower baseline BMI.*

Hypothesis 3b: *Ex-SE will mediate the relationship between moderate physical activity and BMI.*

4. Assess the relationship between perceived exercise self-efficacy, frequency of **vigorous** physical activity, and BMI in individuals with overweight and obesity.

Hypothesis 4a: *More frequent vigorous physical activity will be associated with higher exercise self-efficacy, and both will be associated with lower baseline BMI.*

Hypothesis 4b: *Ex-SE will mediate the relationship between vigorous PA and BMI.*

Literature Review

The following review will examine current literature in the following areas:

- I. Health Profile of Nursing-Home Employees
- II. Health Behaviors predict Health Outcomes: Physical Activity and Dietary Intake
- III. Determinants of Health Behavior: The Theoretical Framework
 - I. Social Change Models (SCM):
 - a. Social Cognitive Theory (SCT)
 - b. Self Determination Theory (SDT)
 - c. Transtheoretical/Stage of Change Model (TTM/SOC)
- IV. Self-Efficacy (and Perceived Barriers) in relation to Health Behavior and Health Outcomes
- V. Additional Determinants of Self-Efficacy, Health Behavior and Body Weight
- VI. Measurement of Perceived Self-Efficacy and Health Behaviors
- VII. Summary

Literature Review

I. Health Profile of Nursing-Home Employees

According to the Centers for Disease Control (CDC)'s National Nursing-Home Survey, there were 1.7 million nursing home beds (1,500 facilities with about 108 beds per home) in the United States in 2004.¹² The occupancy rate (number of residents divided by number of available beds) was 86.3%. A total of 936,000 persons (registered nurses, licensed practical nurses, certified nursing assistants, nurse's aides, and orderlies) provided nursing care to nursing-home residents.¹² Certified nursing assistants (CNA) (600,800) represented the majority of all nursing staff employed in nursing homes.¹² Nursing homes employ Registered Nurses (RN), Licensed

Practical Nurses (LPN), Geriatric Nursing Assistant (GNA), Occupational and Physical Therapists (OT/PT), among other healthcare professionals. These facilities operate 24 hours a day, 365 days a year and often schedule employees to 12 hour shifts, instead of the typical 8 hours that is common in other fields of work. The typical patient in nursing homes are individuals who are often unable to care for themselves independently, whether it be due to illness, disability, or mental disorder. To provide care for these patients, nursing-home employees are frequently on their feet much of the workday, physically helping patients with activities of daily living. Strenuous physical effort and psychosocial strain is common among low-wage workers, such as nursing-home employees. Despite the physical demands that nursing-home employees face while working, as a population, they are still at an overall heightened risk of being overweight and obese. The current nursing workforce is predominately (91%) comprised of middle-aged females, with an average age of 44.6 years.¹³ This population of middle-aged females is already at an increased risk for being overweight or obese. Since the late 1990s, women have tended to have higher BMIs than men.¹⁴ Regardless of race, women have a higher risk of becoming overweight/obese than men.¹⁵ Obesity is also higher among middle age adults, 40-59 years old (39.5%).¹ A cross-sectional study conducted by Miranda et al published in 2015 analyzed associations between workplace stressors and health-related outcomes in nursing home employees. Of 1506 respondents, 20% reported having at least 3 physical workplace stressors, which were strongly associated with obesity and physical inactivity.¹⁶ Due to the demographic, social, and workforce characteristics of nursing home employees, this population is at increased risk for obesity.

II. Health Behaviors predict Health Outcomes: Physical Activity and Dietary Intake

Defining 'Health Behaviors'

Health behaviors are defined as ‘behavior patterns, actions and habits that relate to health maintenance, to health restoration and to health improvement’.¹⁷ This definition includes self-directed behaviors, compliance with medical regimens (such as medication-taking), as well as usage of medical services (such as doctor visits). Behaviors that can critically impact health and well-being include direct biological changes, early detection and treatment of disease, and/or protecting against risks.¹⁸ Health behaviors are commonly discussed as either factors that enhance or impair health. Behaviors that enhance health, or prevent disease, include exercise and keeping a healthful diet. Behaviors which impair health, or heighten risk of disease, include activities such as physical inactivity, poor diet quality or smoking. Quality of health also impacts an individual’s quality of life, through prevention of disease and extension of an active lifestyle. In turn, these behaviors may determine health related outcomes including disease risk, morbidity, and mortality. It is well established that regular exercise, healthy dietary habits and maintaining a desirable body weight are all associated with lower morbidity and mortality.¹⁹ Positive behavior changes such as increasing physical activity and improving diet lead to improved health outcomes and prevention of chronic diseases.

Physical Activity

Many westernized diseases, including Obesity and Type 2 Diabetes, can be managed or prevented through regular physical activity.²⁰ Benefits of regular exercise also include reduced cardiovascular morbidity and mortality, reduced blood pressure, and reduced stress, as well as improvements in self-esteem and mood. Despite the well-established known benefits of physical activity, the majority of Americans do not participate in regular exercise.²⁰ In fact, the Healthy People 2010 report put out by the U.S. Department of Health and Human Services in 2000, stated that only 15% of Americans reported regular physical activity for 30 min, ≥ 5 days a week.²⁰ A

disturbing 40% reported no leisure time physical activity, which is for most people the greatest opportunity for affording exercise outside of normal daily routines.²¹

The 2008 Physical Activity Guidelines for Americans states that adults should engage in 2.5 hours of moderate or 1.25 hours of vigorous activity per week in order to achieve substantial health benefits, in addition to muscle-strengthening activities at least 2 days per week.²² Examples of such intensity levels include brisk walking or gardening (moderate) to jogging or kickboxing (vigorous). Participation in regular physical activity has been shown to correlate to socio-demographic variables, such as gender, age, or race. Females, in particular, are less likely to engage in regular physical activity than their male counterparts, regardless of age. Data from 2007 to 2009 reflects that only 14.7% of women met recommended levels of adequate physical activity, compared to 21.1% of men.²³

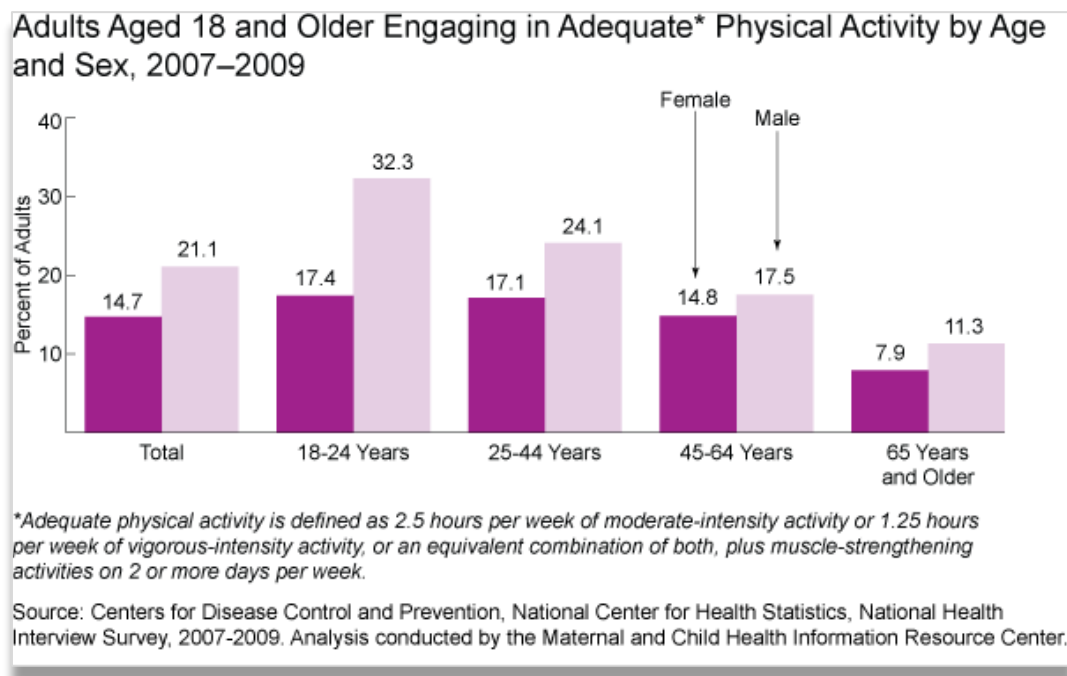


Figure 1. Percent of Adults Engaging in Adequate Physical Activity by Age and Sex, 2007-2009

In addition to infrequent physical activity, many socio-environmental lifestyle patterns have shifted in recent years, contributing to an increased sedentary lifestyle. As the AHA (2015) explains, it is more difficult today to create an active lifestyle than in the past. Improvements in technology and mass transportation have allowed many to work sedentary jobs. Sedentary jobs have increased 83% since 1950, while physically active jobs make up less than 20% of the current workforce.⁴ In addition, the average workweek is longer, with full time US workers averaging 47 hours of work per week, accounting for over 350 more hours of sedentary activity over the course of a year.⁴ The average American worker is inactive in both realms of life, at home and at the workplace, thus further contributing to energy imbalance.

In addition to increased sedentary activities, research efforts have attempted to identify other major determinants of physical activity. A correlational study conducted by Stutts (2002) analyzed 137 adults to explore social cognitive motives for physical activity. A validated and reliable questionnaire was administered as an interview, investigating participants' perception of benefits, barriers and self-efficacy for physical activity. The majority of participants were overweight white (61%) women (80%) with a mean age of 39 years. Findings revealed that low self-efficacy levels were associated with more perceived barriers, while higher self-efficacy levels were associated with decreased perception of barriers. BMI was the only factor which significantly predicted self-efficacy, with higher BMI associated with lower reported self-efficacy surrounding physical activity. Higher BMI was also associated with greater perceived barriers to physical activity implementation and maintenance. Time constraints were the primary barrier reported for not participating in regular physical activity. Lack of control over time was thought to lead to a perceived barrier to physical activity.²¹ In addition to self-efficacy of physical activity, "energy in" or dietary intake behaviors are also an important, well-established factor impacting body weight

and should be considered when discussing the issue of chronic disease prevalence. Diet has been shown to impact Diabetes, CVD, stroke, blood pressure, osteoporosis, and cancer, while insufficient physical activity and caloric over-consumption is a common problem contributing to obesity in North America.

III. Determinants of Health Behavior: The Theoretical Framework

Social Change Models (SCMs): Cognitive factors, such as personal knowledge and efficacy, play an important role in how an individual behaves and why they engage in such behaviors. Many behavior and behavior change theories are built upon, and emphasize, this particular construct.

a. Social Cognitive Theory

Social Learning Theory, originally developed by Bandura in the 1960's, claimed that an individual's self-efficacy and behavior change were directly correlated. In 1986, this theory developed into the Social Cognitive Theory (SCT) which claimed that learning occurs as a dynamic relationship between an individual, his or her environment, and personal behavior.²⁴ SCT takes into account an individual's past experiences and how these memoirs shape current behavioral actions through reinforcements and expectations. In summary, concepts behind the SCT may explain why a person engages in certain behaviors. In addition to client history, SCT is built upon the concept of self-efficacy, which has been shown to be one of the most powerful predictors of health behavior.²⁵ The theory states that behavior is a function of both incentives (reinforcements) and expectancies. Specifically, self-efficacy expectancy refers to an individual's perception of their ability to perform a behavior. Other expectancies in SCT include situation-specific and outcome expectancies. Thus, for an individual to engage in a certain behavior, it is proposed that they must first value their health (an incentive), believe that their current situation needs to be changed as it poses a health threat (situation-outcome expectancy), believe that

changing their behavior will reduce this health risk (outcome expectancy), and finally, they must believe they are capable of the behavior (self-efficacy expectancy). Individuals with a greater self-efficacy are believed to have a stronger intention or motivation to act, to put forth greater effort to achieve what they set out to do, and are able to persist through and overcome barriers.

b. Self Determination Theory

To take action, an individual must be intrinsically motivated and engaged. The Self-Determination Theory (SDT), originally developed by Edward Deci and Richard Ryan represents a framework for explaining human behavior through self-motivation. The theory emphasizes that motivation is made up of a multitude of factors which determine the way we regulate our behaviors. Social and cultural factors influence one's volition to initiate and self-regulate their behaviors. Intrinsic, autonomous motivation facilitates or enhances the likelihood of a specific behavior, whereas a lack of motivation weakens this likelihood.²⁶

c. Transtheoretical / Stage of Change Model

The Transtheoretical (TTM or Stage of Change) Model facilitates further understanding of human behavior and has been rapidly expanding in scope to include research and application to many health-related behaviors, including substance abuse, stress, violence, anxiety, depression, panic, eating disorders, obesity, high-fat consumption, exercise, sedentary lifestyles, and many other health related (risk) behaviors.²⁷ The model suggests that health behavior change involves progress through six stages of change, beginning in initiation phase and extending through maintenance phase. The stages progress in the following order: pre-contemplation, contemplation, preparation, action, maintenance, and termination.²⁸ These stages are illustrated in the figure below:



Figure 2. Structural representation depicting stages involved in the Stage of Change Model

Interventions based on the TTM/Stage of Change Model have demonstrated positive impact on populations who engage in potentially detrimental eating behaviors. Menezes (2015) conducted a randomized control trial in Brazil to analyze the effects of an educational-based intervention using the Stage of Change model on anthropometric and dietetic profiles among women working in primary healthcare. The experimental group participated in 10 workshops based on the TTM, while the control participated in physical activity and group nutrition education lessons. At the end of the study, the intervention group showed lower consumption of calories and high-fat foods, improved body perception, overall reduced weight and BMI. This weight loss was associated with reduced consumption of protein, lipids, and animal fat (as well as higher per capita income). The study concluded that the TTM-based intervention promoted less consumption of high calorie and high fat foods, with positive effects on weight and body.²⁹ Overall, the TTM/Stage of Change Model has been used in many health-behavior interventions which has expanded its use, as well as further validated, applied and challenged the constructs of the model in the fields of health promotion and disease prevention.²⁷

By examining these Social Cognitive Models, it is evident they provide a clear framework for understanding various behaviors related to health and what may drive individuals to engage in health-related behaviors. It is important to allow these models to guide critical thinking processes when it comes to intrinsic motivators that pertain to health behavior change and more attainable health-related outcomes.

IV. Self-Efficacy in relation to Health Behavior and Health Outcomes

The obesity epidemic involves a complex interaction of biological, behavioral, cognitive, and motivational factors. Self-regulation of health behaviors (including weight loss, nutrition and exercise) involves many psychological and behavioral factors.³⁰ The amount of effort an individual is likely to invest towards achieving an outcome, despite challenges along the way, may be explained by the individuals' amount of perceived self-efficacy to regulate a behavior. Self-efficacy is an individual's perception of their ability to perform a behavior successfully and has been reported to have a beneficial effect on health behavior. Self-efficacy is a key construct involved in many health behavior theories that propose higher self-efficacy is associated with better adoption of behavior changes. Previous research has shown self-efficacy to be a strong predictor of health behaviors and weight control, including physical activity and dietary intake.^{8,30-32} Studies have shown self-efficacy to be positively associated with, and a powerful indicator of dietary intake, nutrition-related behaviors and health.^{30,33} A review of studies concluded that self-efficacy predicted 10-35% of the variability in dietary behavior.³⁴ Evidence from several other recent systematic reviews and meta analyses show that more autonomous regulation and higher self-efficacy of one's health behavior in physical activity and in weight control is predictive of improved health outcomes.²¹

Further reinforcing the benefits of autonomous regulation, a 2009 study performed by Leong et al. examined the cross-sectional relationship between different styles of eating behavior, self-regulation and body mass index (BMI). In this study, 2,500 New Zealand women aged 40-50 years old were chosen for their high prevalence of obesity and high risk of weight gain and were randomly selected from national electoral rolls. A 21-page self-administered questionnaire was sent to all potential participants. The questionnaire used questions taken from a variety of existing questionnaires and surveys, such as the 2006 New Zealand Census, Rapid Assessment of Physical Activity Questionnaire, Eating Disorder Examination Questionnaire, New Zealand National Nutrition Survey, and Regulation of Eating Behavior Scale (REB), which measured the six styles of the Self-Determination Theory (SDT). Overall autonomous regulation scores were summed. Univariate linear regression models were used to examine the associations among demographic, health and behavioral variables, and BMI. Multivariate linear regression models were developed to investigate the relationships between autonomous and controlled forms of eating behavior regulation and BMI. The results revealed BMI was 2.8% lower for every ten-unit increase in autonomous regulation, and 2.9% higher for every ten-unit increase in controlled regulation. When controlled for the potential mediators, BMI was 2% lower for ten-unit increase in autonomous regulation, and 1.4% higher for 10-unit increase in controlled regulation. For every ten-unit decrease in controlled regulation, BMI decreased by 1.4%. Among the six styles of SDT, ‘amotivation’ showed the strongest positive associations with BMI, stating that for every five-unit increase, BMI was 4.8% higher. Overall, the study determined that in this population of middle-aged women, developing a self-determined, autonomous regulation of eating behavior is related to lower body mass index, likely because it facilitates healthier food habits.¹¹

A study conducted by Annesi (2011) assessed whether self-regulation skills in severely obese participants was associated with the amount of exercise they engage in and the amount of fruits and vegetables they consume. Mood and self-efficacy, specifically, were tested as mediators in this relationship. Inclusion criteria required participants to be over 21 years of age, have a BMI of 35 kg/m² or more, participate less than 30 minutes of exercise/week in the previous year, and report that their goal was weight loss. Participants with psychological conditions, taking medication for weight loss, or planning to soon become pregnant were excluded. 88 women and 28 men were included in the study, with a mix of mainly Euro-American (60%) and African American (37%), and a majority of low to middle income range. The study held an intention-to-treat design and all 116 participants were enrolled in the behavioral weight management program. The program consisted of both exercise and nutrition support and were based on components of the SCT. The exercise component included access to a YMCA wellness center, one-on-one meetings with a wellness specialist, and an individualized-exercise plan. The nutrition education portion included group sessions which emphasized the importance of fruit and vegetable consumption and self-regulation of eating patterns to reflect appropriate eating behavior. A computer program was used to instruct and guide participants through the program. Instruction in self-regulation included goal setting, cognitive restructuring, stimulus control, barrier preparation and relapse recovery. Self-efficacy, increased physical activity and increased fruit and vegetable consumption was encouraged through the entirety of the program. Linear bivariate relationships, regression, and mediation of variables were analyzed. Findings revealed that relationships between self-regulation, physical activity, and fruit and vegetable consumption were significantly mediated by negative mood, but not self-efficacy.⁵ The study also found a significant relationship between self-regulation of exercise and eating habits, indicating that self-regulatory skills may be a trait-

like characteristic of the individual. One limitation that might may explain this finding was that the participants were voluntary, which may predispose them as a group that was already self-motivated. Another limitation is that participants reporting their self-regulatory skill could be biased due to the obvious emphasis of the study.

