Baseline Predictors of Early Weight Loss During a Standard Behavioral Weight Loss Intervention

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Lifestyle interventions that target behavior change for weight loss are effective treatments for overweight and obesity. Despite the effectiveness of these interventions, there is variability in weight loss among individuals, with some individuals being more successful with weight loss resulting from these behavioral interventions. There is a lack of consistent baseline factors to assist in identifying for whom these behavioral interventions may be most effective as a treatment for overweight and obesity. Recently, early weight loss in response to these behavioral interventions has been associated with long-term weight loss success. However, studies have not examined whether baseline factors may be predictive of early weight loss success in response to a behavioral intervention. PURPOSE: This study examined the following aims: 1) the association between early weight loss in a behavioral intervention and weight loss at 6 and 12 months; 2) the association between baseline factors (current behaviors, weight history, psychosocial factors) and early weight loss at 4, 8, and 12 weeks of an intervention. METHODS: Participants (N=383) who participated in a behavioral weight loss intervention (age 45.0±7.9 years, BMI 32.4±3.8 kg/m^2) self-reported baseline behaviors, weight history, and psychosocial factors. Weight was measured at baseline, 4 weeks, 8 weeks, 12 weeks, 6 months, and 12 months of the intervention. Multi-level regression was applied to examine the association between baseline factors and weight loss trajectory from 0-4, 0-8, and 0-12 weeks. RESULTS: Early weight loss at 4, 8, and 12 weeks was associated with weight loss at 6 and 12 months. Several baseline behaviors, weight history, and psychosocial factors were associated with early weight loss trajectory; however, the effect that each individual variable might have on weight loss trajectory was modest. CONCLUSIONS: These findings demonstrate there are baselines factors reflective of current behaviors, weight history, and psychosocial domains associated with early weight loss. These findings may suggest that there are baseline factors that could potentially be intervention targets to enhance early weight loss, which may then contribute to long-term weight loss. However, further examination of these factors should be the focus of future research.

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Preface

This is dedicated to my family, friends, teachers, and mentors. I appreciate all of the love and help you have provided me. For sticking with me when things were bad and I was vulnerable. As far as teachers and mentors, I would not have this opportunity without their support. Thank you Dr. Davis, Dr. Rogers, Dr. Page, Dr. Venditti. Nalingna, thank you for helping. Dr. J, I trusted you would be there when the time came to help me through it all and I appreciate all that you do. Dr. Gallagher, Kevin, and Dr. Nagle: I do not finish school without you. Mom, Dad, Becca, and Jeff: thank you for everything. And to my wife, I'm thinking of you as I write this right now, you are away from me now because you follow through on your commitment, because you're willing to give everything to help others, you are what this is all about. Come home safe Jamie.

1.0 Introduction and Scientific Premise

1.1 Background

Excess body weight, which is clinically defined as overweight (body mass index [BMI] ≥25.0 kg/$m^2$2 and obesity (BMI ≥30.0 kg/m^2) are associated with poorer health factors [1, 2] . The health factors include coronary heart disease, hypertension, dyslipidemia, type 2 diabetes, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems, and some cancers [3-5]. Of great public health concern is the increase in the prevalence of obesity over the past 3 to 4 decades. For example, national survey data from the United States demonstrate that there was a sharp increase in the prevalence of obesity from 12.8% in 1980 to 22.5% in 1994, with a further increase to 27% by 1999 [6, 7]. Since 1999 there has been a further increase in the prevalence of obesity to a level of 39.8% by 2015-16 [8].

Given the high prevalence rates of obesity, there is a need for effective treatment options for patients. At the foundation of most treatment options has been lifestyle factors, with a primary emphasis on dietary modification and increased physical activity. Typically, these lifestyle factors have been the target of behavioral weight loss intervention for obesity treatment. Interventions that have focused on these lifestyle factors produce an average weight loss of approximately 10 percent of initial body weight within 6 months of initiating treatment, which is important given that weight loss of 5-10% of initial weight can reduce blood pressure, blood lipids, and blood glucose [3, 9-17]. Moreover, the Diabetes Prevention Program has demonstrated that weight loss of approximately 7% of initial weight can significantly reduce the development of type 2 diabetes mellitus [18], and a recent secondary analysis of the Look AHEAD Study data indicates that 10% weight loss is associated with a decrease in cardiovascular disease [19].

Despite the overall health impact of weight loss achieved through a behavioral intervention, not all individuals respond favorably to this treatment option. For example, it has been estimated that 20-30% of adults enrolling in a behavioral weight loss intervention fail to achieve a weight loss of at least 5% of initial body weight [20-23]. This likely reduces the health benefits that are realized in these individuals. Moreover, maintenance of weight loss has also been shown to be difficult. For instance, on average individuals regain 25 -50% of their initial weight loss within the first year with slower regain in following years [10, 13, 24-26]. Weight regain is variable between studies, but also between individuals with some individuals never losing weight, some individuals losing weight late, some individuals regaining weight, and some individuals maintaining weight loss [27]. Because of this, there is a need to better understand factors that contribute to both short-term and long-term weight loss success to enhance the effectiveness of behavioral weight loss interventions.

An observation is that there is high variability in response to intervention and the regain of weight long-term. In a review of long-term outcomes of behavioral weight loss interventions with a calorie restriction component, Mann et al. concluded that most individuals are not successful maintaining their weight loss long-term [28]. As a result of this, others have suggested that alternative interventions that go beyond the current focus of behavioral weight loss interventions are needed [29]. In contrast to this perspective, others have reported long-term weight loss success in response to a behavioral weight loss intervention [30, 31]. Moreover, there is evidence of long-term success as demonstrated by the National Weight Control Registry, which is a cohort of adults who report an average loss of approximately 33 kg over more than 5 years [31].

In addition to variability in weight loss across studies in response to a behavioral intervention, there is also wide intra-individual variability within a common behavioral weight loss intervention. For example, data from studies conducted by Jakicic et al. demonstrate both the pattern in weight loss response and the individual variability in this response [32]. Within clinical trials conducted by Dr. Jakicic and his colleagues at the University of Pittsburgh, approximately 40%-50% of randomized participants achieve a weight loss of ≥10% of initial body weight after 6 months of a behavioral intervention. It has also been observed that ~25%-33% of individuals who achieve a weight loss of ≥10% at 6 months are able to maintain ≥10% weight loss at 12 to 24 months. Moreover, there is wide intra-individual variability in weight loss across the intervention period, which is illustrated in **Figures 1-5** [32, 33]. Thus, there is a need to understand the variability in response to a behavioral weight loss intervention to better tailor obesity treatment and potentially enhance success.

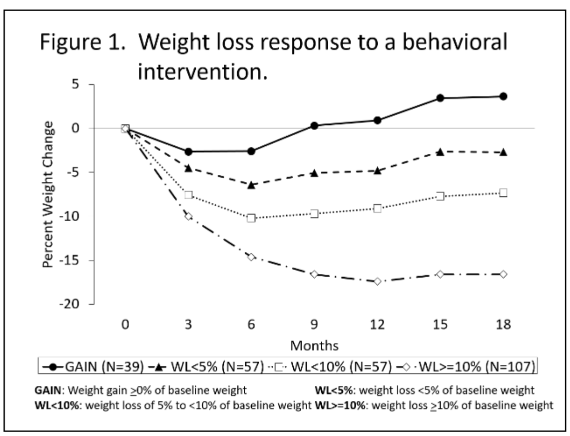


Figure 1 Weight loss response to a behavioral intervention.

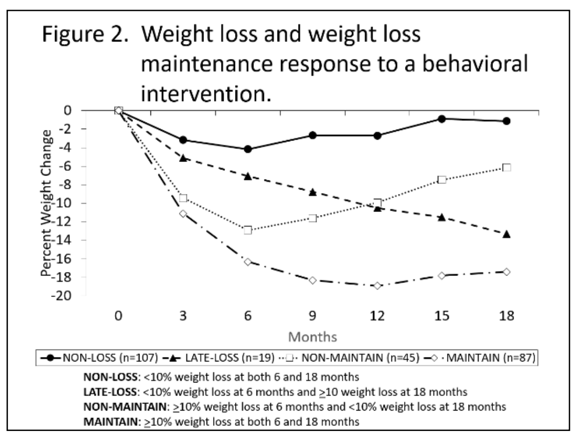
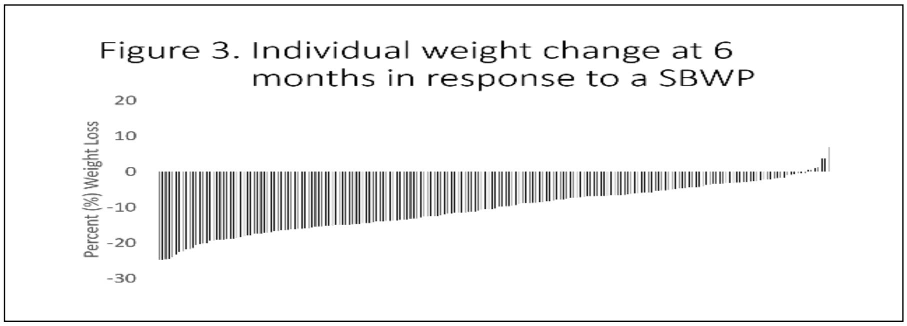


Figure 2 Weight loss and weight loss maintenance response to a behavioral intervention.



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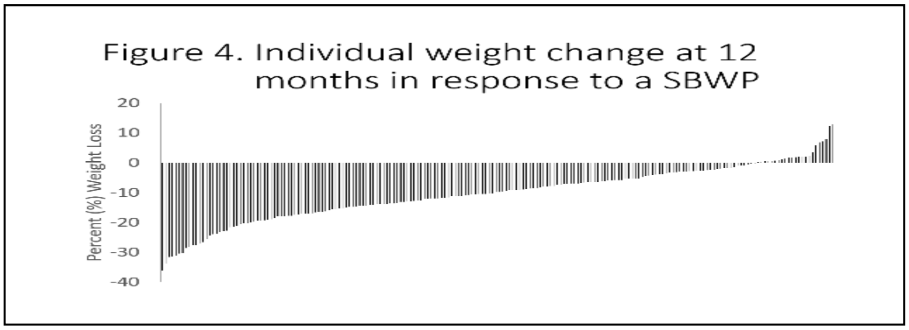

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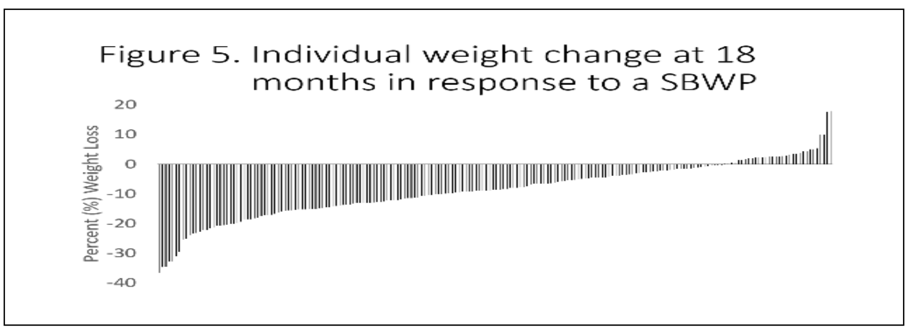

Figure 5 Individual weight change at 12 months in response to a SBWP.

A potential approach to improve the effectiveness of behavioral weight loss interventions is to identify factors predictive of treatment success, and then to tailor/individualize treatment based on these factors [34, 35]. Thus, research has been conducted to identify pre-treatment factors that may be predictors of whom would be a responder (successful) or non-responder (attrition/dropout/non-adherence) to behavioral intervention approaches for weight loss [13, 36, 37]. Some of these studies identify fewer weight loss attempts, self-motivation, general efficacy, and autonomy [36] as pre-treatment factors that predict weight loss success. However, more recently a review has concluded that the only consistent psychosocial predictor of weight loss success is fewer previous weight loss attempts [38].

While there are few if any consistent predictors of who will and will not respond to behavioral weight loss intervention, it is possible that the data exists, but the methods to analyze the data have not yet been applied. For example, on a single study level there are significant predictors of weight loss responses at baseline. Teixeira et al. in a study of middle-aged women enrolled in a 4-month behavioral weight loss program found more stringent weight outcome evaluations, higher perceived negative impact of weight on quality of life, lower self-motivation, higher body size dissatisfaction, and lower self-esteem were associated with less weight loss and significantly distinguished non-responders from responders [39]. In another study comparing baseline predictors to short-term weight loss patterns the non-responding group had significantly higher friend encouragement for dietary change, higher obesity-related problems, and low physical well-being [40]. Across these two studies, obesity related problems/quality of life was the only common factor that was predictive of weight loss success. In contrast to baseline predictors in single studies, meta-analysis/reviews of baseline psychosocial factors demonstrate little consistency in predicting weight loss success [38]. The evidence from meta-analysis and reviews is mixed and may reflect the challenge of combining data across numerous studies of behavioral weight loss interventions [13, 35, 37, 38].