Self-Efficacy and Perceived Barriers

Low self-efficacy, on the other hand, can be thought of as an individual exhibiting low confidence or doubting their ability to carry out a specific activity or achieve a certain outcome. Bandura explains that these individuals may avoid the activity due to a self-imposed barrier, which further enforces low efficacy and avoidance of the activity. Environmental factors (such as time) influence self-efficacy and can subsequently act as facilitators and/or internal barriers to behavior.

This can be further explained by the concept of locus of control (LOC). LOC is a psychological construct referring to the relative degree to which one attributes the control over their life to either themselves (internal factors), or external factors, in explaining their various health behaviors.³⁵ Research has linked internal LOC to lower likelihood of risky health behavior (such as being overweight) and higher likelihood in engaging in positive health behaviors. Internal LOC has been shown to be strongly associated with both increased preventative (risk aversion) and potentially risky health behavior and health outcomes.³⁵

Self-efficacy plays a strong role in individuals' perceived skills, perceived barriers, and weight management practices.³⁶ It is thought to be a central psychosocial factor underpinning weight management practices in healthcare settings.³⁶ Perceived barriers to obesity management are associated with lower levels of motivation and perceived ability to manage overweight and obesity in adults.³⁶ A 2002 study conducted by Stutts et al studied a majority of white, middle-aged, overweight and obese women with at least a high school diploma. Reasons given for not

engaging in regular physical activity sorted into four categories: internal barriers (ex: lack of motivation, time constraint, boredom); barriers in the physical environment; barriers in physicality (ex: health problems); and barriers with others (ex: lack of support).²¹ In addition, individuals experiencing failed self-efficacy may have a more difficult time when imbalances of eating and exercise behaviors arise. Personal BMI has also been shown to be a significant predictor of self-efficacy. Several studies found that a higher BMI was associated with lower levels of perceived self-efficacy (and higher perceived barriers) in exercise and physical activity²¹ and dietary intake.⁸

³⁷ Obese individuals may have less self-confidence and may struggle more with their ability to cope and manage with situations related to food and eating behaviors effectively when compared to their non-obese counterparts. Current or previous weight status may also predict self-efficacy. Kitsantas (2000) found that individuals who were currently at a healthy weight, or had previously been overweight, reported a higher self-efficacy to maintain their optimum weight than those who were currently overweight.³⁸ These findings were similar to those found in Richman's study (2001), which found that obese women scored significantly less on weight loss self-efficacy than their non-obese counterparts.⁸

V. Additional Determinants of Self-Efficacy, Health Behavior and Body Weight

As previously indicated, differences in socio-demographics, such as economic status (SES), education and ethnic group, are apparent predictors in health behaviors like diet and exercise.³⁹ Mental health, personal crises, negative thought processes, and stress have been found to negatively impact initiation of intrinsic motivation.

Stress symptoms can manifest physically, psychologically, and behaviorally. Left untreated, elevated stress can contribute to high blood pressure, heart disease, overeating and obesity, diabetes. Cognitively, elevated stress can also lead to anxiety, lack of motivation,

irritability or anger, sadness or depression, as well as social withdrawal.⁴⁰ Higher levels of stress are also associated with more health-risking behaviors, such as substance abuse (such as drug use, smoking, alcohol consumption). A review of studies from 1989 to 2006 sought to investigate the relationships between psychosocial stress at work and health-risk behaviors, which was analyzed as a broader term to represent consumption patterns of the Westernized lifestyle, both socially and economically. The review, which included 46 studies, revealed that work stress had a strong relationship to alcohol consumption and being overweight, as well as playing a role in the co-manifestation of several other health risk behaviors.⁴¹ A number of studies have reflected that physiological arousal, such as anxiety, influences self-efficacy, as Bandura hypothesized. It is also likely that low self-efficacy could be a source of anxiety.⁴²

A study conducted by Simon et al. (2008) consisted of a phone interview of 4,641 female health-plan enrollees, aged 40 to 65. The women responded to items on height, weight, exercise, diet, and body image, as well as the Patient Health Questionnaire, to measure signs and symptoms of depression. The study revealed that obese participants were more than twice as likely to be depressed, and those with clinical depression were more than twice likely to be obese, indicating depression and obesity likely fuel each other. This finding held true even after being controlled for education, marital status, antidepressant and tobacco use. Additionally, obese participants consumed 20% more calories and had the poorest body image, compared to those with a lower BMI. This study suggests that the stigma of being overweight or obese could hurt self-esteem, and subsequently, could be detrimental to efforts towards weight loss.⁴³

VI. Measurement of Perceived Self-Efficacy and Health Behaviors

Sallis et al. (1988) conducted two studies focusing on self-efficacy. The first aimed to identify behavioral and situational components of diet and exercise change, while the second

aimed to examine the psychometric qualities of scales used to assess self-efficacy in a research setting.

Specifically, study one set out to determine the behavioral components of eating a low-sodium, low-fat diet and engaging in regular physical activity. This study involved a one-hour structured interview, with a total of 40 subjects in all (32 females and 8 males). Inclusion criteria included that the individuals must be in the process of changing or attempting to change their dietary and/or exercise patterns. This ensured that subjects would have first-hand personal experiences of how changing habits can be affected by factors of daily life, thus improving the content validity of the scored items. A total of 27.5% of the subjects were making diet changes only, 10% exercise only, and 62.5% were making changes in both areas. Subjects were asked to answer open-ended questions to specify what changes they had made in various areas of their life (including family and social support, leisure activities, eating habits, etc.), as well as what made it difficult to initiate and maintain these changes. Subjects' responses were used to construct specific diet and exercise measures to be used on the self-efficacy scale. The quality of this scale was assessed during study two. Study two consisted of administration of the scale to 171 new subjects in pursuit of analyzing reliability and validity using a 5-point Likert-scale ranging from believing they could not complete the measure (1) to being sure they could do it (5). In total, 64% of subjects engaged in regular exercise. This sample was also reported to be currently trying to make diet and exercise changes combined. Specifically, 43% were trying to consume less sodium, 54% trying to consume fewer calories and 40% trying to consume less fat. The exercise efficacy scale administered to this sample consisted of 89 items, and the eating efficacy scale consisted of 49 items. The subjects were instructed to rate their confidence that they could motivate themselves to engage in such behaviors consistently for at least 6 months.⁴⁴

Factor analysis, factor test-retest reliability, criterion-related validity, specificity and construct validity, and analysis of variance were conducted and analyzed. Results showed high internal consistency and significant correlations between self-efficacy and health behaviors, providing further evidence of criterion-related validity. Sallis et al. suggested that the moderate levels of correlations found indicated that self-efficacy is one of many possible mediators of diet and exercise habits. Overall, it was concluded that these efficacy scales developed by Sallis et al. may be used to study the mediating effects of self-efficacy in future health behavior change studies focusing on diet and exercise.⁴⁴

VII. Summary

Obesity is a major public health concern and continues to contribute to escalating healthcare costs across the United States. Despite the well-established and widely-known benefits of regular physical activity and maintaining a desirable body weight, most Americans fall short of such health behaviors. The question of how to get an already physically inactive population to become more active and to engage in more healthful behaviors remains largely unanswered. As a review of current literature indicates, self-efficacy is a factor impacting health behaviors related to eating behaviors, physical activity and body weight. By utilizing the concept of the social cognitive theoretical framework previously presented, it could also be hypothesized that self-efficacy is predictive of health behavior, and therefore, BMI.

Identifying mediators in the relationship between health behaviors and BMI is a critical step in the process of facilitating positive lifestyle and behavior changes. There is a clear need to develop and examine methods to improve individuals' belief in their ability to lose and maintain weight loss, especially for those who are already overweight. This could facilitate the weight loss process and increase likelihood of achieving and maintaining weight loss goals. More investigation

is needed in identifying cognitive variables affecting health behavior, such as self-efficacy, while controlling for various sociocultural and demographic factors.

Methods

Study Design

A cross-sectional analysis was conducted among individuals with overweight and obesity and at risk for Type 2 Diabetes, based on the CDC Diabetes risk score >8 , indicating a high risk for current pre-diabetes.⁴⁶

Participants

Ninety-nine full or part-time individuals employed at four long-term care facilities in the Northeastern United States were selected to participate in the study. Trained health educators measured participants' height and weight to calculate their BMI. All of the participants were classified as being overweight or obese ($\text{BMI} \geq 25 \text{ kg/m}^2$), according to CDC recommendations⁴⁵ and were at risk for Type II Diabetes. Participants had to be at least 18 years of age, but could be of any race, gender, education level, or salary level. Exclusion criteria included having any current or past history of heart disease, stroke, Type 1 Diabetes, or receiving radiation or chemotherapy for cancer treatment in past 5 years. Participants currently pregnant or lactating, taking weight loss supplements, who had lost 20 or more pounds in the last 6 months, or were planning to undergo weight loss surgery during the duration of the study were also excluded. All participants signed an informed consent form approved by the University of Connecticut Institutional Review Board (IRB).

Questionnaire

Participants completed a questionnaire to self-report their demographic information, anthropometric measurements, and respond to questions regarding their health and health-related behaviors. These scores were used to further assess the individuals' lifestyle choices and health-related behavior patterns, including dietary intake and physical activity, as well as self-efficacy involving eating and exercise activities and their health behaviors. These sub-scores were appropriately manipulated to form overall self-efficacy and health behavior scores for each behavior category (healthy eating and physical activity).

Variable Measures

Body Mass Index (BMI): Trained health educators measured height and weight. A calibrated Seca 700 physician balance beam scale was used to measure weight to the nearest 0.1 kg and height was measured the nearest mm. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared and categorized based on CDC recommendations of overweight (25-29.99 kg/m²), obese class I (30-34.99 kg/m²), obese class II (35-39.99 kg/m²), and (> 40 kg/m²).

The frequency-based Healthy Eating Score (HES) consisted of nine questions, which asked respondents to answer how often they consume particular foods and/or beverages using a 4-point Likert scale, which ranged from “never to 1 time/week and 1-4 times/week” (1), “5-7 times/week” (2), “2 times/day” (3) and “3+ times a day” (4). The scale provides one global scale with the highest possible score of 36 (9x4).⁴⁷

Eating self-efficacy (Eat-SE), originally the Weight-loss Self-Efficacy Score (WLSE), developed by Clark et al (1991),⁴⁸ was defined in terms of a summary score consisting of 20 questions, which asked participants to rate their confidence that they could motivate themselves to resist eating in certain situations, consistently, for at least six months (See Appendix). Rating was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2),

“moderately confident” (3), and “very confident” (4). The situational factors consisted of: Negative Emotions (ex: eating when anxious/sad), Availability (ex: eating when food is readily available, such as at a party), Social Pressure (ex: eating food when others encourage eating), Physical Discomfort (eating when in pain or fatigued), and Positive Activities (ex: eating while watching television). The scale provides one global scale with the highest possible score of 80 (20x4).⁴⁴

The frequency-based Physical Activity Scores were defined using three questions, which obtained information on self-reported performance of mild, moderate, or vigorous physical activity for a 30-minute duration during a typical 7-day week. Individuals were provided with intervals of days for responses, including: 0 days, 1-2 days, 3-4 days, or 5 days or more.^{49,50}

The confidence-based Exercise Self-Efficacy Score (Ex-SE), was defined in terms of a summary score consisting of 11 questions, which asked participants to rate their confidence that they could motivate themselves to keep up with certain exercise behaviors and activities consistently for at least six months. Rating was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2), “moderately confident” (3), and “very confident” (4). The scale provides one global scale with the highest possible score of 44 (11X4).⁴⁴

Statistical Approach and Data Analysis

To analyze descriptive statistics, frequency and means tests were run among different variables of the sample population using the Statistical Analysis Software program (SAS). These variables included gender, age, anthropometric measurements, race, and highest education level. Descriptive results were compiled and analyzed to assess overall population health, participant characteristics, distributions of variables of interest (self-efficacy, stage of change, barriers to physical activity) and compare ratios such as gender of participants and classes of obesity. Also

assessed were the general health of the population and the prevalence of chronic disease and conditions, such as hypertension, high cholesterol, and Diabetes.

BMI normality was tested in the statistical program SAS. Latent variables were created for HES, Eat-SE and Ex-SE using sum scores, where higher scores were indicative of a more healthful diet and higher perceived SE. Missing values in the dataset were imputed using the Multivariate Imputation by Chained Equations (MICE) package in R. Bivariate correlations were run among variables in the Statistical Package for Social Sciences (SPSS).

Mediation models and bootstrapping were all run in the statistical program R Studio using the Mediation package. Proposed Model to examine the mediating effect of self-efficacy on health behaviors and BMI:

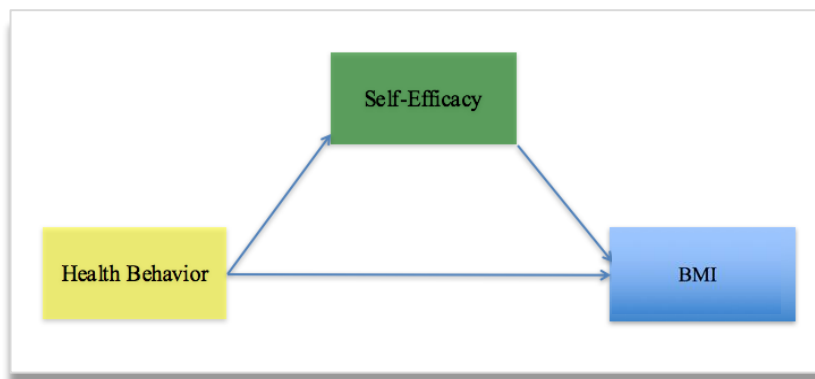


Figure 3. Structural Model of Self-Efficacy as Mediator between Health Behavior and BMI

Results

Descriptive Statistics: Demographics

Participant Demographics		
		(n=99)
Gender	Female	88.89% (n=88)
	Male	9.09% (n=9)
Age	Years \pm SD	46.98 \pm 11.36
Anthropometrics	Weight (lbs) \pm SD	203.84 \pm 40.93
	Height (feet) \pm SD	4.96 \pm 0.24
	Height (inches) \pm SD	5.09 \pm 2.92
	BMI \pm SD	35.33 \pm 6.91
Weight Classification	Overweight	19.79%
	Obese	34.38%
	Severe Obesity	22.92%
	Morbid Obesity	17.71%
	Super Obesity	5.21%
Race	White	48.48%
	Black	40%
	Hispanic	5.05%
	Asian	3.03%
	American Indian	1.01%
Education	10 yrs (high school/secondary)	4.12%
	11 yrs (high school/secondary)	3.09%
	12 yrs (high school/secondary)	40.21%
	13 yrs (college/professional)	12.37%
	14 yrs (college/professional)	12.37%
	15 yrs (college/professional)	10.31%
	16 yrs (college/professional)	10.31%
	17 yrs (post-graduate)	7.22%

Table 1. Participant Demographic Information (gender, age, anthropometric measurements, weight classification, race and education)

The majority of participants were middle-aged females (See Table 1). As evidenced by calculated anthropometric measurements and by BMI class frequencies, all of the participants were overweight and obese ($\text{BMI} \geq 25.0 \text{ kg/m}^2$), with the greatest number of participants classified in BMI Class 2 (Obese). Also analyzed were educational level and race frequencies, revealing that

majority of participants were white or black, and the highest frequency of education level was 12 years (high school/secondary), equivalent to at least a high school diploma. Pearson's correlation tests revealed that age had no significant correlation with BMI ($r = 0.022$, $p = 0.837$), eating self-efficacy ($r = 0.112$, $p = 0.306$), or exercise self-efficacy ($r = -0.023$, $p = 0.823$).