It has been suggested that the inability of meta-analysis and reviews to identify consistent baseline predictors of weight loss success may be a factor of the overall heterogeneity of the interventions and measures used across studies [35]. For example, behavioral weight loss interventions consist of multiple behavior change strategies to induce a negative energy balance, which can include diets to reduce energy intake and physical activity to increase energy expenditure. However, there is typically variability in the dietary approach and variability in the prescribed mode, duration, and intensity of physical activity across studies. In addition, interventions include different types of contact (e.g., group-based in-person, individual in-person, telephone-based, technology-based, etc.) and varying amounts of scheduled contact frequency. Further, components of study heterogeneity include study samples with varying age, ethnicity, and other characteristics. There is also wide variation of measures/constructs examined.

Studies examining predictors of weight loss success also vary in their definition of success/response to an intervention (e.g., success defined as either 5%, 7%, or 10% weight loss). Moreover, the time at which a defined weight loss is achieved can also vary across studies of predictors of weight loss success. For example, there is wide variability when examining short-term, which can be examined between 1 week to 6 months of initiating treatment, and long-term success has been examined within the range of 1 year to 5 years of treatment. Thus, the inconsistency across studies of predictors of weight loss success may be partially explained by the magnitude of weight loss necessary to define success and the time within the intervention at which this magnitude of weight loss needs to be achieved.

The timing of when weight loss is achieved may be of importance. For instance, there is emerging evidence on the importance of early success within a behavioral weight loss intervention and its relation to longer-term weight loss success. That is, those individuals who lose weight early in an intervention are much more likely to have long-term success in response to this intervention. For example, in the Look AHEAD Trial, participants who lost at least 2% of their baseline weight within the first month of an intervention, or who lost at least 3% of their baseline weight by the end of the second month of intervention, were 5.6 times and 11.6 times more likely to achieve 10% weight loss at one year [41]. Another study found that at least 2% weight loss achieved at 1 month was associated with longer-term weight loss success and conversely those who did not achieve the 2% threshold were 5 times more likely to drop out of the intervention [42]. These findings are consistent with others studies that have reported that weight loss as early as week 1 or week 2 is associated with the magnitude of weight loss response, while lack of early weight loss is associated with attrition and dropout [43-45]. Studies have demonstrated that weight loss within the early phases of intervention can be predictive of long-term weight loss for periods ranging from 1 to 8 years [46, 47], and the evidence appears to be consistent that early weight loss success is predictive of future weight loss and less attrition/dropout [48-52].

Despite the finding of early success in weight loss being predictive of future weight loss success in response to an intervention, it does not appear that studies have attempted to identify modifiable baseline psychosocial factors that may be predictive of this early weight loss success. This gap in the research is the focus of this investigation.

1.2 Clinical Significance and Implications

Based on the evidence presented above, the period early in behavioral weight loss interventions is a critical period that can influence long-term success response. This has led some investigators to target interventions to periods early in interventions in an attempt to enhance response that may result in improved longer-term weight loss success. For example, Jakicic et al. implemented a stepped-care intervention approach that focused on intensifying the intervention when individual weight loss was not achieved [33]. Jakicic et al. also implemented a time-based approach to modify intervention components at predetermined times throughout the intervention period, and this was shown to improve weight loss compared to an intervention that did not include these strategies. Unick et al. added extra support within the context of a behavioral intervention to individuals who lost less than 2.3% of baseline weight at week 4 (early non-responders), and this enhanced weight loss compared to those early non-responders who did not receive this additional support [53]. However, in this study, even with this additional support, overall weight loss across the entire intervention period was less in early non-responders compared to early responders (those who lost >2.3% of initial weight). Thus, there is a need to further identify factors that may be predictive of very early weight loss success in response to a behavioral intervention, which has not been examined, which may allow interventions to be matched to those individuals who may be most likely to respond or to target the intervention to modifiable baseline factors that may be predictive of weight loss success. This approach is consistent with efforts related to precision and personalized medicine, which attempts to match interventions to individual-level factors to enhance response to treatment and improve clinical outcomes [34].

1.3 Study Aims

This study will conduct secondary and exploratory analyses of data from a completed clinical weight loss study to examine the following aims.

1. To examine if early weight loss achieved at 4, 8, or 12 weeks is associated with weight loss at 6 or 12 months.

2. To examine if baseline eating behaviors, physical activity, sedentary behaviors, or sleep are associated with the weight loss trajectory from 0-4 weeks, 0-8 weeks, or 0-12 weeks of a behavioral weight loss intervention.
3. To examine if variables representing pre-intervention weight history are associated with weight loss trajectory from 0-4 weeks, 0-8 weeks, or 0-12 weeks of a behavioral weight loss intervention. These variables include:
    a. Parental Weight Status
    b. Participant's Child/Adolescent Weight Status
    c. Highest and Lowest Adult Lifetime Weight
    d. Magnitude and Number of Episodes of Intentional and Unintentional Weight Loss
    e. Weight Goal and Weight Loss Goal
    f. Baseline BMI
4. To examine if baseline psychosocial factors are associated with weight loss trajectory from 0-4 weeks, 0-8 weeks, or 0-12 weeks of a behavioral weight loss intervention. These variables include:
    a. Depressive symptoms
    b. Health-Related Quality of Life
    c. Weight Loss Self-Efficacy
    d. Physical Activity Self-Efficacy
    e. Expected Weight Loss Benefits
    f. Expected Physical Activity Benefits
    g. Weight Loss Barriers

h. Physical Activity Barriers

2.0 Review of the Literature

2.1 Prevelence of Obesity

The prevalence of obesity determined from national survey data in the United States has increased from 12.8% in 1980 to 39.8% in 2015-16 [6, 8]. The survey from 2017-18 found obesity prevalence in the United States further increased to 42.4% and there was no significant differences in obesity prevalence by age or gender [54]. Additionally, it is concerning that between 2013-14 and 2017-18 the prevalence of severe obesity (BMI≥40) increased from 7.7% [55] to 9.2% [54] of the United States population. Among individuals with severe obesity, there are gender differences with the prevalence at 11.5% and 6.9% in females and males, respectively. While the incidence of obesity has slowed over the years, the overall prevalence of obesity and severe obesity continues to rise [54].

2.2 Consequences of Obesity

The high prevalence of obesity is concerning because obesity is associated with poorer health factors including coronary heart disease, hypertension, dyslipidemia, type 2 diabetes, stroke, gallbladder disease, osteoarthritis, sleep apnea, respiratory problems, and some cancers [2-5, 56]. For example, when comparing individuals of normal weight to individuals with Class III obesity the odds ratio of developing hypertension were 4.8 (95% CI: 3.8 to 5.9), 5.1 (95% CI: 3.7 to 7.0) for diabetes, and 2.2 (95% CI: 1.7 to 2.4) for dyslipidemia[57]. Also, in a pooled analysis of prospective cohort studies the odds ratio for developing two of three cardiometabolic morbidities (coronary heart disease, type 2 diabetes, or stroke) was 2.0 (95% CI: 1.7 to 2.4) in individuals classified with overweight and more than 4 times higher for individuals with class I obesity (95% CI 3.5 to 5.8) when compared to normal weight individuals[58]. Thus, the preponderance of the evidence supports that overweight and obesity are associated with negative health factors.

2.3 Benefits of Weight Loss

Weight loss through behavioral weight loss interventions that incorporate behavioral modification to reduce dietary intake and increase physical activity have demonstrated modest weight loss is associated with a reduction in negative health factors. A weight loss of 2-5% body weight at one year is related to a 0.2-0.3% reduction in HbA1C, which is reflective of improved blood glucose control [59-61]. In addition, weight loss of 3 kg is associated with an average reduction in triglycerides of at least 15 mg/dL [12, 59, 60, 62, 63], and weight loss of less than 5% body weight is associated with a small reduction in systolic and diastolic blood pressure, and improvement in blood lipid markers for some individuals.

Greater magnitudes of weight loss in behavioral weight loss interventions are associated with a significant decrease in negative health factors. Weight loss of 7% and 10% body weight are related to reduced development of type 2 diabetes and decreased development of cardiovascular disease, respectively [18, 19]. Additionally, there is a dose response relationship with weight loss and the lowering of blood lipids, blood glucose, and blood pressure. For example, weight losses of 5 to 10% body weight at one year is related to a 0.6-1.0% reduction in HbA1C [11, 63]. Also a weight loss of 5 to 8 kg is associated with reductions in LDL-C of about 5 mg/dL and increases in HDL-C of 2 to 3 mg/dL [12, 59, 62-64]. Additionally, a linear relationship between more weight loss and lowering systolic and diastolic blood pressure has been observed across studies [17, 59, 64], with a 5% weight loss associated with an average reduction of 3 mmHg of systolic blood pressure and an average reduction of 2mmHg of diastolic blood pressure [56].

2.4 Behavioral Treatment of Obesity

Behavioral weight loss interventions typically report average weight losses of 8% to 10% of initial body weight [9-14]. This amount of weight loss is important for improving health factors; however, there is variability in weight loss among individuals in weight loss interventions. It is important to consider within weight loss interventions that while a majority of individuals lose weight, there are also many individuals that do not lose weight or even gain weight overall and this is considered when reporting average weight loss within an intervention [65]. For example, within a behavioral weight loss intervention where the median weight loss was 8.8% at 6 months, 25 percent of individuals lost 13.4% or more of their initial weight while 25 percent of individuals lost less than 3.8% of their initial body weight [66]. It is interesting that 25% of individuals lost greater than 13.4% of their initial weight, this suggests that many individuals who enter behavioral weight loss interventions lose large magnitudes of weight that is not captured when considering mean or median weight loss. In another behavioral weight loss intervention 51% of individuals achieved a weight loss of greater than 10% at 6 months and 41% achieved a weight loss of greater than 10% at 18 months [32, 33]. The individuals who achieved greater than 10% weight loss at 18 months averaged a weight loss of 16.6% ±0.5% as a group [32, 33]. While the average group weight loss within behavioral weight loss interventions is most commonly reported, this ignores the significant variability in the amount of weight loss that many individuals achieve.

Because there is significant variability in weight loss among individuals, many studies have attempted to identify pretreatment predictors of weight loss to better understand who will lose weight in behavioral weight loss interventions. In reviews of pretreatment factors predictive of weight loss, there are few consistent pretreatment predictive factors across studies [35-38]. And even when studies find pretreatment predictive factors of weight loss, predictive factors as a group only account for about 20-30% of the variance in weight loss, with individual factors only accounting for a small proportion of the total variance [35]. Consistent pretreatment factors that explain variation in the response to behavioral weight loss interventions have not been identified, however more initial weight loss within behavioral interventions has been found to predict long-term weight loss.

Early weight loss, defined as weight loss of 0.5-3.0% of initial weight in the first 1 to 2 months of behavioral weight loss interventions, consistently predicts long-term weight loss [41, 47, 50-52, 67-71]. In addition approximately one-quarter to one-third of individuals do not lose weight early and they are 3 to 11 times less likely to achieve clinically significant weight loss (weight loss ≤5%) long-term [72]. Initial weight loss predicts long-term weight loss, so maybe we need to understand who is most successful at initial weight loss. It is possible that baseline factors may explain who will be successful within a behavioral weight loss intervention and elucidating these factors will help to better tailor future weight loss treatment. Thus, the literature described herein is focused on potential baseline factors to consider that may be predictive of initial weight loss in response to a behavioral intervention.

2.5 Current Behaviors

2.5.1 Eating Behaviors

The eating behavior inventory (EBI) is a self-report instrument that was developed to measure eating and weight control behaviors commonly targeted within behavioral weight loss interventions. Further, the EBI is a valid measure of eating and weight control behaviors that is sensitive to differences in individuals with and without previous weight loss treatment, demonstrates agreement with other reports of eating behaviors, and is sensitive to weight loss changes in those completing weight loss treatment [73]. Additionally, the EBI has demonstrated validity when examining individual measures as well as total score for the measure [73]. More evidence of the EBI as a robust measure of eating and weight loss behaviors comes from the systematic review of the EBI in clinical obesity research over 25 years that included 23 studies and 1325 subjects [74]. For example, positive changes in the EBI consistently predict more weight loss within behavioral weight loss interventions [74]. Additionally, the total EBI score is consistently correlated with weight loss, with correlations ranging from r=0.34 [75] to r=0.74 [76]. In addition, the magnitude of improvement in the EBI score within the context of a weight loss intervention is correlated with greater weight loss [74].

Although the relationship between EBI and behavior is less commonly reported, there is some evidence that higher EBI scores are related to eating and weight loss behaviors such as recording diet and physical activity, and daily self-weighing [73, 77]. For example, higher EBI scores have been found to be associated with daily self-weighing [77]. In a study that compared mobile applications for tracking diet and physical activity, individuals who used at least one mobile application had higher EBI scores than individuals who did not use any mobile applications [78].

Moreover, within this study, individuals that used 2 or more mobile applications reported more self-regulation behaviors such as recording diet and physical activity [78]. Despite many studies not exploring the relationship of EBI to actual participation in eating and weight loss behaviors, it is likely that higher EBI scores are associated with more frequent eating and weight loss behaviors such as dietary and physical activity self-monitoring.

The EBI is consistently responsive to weight loss intervention. That is, eating and weight loss behaviors within weight loss studies as measured by the EBI consistently increase on average across multiple time points as well as responding to different types of weight loss interventions. For example, EBI has been found to increase from baseline to 6 weeks [79], 12 weeks [79-82], 4 months [83, 84], and 6 months [80, 81, 85-89] within weight loss interventions. The short-term period from 6 weeks to 6 months is indicative of the more active phase of interventions and typically where individuals lose the most weight. Additionally, there is evidence of long-term EBI increases at 12 months [90, 91], at 18 months [66], and at 24 months [85, 92] suggesting that positive change in EBI is achievable for many individuals participating in weight loss studies in the long-term. Other studies have reported on average that EBI scores decrease in individuals long-term with concurrent weight regain and it is likely important to continue the eating and weight loss behaviors that help individuals lose weight as indicated by EBI long-term [74]. The EBI also demonstrates responsiveness to multiple weight loss intervention types. For example the EBI has demonstrated responsiveness to standard behavioral interventions [66, 81, 85, 87, 92], web-based interventions [90], standard behavioral interventions that included wearable technology [80, 86], text based interventions [84], commercial weight loss programs [82, 91], interventions that included meal replacements [83], mobile application assisted interventions [79, 88], and interventions that included a mindfulness component [89]. Overall, the responsiveness of the EBI to a variety of different weight loss interventions as well as across multiple timepoints is consistent and a promising indicator of the EBI's overall utility.

There is also evidence of a consistent inverse association of the EBI score to weight change in weight loss studies and across multiple time points, that is higher EBI is related to more weight loss[74]. For example, increases in EBI within weight loss interventions are associated with more weight loss and have been observed at 12 weeks [81, 82], at 4 months [83, 84], and at 6 months [81, 86, 88, 89]. This indicates that changing behaviors and engaging in key weight loss strategies as reflected in the EBI is important for short-term weight loss. Long-term weight loss has also been associated with increases in EBI compared to baseline at 12 months [90, 91], 18 months [66], and at 24 months [85, 92]. Additionally, modest correlations have been observed for increases in EBI and weight loss at 4 months (r=-30) [84] as well as at 24 months (r=-.38) [92]. The magnitude of change in EBI is also predictive of achieving a specific threshold of clinically meaningful weight loss, such that greater increases in EBI are associated with weight losses of 10% or more at 24 months [85, 92]. The inverse association of EBI to weight change is consistent across weight loss studies such that when weight loss occurs, positive changes in EBI is consistently associated with greater weight losses [66, 81-86, 88-92]. The relationship of change in EBI and weight loss is consistent across studies and it is possible that baseline EBI may be an important characteristic related to how individuals do within behavioral weight loss interventions.

Within randomized controlled studies comparing different weight loss interventions, change in EBI has been shown to mediate the relationship between intervention and weight loss outcomes. For example, a standard behavioral weight loss intervention resulted in significantly greater weight loss than a web-based intervention (8.3 ±7.9 kg vs. 4.1 ±6.2 kg p=0.004) at 12 months and change in the EBI score from baseline to 12 months explained the greater weight loss

[90]. In another study, a standard behavioral weight loss intervention with wearable technology resulted in greater weight loss at 6 months compared to a standard intervention without wearable technology, the greater change in EBI from 0 to 6 months partially explained the greater weight loss achieved in the wearable technology intervention [86]. In addition, a text-based intervention lost significantly more weight compared to a mail-based intervention at 4 months and greater change in EBI scores across the intervention mediated the relationship between intervention and weight loss [84]. Overall, in randomized controlled studies that find a difference in weight change between groups, change in EBI appears to be a consistent mediator of the relationship, that is interventions that increase eating and weight loss behaviors as reflected in the EBI result in greater weight loss.

There are relatively few studies that report whether baseline EBI is predictive of weight loss outcomes and based on the available evidence the results are mixed. Two studies have found evidence that baseline EBI is predictive of weight loss [83, 93]. For example, women with higher baseline EBI scores were more likely to complete a 9 month behavioral weight loss intervention, indicating higher baseline scores may be protective against dropout [93]. However, Theim et al. found lower baseline EBI scores to be predictive of greater weight loss at 4 months [83]. These two studies suggest there could be advantages to higher and lower baseline EBI when initiating a behavioral weight loss intervention, but for whom this benefit would apply is less clear. Two other studies did not find baseline EBI to be predictive of weight loss outcomes [94, 95]. Self-reported eating and weight loss behaviors at baseline by EBI do not appear to be predictive of weight loss outcomes, although baseline EBI has infrequently been explored or reported in the weight loss literature and due to the consistent relationship between EBI change and weight loss outcomes further exploration of baseline EBI as a predictor is warranted.

2.5.2 Physical Activity and Sedentary Behavior

Physical Activity and Weight Status

There is cross-sectional evidence to support that physical activity is inversely related to BMI, with higher levels of moderate-to-vigorous physical activity consistently inversely associated with BMI [96-98] and this association is independent of sedentary behavior [97]. Additionally, even a small difference between individuals for moderate-to-vigorous physical activity is associated with reduced risk for having obesity [97]. Examination of physical activity showed that the two tertiles representing the highest levels of physical activity had an odds ratio of 0.56 (95% CI: 0.41-0.77) and 0.30 (95% CI: 0.22-0.40) lower risk, respectively, of having higher body fat compared to individuals that reported the lowest tertile of moderate-to-vigorous physical activity[98]. Overall evidence suggests that weight status is consistently related to moderate to vigorous physical activity levels and even small amounts of physical activity explain differences in weight status [98].

Physical Activity Interventions and Weight Loss

There is evidence that physical activity interventions without dietary modification results in modest weight loss, with this average ranging from 0.5 to 3.0 kg [99]. Despite this modest weight loss, there is variability in the magnitude of weight loss in response to a change in physical activity [13, 100-102]; however, the factors that contribute to this variability in weight loss are not well understood and could result from both biological and behavioral responses. Moreover, the magnitude of weight loss appears to increase with an increased dose of physical activity [99], possibly suggesting that relatively high levels of physical activity are needed to result in higher amounts of weight loss.

Physical Activity Combined with a Dietary Intervention for Weight Loss

Clinical recommendations typically include combining both dietary modification with increased physical activity to enhance weight loss. The combination of diet plus physical activity results in approximately 2.5 kg more weight loss than what is observed with dietary modification alone, which equates to approximately 20% more weight loss [99, 103]. Among literature reviews comparing diet plus physical activity interventions to diet only interventions, short-term weight loss achieved between 15 weeks to 6 months appears to be similar between these interventions [13, 26, 104]. However, in interventions of one year or more, diet plus physical activity interventions appear to produce significantly greater weight loss than diet interventions alone [104]. One review reported weight loss at one year of 6.7 kg vs. 4.5 kg and another review reported 8.6 kg vs. 6.6 kg at one year among diet plus physical activity versus diet only interventions, respectively [13, 26].

Physical Activity and Weight Loss Maintenance

While physical activity may enhance weight loss when added to a dietary intervention, the most important benefit of physical activity may be its contribution to enhancing long-term weight loss and maintenance. Data from the National Weight Control Registry of adults who reported an average weight loss of 33 kg that was maintained for 5 years or more also reported that these individuals were engaged in high levels of physical activity levels [101, 105]. There is also a growing body of evidence from prospective and intervention studies to support that approximately 250 minutes per week of moderate-to-vigorous intensity physical activity is associated with enhanced weight loss maintenance [32, 85, 99, 106, 107]. Moreover, 60-90 minutes per day of physical activity is associated with long-term weight loss maintenance [101]. Thus, overall, physical activity is an important component behavior that contributes to long-term weight loss and maintenance.

Physical Activity and Health Outcomes

In addition to its contribution to weight loss and weight loss maintenance, physical activity is an important health behavior and is related to better overall health outcomes. For example, among cross-sectional studies higher levels of physical activity decrease the risk of obesity, coronary heart disease, type II diabetes mellitus, stroke, some cancers, mental health issues, mortality, and other diseases independent of weight status [108-115]. Moreover, there is a dose-response relationship with higher levels of physical activity associated with greater health benefits such as decreasing blood lipid levels, better blood glucose metabolism, and improvement in coronary heart disease markers [110, 112]. Additional research suggests that the relationship between physical activity and health is curvilinear with even small amounts of physical activity increases being beneficial in reducing chronic conditions as well as mortality [109, 110]. Data also support that the health benefits of physical activity are present independent of weight status [116-120].

Sedentary Behavior

Sedentary behavior, which is distinct from physical activity [121], is typically defined as any waking activity ≤ 1.5 metabolic equivalents (METS) [122] or any waking activity in a seated or reclining posture ≤ 1.5 METS [123, 124]. Higher levels of sedentary behavior are associated with negative health outcomes including all cause mortality, cardiovascular disease mortality, cardiovascular disease incidence, and type 2 diabetes [125-127]; and higher levels of sedentary behavior have been found to be independently associated with worse cardiometabolic health [128] and obesity [129]. Additionally, there is a dose response relationship between sedentary behavior and all-cause mortality, cardiovascular disease mortality, and cardiovascular disease incidence [127], while higher levels of moderate to vigorous physical activity (MVPA) appear to attenuate the relationship between sedentary behavior and negative health outcomes [127].

Studies have also been conducted to better understand the relationship between sedentary behavior and weight status. For example, both weight loss interventions and interventions targeting changes in sedentary behavior have been successful in decreasing sedentary behavior [66, 130-134]. And some studies observe when sedentary behavior is reduced, it is associated with an increase in MVPA [134, 135]. It is possible that the activities that replace sedentary behavior may be important to understand how sedentary behavior is related to health. In weight loss interventions, increases in MVPA [134] and episodes of MVPA ≥10 min minutes [66] are associated with greater weight loss, however decreases in sedentary behavior have not been found to be associated with weight change [66, 134]. Sedentary behavior is an important factor to consider in relation to overall health, however the relationship between weight loss and sedentary behavior warrants further exploration.

2.5.3 Sleep Behavior

There is cross-sectional evidence that short sleep duration (typically defined as less than 7 hours), poor sleep quality, or obstructive sleep apnea diagnosis is related to being overweight or obese, and that overweight or obesity status is related to poor sleep [136, 137]. Short sleep duration is consistently associated with increased BMI and increased amount of body fat [137-140]. In addition, a meta-analysis found individuals who reported shorter sleep duration had a pooled odds ratio of 1.55 (95% CI: 1.43-1.68) of having obesity [139].

While a few studies report no association of sleep duration with obesity [141], the evidence shows that studies support the association of shorter sleep duration and increased weight [138]. For example, in a review by Patel et al., short sleep duration was independently related to increased weight in 17 of 23 studies [138]. There is also evidence that poor sleep quality may be associated with increased BMI and fat mass [142].

There is support for an association of shorter sleep duration predicting future weight gain in longitudinal studies. A recent review found shorter sleep duration was independently associated with weight gain and obesity, and it is possible longer sleep duration may also be related to weight change [143]. This is in contrast to a past review that revealed mixed evidence when examining sleep duration and weight change among longitudinal studies [141]. However, Patel et al. found the three longitudinal studies included in their review demonstrated consistent evidence that shorter sleep duration was independently associated with future weight gain [138]. In another large longitudinal study in individuals who were 50 years of age or older, shorter sleep duration was predictive of increasing BMI; however, sleep quality was not predictive of change in BMI [144]. It is possible that individual factors such as age may relate to how sleep and weight are related among different individuals and a better understanding of these factors is warranted [137]. Because there is evidence that differences in sleep may be predictive of weight change, it is important to consider whether baseline differences in sleep are predictive of weight loss in behavioral weight loss interventions.

Shorter sleep duration has been shown to attenuate weight loss in response to interventions [145, 146]. Additionally, individuals with similar BMI who are diagnosed with obstructive sleep apnea lose significantly less weight than individuals who are not diagnosed with obstructive sleep apnea participating in weight loss interventions [147, 148]. When examining sleep quality, Thomson et al. found that poorer baseline sleep quality decreased the likelihood of weight loss success by 33% (relative risk 0.67 [95% CI: 0.52-0.86]) compared to individuals who reported better sleep quality, with weight loss success defined as losing greater than or equal to 10% of initial body weight at 6 months [146]. Conversely, weight loss interventions have resulted in improvements in sleep quality [137]. Although causal associations between sleep and weight need to be further explored [137, 143], baseline levels of subjective sleep behavior may be an important predictor of who will lose weight in a behavioral weight loss intervention.