Descriptive Statistics: General Health, Health Behavior, and Self-Efficacy

General Health and Physical Activity			Healthy Eating Score and Self-Efficacy		
		n=99			n=95
General Health	Poor	1%	HES (max score of 36)	Under 20	9.5%
	Fair	17.20%		20-25	60%
	Good	44.40%		26-30	26%
	Very Good	27.30%		Over 30	4.5%
	Excellent	7.10%			
Physical Activity	Mild				
	0 days	24.20%			
	1-2 days	36.40%			
	3-4 days	26.30%			
	≥ 5 days	11.10%			
	Moderate				
	0 days	31.30%			
	1-2 days	39.40%			
	3-4 days	19.20%			
	≥ 5 days	3%			
	Vigorous				
	0 days	64.60%			
	1-2 days	18.20%			
	3-4 days	9.10%			
	≥ 5 days	1%			
					n=99
Self-Efficacy			Eating		
			Not Confident		0%
			Somewhat Confident		4%
			Moderately Confident		32.30%
			Very Confident		63.70%
			Exercise		
			Not Confident		0%
			Somewhat Confident		13%
			Moderately Confident		42.4%
			Very Confident		44.4%

Table 2. Participant General Health, Health Behaviors and Self-Efficacy

Majority of participants reported their current general health as 'good' (45.8%), followed by 'very good' (28.1%), 'fair' (17.7%), and 'excellent' (7.3%). General health had a significant negative correlation with current level of physical activity ($r = -0.284$, $p = 0.006$). General health also had a negative correlation with eating self-efficacy ($r = -0.130$, $p = 0.227$) and exercise self-efficacy ($r = -0.124$, $p = 0.254$), although not significant.

Current level of physical activity is significantly positively correlated with eating self-efficacy ($r= 0.268$, $p= 0.011$) and exercise self-efficacy ($r= 0.300$, $p= 0.005$). Physical activity is significantly negatively correlated with BMI ($r= -0.301$, $p= 0.003$). BMI is also significantly negatively correlated with moderate physical activity ($r= -0.313$, $p= 0.002$) and vigorous physical activity ($r= -0.233$, $p= 0.026$), as well as eating self-efficacy ($r= -0.262$, $p= 0.013$) and exercise self-efficacy ($r= -0.284$, $p= 0.008$). The top four reasons reported for not exercising include: ‘never persisting’ (39.4%), ‘no time’ (32.3%), ‘lazy’ (28.3%), and ‘no energy’ (23.2%).

Descriptive Statistics: Stage of Change

Participant Stage of Change		
		n=99
Physical Activity	Plan to change in 6 mo	10.10%
	Plan to change this mo	46.50%
	Recently do	26.80%
	Currently do	9.60%
Eating Healthy	No interest in change	1%
	Plan to change in 6 mo	5.10%
	Plan to change this mo	45.50%
	Recently do	28.30%
Lose Weight	Currently do	17.20%
	Plan to change in 6 mo	6.10%
	Plan to change this mo	54.50%
	Recently do	23.20%
Overall Health	Currently do	10.10%
	No interest in change	2%
	Plan to change in 6 mo	7.10%
	Plan to change this mo	40.40%
	Recently do	18.20%
	Currently do	28.30%

Table 3. Stage of Change for physical activity, healthy eating, losing weight, and overall health

Participants were asked to indicate how ready they were to make changes or improvements in their health in the areas listed in Table 3. The response, ‘planning to change this month’ (46.5%) was reported by majority of participants on the subject of physical activity, followed by ‘recently do’ (26.8%). Similar answers were given in response to eating healthy, with 45.5% reporting

planning to change this month and 28.3% reporting they recently have made such changes. The same responses were given for ‘lose weight’, with 54.5% planning to change this month and 23.3% reporting they recently have. Lastly, when asked to indicate readiness to change overall health, 40.4% reported planning to change this month, followed by ‘currently do’ at 28.3%.

BMI Normality

BMI normality was tested in SAS and was found to follow a slightly non-normal distribution. This distribution was expected in this sample, as all participants had a BMI greater than or equal to 25, which classified them all participants as overweight or obese.

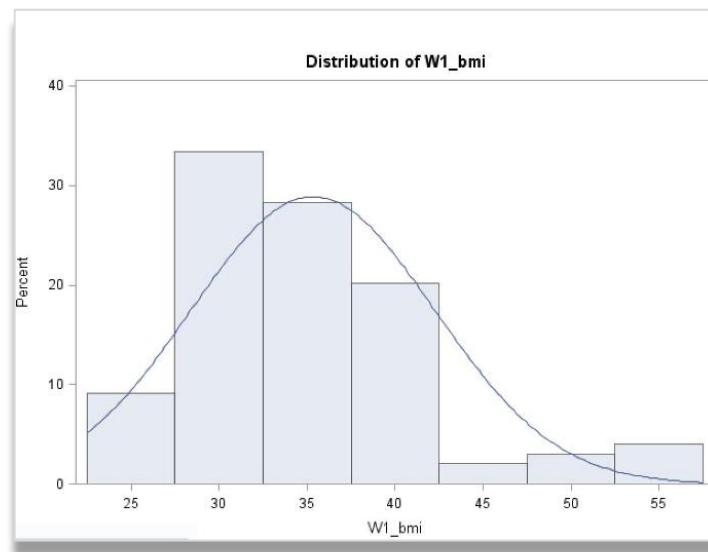


Figure 4. Participant BMI Distribution

Mediation Results

Hypothesis 1: Higher Healthy Eating Score (HES) predicted higher eating self-efficacy ($p = 0.02$).

In turn, a higher Eat-SE predicted a lower BMI ($p = 0.02$). Eat-SE is a marginally significant mediator of HES on BMI, at 40% mediated.

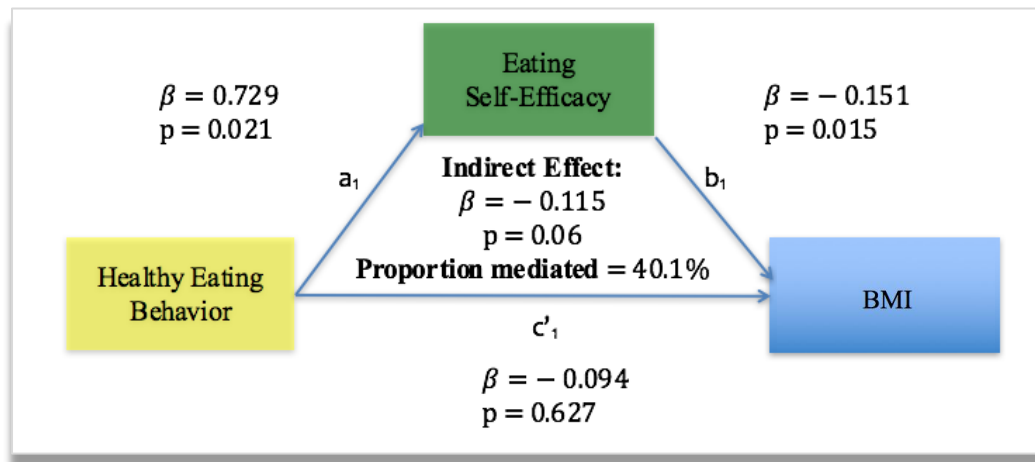


Figure 5. Path Diagram for HES, Eat-SE and BMI

Hypothesis 2: More frequent mild physical activity was associated with higher exercise self-efficacy ($p = 0.15$) and lower baseline BMI ($p = 0.09$), and higher Ex-SE was associated with lower BMI ($p = 0.09$), although none of these relationships were significant. Mild PA frequency was not a strong predictor of Ex-SE.

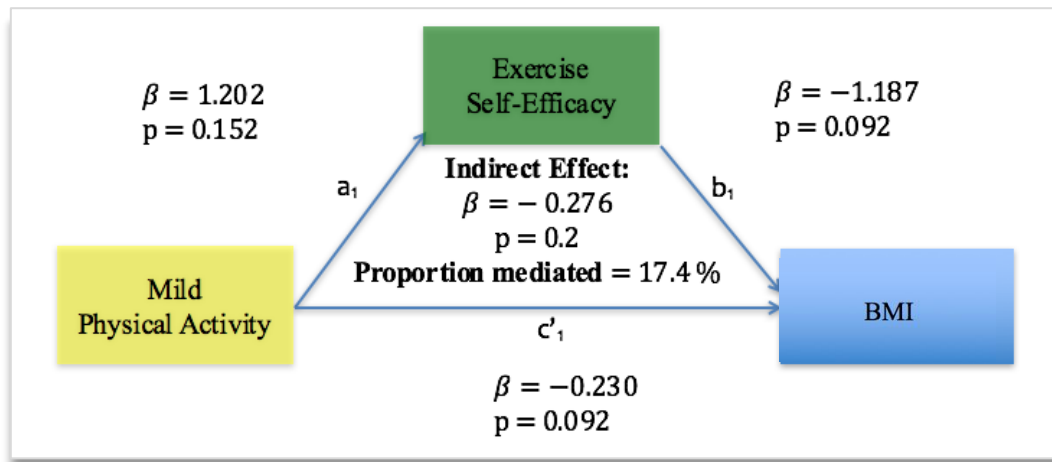


Figure 6. Path Diagram for Mild PA, Ex-SE and BMI

Hypothesis 3: More frequent moderate physical activity predicted higher exercise self-efficacy ($p = 0.01$) and lower BMI. In turn, higher Ex-SE also predicted lower BMI ($p = 0.05$). 30% of the total effect of Moderate PA on BMI was mediated by Ex-SE, with marginal significance.

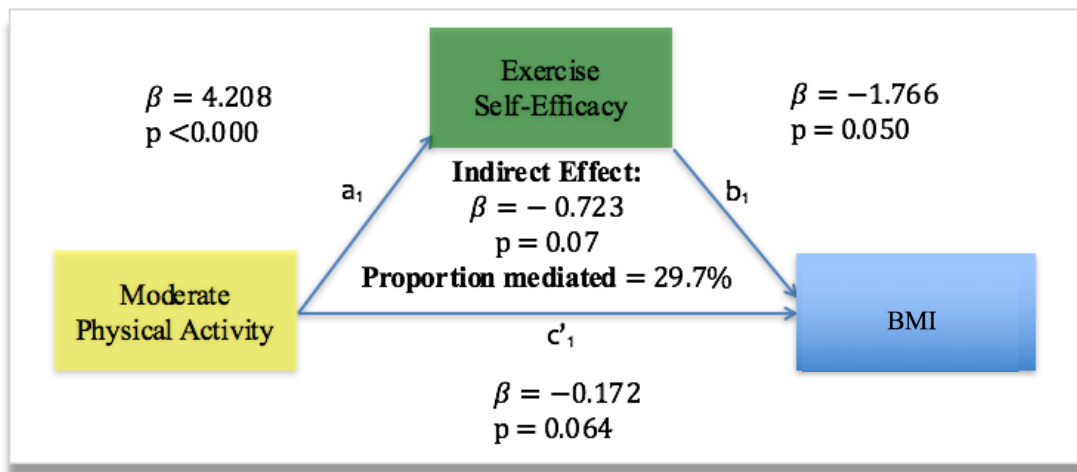


Figure 7. Path Diagram for Moderate PA, Ex-SE and BMI

Hypothesis 4: More frequent vigorous physical activity predicted higher exercise self-efficacy ($p = 0.00$) and lower BMI ($p = 0.02$). 44% of the total effect of vigorous PA on BMI was significantly mediated by Ex-SE.

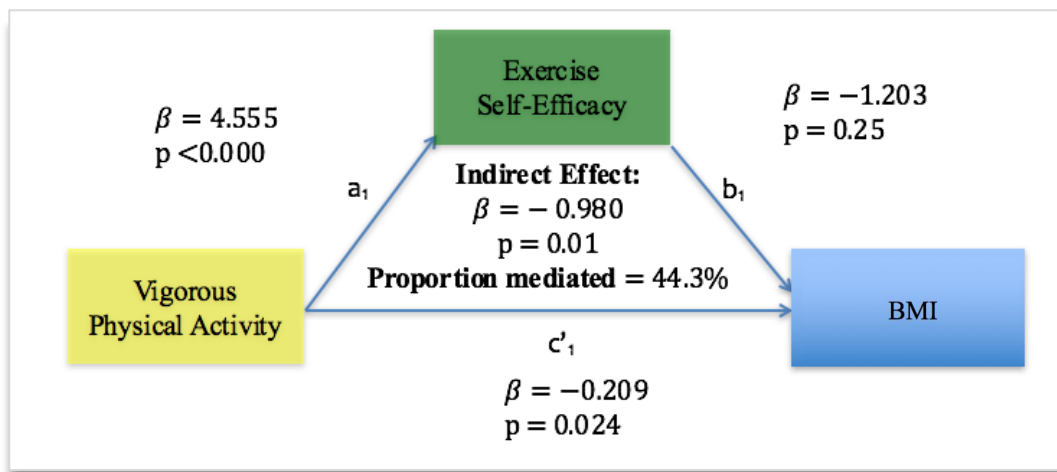


Figure 8. Path Diagram for Vigorous PA, Ex-SE and BMI

Discussion

Dietary Behavior

As the prevalence of Americans adults being overweight and obese has risen to 69% over the past few decades, the American diet quality has declined.⁴ In the present study, mediation analysis revealed that a higher healthy eating score predicted higher eating self-efficacy ($p = 0.02$), and a higher eating self-efficacy further predicted a lower BMI ($p = 0.02$). Self-efficacy was a marginally significant mediator of healthy eating score (40%, $p = 0.06$). Previous studies have shown self-efficacy to be a strong predictor of dietary intake and weight control.^{8,30-32} Lower self-efficacy is associated with poorer diet quality, which is associated with higher BMI. Inappropriate eating habits, which are common among women with Type 2 Diabetes, has been shown to be associated with lower self-efficacy for diet and exercise self-management, and higher BMI.⁵¹ Poor eating habits are often viewed as negative contributors in weight control and are associated with more perceived barriers to weight loss.⁵² Binge eating may even be an independent risk factor for Type 2 Diabetes.⁵¹

As previously indicated, reasons for lower self-efficacy regarding eating healthily could also be due to socioeconomic factors, including socioeconomic status, education, job type, access to healthy foods, improved cooking skills, knowledge of eating healthy, its benefits and what constitutes “healthy”, etc. Food prices may be one factor involved in diet quality disparities, as lower diet costs have been shown to be associated with lower quality diets and vice versa.^{53,54} Lower diet quality is reflected by lower consumption of vegetables, fruits and whole grains, and higher consumption of refined grains, fat and added sugars.^{53,54} Lower income has been recognized as a limiting factor in eating healthy, as foods high in calories, fats and sugars are generally more affordable.⁵⁵

In another study conducted by Rehm (2015), it was found that a strong social gradient in Diabetes and CVD risk was observed for both education and income, with individuals of a lower SES having elevated risk of developing both these chronic diseases. These findings agree with those of Raffensperger et al. (2010), which found sex, age, education and income as significant predictors of diet quality in African Americans and whites.⁵⁶

Higher SES, increased healthful food knowledge and higher healthy-eating self-efficacy have been associated with greater intention to make healthier food choices and participate in physical activity in previous research.⁵⁷ An increased dependence on westernized diets and low physical activity has largely contributed to weight gain and associated chronic disease.⁵⁷ Future efforts to improve the nutritional status of the U.S. public should take food prices and diet costs into account. Socioeconomic interventions should target specific segments of the US population to improve overall diet quality.¹⁴

Exercise

The American Heart Association (AHA) recommend at least thirty minutes of moderate activity (at least 5 days/week, or weekly total of 150 minutes) or at least twenty-five minutes of vigorous activity (at least 3 days/week, or a weekly total of 75 minutes).⁴

Our participants fell short of these recommendations. A majority of participants reported only 0-4 days of mild or moderate physical activity per week. 64.7% reported zero days of vigorous activity per week, while only 27.4% reported engaging in any vigorous physical activity at all. Current level of physical activity was significantly negatively correlated with general health ($r = -0.284$, $p = 0.006$), which majority of participants rated as 'good'. The top four reasons reported for not exercising include: 'never persisting' (39.4%), 'no time' (32.3%), 'lazy' (28.3%), and 'no energy' (23.2%).