2.6 Weight History

2.6.1 Weight History

Weight history is a measure that captures weight status and change that individuals experience across their lifespan. Cross-sectional research compares weight status at a specific timepoint when examining associations between weight and health. However, when examining weight at a single time point, individuals with a past history of overweight or obesity that are normal weight now are grouped with individuals that have never been overweight, and this likely underestimates weight associations with morbidity and mortality outcomes [149]. This is an important consideration because individuals who were overweight or obese in early life have increased risk for mortality at 50 years of age [150] and mortality overall [149].

There is evidence that earlier age when first overweight or obese is predictive of later in life weight status. For example, younger age when first overweight has been shown to be correlated with higher baseline BMI within a behavioral weight loss intervention [151]. In addition, it has been observed that childhood overweight or obesity is predictive of higher BMI at age 20 [152]. Early life overweight or obesity is associated with higher BMI among individuals who are entering a weight loss intervention and this early life weight status may impact how individuals respond to weight loss interventions.

Weight history has also shown potential to predict weight loss success within weight loss interventions. For example, a history of obesity status in childhood was a significant predictor of losing less weight in a behavioral weight loss intervention [153]. In contrast, Rupp et al. found there was no difference in weight loss among individuals who participated in a behavioral weight loss intervention when comparing individuals with juvenile onset of obesity and adult onset obesity [87]. Bautista-Castano et al. reported that children who were overweight or obese in childhood and whose parents were overweight or obese was the most significant predictor of who lost the least weight in a weight loss intervention [153]. This suggests the possibility that early onset of obesity may predict weight loss success. It is possible that a younger age when first overweight may reflect a critical period for some individuals and that parental weight status may play an important role.

2.6.2 Family History of Overweight and Obesity

Parental weight status is an important consideration in understanding children's weight history and current weight status. In addition, parental weight status may be an important factor in understanding why childhood overweight and obesity has been observed to predict weight loss for some individuals within weight loss interventions. For example, there is evidence that parental overweight and obesity status is related to increased odds of becoming overweight or obese in childhood [154-157]. Additionally, a large meta-analysis of cross-sectional data found children of parents who were overweight or obese had an odds ratio of 2.22 (95% CI: 2.09 to 2.36) to become overweight or obese compared to children of parents who were normal weight [156]. Overall it appears that parental overweight or obesity status is predictive of later life overweight or obesity status in their children, and it is possible that early life overweight status in conjunction with parental weight status may play an explanatory role in who does well within a weight loss intervention.

One possible explanation for how parental weight status may play a role is through similar genetic profiles between parents and their children. For example, it has been reported that 35%-40% of children's predisposition to becoming overweight or obese is inherited from their parents [158]. In addition, other research supports the consistent association between similar genetic profiles through inheritance and obesity [159, 160]. There is also evidence of genetics extending to a predisposition of higher susceptibility to maladaptive eating behaviors such as emotional eating [161]. Currently, efforts are focusing on better understanding how genetics and parental behaviors may interact in determining the pathway to childhood overweight and obesity [162].

While similar genetic profiles between parents and children may explain some variation in who becomes overweight or obese, it is also important to consider how parents' behaviors and parenting styles may influence childhood weight status. For example, it has been observed that children of overweight or obese parents preferred higher fat foods, liked vegetables less, and displayed a greater predisposition to overeating compared to children of normal weight parents [163]. This is supported by consistent cross-sectional and longitudinal evidence of parental feeding practices and behaviors and their influence on childhood eating patterns and behaviors [162, 164, 165]. Overall there is consistent evidence that parental overweight and obesity status is associated with their children's weight history and this may be important to consider when examining how individuals respond to weight loss interventions.

2.6.3 Baseline Weight as a Predictor of Weight Loss Success

Another potential predictor within the weight history domain is baseline weight/BMI and numerous studies have explored this potential predictor as it relates to weight loss success. There is mixed evidence of initial BMI as a predictor of weight loss success [36]. In their review, Teixeira et al. reported eight studies found no association between baseline BMI and weight loss success [39, 166-172], five studies found a positive association with weight loss success [173-177], and two studies found a negative association with weight loss success [178, 179]. Interestingly, among these studies, when the average BMI was higher(BMI 37), higher baseline BMI was more consistently associated with weight loss success, while in studies where the average BMI was lower (BMI 31) no association with BMI and weight loss was observed [36]. This may suggest that it is possible that baseline BMI of higher magnitudes is associated with more weight loss across behavioral weight loss interventions, while more modest BMI at baseline is not associated with greater magnitudes of weight loss. In an update review, higher initial BMI at baseline was associated with weight loss and had an effect size of 0.13 ± 0.11 [38]. The update included four new studies where higher baseline BMI was positively associated with weight loss success [180-183] and four new studies where higher baseline BMI was negatively associated with weight loss success [184-187]. Overall, based on these reviews, there is mixed evidence that baseline BMI is a predictor of weight loss success, and when present the association may be modest.

2.6.4 Weight Loss History

Intentional weight loss history provides a representation of previous weight loss attempts and the magnitude of lifetime weight loss. For repeated weight loss attempts, this can provide a representation of weight cycling. There is a belief that weight cycling may be related to negative cardiometabolic effects that occur with regaining weight such as increased sympathetic activity, dysregulation of blood glucose, and adverse changes in lipid levels among others [188]. However, there is limited evidence that weight cycling negatively effects these cardiometabolic risk factors [189]. For example, weight cycling does not appear to influence type 2 diabetes incidence, negatively influence body composition, or predict future overweight or obesity status in cross sectional research [190].

Adverse associations of weight cycling may be modified by gender and weight status. For example, weight cycling associations appear to be more consistent in women, with weight cycling in normal weight individuals being associated with worse lipid profiles and weight cycling in individuals that are overweight or obese being associated with slightly reduced insulin sensitivity [191]. A review by Montani et al. suggests its possible some of the negative health consequences observed cross-sectionally and prospectively, in relation to weight cycling, are related to observed cardiometabolic changes in weight cycling amongst individuals who are normal weight [192]. Additionally, a study exploring a single episode of weight cycling across two behavioral weight loss interventions where individuals that regained weight after the first intervention did not find negative physical or psychological effects from the weight cycling episode [193]. Overall, it appears the benefits of pursuing weight loss are greater than the risk of staying overweight or obese status, despite the high probability of weight regain.

Weight cycling has also been explored as a predictor of weight loss within behavioral weight loss interventions. In a review, Teixeira et al. concluded that there is consistent evidence of fewer previous weight loss attempts at baseline predicting significantly more weight loss within behavioral weight loss interventions [36]. Within this review, two studies found no association of previous weight loss attempts being predictive of weight loss [168, 174], and three studies found fewer previous weight loss attempts to be positively associated with more weight loss [166, 167, 179]. A recent update of this review found that fewer previous weight loss attempts was a baseline predictor of weight loss with an effect size of 0.10 ± (0.05) [38]. The update included four additional studies that showed fewer weight loss attempts at baseline was positively associated with more weight loss [185, 194-196]. Overall, when studies are pooled together, fewer previous weight lost attempts at baseline are predictive of weight loss success.

When examining weight cycling on a single study level there is support for fewer previous weight loss attempts/weight cycles being associated with better weight loss success. For example, fewer previous weight loss attempts at baseline have been associated with more weight loss at the end of study [194], and with less risk to regain weight [197]. This suggests fewer weight loss attempts are associated with weight loss and may also be associated with weight maintenance. Also, fewer weight loss attempts is related to intervention completion, while more weight loss attempts are related to dropout from weight loss interventions [153].

It is important to note that when examining studies on the single study level, some studies do find individuals with more previous weight loss attempts lose significant weight. For example, Kerrigan et al. demonstrate that when individuals past attempts at weight loss have been successful and a subsequent behavioral weight loss intervention applies similar methods that have been successful in the past, individuals reporting more previous weight loss attempts lose more weight than individuals who reported fewer previous weight loss attempts [134]. This is supported by two studies that found more previous weight loss attempts were predictive of more weight loss at 6 months [198, 199] and 18 months [199]. Within these two studies individuals that lost greater magnitudes of weight in their previous weight loss attempts lost the most weight within the intervention [198] or lost more weight at 18 months [199].

Although individuals with more previous weight loss attempts are on average less successful within weight loss interventions, some individuals with a history of more weight loss attempts are still able to lose significant weight. It is possible that among individuals with more previous weight loss attempts, individuals who were more successful in the past at losing weight may have more beneficial outcomes than individuals who were less successful. This is important because cross-sectional evidence suggests the prevalence of previous weight loss attempts is high, with one U.S. representative sample reporting 33% of individuals reported past attempts at weight loss [191]. In addition one study reported an average of 5.1 prior weight loss attempts among individuals seeking behavioral weight loss intervention [199]. Because many individuals who are attempting to lose weight have a history of previous weight loss attempts, it is important to explore which individuals are at higher risk of being less successful within weight loss interventions.

2.6.5 Weight Loss Goals

Individuals enter weight loss interventions with different weight loss goals or expectations, and it is possible the magnitude of individual weight loss goals or expectations may be predictive of their weight loss outcomes. There is evidence that behavioral weight loss interventions produce on average modest weight loss and most health benefits of weight loss are generally observed with modest weight loss of 5-10% [3, 9, 11-17, 63]. Additionally, there is evidence that individuals entering behavioral interventions have weight loss goals that on average are higher than the average weight loss that can typically be expected from behavioral weight loss interventions [200-202]. Because several studies have reported higher less realistic weight loss goals are associated with less weight loss success and because modest weight loss is achievable and related to health benefits, some researchers have suggested participants should be encouraged to set more realistic and modest weight loss goals [39, 202, 203]. It is important to consider whether individual weight loss goals are predictive of who will be successful in losing weight.

Reviews on baseline weight loss goals and subsequent weight loss are generally mixed with some studies reporting lower weight loss goals are associated with more weight loss, while other studies report higher weight loss goals to be associated with weight loss success. For example, Teixeira et al. found mixed evidence that weight loss goals are associated with weight loss [36]. Within the Teixeira et al. review, two studies found no association of weight loss goals to weight loss outcomes [169, 204], while two studies found higher weight loss goals to be associated with less weight loss [39, 166]. Overall Teixeira et al. concluded that it was possible more realistic weight loss goals may be related to weight loss outcomes, although there is not enough evidence at this time. In a more current update to the review [38], two additional studies reported higher weight loss goals were associated with greater weight loss success [180, 205] and one study that found higher weight loss goals were associated with less weight loss [185]. Overall weight loss goals do not appear to be consistently predictive of weight loss outcomes, although, it appears more modest weight loss goals have a small association with weight loss across studies [38].

When looking at individual studies related to weight loss goals it appears that not just the magnitude of the weight loss goal is important, but also whether their weight loss goals are achievable. For example, within a review on maintaining weight loss, individuals who reached their self-determined weight loss goals were more likely to maintain their weight loss [197]. In addition, when comparing only individuals who completed a weight loss intervention, higher weight loss goals for one year weight loss was the most successful predictor of weight loss in individuals that were able to achieve their one year weight loss goal [206]. In contrast, lower dream BMI was associated with dropout from the weight loss intervention [206]. It is possible that higher weight loss goals are predictive of more weight loss for those who are able to achieve their desired weight loss, while higher weight loss goals in individuals who are unable to achieve their goals is detrimental to their weight loss efforts.

2.7 Psychosocial Factors

2.7.1 Weight Loss Self-Efficacy

Self-efficacy, the confidence an individual has to perform a specific behavior, is a mediator of weight loss within behavioral weight loss interventions [207]. Weight loss self-efficacy is the confidence an individual has in their ability to follow dietary behaviors and avoid overeating. Behavioral weight loss interventions utilize behavior change strategies with one goal being to increase participants weight loss self-efficacy with the intention that performing these weight loss behaviors are a principle factor related to weight loss success [208].

Weight loss self-efficacy is typically measured with a validated questionnaire such as the Eating Self-efficacy scale (ESES) or the Weight loss self-efficacy questionnaire (WEL) [209], with higher scores associated with a higher BMI in cross-sectional analyses. For example, in a study that assessed the difference in the WEL score between women with obesity and women of normal weight, the WEL score was lower in women with obesity (WEL=99) compared to women of normal weight (WEL=139) [210]. Other studies have shown that the WEL score is inversely related to weight [211].