Gender-associated roles that have become the social-norm play an important role in women's physical inactivity, as discovered by Duin et al. (2015).⁵⁸ Several gender-based barriers to physical activity exist for women compared to men: less time to dedicate to regular exercise, due to their responsibility as care-givers; hobbies and leisure activities, which are typically less active than those of men; and women's' image-expectations in their community.⁵⁸ This may be one factor causing the study sample to be more physically inactive.

The present study reveals that more frequent moderate and vigorous physical activity is significantly predictive of higher exercise self-efficacy ($p= 0.00$, $p= 0.00$). These findings are consistent with previous studies which also found moderate and vigorous exercise to be positively influenced by intrinsic motivation and self-efficacy.⁵⁹⁻⁶¹

Mediation analysis also reveals that more frequent physical activity further predicted a lower BMI ($p= 0.05$). Exercise self-efficacy was a significant mediator of vigorous physical activity on BMI, accounting for 44% of the total effect ($p= 0.01$), and it was a marginally significant mediator of moderate physical activity (30%, $p= 0.07$) on BMI.

Leisure time physical activity has been shown to be predicted by self-motivation, perceived barriers and benefits, and BMI. Exercisers are more likely to possess lower BMIs, possess higher self-motivation, perceive more benefits to exercise and perceive less barriers to exercise than non-exercisers.⁶² A relatively small percentage of the present participants reported engaging in any vigorous activity (27%). These subjects, who were already vigorous exercisers, had the first-hand knowledge, experience and motivation to push themselves to exercise regularly, had higher self-efficacy to continue their exercise routines, believed they could perform future exercise behaviors (hence, the significant mediation effect seen of self-efficacy between vigorous activity and BMI).

Individuals with a strong sense of self-efficacy view challenges as something to be mastered. They developed deeper interest and commitment in activities in which they participate. Those with low self-efficacy often avoid tasks they find challenging (in this case, physical activity). There was a wide distribution of both physical activity levels and level of exercise self-efficacy for the majority of the sample, which may be why the models involving mild to moderate activity had more variability in mediation significance.

Cognitive factors such as stress, anxiety, depression and self-image can adversely affect self-efficacy and health behaviors. For example, some people perceive their excess weight as emotionally distressing, while others of similar weight are unaffected by.^{63,64} This could potentially deter participants with low self-efficacy from attempting to make changes, such as making time to go to the gym and/or initiating exercise.

On the other hand, the adoption of exercise and engaging in regular physical activity is associated with decreased stress and anxiety, and improved mood and self-image, which can all improve one's quality of life and facilitate the process of making healthier lifestyle choices. These changes could lessen perceived barriers and thus improve self-efficacy for performing activities. Exercise also may contribute to improved compliance with a healthy diet.⁶⁵ By learning how to minimize stress and elevate mood when faced with difficult or challenging tasks, individuals can improve their sense of self-efficacy and thus, achieve improved health behaviors and outcomes.⁶⁶

Conclusion

Status of being overweight or obese leads to a much greater risk of related conditions, such as Type 2 Diabetes and CVD. As the obesity epidemic continues to grow, so do the prevalence of interventions combatting it. Recent research has provided evidence to suggest that cognitive factors, such as self-efficacy, play a major role in individual engagement of health behaviors.

Findings from this study agree that self-efficacy is a promising factor affecting health behaviors, and could be a focus of improvement in future obesity interventions. Identifying mediators in the relationship between health behaviors and BMI is a critical step in the process of facilitating positive lifestyle and behavioral changes. Major findings from the present study include that more healthful eating habits and more frequent physical activity are predictive of higher self-efficacy and lower BMI. We found self-efficacy regarding diet and exercise to mediate the effects between diet and exercise behaviors and weight status.

Cognitive and psychological factors (such as stress, anxiety, depression, mood, self-image) interact with the physical environment in highly complex ways. There is a large heterogeneity in the way individuals physiologically respond, which largely contributes to body mass and weight. All individuals who are overweight or obese are not the same, meaning a “one size fits all” approach is ineffective when attempting weight loss. It is inappropriate to assume that giving all obese women, for example, the same treatment and expecting them all to have similar outcomes.⁵² As a result of this indication, many patient-matching treatment algorithms have been produced in recent years which are based on biological or morphological variables. Prior studies have indicated that factors such as personal preference, outcome expectancies, attitudes towards physical activity and exercise, body image, emotional distress and depression should be considered when determining appropriate treatment strategies.⁵²

By improving individuals’ perceived self-efficacy and belief in their ability to make healthful lifestyle changes, they are more likely to move forward in their readiness to change, which would further facilitate weight loss and desired health outcomes. The results of our study indicate that future interventions should focus on improving participants’ perceived self-efficacy to achieve greater weight loss. Educational interventions which recognize and address individuals’

perceived barriers and personal beliefs, and work to improve their readiness to change towards healthful behaviors, are more likely achieve greater success in weight loss outcomes. Once individuals become more autonomous and self-motivated, they are more likely to successfully maintain weight status after loss. Laying a foundation of improved self-efficacy relating to health behaviors may be a pre-requisite for weight loss management.

Future interventions can also improve outcomes by first identifying other factors contributing to weight change, by examining alternative methods such as causal mediators of health behaviors affecting body weight for individuals who have lower self-efficacy and are less likely to succeed.

Limitations

It should be noted that a high pretreatment self-efficacy may indicate overconfidence and/or lack of experience with the difficulties associated with weight loss efforts,⁶⁷ which is a possible limitation of the current sample of individuals. This sample of nursing-home employees were aware that they would soon be participating in a weight-loss program, which could have led to a sense of heightened self-efficacy in relation to their current BMI. Individuals' perception that the weight loss program would help make them lose weight could have swayed their perception of their own abilities, aside from the intervention they were about to undergo. However, it seems excessively optimistic expectations are the norm in American obesity-treatment-seeking individuals.⁶⁸ Participants' awareness of their upcoming participation in the weight loss program may also explain why a majority reported 'planning to change this month' or that they had recently changed their behavior in questions regarding stage of change.

The cross-sectional design of this analysis only captures a glimpse of the population at a specific point of time, and doesn't capture the scope of these individuals over time. Studies which

carry a longitudinal design have a better measure of factors contributing to weight change over time, which may carry more reliability as far as measuring the variables at hand. The small sample size of ninety-nine individuals also poses a limitation.

The measures used for frequency of mild, moderate, and vigorous physical activity did not specify the type of activity performed, the duration of the activity, or the specific intensity of the activity as it applies to the individual. Since the questionnaire was self-reported, perception of these measures may differ from one individual to the next. Examining type of activity, intensity, duration, as well as differentiating between aerobic vs strength-building activities could provide more insight into a measurement of individuals' physical activity level. However, this questionnaire has been validated and provides an overall general summary of the participants' physical activity at various levels.

Additionally, BMI may be a poor indicator of health status. BMI is a simple method of indicating body fatness and screening for bodyweight categories. Although this measure can be indicative at a glance, it is not a diagnostic tool for health. Body fatness may still differ between two people with the same BMI, since BMI does not differentiate between fat mass and high lean body mass (muscle and bone) or account for body shape or weight distribution. Therefore, BMI must be further examined on a very situational and individual basis in order to assess body weight and distribution as it relates to health quality.

Limitations aside, this study found that consuming a more healthful diet is indicative of higher eating self-efficacy, and that engagement in more frequent physical activity is indicative of higher exercise self-efficacy. Higher self-efficacy involving these health behaviors may further predict a lower BMI, as is the case in the present study, while individuals with lower self-efficacy may predict a higher BMI. Findings from this analysis conclude that self-efficacy appears

promising as a cognitive factor that is involved as a mediator between health behaviors and body mass index. These findings further support the extensive evidence which has previously found higher self-efficacy in eating and exercise as predictive of more optimal health-related behaviors, such as healthy eating, regular exercise and lower BMI. The concept that self-efficacy is a cognitive factor that can be improved upon to facilitate positive lifestyle and behavior changes is an intriguing notion in the pursuit of weight loss interventions and obesity prevention efforts.

Approaches focusing on individual behavior change remains an important topic of interest in obesity research. There is a need for further research to identify causal predictors of long term weight control. Testing of causal mediation in the pursuit of behavior modification and lifestyle change is a critical step in improving future weight interventions, as it will provide the strongest possible inference for the identification of intervention variables responsible for desired health outcomes.

CHAPTER TWO

Self-Efficacy and Financial Incentives: Factors affecting Health Behavior and Body Weight in Individuals with Overweight and Obesity in a Weight Loss Program

Abstract

Obesity is a public health crisis affecting the majority of Americans. Behavior change is difficult to sustain and many successful weight losses end in weight regain. Self-efficacy (SE) and financial incentives (FI) are factors that may facilitate behavior change initiation and short-term weight loss. It is unclear if these approaches are effective long-term. To assess how these factors influence health behavior and weight change in individuals with overweight and obesity, an incentivized randomized control trial was conducted through a weight-loss program. The study lasted 16 weeks with a 28-week follow-up. Ninety-nine nursing-home employees at risk for type 2 diabetes (T2DM) were recruited. Participants' level of self-efficacy (SE) regarding eating (Eat) and exercise (Ex) were assessed using confidence-based questions and converted into qualitative scores for each scale (Eat-SE, Ex-SE). Healthy eating scores (HES) and physical activity (PA) were assessed using frequency-based questions. Correlation and causal mediation analyzed relationships between diet and PA behaviors, Eat-SE and FI. 44.4% of the total effect of HES on weight change (1 to 16 weeks) was mediated by Eat-SE ($p=0.05$). Incentives further moderated this relationship ($p=0.00$). Ex-SE was a significant mediator in all levels of PA on BMI at 16 weeks and BMI-change (16 to 28 weeks). Incentives significantly moderated all of these PA models. SE is an important factor in weight-loss initiation, and focus on SE improvement should be considered in future obesity interventions. Incentives appear to be an effective strategy in short-term weight loss, however, further investigation is needed on its sustainability in maintaining weight loss long-term.

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Introduction

Rising rates of obesity continue to be a public health crisis, currently affecting an estimated 35.7% of the American adult population.⁶⁹ Obesity is associated with chronic, non-communicable diseases including Type 2 Diabetes, cardiovascular disease, stroke, and hypertension.² The obesity epidemic is currently a leading cause of morbidity and mortality in the United States,⁶⁹ affecting individuals of all ages, genders and race.³

It is well-established that regular engagement in physical activity can combat obesity, however, the majority of the U.S. population is sedentary. Less than 5% of U.S. adults engage in the recommended amount of physical activity to maintain health.⁷⁰ Despite widespread efforts to educate and encourage individuals to practice healthy behaviors, these recommendations are not often heeded. Poor diet quality and physical inactivity are predictive of obesity and account for as much as 40% of premature deaths in the U.S.⁷¹ Sedentary behavior has grown increasingly prevalent in westernized society over recent decades. As workplaces have become more aware of how health affects efficiency and productivity through absenteeism, employers have become eager to find strategies to keep their workforce healthy and productive. As a result, the prevalence of workplace behavior-change interventions continues to increase, as the search continues for finding cost-effective tools to encourage and facilitate healthy weight status of their employees. In doing so, weight-related chronic conditions improve, absenteeism can be kept down and workforce efficiency and productivity improves.

With current estimates claiming that 71% of US adults are overweight or obese,⁶⁹ it is critical to design evidenced-based interventions that will facilitate lasting behavioral change. The change our society needs to combat these trends must involve significant, widespread but individual behavioral changes. This is difficult to implement and sustain, as evidenced by

literature on many weight loss interventions. Interventions aimed at changing human behavior may initially be successful, but often do not have sustained effects and many weight losses end in weight regain. Relapse is high in obesity interventions involving behavior and weight change.³¹ Relatively little weight-loss accomplished through weight-loss programs is maintained long term.³⁷ In fact, it is not uncommon for an individual to regain more than their initial weight, after attempting to lose weight and relapsing. Behavior change is complex and is influenced by a wide array of factors including physiological, psychological, environmental, sociological, and socioeconomic factors. Each individual develops a unique belief system, knowledge base, and skill set. These functional modes are impacted by attitudes, emotions, past experiences, and motivations that are all unique to the individual. When environment and culture are layered into the mix, the variety of barriers individuals face in making healthy choices grows more diverse.

The challenge we now face is how to best encourage an already sedentary, overweight and obese population to be more confident and motivated to actively engage in health-promoting activities in adoption of a better lifestyle. In addition to the biological factors contributing to body weight, psychological factors also influence the behaviors associated with energy intake (diet) and expenditure (physical activity). In particular, self-efficacy has been shown to be a promising mediator of health related behaviors, such as dietary intake and physical activity, in previous short-term weight-loss interventions. Additionally, more autonomous forms of health behavior regulation have predicted better adherence and improved outcomes in previous weight-loss interventions. If self-efficacy can be improved upon in weight-loss interventions and maintained, perhaps it can increase the likelihood of positive health behavior change outcomes in long-term weight control and maintenance.

Behavioral economics has also emerged as a potentially effective strategy for behavior modification, specifically in the context of short-term weight-loss. Behavioral economics is based on the framework of standard economics, but focuses on applying psychological factors to modify one's behavior. Behavioral economics in the form of modest financial incentives have been shown to improve health outcomes in short-term lifestyle and behavior modification interventions.⁷² Financial incentives provide people with immediate and tangible feedback that helps make it easier for them to do in the short term what is in their long-term best interest.⁷¹ However, some previous efforts to use incentives for weight loss have resulted in substantial weight regain after 16 weeks.⁷³ Despite widespread implementation of financial incentive-based public health and workplace wellness policies, the effects of financial incentives on exercise initiation and maintenance in adults remain unclear.

Current literature has established the difficulty involved in the sustainability of health behavior change over time. SE and FI have been shown to be two promising factors associated with behavior change, however, it is unclear if these approaches are sustainable. The challenge facing health professionals today is determining which factors contribute to sustainable positive behavior modifications, leading to improved health outcomes. Due to the detrimental health consequences of obesity, it is essential to identify effective strategies to treat and manage the disease. Further investigation on mediators in weight change should be the focus of future research. This knowledge will aid in designing future weight loss and lifestyle interventions to promote effective and sustainable improvements in health behaviors and weight status.

Literature Review

The following review will examine current literature in the following areas:

- V. Theory behind Behavior Change
- VI. Self-Efficacy (SE) regarding Eating and Exercise
- VII. Financial Incentives (FI) in Weight Interventions
 - a. Diet Behavior Modification
 - b. Exercise
 - c. Weight Loss
 - d. Maintenance
- VIII. Summary

Literature Review

I. Theory behind Behavior Change

Human behavior remains the largest source of variances in health-related outcomes,⁷⁴ warranting it a major area of interest in battling obesity. Cognitive factors such as personal health-related knowledge and self-efficacy play an important role in how an individual behaves. Many behavior and behavior change theories are built upon, and emphasize, this construct.

Social Cognitive Theory

The Social Cognitive Theory (SCT), developed in 1986 by Albert Bandura, attributes the process of learning to a dynamic relationship between the individual, their physical environment and their behavior.²⁴

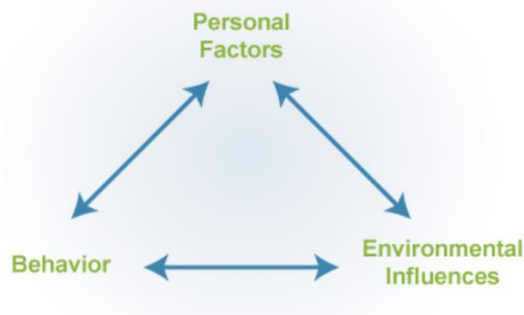


Figure 1. Overview of Bandura's Social Cognitive Theory

SCT takes into account an individual's past experiences and how they shape current behavioral actions through reinforcements and expectations. These concepts explain why a person engages in certain behaviors. SCT is built upon the concept of self-efficacy, which has been shown to be one of the most powerful predictors of health behavior.²⁵ The theory states that behavior is a function of both rewards (reinforcements) and expectancies. Specifically, self-efficacy expectancy refers to an individual's perception of their ability to perform a behavior. Other expectancies in SCT include situation-specific and outcome expectancies. Thus, for an individual to engage in a certain behavior, it is proposed that they must first value their health (an incentive), believe that their current situation needs to be changed as it poses a health threat (situation-outcome expectancy), believe that changing their behavior will reduce this health risk (outcome expectancy), and finally, they must believe they are capable of performing the behavior (self-efficacy expectancy). Individuals with a greater self-efficacy are believed to have a stronger intention or motivation to act, put forth greater effort to achieve what they set out to do, and are able to overcome barriers.