On average the WEL has been shown to increase in response to behavioral weight loss interventions [210, 212]. Additionally positive changes in WEL within interventions is associated with greater weight loss [212, 213]. Within behavioral weight loss interventions not all individuals increase their weight loss self-efficacy. For example in one study individuals on average decreased their weight loss self-efficacy, while those that increased weight loss self-efficacy within the intervention lost more weight [214]. In this study individuals with low baseline weight loss self-efficacy increased their weight loss self-efficacy scores across the intervention while individuals that started with higher baseline self-efficacy significantly decreased their weight loss self-efficacy scores across the intervention [214]. While on average individuals increase weight loss self-efficacy through behavioral intervention and increases are related to more weight loss, not all individuals respond by increasing their weight loss self-efficacy. Weight loss self-efficacy may be important in helping to identify who will respond to behavioral weight loss interventions.

Studies have examined whether baseline weight loss self-efficacy is predictive of subsequent weight loss with mixed results among studies. Two systematic reviews of the literature conclude that baseline weight loss self-efficacy does not predict who will lose weight. For example, Teixeira et al.'s review concluded that weight loss self-efficacy did not predict weight loss [36]. The update to the review also found weight loss self-efficacy was not predictive of weight loss outcomes with a small effect size of 0.06 (-0.02-0.14) [38].

Many individual studies support the conclusion that baseline weight loss self-efficacy does not predict who will lose weight. For example, 6 studies from the initial Teixeira et al. review demonstrated no association of baseline weight loss self-efficacy to weight loss [39, 168, 174, 215-217]. Additionally in the update, three studies showed there was no significant association of baseline weight loss self-efficacy to weight loss with effect sizes of 0.0, -0.05, and 0.05 [185, 194, 196].

While reviews and some individual studies find no association of baseline weight loss self-efficacy with weight loss outcomes, some studies do find baseline weight loss self-efficacy is predictive of weight loss. For example, one study found higher baseline eating self-efficacy was correlated with weight loss at four months (r=0.21) [166]. Additionally, while Delahanty et al. did not find an independent association of baseline weight loss self-efficacy to weight loss, they did find baseline weight loss self-efficacy was a significant predictor in multivariate regression [194]. Also three more recent studies found higher baseline weight loss self-efficacy to be associated with more weight loss with effect sizes of 0.13, 0.34, and 0.15 respectively [218-220]. Overall the evidence of weight loss self-efficacy as a predictor of weight loss is mixed, however some studies do find that baseline weight loss self-efficacy is predictive of weight loss and a better understanding is warranted.

It may be important to explore other factors related to weight loss self-efficacy and weight loss outcomes to better understand for whom weight loss self-efficacy is a better predictor. For example, in the study by Linde et al. women with low baseline weight loss self-efficacy lost less weight than their higher scoring counterparts, while weight loss self-efficacy scores in men were not predictive [211]. In another study of African American women, improvement in weight loss self-efficacy across the intervention was associated with better weight loss, however participants with high self-efficacy at baseline lost less weight [212]. In these two separate studies high baseline weight loss self-efficacy predicted more weight loss for women, less weight loss in a sample of African American women, and found no association for men. In a study that looked at weight change over 3 months the baseline composite score for weight loss self-efficacy was not predictive of weight change, but a higher baseline score in the positive activities domain was predictive of intervention completion [210]. This is similar to the finding by Presnell et al. where the subscales within weight loss self-efficacy, confidence in eating during negative affect, and positive activities drove the association with weight loss [220]. These studies demonstrate there are differences in the predictive ability of weight loss self-efficacy that may depend on individual characteristics such as gender, ethnicity, or binge eating status. Additionally it may be important to explore individual sub-scores within the weight loss self-efficacy domain to see which sub-scores drive the associations and for whom they drive it. Weight loss self-efficacy scores appear to be related to weight loss, but an understanding of who weight loss self-efficacy scores are predictive for weight loss is not well understood.

2.7.2 Physical Activity Self-Efficacy

Objectively measured physical activity is inversely related to weight status with lower levels of physical activity associated with higher BMI levels and higher levels of physical activity associated with lower BMI levels [96]. Additionally interventions targeting physical activity behavior alone produce modest weight loss of about 2.1 kg [13] and higher physical activity levels are predictive of long-term weight loss success [221, 222]. Thus targeting physical activity behavior within a behavioral weight loss intervention is important. One way to target physical activity behavior is to promote individuals beliefs in their ability to perform physical activity. Studies utilize the Physical Activity Self-efficacy questionnaire [223] and the Exercise Self-efficacy Scale (ESES) [224] which are two validated instruments commonly utilized to measure individual confidence in a person's ability to perform exercise when specific barriers arise. Physical activity self-efficacy scores are associated with the individual stages of change an individual is in, such that lower physical activity self-efficacy scores are associated with lower activity levels, while higher physical activity self-efficacy scores are associated with higher activity levels [223].

Physical activity interventions have been shown to increase physical activity self-efficacy [225]. On average some behavioral weight loss interventions do not increase physical activity self-efficacy, with several studies seeing decreases in physical activity self-efficacy across the intervention [214, 226, 227]. However, some individuals in behavioral weight loss interventions do increase physical activity self-efficacy throughout the intervention [228]. Increases in physical activity self-efficacy through behavioral weight loss interventions are associated with increased health promoting and exercise behaviors [213, 228]. Additionally, the individuals who increase their physical activity self-efficacy scores within interventions, have been shown to lose more weight at 12 weeks [226], 6 months and 18 months [214].

Combining studies into reviews reveals mixed evidence that baseline physical activity self-efficacy is predictive of weight loss outcomes. In a review by Teixeira et al., they concluded that there was suggestive evidence that baseline physical activity self-efficacy was predictive of weight loss outcomes [36]. The two studies included in the review found higher baseline physical activity self-efficacy to be predictive of greater weight loss [39, 166], however it was concluded that additional studies were needed before higher baseline physical activity self-efficacy could be considered a consistent predictor of greater weight loss. In the systematic review update, baseline physical activity self-efficacy was not found to consistently predict weight loss with an overall effect size of baseline physical activity self-efficacy of 0.05 (-0.02-0.12) [38]. The update included 3 new studies where baseline physical activity self-efficacy was not predictive of greater weight loss [194, 196, 218].

In support of the review, some individual studies do not find baseline physical activity self-efficacy to predict greater weight loss [214, 226, 227, 229]. However, some studies do find baseline physical activity self-efficacy is predictive of weight loss and physical activity. For example, among individuals participating in a 8 week behavioral weight loss intervention, higher baseline levels of physical activity self-efficacy were predictive of more weight loss at 8 weeks, but not at 6 months [227]. Additionally, another study found lower levels of baseline physical activity self-efficacy was predictive of less physical activity in individuals who were overweight or obese participating in a weight loss intervention [229]. Also, while baseline physical activity self-efficacy was not predictive of weight loss at 6 months, baseline physical activity self-efficacy was predictive of weight loss at 2 and 3 years [194]. Overall baseline physical activity self-efficacy does not consistently predict weight loss outcomes, however there are some studies that demonstrate baseline physical activity self-efficacy is predictive of weight loss. This suggests it may be important to understand for whom baseline physical activity self-efficacy may be predictive.

2.7.3 Physical Activity Outcome Expectancies

Expectations of the benefits of physical activity may be associated with higher levels of physical activity [230]. However, cross-sectional evidence to support this conclusion is mixed, with some evidence supporting this association and other evidence not supporting this association. For example, some studies find higher physical activity outcome expectations is related to a higher level of physical activity [230, 231], while other studies find no association of physical activity outcome expectations to a physical activity levels [232, 233]. Because physical activity is an important component of many behavioral weight loss interventions it is important to understand physical activity outcome expectations in individuals with overweight or obesity.

Few studies have examined associations between physical activity outcome expectations and physical activity levels among individuals with overweight or obesity. However, there is some evidence that among individuals with overweight or obesity that physical activity outcome expectations are similar to individuals who are normal weight. For example, a study with individuals that were class 2 or 3 obesity found the average scores of physical activity outcome expectations to be high and not significantly different from scores among the normal weight population [234]. This is supported by evidence in a study by Gallagher et al. where within a behavioral weight loss intervention 96.4% of participants rated physical activity outcome expectations at baseline between a score of 3 and 5 [235] on a 5-point Likert scale, suggesting that most participants agree that higher physical activity levels are beneficial to psychological health, body image improvements, and general health. This high agreement further suggests that individuals with overweight or obesity share a similar perspective of the benefits of physical activity when compared to their normal weight peers.

There is also limited evidence of physical activity outcome expectations changing within behavioral weight loss interventions. For example, Gallagher et al. reported that the subscale of psychological benefits of exercise increased significantly from baseline to 6 months, but health and image benefits did not change significantly [235]. Additionally, in a behavioral weight loss intervention conducted by Thomson et al., they found the psychological benefits subscale to increase from week 10 to week 20, although there was no change from baseline to week 10 [236]. Interestingly, it has been suggested that because individuals with overweight or obesity are aware of the benefits of physical activity, that the high agreement may limit the magnitude in which individuals can improve physical activity outcome expectation scores [235].

In addition to the limited evidence that physical activity outcome expectations change in response to intervention, there is also limited evidence of the predictive ability of physical activity outcomes expectations as they relate to increased physical activity or weight loss. For example, in a physical activity intervention, higher physical activity outcome expectations at 6 months was predictive of individuals who were active vs. not active at 12 months [237]. Also, Gallagher et al. found higher baseline perceived benefits of physical activity on body image was modestly predictive of weight loss at 6 months ($r=0.15$) [235]. Although both studies demonstrate some baseline predictive ability of physical activity outcome expectations to predicting future physical activity levels and weight loss, respectively, overall many studies do not include physical activity outcome expectation measures or fail to report results of its utility. Thus, the utility of physical activity outcome expectations as a predictor of weight loss is limited and it may be that on average individuals are aware of the positive benefits related to physical activity participation and that interventions addressing barriers to physical activity may be more important.

2.7.4 Physical Activity Barriers

Physical activity is an important behavior within the context of a behavioral weight loss intervention. When added to a calorie restricted diet, physical activity has been shown to enhance weight loss by approximately 20 to 25 percent compared to what is achieved through calorie restriction alone [103]. However, at the population level, engagement in a sufficient amount of physical activity appears to be less than optimal to impact body weight. Even within the context of a behavioral intervention not all participants initiate sufficient engagement in physical activity. Because of these considerations, it is important to explore individual perceptions of exercise barriers as they relate to weight loss in adults with obesity.

Examination of cross-sectional findings support that there is an inverse relationship between perceived physical activity barriers and physical activity engagement. For example, in a review of correlates of physical activity there is consistent evidence of higher barriers to physical activity being associated with lower activity levels independent of weight status [238]. This relationship is also observed for individuals with overweight or obesity. In behavioral weight loss interventions higher perceived physical activity barriers were inversely associated with moderate to vigorous physical activity at baseline [239] and at 6 months [235]. In addition Napolitano et al. observed that women with obesity and higher perceived physical activity barriers at 3 months reported 70 fewer minutes of physical activity compared to women with obesity with lower perceived barriers [240]. There is also evidence that decreasing perceived physical activity barriers within an intervention is associated with higher physical activity levels at 6 months [239, 241], 12 months [239], and 24 months [239].

Higher perceived barriers to physical activity are associated with higher weight status. For example, women report that their weight status is a barrier to engaging in physical activity [242].

Additionally, women with obesity were 10 times more likely to agree their weight makes physical activity more difficult compared to women who were normal weight [243]. At baseline prior to initiating a behavioral physical activity intervention, women with obesity reported significantly higher perceived physical activity barrier summary scores(60.8 ± 12.2) compared to overweight (56.7±13.3) or normal weight women(55.4±12.5) [240].

There is no consensus of whether perceived physical activity barriers are associated with weight loss within behavioral weight loss interventions or not. In a review by Teixeira et al., there was suggestive evidence based on two studies that perceived physical activity barriers at baseline were predictive of weight loss [36]. However, in an update to this initial review, it was found that perceived physical activity barriers were not predictive of weight loss, with there being limited studies exploring this psychosocial variable [38].

When examining individual studies, there is limited evidence to support baseline physical activity barriers as a predictor of weight loss. While Teixeira et al. found that baseline perceived physical activity barriers predicted weight loss success [39, 166], other studies have not replicated this. For example, two studies did not find baseline perceived physical activity barriers to predict weight loss at 4 months [208, 244]. In addition, while Gallagher et al. found a decrease in perceived physical activity barriers from baseline to 6 months to predict more weight loss at 6 months, they did not find baseline barriers to predict weight loss at 6 months [235]. Thus, additional research may be needed to address this discrepancy in findings regarding whether perceived physical activity barriers at baseline is predictive of subsequent weight loss.