Self-Determination Theory

The Self-Determination Theory further attempts to explain factors motivating individuals to behave the way they do. SDT is particularly focused on how a person acquires motivation to initiate new health behaviors and maintain them. SDT suggests that maintaining change over time requires one to internalize values and skills associated with the change and have determination to continue the behavior.⁷⁴ Essential to this internalization is the individual's development of autonomy and competence toward the change.

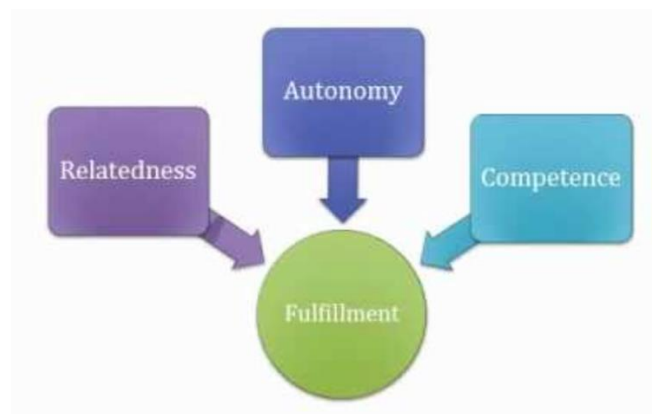


Figure 2. Overview of the Self-Determination Theory

Based on SDT, an individual must be intrinsically motivated to make a lasting change, since improving health behaviors, such as increasing physical activity, are not always enjoyable activities.⁷⁵ The person must believe that changing their behavior is both important and valuable. Once a change is internalized and becomes integrated with one's values and lifestyle, it becomes easier to sustain the behavior over time.⁷⁴ Based on this theory, it is predicted that competence alone is not sufficient to ensure adherence; it must be accompanied by volition or autonomy.

II. Perceived Self-efficacy (SE) regarding Eating and Exercise

Behavior Modification

A cross sectional study conducted by Richman et al. (2001) aimed to evaluate the effect of a behavior modification intervention program on weight and self-efficacy in obese women. The study also compared eating self-efficacy in obese versus non-obese women. 161 non-obese women and 138 obese women were offered the same 3-month program that emphasized monitoring dietary fat intake and frequency of exercise. Six behavioral modification modules on lifestyle/weight issues were administered, each addressing different topics regarding diet and exercise. The educational modules included sections on how to initiate change, emotional/physiological factors related to food, positive self-talk, and problem-solving. Self-monitoring and goal setting was utilized. The women were given a choice of joining one of three groups; 'self-help', allowing them to progress through the program at their own set pace; 'supervised by the general practitioner', consisting of visits for support and counseling; and 'group', which allowed for a discussion of relevant issues, led by an experienced social worker/family therapist, dietitian, and physiotherapist. The women were told to follow a diet consisting of approximately 50% from carbohydrates, 30% from fat and 20% from protein. Follow-up appointments were made at 3 and 12 months after this initial assessment. The obese group consisted of 138 women, while there were 161 in the non-obese group. 47% of the women kept their follow-up appointments for reassessment at 3 months, after the program had ended. There was not a significant weight loss difference across the three groups at this time, but all were successful with at least modest weight loss. The obese group scored significantly less on self-efficacy than their non-obese counterparts, with a significant negative correlation between BMI and self-efficacy score. Obese participants who completed the program saw significant improvements in their self-efficacy scores, although still significantly lower than the non-obese group. Improvements in self-efficacy among obese women were of sufficient magnitude, scaling similar to women of a normal weight. Improvements in eating self-

efficacy were maintained at 12 months, in those who completed the entire program. Although this study held high attrition rates, results agree with previous research in that behavior modification weight interventions can be effective in an obese, female population. The authors noted that retention in such programs requires commitment on behalf of both the client and health professional, and that self-management with adequate support should be encouraged to improve outcomes.⁸

Diet and Exercise

Self-efficacy has been identified as a key determinant in the act of increasing one's physical activity.⁷⁶ Research findings show that self-efficacy can mediate the effects of interventions on physical activity behavior (Dishman, 2005). Research also suggests that beginning a weight loss program with high weight loss self-efficacy predicts a greater likelihood of losing weight.⁷⁸ Annesi (2012) investigated the effects of treatments framed using behavioral change models on psychosocial predictors of exercise and improved eating in obese, middle-aged adults. It was hypothesized that much of the effects of exercise as a predictor of maintained weight loss were due to associated changes in psychosocial factors, including mood and self-regulation. Overall, improvements in self-efficacy and self-regulation for both exercise and managed eating were found to have significantly greater improvements associated with the cognitive-behavioral nutrition condition in self-regulation for eating and mood.⁵ Multiple regression analyses indicated that significant portions of the variance in both increased frequency exercise ($R^2 = 0.45$) and fruit and vegetable intake ($R^2 = 0.21$) were explained by changes in self-regulatory skill usage, self-efficacy, and mood.⁵ Researchers concluded that cognitive-behavioral methods for improving eating, along with behavioral support of physical activity, may improve weight loss outcomes through effects of self-regulation and self-efficacy.

In a systematic review conducted by Teixeira et al. (2015), self-efficacy was reported as a main predictor of physical activity maintenance. This was the first review of mediational psychological mechanisms of successful obesity interventions, which included community or clinically-set studies, published between 2000 and 2014. This study found self-efficacy to be a main predictor of long-term physical activity, as well as a mediator of short-term weight control, dietary intake and physical activity, and suggested it as a potentially effective strategy for promoting weight loss.³¹

III. Financial Incentives (FI) in Weight Interventions

Financial Incentive and Diet Modification

Previous reviews of the literature on financial incentive for diet behavior change have reported mixed findings. While most report incentives to be effective, these results tend to be short lived, and have not been shown to sustain weight loss maintenance.⁷⁹

Wall et al. (2006) conducted a systematic review of randomized control trials that measured the effectiveness of monetary incentives in the modification of diet behavior. Four studies met the inclusion criteria. Populations, settings, intervention components, trial duration and follow-up data were extracted for comparison. Methodological quality was assessed based on these comparison measures, as well as baseline characteristics, randomization method, blinding, and intention-to-treat analysis. Some limitations of the studies noted were small sample sizes and short trial durations. All four studies demonstrated a positive effect of monetary incentives on food purchases, consumption, and/or weight loss in the short-term.⁷⁹ This review supports the notion that monetary incentives are promising strategy in dietary behavior modification. Trials with a longer duration and larger sample sizes are needed, as well as within populations that are at high-risk of developing diet-related diseases.⁷⁹

A more recent systematic review on this topic, conducted by Purnell et al. and published in 2014, included studies published between 2006 and 2012.⁶⁹ This review was able to expand on previous attempts by including not only randomized control trials, but also quasi-experimental, observational and simulation studies also using financial incentives to modify diet behavior. Data was compiled on study populations, design, duration, follow-up, outcome measures and overall key findings of twelve studies. The most common limitations were small sample size and selection bias in participants. Eleven studies found a positive link between monetary incentives and diet behavior change short-term. FI were generally found to have a positive short-term effect on dietary behavior, but this did not appear to be maintained at long-term follow ups.⁶⁹

These reviews build a foundation for the use of monetary incentives for modifying diet behavior. Although findings are mixed and limitations noted, financial incentives remain to be a potentially useful tool in aiding diet behavior modification.

FI and Exercise

Mitchell et al. conducted a systematic search of 15 databases in June 2012 to compile randomized control trials which analyzed the use of financial incentives on exercise behaviors. Eleven studies were included with a total of 1,453 individuals, 50% of which were female, and ages ranged from 18-85 years. Pooled results favored the incentive condition ($z=3.81$, $p<0.0001$). Previously sedentary adults responded favorably to incentives 100% of the time ($n=4$).⁷⁰ Eight studies showed incentives to have significant, positive effects on exercise. One of the studies determined that incentives can sustain exercise for longer periods (>1 year), and two studies found exercise maintenance to persist after withdrawal of the incentive. Overall, this review concluded that financial incentives can increase exercise adherence in adults in the short term (<6 months).⁷⁰

FI and Weight Loss

In 2007, Finkelstein investigated the ability of financial incentives to encourage weight loss in overweight employees.⁸⁰ Incentives in this randomized design study were modest, and consisted of two levels, \$7 and \$14 per percentage point of weight lost. All participants had equal chances of obtaining the incentives. Measurements were taken at baseline, three months and six months. At three months, participants with no financial incentive lost 2 pounds, those in the \$7 group lost approximately 3 pounds, and those in the \$14 group lost 4.7 pounds. This study revealed that modest financial incentives can be effective in motivating overweight employees to lose weight.⁸⁰ In addition, a study performed by Leahey et al further supports findings related to weight loss and incentives. Researchers evaluated whether or not the addition of financial incentives to a weight loss program would improve overall weight loss. The web-based program was based on a program called Shape Up Rhode Island (SURI), which included 3,234 individuals diagnosed with pre-Diabetes.⁸¹ The SURI participants who were selected to participate in this study (268 individuals) were randomized into three intervention group: Shape-Up Program (SU) + Internet Behavioral Program (IBP); SU + IBP + incentives; and SU + IBP + group sessions. The program lasted a total of three months. Of the three groups included in the study, the SU + IBP + incentives group lost the most weight. Incentives were found to significantly increase engagement, adherence, and weight loss. The incentives were also found to be more cost-effective in the long run.⁸¹

Another web-based study performed by Leahey et al. examined the uses of financial incentives and social gaming to promote weight loss in a weight loss program called 'DietBet'.⁸² This study aimed to make healthy behavior changes both engaging, intellectually challenging, and fun. The program was able to engage 40,000 participants in just 7 short months. The gaming aspect consisted of individuals who bet money and joined a game on the DietBet platform. The players

interact with each other over the course of 4 weeks, in which they try to lose 4% of their initial body weight. At the end of the month, anyone who lost at least this much are declared winners and all winners of the game split the pot of money raised in that game. The average bet was 27 U.S. dollars and winners won an average 59 U.S. dollars. Winners lost an average of ~5% of their body weight, while 30% of winners lost more than 5%.⁸² As a result, it was found that betting more money at the beginning of the game predicted a greater likelihood of losing weight and ultimately winning the cash incentive.⁸² This suggests that the higher level of financial incentive offered, the more motivated or confident the player was to lose weight.

Weight Loss Maintenance

Eventual weight regain is frequently observed after the completion of behavior change/weight interventions.³¹ A randomized control trial conducted by Volpp et al. (2008) aimed to determine if behavioral economic techniques, particularly loss aversion of financial incentives, were effective at promoting weight loss among 57 patients with BMIs between 30 and 40.⁷² Recruited in 2007 from a VA medical center, participants were randomized to three weight loss interventions, consisting of monthly weigh-ins with a (1) control group with no incentive, (2) lottery incentive program, or (3) a deposit contract that used participant matching. The goal for weight loss was one pound per week for 16 weeks focusing on total weight loss as the final outcome. The incentivized groups lost significantly more weight than the control group, with the lottery group losing a mean of approximately 13 pounds and the deposit contract losing a mean of approximately 14 pounds. About half of the incentivized participants met the 16-pound weight loss goal, while only 10.5% of the control group met this goal. Net weight loss was higher in incentivized participants, who weighted significantly less at 7 months than at baseline, ($p=0.01$ for the lottery group; $p=0.03$ for the deposit contract group) whereas controls did not. Overall, this

review found that the use of incentives resulted in significant weight loss during the 16-week intervention. However, the authors noted that longer-term use of incentives should be evaluated.⁷²

To evaluate a longer term weight loss intervention using financial incentives, a 32-week, three-arm randomized controlled trial was conducted by John et al. (2011).⁷³ This study consisted of a 24-week weight loss phase in which all participants were given a weight loss goal of 1 pound per week, for a total of 24 pounds. This was followed by an 8-week maintenance phase and the main outcome measure over the course of the 32 weeks of the study was total weight loss. Sixty-six obese veterans with BMIs between 30 and 40 were selected and were randomly assigned to participate in either the control group or one of two incentivized experimental groups. The control group consisted of a weight-monitoring program involving a consultation with a Dietitian and monthly weigh-ins. The experimental groups underwent the same program with one of two financial incentive plans. Both incentive arms used deposit contracts in which participants put their own money at risk, which was matched, unless they failed to lose the weight, in which case they lost this money. In one incentive arm participants were told that the period after 24 weeks was for weight-loss maintenance; in the other, no such distinction was made. Results revealed that the incentivized participants had lost more weight than control participants, and there was no significant difference in weight loss between the two incentive arms. Follow-up data 36 weeks after the 32-week intervention indicated weight had been regained, making the the net weight loss between groups no longer significant. This trial concluded that financial incentives were successful in producing significant weight loss during the intervention phase, which was not maintained post-intervention.⁷³

IV. Summary

In summary, research supports that an individual with a greater level of self-efficacy is more likely to have greater self-regulation and determination, which could lead to making healthier lifestyle choices and a greater likelihood of weight loss if attempted. In addition, when monetary incentives are added to interventions such as these, it appears to increase the likelihood of adherence and engagement (short term), which in turn, could increase level of self-efficacy.⁷² Ultimately, self-efficacy and financial incentives both appear to promote weight loss and could factor into sustainable weight-loss attainment.

Purpose:

The primary purpose of the present study was to evaluate the effects of perceived (dietary and exercise) self-efficacy and financial incentives on health behaviors, body weight, and weight maintenance in individuals with overweight and obesity participating in a weight loss program.

Specific Objectives:

1. a. Assess the relationship between post-intervention HES at 16 weeks, Eat-SE at 16 weeks, and weight change from baseline to 16 weeks.
b. Determine if financial incentives influence this relationship.

Hypothesis 1a: Higher HES at 16 weeks will be associated with higher Eat-SE at 16 weeks and greater weight loss from baseline to 16 weeks.

Hypothesis 1b: Incentives will moderate this relationship, strengthening the effect of self-efficacy.

2. a. Assess the relationship between frequency of mild, moderate and vigorous PA, Ex-SE, and BMI at 16 weeks.
b. Determine if financial incentives influence this relationship.

Hypothesis 2a: *Higher frequencies of mild, moderate and vigorous PA at 16 weeks will be associated with higher Ex-SE at 16 weeks and lower BMI at 16 weeks.*

Hypothesis 2b: *Incentives will moderate this relationship, strengthening the effect of self-efficacy.*

3. a. Assess the relationship between frequency of mild, moderate and vigorous PA at 16 weeks, Ex-SE at 16 weeks, and BMI change from 16 to 28 weeks.
- b. Determine if financial incentives influence this relationship.

Hypothesis 3a: *Higher frequencies of mild, moderate and vigorous PA at 16 weeks will be associated with higher Ex-SE at 16 weeks and greater weight loss from 16 to 28*

weeks. Hypothesis 3b: *Incentives will moderate this relationship, strengthening the effect of self-efficacy.*

4. Assess the relationship between frequency of mild, moderate and vigorous PA, Ex-SE and BMI at 28 weeks' follow-up.

Hypothesis 4: *Higher frequencies of PA will predict higher Ex-SE, which will further predict lower BMI at follow up.*

Methods

Study Design

This study was an intervention for a group of overweight and obese nursing-home employees at risk for Type 2 Diabetes, based on the CDC Diabetes risk score >8, indicating a high risk for diabetes.⁴⁶ Trained health educators measured participants' height and weight to calculate BMI. All of the participants were classified as being overweight or obese (having a BMI greater than 25 kg/m²), according to CDC recommendations,⁴⁵ and were at risk for Type II Diabetes. A

randomized control study was conducted using a weight loss program titled, “A Pound a Week”, which was implemented among four long-term nursing care facilities in the Northeastern United States. The research design and intervention protocol has been previously outlined in additional publications.^{49,50} The program lasted sixteen weeks with one 3-month follow-up. The control group consisted of non-incentivized participants (NIP). There were two experimental groups, both consisting of incentivized participants (IP). The facilities were randomly assigned to either group, with forty-eight employees participating in the non-incentivized group, and fifty-one participating in the incentivized group (n=99).

Prior to beginning the program, all participants received a personalized weight loss consultation based on their reported physical activity habits and dietary preferences. This was meant to encourage each participant to adopt physical activities they enjoy, as well as identify their support system and to address barriers to their weight loss. The action plan encouraged participants to reflect on their lifestyle and how they wish to improve it. It also provided information on safe weight loss, goal setting, healthy eating and increasing physical activity.