Because of the potential inverse association between physical activity and perceived physical activity barriers in adults with obesity, it is important to consider whether behavioral interventions are effective at reducing these barriers. On average, behavioral weight loss interventions produce a reduction in perceived physical activity barriers, although there is evidence of variation with response to interventions regarding when and how perceptions of physical activity barriers increase or decrease [208, 235, 239, 241, 245]. For example, Napolitano et al. observed that perceived physical activity barriers were lower in normal weight individuals compared with individuals with obesity at baseline and 12 months, but not significantly different at month 3, which corresponds to the end of the active phase of the intervention [240]. In another study that examined clinician determined physical activity barriers, during the weight loss phase physical activity barriers decreased; however, following the weight loss phase physical activity barriers appeared to increase during the maintenance period [246]. In addition, Call et al. demonstrated that despite a decrease in barriers through 12 months of active treatment, perceived physical activity barriers increased from 12 to 18 months and then remained stable through 24 months within a behavioral weight loss intervention [239]. Overall, interventions decrease perceived physical activity barriers, however this decrease appears to occur during the intensive intervention phase and it appears that perceived physical activity barriers increase following the most active phase of the intervention.

Individuals that reduce perceived physical activity barriers within behavioral interventions lose significantly more weight, with a decrease in perceived physical activity barriers being associated with short-term weight loss at 4 months [208, 240] and 6 months [235]. Additionally, Teixeira et al. found individuals who reduce their perceived physical activity barriers have greater weight loss at 12 months [247]. Moreover, this study reported that barriers to physical activity was more strongly associated with 12-month weight loss than other psychosocial measures that were examined [247].

There may be demographic factors that contribute to whether physical activity barriers are associated with weight status or weight loss, and a better understanding of their utility is warranted. Call et al. reported that being younger and white was associated with higher perceived physical activity barriers, although they found no differences between gender or BMI status [239]. In addition, variations in perceived physical activity barriers have been demonstrated across gender, race, education, and level of BMI [246, 248]. For example, Venditti et al. found that being female or having obesity was associated with higher clinician assessed physical activity barriers [246] while Stankevitz et al. found higher perceived time barriers to physical activity in white participants compared to other races [248]. Due to the variation of perceived physical activity barriers based on different demographics, it may be important to better understand physical activity barriers to facilitate more individualized behavioral weight loss interventions [249].

2.7.5 Health Related Quality of Life

Quality of life is an important measure of general well-being that covers both the physical and mental domains of general quality of life. The physical domain encompasses measures of role-physical, bodily pain, and general health, while the mental domain encompasses measures of vitality, social functioning, role-emotional, and mental health. While weight status is considered important due to its association with negative health outcomes, subjectively reported quality of life is also associated with negative health outcomes. For example, cross-sectional studies indicate lower quality of life is independently associated with multimorbidity and specifically the physical health domain within the quality of life measurement is consistently associated with negative health outcomes [250]. In support, a recent meta-analysis demonstrates lower scores for the physical health domain appear to be more strongly associated with multimorbidity than the mental health domain [251]. In addition to the relationship of quality of life to negative health outcomes, low quality of life is associated with lower physical activity levels [252] and is able to distinguish individuals that meet the recommended physical activity guideline from those who do not [253].

While low subjective quality of life is associated with negative health outcomes across all BMI's, individuals with obesity appear to be a greater risk in reporting significantly lower overall quality of life compared to individuals of normal weight [254-258]. Additionally there appears to be an inverse relationship with BMI and quality of life where higher BMI is associated with even lower overall quality of life [254, 255, 257, 259]. Among individuals with the highest BMIs, they report significantly lower levels of general health and vitality; and significantly higher levels of bodily pain [255, 258]. While it appears that higher BMI is more strongly associated with lower quality of life scores in the physical health domain [255, 257, 258], it has also been observed that those in the highest BMI categories report significantly lower mental health domain scores [257]. In addition, individuals with higher BMI that report lower quality of life, and consequently indicate higher levels of overall impairment, are more likely to seek weight loss treatment [254, 258].

Among individuals that seek weight loss treatment there is limited evidence of baseline quality of life being able to predict weight change within a behavioral weight loss intervention. For example, a review by Teixeira et al. found among two studies examining quality of life as a predictor within a weight loss intervention, non-completion of the intervention was associated with lower baseline levels of quality of life [36]. However, an update to this review conducted by Carraca et al. did not support the earlier review that quality of life is a predictor of weight loss, and concluded there is a limited number of behavioral weight loss interventions that look at quality of life as a predictor of weight loss [38].

Despite limited evidence of quality of life as a predictor, there is some evidence on a single study level that baseline quality of life may be associated with weight change outcomes within a behavioral weight loss intervention. For example, in a study by Fitzpatrick et al. higher baseline vitality scores were associated with better intervention adherence in addition to long-term weight loss success [260]. Other studies have also demonstrated lower baseline quality of life to be associated with dropout [39, 166]. In addition, Yank et al. found low baseline physical health quality of life to be related to less weight loss at 3 months and 15 months [40]. In contrast, there have been studies that did not find an association between baseline quality of life and weight loss outcomes at 6 months [261, 262] and at 1 year [196]. Overall, the evidence is mixed with some studies demonstrating the potential of quality of life measures to predict dropout and weight loss, while other studies do not find baseline quality of life to predict weight loss outcomes. There is a need for studies to further explore and report how baseline quality of life is associated with weight loss outcomes.

Quality of life measures are typically included in behavioral weight loss interventions and are an important target of change. Overall, behavioral weight loss interventions increase subjective quality of life for most individuals. This is important because individuals with lower subjective quality of life are more likely to seek treatment [258], suggesting the possibility that lower quality of life is an important motivator for seeking treatment and that improvements in quality of life through weight reductions are likely an important factor of success. A review by Maciejewski et al. found mixed evidence that quality of life improved within behavioral interventions with some studies finding significant improvements in quality of life and other studies that did not [263]. However, more recently, a review focused on quality of life and behavioral weight loss interventions found on average individuals significantly improved in the physical health domain, but did not improve in the mental health domain or the overall quality of life summary score across studies [264]. In addition, another review found weight loss of 5-10% was consistently associated with significant improvement in the physical health domain, but there was less evidence of improvement in the mental health domain [265]. Another study comparing a diet only behavioral intervention with a diet plus exercise intervention found that diet plus exercise behavioral interventions increased physical health quality of life significantly more than did diet only interventions [266]. When pooling studies on quality of life and weight loss, it is possible they pool diet and diet plus exercise interventions together and may miss positive associations for weight loss.

When examining studies on an individual level there is evidence of behavioral interventions increasing quality of life. For example, in a study with an intensive lifestyle intervention and a control group, the intervention significantly improved physical health quality of life for the participants in the intensive lifestyle intervention compared to the control [267]. Additionally, this study found that individuals with the lowest levels of quality of life significantly improved in both physical and mental domains of quality of life within the study compared to individuals that had higher quality of life at baseline [267]. This is important because individuals who report the lowest quality of life are more likely to seek behavioral weight loss treatment, and it appears they may increase their quality of life by the greatest magnitude. Another study by Blissmer et al. found that compared to baseline, individuals that completed behavioral intervention significantly improved both physical and mental domains of quality of life and this improvement was maintained at 24 months [268]. Additionally another study comparing bariatric surgery intervention to behavioral weight loss intervention, both groups significantly increased quality of life compared to baseline [269]. Also in this study, while bariatric surgery increased quality life significantly more than behavioral intervention at 6 months, there was not significant difference in quality of life at 12 months between groups [269]. Overall, it appears behavioral weight loss interventions increase quality of life within behavioral interventions.

There is also evidence that subjective quality of life measures may differ between different groups. For example, when comparing men and women age (16-34), men reported significantly lower quality of life in relation to excess weight in more subscales compared to females [256]. However, when comparing men and women 35-64, women reported lower quality of life in relation to excess weight compared to men [256]. This suggests that for younger men and for older women excess weight may be associated with lower rated quality of life. It is possible that for certain groups excess weight may affect perceived quality of life differently.

2.7.6 Depression

Research studies have explored the association between depression and overweight/obesity. While early research was mixed with some studies finding no association between depression and weight [270, 271], early samples were small and may have been samples of convenience. More recent studies find that higher levels of depressive symptoms are associated with higher body weight [272, 273]. A focus of many early studies was to examine these relationships in cross-sectional or longitudinal observational designs. Within these studies has been the suggestion that a reciprocal relationship between depression and obesity may exist. In a recent review, the reciprocal relationship between depression and obesity is elucidated, that is, having depression increases the odds to develop obesity ([OR] 1.58 95% CI 1.33-1.87) and having obesity increases the odds of developing depression ([OR] 1.55 95% CI 1.22-1.98) [274]. The consistent association of depression to obesity may be explained by the many underlying biological mechanisms depression and obesity share, although future research is needed to better understand how the mechanisms interact [275]. Because of the consistent association of depression and obesity it is important to explore this domain as it relates to weight status and weight loss.

Given the potential association between depression symptoms and obesity, it is important to consider how depressive symptoms may change in response to a weight loss intervention. Studies have shown that individuals with depressive symptoms show improvements in these symptoms when engaged in weight loss treatment [276]. Additionally, individuals with obesity and depressive symptoms are more likely to seek weight loss treatment than individuals with obesity and without depressive symptoms [277]. Some studies have also been designed to examine approaches to specifically address depressive symptoms within the context of a weight loss intervention. For example, in a study by Busch et al. [278], participants with major depression were recruited and randomized to behavioral weight loss intervention with and without a depression treatment component. Participants in the depression treatment arm significantly improved their depressive symptoms more than the standard arm and improvement in depressive symptoms was associated with more weight loss. These findings may support the need to address depressive symptoms within the context of weight loss interventions.

Studies have also examined whether depressive symptoms may be associated with intervention adherence and attrition. In a systematic review, Burgess et al. examined determinants of adherence to lifestyle intervention in individuals with obesity and found lower levels of depressive symptoms were associated with better adherence to lifestyle interventions [48]. The review reported that two articles included evidence of lower depression symptoms being associated with increased adherence [279, 280] while two articles supported higher depression symptoms being related to attrition [280, 281]. Overall, there were limited studies to support the existence of a significant relationship of increased depressive symptoms at baseline being predictive of lower adherence to lifestyle intervention. However, additional studies support the conclusion of higher depressive symptoms being predictive of lower adherence. For example, Shell et al. reported that greater levels of depressive symptoms at the start of a behavioral weight loss intervention was associated with poorer attendance throughout the intervention [282]. In addition, depressive symptoms have been shown to be related to less adherence and more dropout independent of weight loss [283].

It is also important to examine whether depressive symptoms are associated with weight loss. Teixeira et al. concluded that baseline depression, measured by the Beck Depression Inventory (BDI), is not predictive of weight outcomes [36], and this is further supported by Carraca et al. who also did not find depression to be predictive of weight loss outcomes [38]. Contrary to these reviews on pretreatment predictors of weight loss, many studies have found depression to predict weight loss outcomes. For example, among a sample of African American women who were assessed at baseline with the Center for Epidemiologic Studies Depression Scale (CES-D) before beginning a behavioral weight loss program, lower depression symptoms at baseline was associated with greater weight loss at 6 months [284].

The relationship between depressive symptoms and both weight loss and attendance/attrition may be influenced by the measure used to assess depressive symptoms. For example, participants in a translational study based on the Diabetes Prevention Program who were assessed with the CES-D that had more depressive symptoms lost less weight and attended less sessions than participants with lower depressive symptoms at baseline [285]. However, the Diabetes Prevention Program which assessed depressive symptoms via the BDI did not find baseline depression symptoms to predict weight change over the intervention [194]. The multicenter Look AHEAD Study did not find that baseline depression, assessed by BDI, predicted weight loss at one year, but more depressive symptoms at baseline did predict higher likelihood to miss 2 consecutive 6 month assessment visits across the first 48 months of this study [286, 287].

2.8 Summary

The aims of this study focus on examining the association between early weight loss (weeks 4, 8, and 12) and longer-term weight loss (6 months and 12 months) and also examining whether current behaviors, weight history, or psychosocial factors are associated with weight loss trajectory across 0-4, 0-8, or 0-12 weeks of a behavioral intervention. This literature review suggests there are baseline factors and characteristics that may be associated with weight loss, while others are not associated with weight loss. However, the majority of the literature examining the association between these baseline factors and weight loss have not focused on early weight loss that occurs within the initial 4 to 12 weeks of treatment. This supports the rationale for examining these important questions in this current study.

The literature review examined the evidence regarding whether baseline eating behavior, physical activity and sedentary behaviors, and sleep behaviors are associated with weight loss. This literature suggests that there is mixed evidence of an association between baseline eating behavior and weight loss. The evidence appears to support that baseline measures of sleep are associated with weight loss; however, baseline physical activity and sedentary behavior do not appear to be associated with subsequent weight loss.