Weekly weight loss goals were also set during this initial consultation, which consisted of losing 1 to 1.5 pounds per week. Participants who met the total weight loss goal at the end of intervention were encouraged to continue losing weight at this goal rate. Participants were randomized into 2 groups, incentivized and non-incentivized. Incentivized Participants classified as overweight were rewarded ten dollars per 1 pound of weight loss, while obese participants received the same for every 1.5 pounds lost. This amounted to a total possible amount of 160 dollars, which was awarded at the end of intervention. Participants who met their weight loss goal and maintained the loss through the follow-up period were then awarded an additional 100 dollars, for a maximum payment of 260 dollars.

Participants

Ninety-nine full or part-time employees of the long-term care facilities were selected to participate in the study, all of which were classified as being overweight or obese ($\text{BMI} \geq 25.0 \text{ kg/m}^2$) and were at risk for Type II Diabetes. Participants had to be at least 18 years of age, but could be of any race, gender, education level, or salary level. Exclusion criteria included having any current or past history of heart disease, stroke, Type 1 Diabetes, or receiving radiation or chemotherapy for cancer treatment in past 5 years. Participants currently pregnant or lactating, taking weight loss supplements, or had lost 20 or more pounds in the last 6 months, or were planning to weight loss surgery during the duration of the study, were also excluded. All participants signed an informed consent form approved by the University of Connecticut Institutional Review Board (IRB).

Questionnaire

Participants completed a self-reported questionnaire on their demographic information, anthropometric measurements, and respond to questions regarding their health and health-related behaviors. These scores were used to further assess the individuals' lifestyle choices and health-related behavior patterns, including dietary intake and physical activity, as well as self-efficacy involving eating and exercise activities and their health behaviors. These sub-scores were appropriately manipulated to form overall self-efficacy and health behavior scores for each behavior category (healthy eating and physical activity).

Variable Measures

Body Mass Index (BMI): Trained health educators measured height and weight. A calibrated Seca 700 physician balance beam scale was used to measure weight to the nearest 0.1 kg and height was measured the nearest mm. Body mass index (BMI) was calculated as weight in

kilograms divided by height in meters squared and categorized based on CDC recommendations of overweight (25-29.99 kg/m²), obese class I (30-34.99 kg/m²), obese class II (35-39.99 kg/m²), and (> 40 kg/m²).

The frequency-based Healthy Eating Score (HES) consisted of nine questions, which asked respondents to answer how often they consume particular foods and/or beverages using a 4-point Likert scale, which ranged from “never to 1 time/week and 1-4 times/week” (1), “5-7 times/week” (2), “2 times/day” (3) and “3+ times a day” (4). The scale provides one global scale with the highest possible score of 36 (9x4).⁴⁷

Eating self-efficacy (Eat-SE), originally the Weight-loss Self-Efficacy Score (WLSE), developed by Clark et al (1991),⁴⁸ was defined in terms of a summary score consisting of 20 questions, which asked participants to rate their confidence that they could motivate themselves to resist eating in certain situations, consistently, for at least six months (See Appendix). Rating was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2), “moderately confident” (3), and “very confident” (4). The situational factors consist of: Negative Emotions (ex: eating when anxious/sad), Availability (ex: eating when food is readily available, such as at a party), Social Pressure (ex: eating food when others encourage eating), Physical Discomfort (eating when in pain or fatigued), and Positive Activities (ex: eating while watching television). The scale provides one global scale with the highest possible score of 80 (20x4).⁴⁴

The frequency-based Physical Activity Scores were defined using three questions, which obtained information on self-reported performance of mild, moderate, or vigorous physical activity for a 30-minute duration during a typical 7-day week. Individuals were provided with intervals of days for responses, including: 0 days, 1-2 days, 3-4 days, or 5 days or more.^{49,50}

The confidence-based Exercise Self-Efficacy Score (Ex-SE), was defined in terms of a summary score consisting of 11 questions, which asked participants to rate their confidence that they could motivate themselves to keep up with certain exercise behaviors and activities, consistently, for at least six months. Rating was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2), “moderately confident” (3), and “very confident” (4). The scale provides one global scale with the highest possible score of 44 (11X4).⁴⁴

Data Analysis

To analyze descriptive statistics, frequency and means tests were run among different variables of the sample population using the Statistical Analysis Software program (SAS). These variables include gender, age, anthropometric measurements, race, and highest education level. Descriptive results were compiled and analyzed to assess overall population health, participant characteristics, distributions of variables of interest (self-efficacy, stage of change, barriers to physical activity) and to compare ratios such as gender of participants and classes of obesity. Also assessed were the general health of the population and the prevalence of chronic disease and conditions, such as hypertension, high cholesterol, and Diabetes. BMI normality was tested in the statistical program SAS.

Latent variables were created for HES, Eat-SE and Ex-SE using sum scores, where higher scores were indicative of a more healthful diet and higher perceived SE. Missing values in the dataset were imputed using the Multivariate Imputation by Chained Equations (MICE) package in R. Pearson’s bivariate correlation tests were run in the Statistical Package for Social Sciences (SPSS). Mediation models and bootstrapping were run in the statistical program R Studio using the Mediation package.

Results

Descriptive Statistics: Demographics

Participant Demographics		
		(n=99)
Gender	Female	88.89% (n=88)
	Male	9.09% (n=9)
Age	Years \pm SD	46.98 \pm 11.36
Anthropometrics	Weight (lbs) \pm SD	203.84 \pm 40.93
	Height (feet) \pm SD	4.96 \pm 0.24
	Height (inches) \pm SD	5.09 \pm 2.92
	BMI \pm SD	35.33 \pm 6.91
Weight Classification	Overweight	19.79%
	Obese	34.38%
	Severe Obesity	22.92%
	Morbid Obesity	17.71%
	Super Obesity	5.21%
Race	White	48.48%
	Black	40%
	Hispanic	5.05%
	Asian	3.03%
	American Indian	1.01%
Education	10 yrs (high school/secondary)	4.12%
	11 yrs (high school/secondary)	3.09%
	12 yrs (high school/secondary)	40.21%
	13 yrs (college/professional)	12.37%
	14 yrs (college/professional)	12.37%
	15 yrs (college/professional)	10.31%
	16 yrs (college/professional)	10.31%
	17 yrs (post-graduate)	7.22%

Table 1. Participant Demographic Information (gender, age, anthropometric measurements, weight classification, race and education)

Demographic and anthropometric data are presented in Table 1. Majority of participants were obese, middle-aged, white or black females with at least 12 years' education (equivalent to a high school diploma). Pearson's correlation tests revealed that age had no significant correlation with BMI ($r=0.022$, $p=0.837$), eating self-efficacy ($r=0.112$, $p=0.306$), or exercise self-efficacy ($r=-0.023$, $p=0.823$).

BMI Normality

BMI normality was tested in SAS and was found to follow a slightly non-normal distribution. This distribution was expected in this sample, as all participants were classified as overweight or obese.

Descriptive Statistics: General Health, Health Behavior, and Self-Efficacy

		Baseline	16 weeks		28 weeks	
			IP	NIP	IP	NIP
Physical Activity Mild						
	0 days	24%	0%	0%	0%	0%
	1-2 days	36%	33%	35%	55%	58%
	3-4 days	26%	67%	65%	45%	42%
	>5 days	11%	0%	0%	0%	0%
	Moderate					
	0 days	31%	0%	0%	0%	0%
	1-2 days	39%	37%	42%	75%	65%
	3-4 days	19%	63%	58%	26%	35%
	>5 days	3%	0%	0%	0%	0%
	Vigorous					
	0 days	65%	0%	0%	0%	0%
	1-2 days	18%	71%	73%	78%	77%
	3-4 days	9%	29%	27%	22%	23%
	>5 days	1%	0%	0%	0%	0%
HES						
	<20	10%	6%	0%	6%	6%
	20-25	60%	45%	46%	53%	46%
	26-30	26%	20%	29%	33%	33%
	Over 30	5%	29%	25%	8%	15%
Self-Efficacy Eating						
	Not Confident	0%	4%	0%	0%	0%
	Somewhat Confident	4%	37%	2%	10%	13%
	Moderately Confident	32%	26%	29%	39%	21%
	Very Confident	64%	33%	69%	51%	67%
	Exercise					
	Not Confident	0%	4%	0%	0%	0%
	Somewhat Confident	13%	14%	25%	33%	15%
	Moderately Confident	42%	28%	29%	28%	31%
	Very Confident	44%	55%	46%	39%	54%

Table 2. Comparison of incentivized vs non-incentivized participant health, physical activity, healthy-eating score and self-efficacy at baseline, 16 and 28 weeks

At baseline, a majority of participants reported their general health as ‘good’ (45.8%), followed by ‘very good’ (28.1%), ‘fair’ (17.7%), and ‘excellent’ (7.3%). General health had a significant negative correlation with current level of physical activity ($r = -0.284$, $p = 0.006$). General health also had a negative correlation with eating self-efficacy ($r = -0.130$, $p = 0.227$) and exercise self-efficacy ($r = -0.124$, $p = 0.254$), although not significant.

Baseline level of physical activity has a significant positive correlation with baseline eating self-efficacy ($r = 0.268$, $p = 0.011$) and exercise self-efficacy ($r = 0.300$, $p = 0.005$). Physical activity had a significant negative correlation with BMI ($r = -0.301$, $p = 0.003$). BMI also had a significant negative correlation with moderate physical activity ($r = -0.313$, $p = 0.002$) and vigorous physical activity ($r = -0.233$, $p = 0.026$), as well as eating self-efficacy ($r = -0.262$, $p = 0.013$) and exercise self-efficacy ($r = -0.284$, $p = 0.008$). The top four reasons reported for not exercising include: ‘never persisting’ (39.4%), ‘no time’ (32.3%), ‘lazy’ (28.3%), and ‘no energy’ (23.2%).

There are no significant differences in physical activity or healthy-eating score between groups at 16 or 28 weeks. Both groups report less frequent physical activity from 16 to 28 weeks at mild and moderate intensity levels, with minimal change at vigorous intensity. Eating self-efficacy increased from 16 to 28 weeks in the incentive group, but decreased in non-incentive group. Conversely, exercise self-efficacy decreased from 16 to 28 weeks in the incentive group, but increased in the non-incentive group. There were no significant differences in characteristics between groups other than initial body weight, which was higher in IP ($p = 0.03$). Overall, IP lost an average of 5.05 lbs more than NIP ($p = 0.027$), and reduced their BMI by an average of 1.73 kg/m² more than NIP ($p = 0.043$) at week 16.

Mediation Results

Hypothesis 1a: Higher HES at 16 weeks will be associated with higher Eat-SE at 16 weeks and greater weight loss from baseline to 16 weeks. **Hypothesis 1b:** Incentives will moderate this relationship.

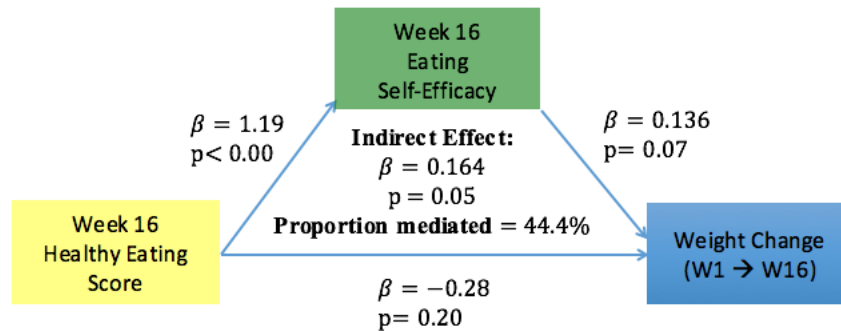


Figure 4. Path Diagram: HES and Eat-SE at 16 weeks, and weight change from week 1-16

Higher HES at 16-weeks significantly predict a higher eating self-efficacy at 16 weeks ($\beta = 1.19$, $p < 0.00$), and marginally significant greater weight loss from baseline to 16 weeks ($\beta = 0.136$, $p = 0.07$). Incentives significantly moderate this relationship ($\beta = 0.321$, $p = 0.00$), explaining 58.9% of the total effect for incentivized participants. When incentive is tested as mediator in place of Eat-SE, there is no longer a significant relation between HES and weight change at 16 weeks, indicating self-efficacy at 16 weeks is a more powerful factor contributing to behavior and weight change than incentive alone.

Hypothesis 2a: Higher frequencies of mild, moderate and vigorous PA at 16 weeks will be associated with higher Ex-SE at 16 weeks and lower BMI at 16 weeks. **Hypothesis 2b:** Incentives will moderate this relationship.

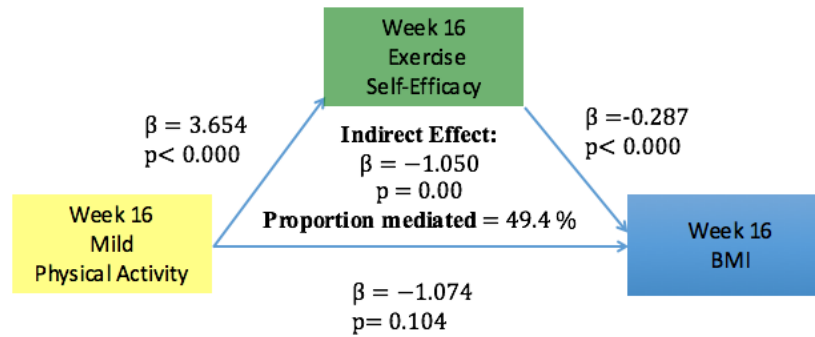


Figure 5. Path Diagram for Mild PA and Ex-SE at 16 weeks, and BMI at 16 weeks

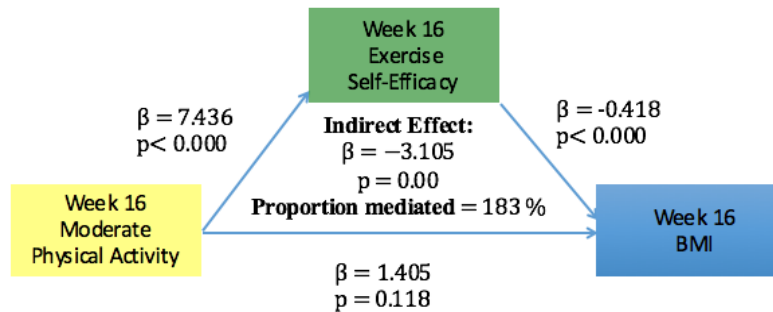


Figure 6. Path Diagram for Moderate PA and Ex-SE at 16 weeks, and BMI at 16 weeks

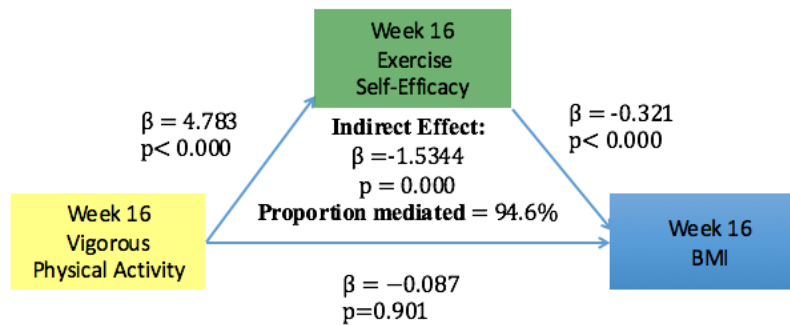


Figure 7. Path Diagram for Vigorous PA and Ex-SE at 16 weeks, and BMI at 16 weeks

More frequent engagement in mild, moderate and vigorous physical activity at the end of intervention significantly predict Ex-SE at 16 weeks ($p < 0.00$). Higher Ex-SE at 16-weeks further predict a lower BMI at week 16 ($p < 0.00$) in all the PA models.

Financial incentives significantly moderate this relationship in all PA models, explaining 51.6% of the total effect for incentivized participants ($\beta = -1.115, p = 0.00$), and 25.08% for non-incentivized participants ($\beta = -0.6068, p = 0.06$) at mild intensity. For moderate intensity PA, incentives explain 223% of the total effect ($\beta = -3.81, p = 0.00$) for incentivized participants, and the absence of incentives explain 91.6% of the total effect for non-incentivized participants ($\beta = -1.5385, p = 0.02$). Finally, for vigorous PA, incentives explain 94.57% of the total effect for incentivized participants ($\beta = -1.5422, p = 0.00$), and 73% for non-incentivized participants ($\beta = -1.179, p = 0.02$).

Hypothesis 3a. Higher frequencies of mild, moderate and vigorous PA at 16 weeks will be associated with higher Ex-SE at 16 weeks and greater weight loss from 16 to 28 weeks.

Hypothesis 3b. Incentives will moderate this relationship.

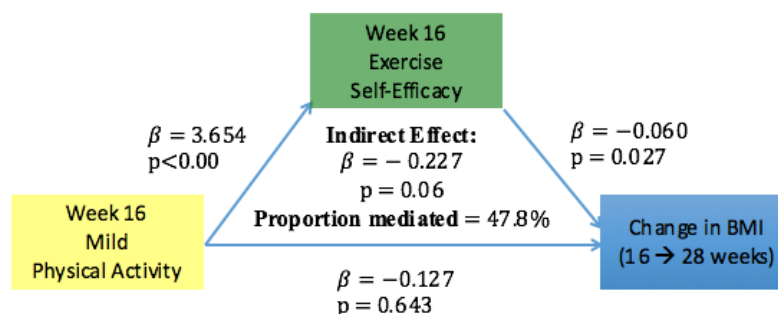


Figure 8. Path Diagram: Mild PA and Ex-SE at 16 weeks, and BMI change from week 16 to 28

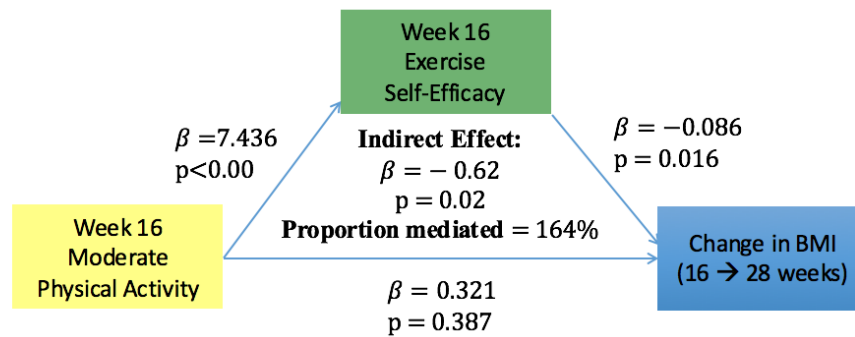


Figure 9. Path Diagram: Mod PA and Ex-SE at 16 weeks, and BMI change from week 16 to 28

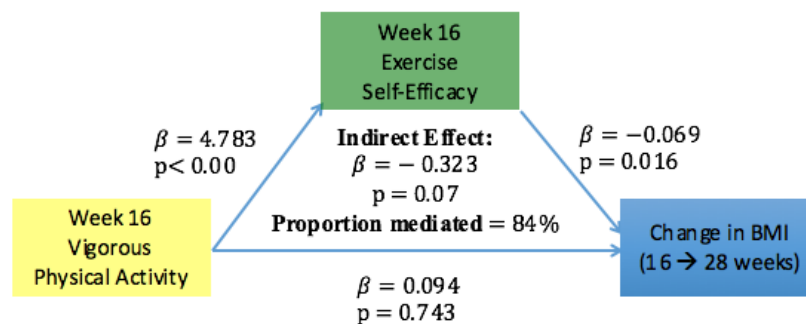


Figure 10. Path Diagram for Vig PA, Ex-SE at 16 weeks, and BMI change from week 16 to 28

More frequent engagement in mild, moderate and vigorous physical activity at 16 weeks significantly predict higher Ex-SE at 16 weeks ($p < 0.00$). Higher Ex-SE at 16 weeks further predict a greater loss in BMI from 16 to 28 weeks ($p = 0.02$) in all three models.

Incentives significantly moderate this relationship in all three models, explaining 46.6% of the total effect for incentivized participants ($\beta = -0.332, p = 0.02$) at mild intensity. For moderate intensity, incentives explain 113.4% of the total effect ($\beta = -0.883, p = 0.05$) for incentivized participants. Finally, at vigorous intensity, it explains 90.2% of the total effect for incentivized participants ($\beta = -0.486, p = 0.00$).

Hypothesis 4. Higher frequencies of PA at 28 weeks will predict higher Ex-SE at 28 weeks, which will further predict lower BMI at 28 weeks.

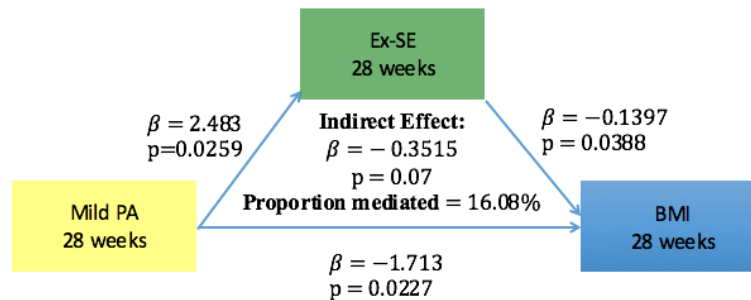


Figure 11. Path Diagram for Mild PA, Ex-SE and BMI at 28 weeks

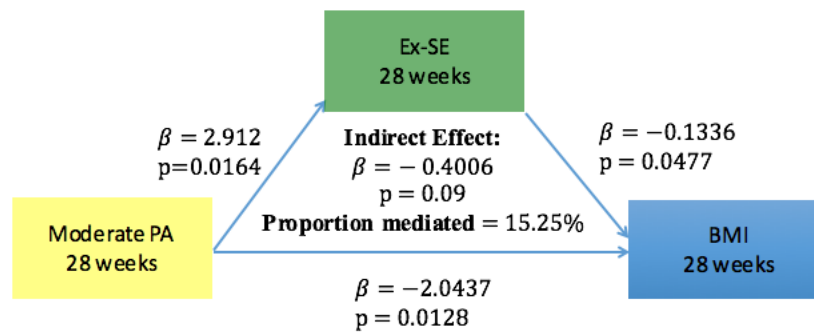


Figure 12. Path Diagram for Moderate PA, Ex-SE and BMI at 28 weeks

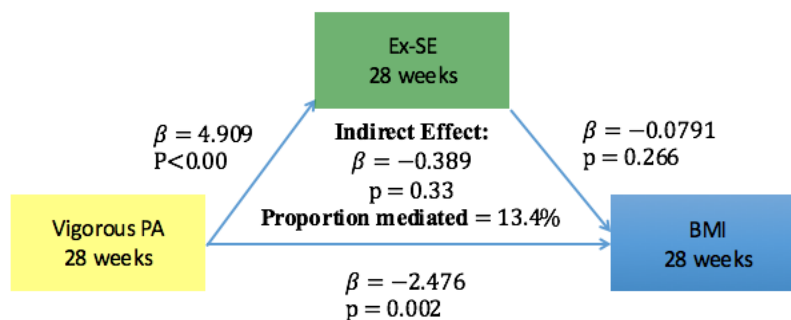


Figure 13. Path Diagram for Vigorous PA, Ex-SE and BMI at 28 weeks

More frequent mild and moderate PA reported at 28 weeks significantly predict higher Ex-SE at 28 weeks ($p=0.026$, $p=0.016$). Higher Ex-SE at follow-up further predict a lower BMI at 28 weeks ($p=0.03$, $p=0.04$). More frequent vigorous PA at 28 weeks is also significantly predictive of higher Ex-SE at 28 weeks ($p<0.00$), as well as a lower BMI at 28 weeks ($p=0.002$).

Discussion

With the majority of U.S. adults currently overweight or obese,⁶⁹ it is critical to design and implement evidenced-based interventions that will achieve sustained behavioral change and improved weight status nationwide. The change our society needs to combat these trends must involve widespread, yet individualized strategies to induce behavior changes. Behavior change interventions are difficult to implement and sustain, as evidenced by previous literature. In an effort to determine how internal (self-efficacy) and external motivators (financial incentives) affect health behaviors and weight in an overweight population, the present study assessed the effects of perceived (dietary and exercise) self-efficacy and financial incentives on health behaviors and weight status in an overweight and obese sample participating in a weight-loss program.

Data Analysis at 16 weeks

Results show higher healthy-eating score at 16-weeks significantly predicts higher eating self-efficacy at 16 weeks and greater weight loss from baseline to week 16, as predicted. Incentives significantly moderate this relationship ($\beta =0.321$, $p=0.00$), explaining 58.9% of the total effect for incentivized participants. When incentive is tested as the mediator, in place of eating self-efficacy, there is no longer a significant prediction between HES and weight change at 16 weeks, indicating eating self-efficacy is a more powerful factor contributing to behavior and weight change than financial incentive alone.

Regarding physical activity, our hypotheses state that more frequent PA (at all intensity levels) will predict higher Ex-SE and lower BMI at 16 weeks, and that incentives will moderate this relationship. We found that more frequent PA at all intensity levels significantly predicts higher Ex-SE ($p<0.00$) and lower BMI ($p<0.00$) at 16 weeks. Ex-SE significantly mediates these relationships at all intensity levels ($p=0.00$). Incentives moderate the effect of self-efficacy in all PA models, as further predicted. When incentive is tested as a mediator in place of Ex-SE, however, there is no longer a significant prediction between frequency of PA and BMI/weight change at end of intervention, indicating that exercise self-efficacy at 16 weeks is also a more powerful factor contributing to behavior and weight change than incentive alone.

Data Analysis at 28 weeks

Participants who reported more frequent PA and higher Ex-SE at 16 weeks also had greater weight loss from week 16 to week 28, as predicted. These findings agree with those of a 2013 review by Mitchell et al., which concluded that incentives can sustain exercise for longer duration and that exercise adherence can persist even after incentives are withdrawn.⁷⁰

Finally, as predicted, more frequent PA at 28 weeks predicted higher Ex-SE at 28 weeks, at all intensity levels. Higher Ex-SE further predicted a lower BMI in mild and moderate intensities, explaining 15-16% of the variability between self-efficacy and BMI. At the vigorous level of PA, the direct effect on BMI at 28 weeks ($p=0.002$) is more significant than when mediated through self-efficacy.

Indications

Overall, findings from this study indicate that perceived self-efficacy regarding eating and exercise has a powerful influence on health behavior and weight control. Adopting healthy behaviors such as increased physical activity and improved diet quality further predict improved

weight status in this group of individuals participating in a weight-loss program. Furthermore, the present study found that financial incentives moderate the effect of self-efficacy.

Diet and physical activity have a major impact on health. Metabolic improvement and successful weight management can occur regardless of actual weight change.⁸ Autonomous motivation, self-efficacy and self-regulation skills have been associated with better weight control, adherence and improved health outcomes.³¹ When individuals are able to self-regulate the way they behave, the effects are not only sustainable, but also produce a ripple effect that helps change related behaviors, which is essential for lasting desired health outcomes. This suggests that once an individual begins to feel better about themselves, their confidence and self-efficacy levels naturally rise, resulting in a positive impact on their future health behaviors. Although it may be a difficult cycle to initiate, utilizing FI strategies focused on self-efficacy may improve internal motivation and facilitate weight loss, and perhaps maintenance.⁷⁵ Using individualized approaches to target one's internal motivations to act may be an effective approach to incorporate in future weight loss interventions.

Financial incentives have been shown to improve treatment outcomes in the short-term. Perhaps this strategy provides incitement and external motivation, by acting as a catalyst for initiating behavior change.⁶⁹ However, financial incentives also appear ineffective long-term.⁷³ Overall, incentives may be especially useful in the early stages of behavioral adoption, however, motivational factors such as self-efficacy may be more operative along the entire continuum, from adoption to maintenance.⁸³ Incentivized approaches to behavior change may motivate individuals to continue healthful behaviors after incentives are withdrawn, however the extent to which these outcomes can be successfully sustained remains questionable. An interesting finding in this study is that the non-incentivized group generally reported higher self-efficacy than the

incentivized group at 16 and 28 weeks. This could perhaps be explained by the notion that self-efficacy and goal-setting can also be self-debilitating, as posed by Vancouver and his associates (Bandura and Locke, 2003). The incentivized group were required to report their weight (goal attainment) to receive their incentive, whereas the non-incentive group were not required to report their weight. Those that were required to report their goal and did not reach their goal, perhaps lost confidence in their ability. Bandura explains that when individuals fail to fulfill their goals, they react self-critically.⁸⁴ In turn, self-satisfaction and self-efficacy plummet, which affects future performance and efficacy beliefs. In other words, the feedback provided by the incentive was perhaps self-debilitating to those who did not reach their goals. Therefore, although incentive appears to improve self-efficacy as an extrinsic motivator, intrinsic motivation may be a more important factor leading to success in changing behavior. Resilient belief that one has what it takes to succeed provides the necessary power to face setbacks when undertaking challenging endeavors.

⁸⁴ A resilient sense of efficacy is needed in managing challenges in performance attainments in order to minimize feelings of failure and to overcome setbacks. The next challenge to researchers is to find constructive strategies to promote resilient self-efficacy while also providing informative feedback that will not interfere with belief in one's capability to succeed.

A high pretreatment self-efficacy may indicate overconfidence and/or lack of experience with the difficulties associated with weight loss efforts.⁶⁷ However, Americans seeking weight loss tend to be excessively optimistic in their ability to lose weight.⁶⁸ Obese individuals tend to have a lower self-efficacy regarding health behaviors than their non-obese counterparts,⁸ thus, indicating an even greater need for self-efficacy improvement in obese populations. Furthermore, obese individuals who complete weight-loss interventions see improvements in their self-efficacy. If improvements in self-efficacy can improve chances of weight-loss as indicated, perhaps it is more

important to focus on increasing self-efficacy prior to and/or during treatment, as it would likely improve behavior change initiation and adherence in previously unmotivated individuals. This may be particularly true in regards to physical activity, which has the potential to improve intervention outcomes. Initiation and adoption of regular physical activity is a critical step in the process of weight management, particularly for sustained success. Besides its direct contribution to energy expenditure, physical activity may also contribute to improved diet compliance through eating disinhibition and improved psychological well-being. That said, approaches which focus on improving self-efficacy, particularly targeted at initiating physical activity and/or adopting regular exercise could be the effective strategy needed to see both short and long-term weight loss. It is possible that personality traits such as general autonomy or overall confidence may independently influence weight loss behaviors. Generalized measures of efficacy may be more predictive of health outcomes than self-efficacy for specific behaviors.³¹ Therefore, it may also be helpful to improve overall psychological well-being and self-efficacy, rather than solely focusing on specific behaviors.

In practical terms, findings from this study can direct practitioners and healthcare professionals in clinical settings to include time-efficient ways of assessing their patients' perceived efficacy and barriers. By doing so, weight intervention efforts can be tailored to target individual patient needs to improve health outcomes. Techniques such as motivational interviewing can help improve awareness and understanding the patient has of their own health status, which may encourage self-efficacy and improve weight loss outcomes.

There lies a need for further research that identifies causal predictors of sustained weight control. Although it is unlikely that any single factor by itself will explain large variability in complex behaviors, testing of causal mediation in the pursuit of behavior modification and lifestyle

change is a critical step in improving future weight interventions, as it will provide the strongest possible inference for the identification intervention variables responsible for desired health outcomes. Behavior modification, and comprehensive lifestyle interventions, in particular, are currently the first recommended step in obesity management.⁸⁵ Research on exercise-related psychological variables in obesity-treatment is scarce and is an area warranted for future investigation. Future interventions should seek to identify causal mediators to weight change and elements of weight loss interventions that are needed for achieving desired health outcomes. Additionally, investigation into effectiveness of various strategies to improve self-efficacy should be incorporated in future interventions. In particular, interventions designed to address improving self-efficacy in already overweight population, as obese individuals have been shown to perceive less self-efficacy than non-obese individuals.⁸ Individuals that can successfully improve eating and exercise self-efficacy and maintain diet and exercise behavior changes conducive of improved health outcomes after intervention may have an improved likelihood of maintaining their desired weight once it has been achieved.

Limitations

Limitations of the present study include the small sample size, as well as the use of BMI as a potentially poor indicator of health status. BMI is a simple method of indicating body fatness and screening for bodyweight status. Although this measure can be indicative at a glance, it is not a diagnostic tool for health. Body fatness may still differ between two people with the same BMI, since BMI does not differentiate between fat mass and high lean body mass (muscle and bone) or account for body shape or weight distribution. Therefore, BMI must be further examined on a very situational and individual basis in order to assess body weight and distribution as it relates to health quality. An additional limitation is the use of self-reported questionnaire items, which could

be inaccurate due to errors in self-observation.⁸⁶ Participants may have a skewed perception of their behavior or confidence, especially with knowledge of their upcoming participation in a weight-loss program, which could lead to an inflated sense of confidence about their ability to lose weight. Lastly, mediation results over 100% reflect an issue likely relating to the small sample size or collinearity among predictor variables, rendering these results as non-robust.

Conclusion

In summary, the present study agrees with current literature stating that self-efficacy and financial incentives are promising factors contributing to weight-loss in obesity interventions. However, self-efficacy has been shown to further predict weight-loss maintenance and appears to be a stronger factor contributing to sustained weight control than financially incentivized approaches.