The literature review also examined whether weight history variables were associated with weight loss. This literature supports that parental overweight or obesity status and childhood weight status are associated with increased odds of becoming obese in childhood and adulthood respectively; however, the literature on whether these factors are associated with weight loss is sparse. The literature on prior weight loss attempts is mixed with most studies supporting that fewer previous weight loss attempts across the lifespan is predictive of weight loss success, whereas a few studies have found more previous weight loss attempts and greater magnitudes of lifetime weight loss have been found to be associated with weight loss. In addition, some studies report higher weight loss goals are associated with greater weight loss, while other studies report individuals who have smaller and more realistic goals lose more weight. It is unclear from the literature whether weight history factors are associated with early weight loss, which is one area of focus in the current study.

The literature on the association between baseline psychosocial factors and weight loss was also reviewed. Some of the factors included self-efficacy, outcomes expectations, barriers, health-related quality of life, and depressive symptoms. The literature is mixed on whether these baseline psychosocial factors are associated with subsequent weight loss, and the literature is sparse on studies that have examined whether these baseline factors are associated with early weight loss response within the context of a behavioral weight loss intervention. However, the literature is more consistent that a change in these psychosocial factors during the weight loss process is associated with weight loss in response to a behavioral intervention.

Thus, this study examines whether baseline factors reflecting current behaviors, weight history, or psychosocial factors may be associated with early weight loss in a behavioral intervention. This information may be helpful in identifying which individuals may be most responsive to a behavioral intervention and which factors may be targets for future interventions in an effort to improve weight loss success in adults with overweight or obesity.

3.0 Methods

3.1 Methods from Parent Study

3.1.1 Subjects

Data from 383 who were recruited to participate in a behavioral weight loss study were used for this project. Eligibility and ineligibility criteria for the parent study included the following:

Eligibility Criteria

1. 18-55 years of age.
2. Body mass index (BMI) between 25.0 to <40.0 kg/m^2.
3. Ability to provide informed consent prior to participation in this study.
4. Ability to provide consent from their personal physician to participate in this study.
5. The ability to complete the baseline graded exercise test, and clearance from the study physician to participate in this study after reviewing the results from this study.

Ineligibility Criteria

1. Unable to provide informed consent.
2. Household member on study staff.
3. Females who were currently pregnant, breastfeeding in the past 3 months, currently lactating, or reporting that she was planning a pregnancy within the next 12 months.
4. History of bariatric surgery.

5. Report current medical condition or treatment for a medical condition that could affect body weight. These may include the following: cancer (Note: Persons previously diagnosed with non-melanoma skin cancers, those successfully treated for cancer who have remained disease-free for five years or more were eligible for participation in this study); diabetes mellitus; hyperthyroidism, inadequately controlled hypothyroidism; chronic renal insufficiency; chronic liver disease; gastrointestinal disorders including ulcerative colitis, Crohn's disease, or malabsorption syndromes; etc.
6. Current congestive heart failure, angina, uncontrolled arrhythmia, symptoms indicative of an increased acute risk for a cardiovascular event, prior myocardial infarction, coronary artery bypass grafting or angioplasty, conditions requiring chronic anticoagulation (i.e. recent or recurrent DVT).
7. Resting systolic blood pressure of >160 mmHg or resting diastolic blood pressure of >100 mmHg, taking medication for blood pressure control, or taking medication that can affect blood pressure or heart rate response to exercise (e.g. beta blocker).
8. Eating disorders that would contraindicate weight loss or physical activity.
9. Alcohol or substance abuse.
10. Currently treated for psychological issues (i.e., depression, bipolar disorder, etc.), taking psychotropic medications within the previous 12 months, or hospitalized for depression within the previous 5 years.
11. Report exercise >60 minutes per week over the past 3 months. (NOTE: It is important that individuals are sedentary when entering this study to allow for maximal effect of the intervention).
12. Report weight loss of >5% or participating in a weight reduction diet in the past 3 months.

13. Report plans to relocate to a location not accessible to the study site or having employment, personal, or travel commitments that prohibit attendance to at least 80 percent of the scheduled intervention sessions and all of the scheduled assessments.

3.1.2 Recruitment, Screening, and Informed Consent

Subjects were recruited through advertisements that were approved by the local Institutional Review Board. Individuals responding to the advertisements were instructed to call the investigators by telephone to obtain further information about the study. Upon receipt of a telephone call, staff provided a brief description of the study. Individuals interested in study participation after hearing the description, answered questions to determine initial eligibility based on the criteria listed above. Individuals who appeared to be eligible based on the initial telephone screen were invited to an orientation session where the study was explained to them in detail, components of informed consent were explained, and the individuals were given the opportunity to ask additional questions to the investigators.

Prior to undergoing any experimental procedures for this study, written informed consent was obtained from the potential subject, as well as a medical history and physical activity readiness questionnaire to confirm that no conditions were present that would exclude the participant. Moreover, prior to undergoing any experimental procedures, individuals also provided medical clearance from their personal physician stating that it was safe to participate in a weight loss intervention that included a reduced energy intake diet and exercise.

3.1.3 Research Design and Randomization

Following baseline assessments to confirm eligibility and to collect additional study-related data, eligible individuals were randomly assigned to one of three weight loss intervention conditions. Analysis of data from the parent study showed no significant difference in weight loss between the randomized conditions, and therefore the participants across the intervention conditions were combined for all analyses presented for this current study. However, to provide an understanding of the intervention conditions, a brief explanation of the intervention components are presented. All participants received a behavioral weight loss intervention that included attendance at group-based intervention sessions from weeks 1-24 and then every other week during weeks 25-52. In addition, participants received a brief telephone contact with an intervention staff member approximately twice per month during weeks 25-52. A brief description of the intervention conditions is the following:

1. DIET: This group was prescribed a diet that reduced energy intake of 1,200-1,800 kcal/day. No physical activity recommendations were provided to the DIET group.
2. DIET+PA150: This group was prescribed the same dietary intervention as the DIET group. In addition, the DIET+PA150 condition was prescribed a progression to 150 min/week of unsupervised moderate-to-vigorous intensity physical activity per week.
3. DIET+PA250: This group was prescribed the same dietary intervention as the DIET group. In addition, the DIET+PA250 condition was prescribed a progression to 250 min/week of unsupervised moderate-to-vigorous intensity physical activity per week.

3.1.4 Behavioral Weight Loss Intervention

Intervention Sessions: Subjects in all intervention conditions were instructed to attend weekly weight loss group sessions for weeks 1-24 and approximately every other week during weeks 25-52. These groups were closed to only those participants randomly assigned to a particular intervention condition (DIET, DIET+PA150, DIET+PA250). These intervention sessions focused on behavioral strategies to reduce energy intake and for DIET+PA150/DIET+PA250 to also increase exercise consistent with the intervention protocol. Sessions were led by a variety of professionals that included exercise physiologists and nutritionists. If a group session was missed a brief individual make-up session was offered to allow the content to be shared with the subject. Body weight was measured at each of the intervention sessions to determine responsiveness of the subject to the weight loss program and to provide ongoing feedback. Subjects unable to attend either the group session or the make-up session were mailed intervention materials that were distributed to the other subjects at the intervention session.

In addition to the in-person group session, participants received an individual brief (approximately 10 minutes in duration) telephone contact from a member of the intervention staff approximately twice per month during weeks 25-52 on weeks when an in-person session was not scheduled. This telephone contact was intended to provide an opportunity for individual interaction with the intervention staff to assist in understanding of the intervention content and to address barriers to engagement or adherence to the intervention components. The interventionist used a standard script to direct the approach and content of this telephone contact.

Diet Intervention: The identical dietary intervention was provided to all subjects regardless of randomized intervention assignment (DIET, DIET+PA150, DIET+PA250). This included prescribing subjects to consume 1,200-1,800 kcal per day, and to reduce their dietary fat intake to 20-30 percent of their total daily energy intake. Initial energy intake as determined based on baseline body weight and then adjusted based on weight loss response across the intervention. Meal plans, which were developed by registered dieticians, were provided to facilitate adoption and compliance with these dietary recommendations. In addition, participants self-monitored their dietary intake in a food diary that was returned to the intervention staff at each intervention session, with the intervention staff reviewing these diaries and providing written feedback relative to self-reported eating behavior.

Physical Activity Intervention: By study design, the DIET group did not receive information about physical activity nor was physical activity prescribed. The Physical activity prescription differed between randomized intervention conditions (DIET+PA150 and DIET+PA250) as described below.

Subjects in the DIET+PA150 intervention were instructed to engage in moderate intensity physical activity 5 days per week. The total duration per day began at 20 minutes per day and gradually progressed to at least 30 minutes per day. Physical activity was progressed in a gradual manner (5 min/d in 4-week intervals) to maximize adherence and minimize the onset of musculoskeletal injuries. Moderate intensity was prescribed using the Borg 15-point Rating of Perceived Exertion (RPE) scale, with the range set at 13-15 on this scale.

Subjects in the DIET+PA250 intervention were instructed to engage in moderate intensity physical activity 5 days per week. The total duration per day began at 20 minutes per day and gradually progressed to at least 50 minutes per day. Physical activity was progressed in a gradual manner (5 min/d in 4-weeks intervals) to maximize adherence and minimize the onset of musculoskeletal injuries. Moderate intensity was prescribed and set using the Borg 15-point RPE scale, with the range set at 13-15 on this scale.

Participants self-monitor physical activity behaviors (MOD-PA and HIGH-PA) in a weekly diary provided by the study. Participants were instructed to return the diary to the intervention staff at each in-person visit for review, and the intervention staff provided written feedback on the diary prior to it being returned to the participant.

3.1.5 Assessment Procedures

Within the parent study that is providing data to address the specific aims as described in Chapter 1, outcome data were collected at baseline, at each intervention sessions, 6-months, and following the 12-month weight loss intervention. The assessments included in the parent study and included in the secondary analyses conducted for this study are described below:

Height, Weight, and BMI: Weight and height were assessed with the subject clothed in a lightweight hospital gown with shoes removed. Weight was assessed using a calibrated digital scale to the nearest 0.1 kg with duplicate measures differing by ≤0.2 kg. Height was assessed using a wall mounted stadiometer to the nearest 0.1 cm with duplicate measures differing by ≤0.5 cm. Weight and height were used to compute BMI (kg/m^2). For the analyses conducted for this study the weight assessed at intervention sessions were used to reflect the weight loss trajectory across 0-4, 0-8, and 0-12 weeks.

Body Composition: Total body composition (fat mass, lean mass, percent body fat) was measured from a total body scan using a dual-energy x-ray absorptiometry (DXA, GE Lunar iDXA, Madison, WI). For this measurement, participants were clothed in a cloth hospital gown with metal removed (e.g. rings, watch, earrings, etc.). Women also completed a urine pregnancy test to confirm non-pregnancy prior to this measurement.

Cardiorespiratory Fitness: Subjects participated in an assessment of cardiorespiratory fitness. Subjects were requested to abstain from vigorous activity for 24 hours prior to the assessment period. American College of Sports Medicine (ACSM) criteria were used to exclude subjects from this study for whom exercise is contraindicated based on the results of this exercise test.

The speed of the treadmill was kept constant at 3.0 mph (80.4 m/min) with the initial grade of the treadmill being 0% and increasing at 1.0% increments at 1-minute intervals. Heart rate during the exercise testing was obtained at the one-minute intervals using a 12-lead ECG and immediately upon termination of the exercise test. Blood pressure was obtained during each even minute (2 min, 4 min, 6 min etc.) and immediately upon termination of the exercise test. Rating of perceived exertion was assessed during the final 15 seconds of each minute and at the point of test termination. The test performed to assess cardiorespiratory fitness was a submaximal test that was terminated when the participant first achieved or exceeded 85% of their age-predicted maximal heart rate (HRmax=220 minus age). A physician evaluated the results of each exercise test to ensure that exercise was not contraindicated.

Oxygen consumption was measured continuously using a SensorMedics Encore (Sensor Medics Corporation, Yorba Linda, CA) metabolic cart, with gas volumes and concentrations calibrated according to manufacturer specifications prior to each test. Fitness is expressed in absolute (L/min) and relative terms (ml/kg/min). Change in cardiorespiratory fitness is computed as the difference between these values and the baseline test and on the subsequent tests.

Self-report data via questionnaires:

Demographics

A demographics questionnaire was utilized to assess race, ethnicity, gender, age, education, marital status, income, smoking history, and alcohol history.

Current Behaviors

Eating Behavior

The Eating Behavior Inventory (EBI) is a validated 26 item inventory assessing behaviors associated with weight loss and weight maintenance [73]. The inventory assesses two domains including adaptive weight loss/maintenance behavior (for example I record the type and quantity of food which I eat) as well as maladaptive weight loss behavior (for example I eat and just can't seem to stop). The scoring for each item is part of a 5 point scale ranging from never or hardly ever to Always or almost always with higher total inventory scores associated with adaptive weight loss/maintenance behaviors. The EBI has been utilized in many weight loss interventions since 1979 and has demonstrated consistent evidence that positive change over intervention to higher scores is related to weight loss success and is considered a valid measure of weight loss behaviors [74].