There is a need for further research to explore causal mediators and moderators of the associations between motivation to improve health behaviors and weight/BMI change. Although research shows self-efficacy and incentives as promising factors influencing weight loss, further research is needed to investigate causal mediators of weight change while controlling for other factors and confounding variables, as well as examining factors contributing to weight maintenance.

Future interventions, as well as health care professionals aiding in weight loss pursuits, may incorporate a focus on an individual's self-efficacy to improve likelihood of overcoming barriers to weight loss and weight management. Identifying successful strategies to facilitate weight loss will help progress us toward achieving adequate physical activity and nutrition, and ultimately, improved weight status of our nation.

CHAPTER THREE

Conclusions

Summary

The nation's obesity epidemic is quickly emerging as a global healthcare crisis. With the majority of U.S. adults currently overweight and obese,^{1,69} obesity and its related diseases have raised levels of morbidity, mortality and healthcare costs to unprecedented heights.

Despite the well-established, widespread knowledge on obesity prevention, such as regular physical activity and a healthful diet, Americans are largely not heeding these recommendations. Diet quality and regular physical activity continue to decline, while prevalence of sedentary behavior and inappropriate calorie consumption continue to rise.^{4,5} It is clear that simply educating the population on proper health habits and weight control is an inadequate approach to inducing widespread behavior change to turn the nation's health around. Behavior change is complex, as it involves many facets of human life, including biological, psychological and environmental factors. Extensive research findings have demonstrated that even when successful, relapse and weight regain is highly common in weight loss interventions.³¹

Self-efficacy describes an individual's perception of their ability to perform a behavior successfully.¹⁰ This term embodies confidence, motivation, belief, and determines how much effort one puts toward achieving their goals. Higher levels of self-efficacy have been found to have a beneficial effect on health behaviors (diet and exercise) and weight control (and lower BMI).^{8,30-32} Higher self-efficacy has also been associated with better adoption (and improved adherence) of behavior change and maintenance, as well as less perceived barriers in weight loss efforts.³⁶ Self-efficacy has been identified as a key determinant in the act of increasing one's physical activity.⁷⁶ Research findings show that self-efficacy can also mediate the effects of interventions on physical

activity behavior,⁷⁷ and that beginning a weight loss program with high weight loss self-efficacy predicts a greater likelihood of losing weight.⁷⁸ In contrast, obese individuals tend to have lower levels of self-efficacy, leading to poorer diet quality, less physical activity, increased difficulty in correcting these eating and exercise imbalances, and higher BMI.²¹ Additional reasons for lower self-efficacy may be due to socioeconomic status, education, job type, access to healthy foods, and food price, all of which could directly negatively affect perceived barriers and thus, perceived efficacy.⁵³⁻⁵⁶ Higher SES, increased healthful food knowledge and higher healthy-eating self-efficacy have been associated with greater intention to make healthier food choices and participate in physical activity.⁵⁷ Overall, self-efficacy has been shown to be a promising factor contributing to health behavior and weight status.

Behavioral economics, particularly in the form of financial incentives, has been a popular approach to recent weight loss interventions. Financial incentives have been used to provide immediate, tangible feedback to weight-loss participants. Although incentives have been linked to increased adherence and success in short-term weight loss interventions,⁷² the sustainability of this approach remains unclear. Previous incentivized weight loss interventions have resulted in substantial weight regain.⁷³ Mixed findings in the sustainability of incentivized approaches signify a gap in knowledge and warrant the need for further investigation into the sustained effectiveness of such approaches.

The purpose of this research was to: 1) evaluate the relationship between perceived dietary and exercise self-efficacy, eating and exercise behaviors, and body mass index in an overweight and obese sample of individuals at risk for Type 2 Diabetes, 2) evaluate the effects of perceived dietary and exercise self-efficacy on health behaviors (dietary and physical activity frequency), body weight, and weight loss maintenance in individuals with overweight and obesity,

participating in a weight loss program, and 3) determine if financial incentives affect the level of perceived self-efficacy in its relation between health behavior and bodyweight.

We hypothesized that: 1) more healthful behaviors (higher healthy eating score and more frequent physical activity) will be associated with higher perceived self-efficacy and lower BMI, 2) higher healthy eating score and more frequent physical activity will be associated with higher perceived self-efficacy and greater weight loss/lower BMI through a weight loss program, and 3) financial incentives will moderate the effect of perceived self-efficacy in the relationship between health behavior and bodyweight/weight loss.

Our findings were in line with previous research, as well as our hypotheses which predicted that higher perceived self-efficacy levels are associated with improved health behaviors (diet and exercise) and weight status.⁵⁹⁻⁶¹ Eating and exercise self-efficacy act as mediators between health behaviors (diet and exercise frequency) and bodyweight/weight loss. Self-efficacy seemed to act as a stronger mediator in the financially-incentivized participants, however, the non-incentivized participants generally reported higher self-efficacy post-intervention. This could mean that incentives were hampering to participants' self-efficacy. Self-efficacy and goal-setting can be self-debilitating, because when individuals fail to fulfill their goals, they react self-critically.⁸⁴ In turn, self-satisfaction and self-efficacy plummet, which affects future performance and efficacy beliefs. In other words, the feedback provided by the incentive was perhaps self-debilitating to those who did not reach their goals. It appears that financial incentives may act as an external catalyst to initiate behavior change,⁶⁹ but may not lead to sustained health improvements,⁷³ and that self-efficacy may be a stronger factor leading to improved behavior changes and weight outcomes than financial incentives.⁸³

In summary, this study further adds to the growing body of evidence that self-efficacy is a major factor impacting health behaviors (diet and exercise) and bodyweight. Higher perceived self-efficacy is associated with better adoption of behavior change, improved dietary intake and physical activity habits, as well as improved weight and health outcomes. Lower self-efficacy is associated with higher perceived barriers to healthful practices. It appears self-efficacy is a clear mediator between health behavior and weight status, whereas the sustainable effectiveness of incentives remains questionable.

Implications

Our findings indicate that weight intervention efforts should focus on improving internal motivation and self-efficacy rather than relying solely on financial incentive to induce behavior change. Techniques such as motivational interviewing may better help overweight individuals improve their confidence and ability to improve health behaviors and weight status.

Generalized measures of efficacy may be more predictive of health outcomes than self-efficacy for specific behaviors.³¹ Therefore, it may also be helpful to improve overall psychological well-being and self-efficacy, rather than solely focusing on specific behaviors. Gender-associated roles may also contribute to lower prevalence of physical activity among women.⁵⁸ Regular physical activity however, is associated with decreased stress and anxiety as well as improved mood and self-image. These factors could improve quality of life, lessen perceived barriers to change, and may improve self-efficacy and facilitate making healthier lifestyle choices. These factors should also be taken into consideration in planning future weight loss interventions. Future interventions can also improve outcomes by first identifying other factors contributing to weight change, by examining alternative methods such as causal mediators of health behaviors affecting body weight for individuals who have lower self-efficacy and are less

likely to succeed, and by better matching individuals to treatments in which they will most likely thrive.

There is a need for interventions to incorporate professional and familial support (commitment on behalf of both client and health professional to increase retention), address barriers, environmental factors such as access to healthy foods and safe areas for exercise, food price, gender roles, improving self-efficacy (prior to/during intervention), and to test self-efficacy improvement strategies and long term SE/FI approaches for sustained weight control. Additionally, trials with a longer duration and larger sample sizes are needed to examine sustainability, as well as within populations that are at high-risk of developing diet-related diseases.⁷⁹

Additionally, a “one size fits all” approach is ineffective in weight loss intervention efforts. Due to the large heterogeneity in environmental circumstances, the physiological and psychological responses involved in behavior change, as well as the difficulty in sustaining behavior change, individualized approaches are likely more effective in leading to successful intervention outcomes.

Further investigation is needed to develop and examine methods to improve individuals’ belief in their ability to lose and maintain weight loss, especially for those who are already overweight, as obese individuals have been shown to perceive less self-efficacy than non-obese individuals. This could facilitate the weight loss process and increase likelihood of achieving and maintaining weight loss goals and health outcomes. Laying a foundation of improved self-efficacy relating to health behaviors may be a pre-requisite for weight loss management. It is important for potential weight loss candidates to recognize and learn how they can overcome barriers and promote their own mental capacities for success. It is critical to design evidence-based

interventions to facilitate lasting behavior changes and to find constructive strategies to promote resilient self-efficacy while also providing informative feedback that will not interfere with belief in one's capability to succeed. Evaluating effectiveness of strategies to improve self-efficacy and overcome barriers to behavior change should be a focus of future interventions.

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APPENDIX

Questions 53-77 are about your eating practices.					
How confident are you that you could really motivate yourself to do things like these consistently for at least six months. Use your best judgement to indicate where you are between "not confident" and "very confident".					
	Not Confident	Somewhat Confident	Moderately Confident	Very Confident	Does not apply
53. I can resist eating when I am anxious (nervous)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
54. I can control my eating on the weekends	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
55. I can resist eating even when I have to say "no" to others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
56. I can resist eating when I feel physically run down	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
57. I can resist eating when I am watching TV	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
58. I can resist eating when I am depressed (or down)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
59. I can resist eating when there are many different kinds of food	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
60. I can resist eating when I feel it's impolite to refuse a second helping	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
61. I can resist eating even when I have a headache	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
62. I can resist eating when I am reading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
63. I can resist eating when I am angry (or irritable)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
64. I can resist eating when I am at a party	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
65. I can resist eating when others are pressuring me to eat	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
66. I can resist eating when I am in pain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
67. I can resist eating just before going to bed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
68. I can resist eating when I have experienced failure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
69. I can resist eating even when high calorie foods are available	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
70. I can resist eating even when I think others will be upset if I don't	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
71. I can resist eating when I feel uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
72. I can resist eating when I am happy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 1. Questionnaire items associated with eating self-efficacy

Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least six months. Use your best judgement to indicate where you are between "not confident" and "very confident".

	Not Confident	Somewhat Confident	Moderately Confident	Very Confident	Does not apply
38. Get up early, even on weekends, to exercise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
39. Stick to your exercise program after a long, tiring day at work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
40. Exercise even though you are feeling depressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
41. Set aside time for physical activity program; that is, walking, jogging, swimming, biking, or other continuous activities for at least 30 minutes, three times per week	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
42. Continue to exercise with others even though they seem too fast or too slow for you	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
43. Stick to your exercise program when undergoing a stressful life change (e.g. divorce, death in the family, moving)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
44. Attend a party only after exercising	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
45. Stick to your exercise program when your family is demanding more time from you	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
46. Stick to your exercise program when you have household chores to do	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
47. Stick to your exercise program when you have excessive demands at work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
48. Stick to your exercise program when social obligations are very time consuming	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
49. Rate your current level of physical activity by selecting the response that most closely describes your current level.					
<input type="radio"/> Not Active <input type="radio"/> Moderately Active <input type="radio"/> Somewhat Active <input type="radio"/> Very Active					
50. In an average week (7 days), on how many days do you participate in <u>mild</u> physical activity (i.e. archery, fishing, bowling, horse shoes, golf with a cart, easy walking, gardening, or mild yoga) <u>for at least 30 minutes per day</u> ?					
<input type="radio"/> 0 days <input type="radio"/> 1 day- 2 days <input type="radio"/> 3 days- 4 days <input type="radio"/> 5 days or more					

Figure 2. Questionnaire items associated with exercise self-efficacy

77. How often do you eat or drink the following foods or beverages?

	Never or less than 1/week	1-4 times/ week	5-7 times/ week	2 times/ day	3+ times/ day
a) Fried Foods	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Red Meat (steak, hamburger, pork, lamb)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Processed Meat (hot dogs, bologna, salami, pepperoni, sausage or bacon)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Cream or oil-based dressing, cream sauces or mayonnaise (do not count low fat or no-fat varieties)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Whole milk dairy products such as whole milk, yogurt, cream, ice cream or butter (do not count low fat or non-fat varieties)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Cookies, pastries, cakes or chocolate candy (do not count low-fat or no-fat varieties)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Whole grain cereals, breads, rice, and pasta	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) A serving of fresh, frozen or canned fruits or fruit juices (1 medium sized, 1/2 c frozen/ canned)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) A serving of fresh, frozen or canned vegetables or vegetable juices (1c fresh, 1/2 c cooked, 1 medium size or 3/4 c juice)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 3. Questionnaire items associated with dietary consumption

49. Rate your current level of physical activity by selecting the response that most closely describes your current level.

☐ Not Active ☐ Moderately Active ☐ Somewhat Active ☐ Very Active

50. In an average week (7 days), on how many days do you participate in mild physical activity (i.e. archery, fishing, bowling, horse shoes, golf with a cart, easy walking, gardening, or mild yoga) for at least 30 minutes per day?

☐ 0 days ☐ 1 day- 2 days ☐ 3 days- 4 days ☐ 5 days or more

51. In an average week (7 days), on how many days do you participate in moderate physical activity (i.e. brisk walking, slow bicycling, easy swimming, dancing, or anything else that causes small increases in breathing or heart rate) for at least 30 minutes per day?

☐ 0 days ☐ 1 day- 2 days ☐ 3 days- 4 days ☐ 5 days or more

52. In an average week (7 days), on how many days do you participate in vigorous physical activity (i.e. running, aerobics, heavy yard work, fast bicycling, fast swimming, or anything else that causes large increases in breathing or heart rate) for at least 30 minutes per day?

☐ 0 days ☐ 1 day- 2 days ☐ 3 days- 4 days ☐ 5 days or more

Figure 4. Questionnaire items associated with frequency and intensity of PA

Glossary: Terms and Abbreviations

Anthropometric

Anthropometric: The study of human body measurements especially on a comparative basis. Anthropometric Measurements: Height (feet, inches); weight, measured in pounds; body mass index (BMI).

BMI: Body Mass Index

A measurement that shows the amount of fat in your body and that is based on your weight and height (the ratio of weight of the body in kilograms compared to the square of its height in meters). BMI Classes: 18.5-24.9 (Normal weight); 25.0-29.9 (Overweight); 30.0-34.9 (Class I Obesity); 35.0-39.9 (Class II Obesity); 40.0 (Extreme Obesity).

CVD: Cardiovascular Disease

Cardiovascular: of or relating to the heart and blood vessels

Cardiovascular Disease: Conditions that involve narrowed or blocked blood vessels that can lead to a heart attack, chest pain (angina) or stroke. Other heart conditions, such as those that affect your heart's muscle, valves or rhythm, also are considered forms of heart disease.

Eat-SE: Eating Self-Efficacy

Confidence-based measure consisting of 20 items in one global score (highest possible score of 80). Items asked participants to rate their confidence that they could motivate themselves to resist eating in certain situations, consistently, for at least six months. Rating

was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2), “moderately confident” (3), and “very confident” (4). The situational factors consisted of: Negative Emotions (ex: eating when anxious/sad), Availability (ex: eating when food is readily available, such as at a party), Social Pressure (ex: eating food when others encourage eating), Physical Discomfort (eating when in pain or fatigued), and Positive Activities (ex: eating while watching television). This originally came from the Weight-loss Self-Efficacy Score (WLSE), developed by Clark et al (1991).

Ex-SE: Exercise Self-Efficacy

Confidence-based measure consisting of 11 items in one global score (highest possible score of 44). Items asked participants to rate their confidence that they could motivate themselves to keep up with certain exercise behaviors and activities consistently for at least six months. Rating was performed using a 4 point Likert-type scale, “not confident” (1), “somewhat confident” (2), “moderately confident” (3), and “very confident” (4).

HES: Healthy Eating Score

Frequency-based measure consisting of nine items, asking respondents how often they consumer particular foods and/or beverages using a 4-point Likert scale, which ranged from “never to 1 time/week and 1-4 times/week” (1), “5-7 times/week” (2), “2 times/day” (3) and “3+ times a day” (4). The scale provides one global scale with the highest possible score of 36 (9x4).

Meta-analysis

A quantitative statistical analysis of several separate but similar experiments or

studies in order to test the pooled data for statistical significance.

MICE: Multivariate Imputation by Chained Equations

Multiple imputation using Fully Conditional Specification (FCS) implemented by the MICE algorithm. Each variable has its own imputation model. Built-in imputation models are provided for continuous data (predictive mean matching, normal), binary data (logistic regression), unordered categorical data (logistic regression) and ordered categorical data (proportional odds). MICE can also impute continuous two-level data (normal model, panel, second-level variables).

Multivariate

Having or involving a number of independent mathematical or statistical variables.

Psychosocial

Involving both psychological and social aspects; Relating social conditions to mental health.

Sedentary

Doing or involving a lot of sitting; not doing or involving much physical activity.

Univariate

Characterized by or depending on only one random variable.