Physical Activity

The Global Physical Activity Questionnaire (GPAQ) is a 22 item validated questionnaire that assesses participants current physical activity intensity in a variety of domains including recreation, household, occupation, transportation, and one item that addresses sedentary time (time spent sitting or reclining in a typical day) [288-290]. Data from the GPAQ are convertible to physical activity levels.

Sedentary Behavior

The Sedentary Behavior Questionnaire is a 16 item validated questionnaire that assesses sedentary behaviors on week days and on the weekends that differentiates behaviors at work (work related) and away from work (non-work related) [291]. The questionnaire is divided into 8 items each for weekdays and weekends and asks 6 nonwork-related questions about the domains of TV, computer/video game use, and transportation and 2 work related questions about the domains of computer related tasks and noncomputer related tasks (paperwork). The questionnaire is scored by the amount of time spent typically doing these tasks from 0 to greater than or equal to 6 hours a day.

Sleep

The Pittsburgh Sleep Quality Index (PSQI) is a 19 item self-reported measure of overall sleep quality and disturbances [292]. The questionnaire assesses 7 different domains of sleep quality over the past month including habitual sleep duration, sleep disturbances, sleep latency, sleep quality, daytime dysfunction, sleep medication usage, and sleep efficiency where the global score accurately identifies individuals with poor sleep quality.

Weight History

Weight History

A weight history questionnaire was utilized to assess highest life time weight, lowest life time weight, current participant weight goal, childhood and adolescent weight status until the age of 18 years, and whether the participant's parents (father, mother) were overweight or obese. This questionnaire also assessed the number of intentional weight loss episodes of at least 10 pounds and the total adulthood weight loss when the weight loss was at least 10 pounds. The number of unintentional weight loss episodes of at least 10 pounds and the total adulthood unintentional weight loss when the weight loss was at least 10 pounds. Past research has used the intentional weight loss attempts data to determine total lifetime weight loss and total number of weight cycles [293]. Additionally, absolute goal weight and weight loss goal were assessed.

Psychosocial Factors

Depressive Symptoms

The Center for Epidemiological Studies Depression Scale (CES-D) is a validated 10 item scale that assesses patients current depressive symptoms [294]. The questionnaire asks about the positive and negative domains of participants depressive affect/symptoms over the past week, for example I was happy (positive) and I felt lonely (negative). Scoring is based on the amount of days a participant felt that way for the week from rarely or none of the time (less than 1 day) to all of the time (5-7 days). Participants that scored greater than 13 were referred to their primary care physician.

Health Related Quality of Life

The Medical Outcomes Study Short Form-36 (SF-36) is a 36 item questionnaire psychometrically validated across diverse populations that provides information on subjectively reported health related quality of life in the physical and mental domains [295]. Within the questionnaire scoring can further differentiate among eight subscales from general health perceptions mental or physical, physical function, role limitations due to physical problems or emotional problems, bodily pain, vitality, and social functioning. Higher scores on this questionnaire are informative of greater health related quality of life.

Weight Loss Self-Efficacy

The Weight Loss Self-Efficacy (WEL) questionnaire is a validated 20 item questionnaire assessing confidence in following dietary recommendations and avoiding overeating [209]. The questionnaire assesses 5 domains including negative emotions, availability, social pressure, physical discomfort, and positive activities. An example from the negative emotion domain is "I am confident that I can resist eating when I am anxious (or nervous) and is rated on a Likert scale from 0 (Not confident at all) to 9 (Very confident). The global score and the specific domain scores are sensitive to changes in weight change within behavioral weight loss interventions.

Physical Activity Self-Efficacy

The Physical Activity Self-Efficacy questionnaire is a validated 5 item questionnaire assessing confidence in ability to exercise when specific barriers arise [223]. The questions address the individuals confidence that they can be physically active in situations where they are tired, in a bad mood, do not have time, are on vacation, and when it's raining or snowing. The questionnaire is scored by rating confidence levels on a Likert scale from 0 (Not at all Confident) to 5 (Extremely Confident) with higher scores associated with individuals activity levels.

Weight Loss Diet Expectations and Barriers

The Weight Loss Diet Expectations and Barriers was developed by the investigators specifically for the parent study. This is a 25 item questionnaire assessing individual level expectations (psychologic, body image, and health) for weight loss and individual level barriers to weight loss (time, effort, and obstacles). 10 items measure the outcome expectancies for weight loss for example, "A major benefit of weight loss for me is it enhances opportunities for fun and enjoyment", while 15 items measure the barriers for weight loss, for example "A major reason I have difficulty losing weight is family obligations". The responses are scored on a 5 point Likert scale ranging from 1 point strongly disagree to 5 points strongly agree, with higher scores in expectations related to weight loss behavior and lower scores in barriers related to weight loss behavior.

Exercise Outcomes Expectations and Barriers

The Exercise Outcome Expectations and Barriers questionnaire is a validated 26 item questionnaire predicting physical activity engagement that assesses individual expectations (psychologic, body image, and health) and individual barriers to physical activity participation (time, effort, and obstacles) [230]. 12 items measure the domain of outcome expectancies for physical activity for example, "A major benefit of physical activity for me is to improve my appearance", while 14 items address the domain of barriers to physical activity, for example "The major reason when I do not exercise is that I am too lazy". The responses are scored on a 5 point Likert scale ranging from 1 point strongly disagree to 5 points strongly agree and the higher scores in the expectations are related to physical activity behavior, while lower scores in the barrier domain relate to increased physical activity participation.

3.2 Data Analysis

Statistical significance was defined at $p \leq 0.05$. Statistical were performed using SAS (version 9.3). Pearson Correlations Coefficients were computed to examine the association between weight loss achieved at 4, 8, and 12 weeks with weight loss achieved at 6 and 12 months (Specific Aim 1). To allow for the potential for missing data at week 4, 8, or 12, the mean weight loss at 3-5 weeks was used to represent week 4, the mean weight loss at 7-9 weeks was used to represented weight loss at week 8, and the mean weight loss at 11-13 weeks was used to represent the weight loss at week 12 for each individual participant for these analyses. Additionally, correlation coefficients were computed between each of the baseline variables, with Pearson Correlation Coefficients computed for continuous data and Spearman Rank Order Correlations computed for categorical data.

To examine whether any of the variables of interest were associated with the weight loss trajectories from weeks 0-4, 0-8, or 0-12 (Specific Aims 2-4), the multi-level regression model technique described by Singer and Willett [296] was applied to the data. This analysis allowed for all of the available weekly weight data obtained during weeks 0-4, 0-8, and 0-12 to be used, and this also accounted for missing weight loss data with each of the models. Separate models were conducted for each of the dependent variables for each time-period of weight loss (0-4 weeks, 0-8 weeks, and 0-12 weeks). The independent variable X weight loss week effect was used to determine whether the independent variable was significantly associated with the weight loss trajectory.

In addition, each of the baseline variables was transformed to a standardized score using PROC STANDARD in SAS. The multi-level regression models described above were repeated using each standardized score to examine the weight change that would result across 0-4, 0-8, and 0-12 weeks with a one standard deviation change in the baseline.

4.0 Results

This study included 383 adults enrolled in a behavioral weight loss intervention. Mean BMI was 32.4±3.8 kg/m^2 and age was 45.0±7.9 years. The sample consisted of 79.4% females and 29.0% non-white.

4.1 Association Between Early Weight Loss and Weight Loss at 6 and 12 Months

Weight loss at week 4 was associated with weight loss at 6 months (r=0.6280, p<.0001) and 12 months (r=0.5034, p<.0001). A similar pattern was observed for the association between weight loss at week 8 and weight loss at 6 months (r=0.7859, p<.0001), and 12 months (r=0.6070, p<.0001); and weight loss at week 12 was associated with weight loss at 6 months (r=0.7054, p<.0001) and 12 months (r=0.5628, p<.0001).

4.2 Correlation Coefficients Between Baseline Variables

The correlations between each of the baseline variables representing current behaviors, weight history, and psychosocial factors are presented in Appendix A.

4.3 Current Eating, Physical Activity, and Sleep Behaviors

4.3.1 Eating Behavior

Data for baseline eating behaviors (EBI) and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (1). Baseline eating behaviors was not associated with weight change observed from 0-4 weeks (β =0.0042, p=0.2335), but baseline eating behaviors association with weight observed across 0-8 weeks (β=0.0050, p=0.0578) and 0-12 weeks (β=0.0043, p=0.0680) approached statistical significance as represented by the total EBI x week number interaction.

Table 1 Association between baseline Eating Behavior (EBI) and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	101.28	5.3671	<.0001	101.41	5.3745	<.0001	101.17	5.3575	<.0001
Total EBI	-0.1785	0.0996	0.0733	-0.1799	0.0997	0.0714	-0.1776	0.0994	0.0741
Week Number	-0.7643	0.1901	<.0001	-0.8437	0.1410	<.0001	-0.7677	0.1268	<.0001
Total EBI X Week Number	0.0042	0.0035	0.2335	0.0050	0.00262	0.0578	0.0043	0.0024	0.0680

4.3.2 Physical Activity and Sedentary Behavior

Data for baseline physical activity and weight loss across 0-4, 0-8, and 0-12 weeks are shown in table (2). Baseline recreational, home, and occupational MVPA was not associated with weight loss across 0-4 weeks or 0-12 weeks. Baseline recreational MVPA was significantly associated with more weight loss across from 0-8 weeks (β=0.00005, p=0.0406), while baseline home and occupational MVPA were not. In addition, baseline sedentary behavior was not associated with weight loss from 0-4 weeks (β=-0.00002, p=0.2471), 0-8 weeks (β=-0.00002, p=0.1317), or 0-12 weeks (β=-0.00001, p=0.1910) table (3).

Table 2 Association between baseline moderate-to-vigorous activity (MVPA) and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	91.7278	0.8318	<.0001	91.7829	0.8331	<.0001	91.6472	0.8305	<.0001
Recreation MVPA	-0.0003	0.0009	0.7771	-0.0003	0.0009	0.7625	-0.0002	0.0009	0.7942
Week Number	-0.5508	0.0287	<.0001	-0.5956	0.0216	<.0001	-0.5495	0.01934	<.0001
Recreation MVPA X Week	0.00003	0.00003	0.3809	0.00005	0.00002	0.0406	0.00004	0.00002	0.0985
Intercept	91.9968	0.8303	<.0001	92.0494	0.8313	<.0001	91.9132	0.8288	<.0001
Home MVPA	-0.0004	0.0005	0.3926	-0.0004	0.0005	0.3859	-0.0004	0.0005	0.4043
Week	-0.5401	0.0285	<.0001	-0.5803	0.0215	<.0001	-0.5349	0.0194	<.0001
Home MVPA X Week	-5.81E-6	0.00002	0.7200	1.18E-6	0.00001	0.9226	-5.86E-6	0.00001	0.5912
Intercept	91.7164	0.7772	<.0001	91.7735	0.7782	<.0001	91.6467	0.7757	<.0001
Work MVPA	-0.00003	0.0002	0.9006	-0.00003	0.0002	0.8731	-0.00003	0.0002	0.8839
Week	-0.5283	0.0267	<.0001	-0.5710	0.0202	<.0001	-0.5288	0.0182	<.0001
Work MVPA X Week	-0.00001	7.984E-6	0.1125	-7.16E-6	6.01E-6	0.2335	-7.48E-6	5.389E-6	0.1655

Table 3 Association between baseline sedentary behavior and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	90.1243	1.6027	<.0001	90.1835	1.6046	<.0001	90.1131	1.5996	<.0001
Sedentary Behavior	0.0005	0.0004	0.2744	0.0005	0.0004	0.2771	0.0005	0.0004	0.2910
Week	-0.4807	0.0561	<.0001	-0.5216	0.0419	<.0001	-0.4937	0.0376	<.0001
Sedentary Behavior X Week	-0.00002	0.000012	0.2471	-0.00002	0.00001	0.1317	-0.00001	0.00001	0.1910

4.3.3 Sleep Behavior

Data for baseline sleep behavior and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (4). Baseline total sleep behavior was not associated with weight across 0-4 weeks (β=-0.1215, p=0.6974), 0-8 weeks (β=-0.1046, p=0.7381), or 0-12 weeks (β=-0.09713, p=0.7555). Additionally, no sleep subscales were associated with weight across 0-4 weeks, 0-8 weeks, or 0-12 weeks.

Baseline PSQI score was associated with the weight trajectory from 0-4 weeks (β=0.0255, p=0.0186), 0-8 weeks (β=0.0174, p=0.0330), and 0-12 weeks (β=0.0146, p=0.0481), showing that poorer sleep was associated with less weight reduction. In addition, baseline sleep latency was associated with weight trajectory across 0-4 weeks (β=0.0862, p=0.0189), 0-8 weeks (β=0.0547, p=0.0453), and 0-12 weeks (β=0.0401, p=0.0247), while baseline sleep efficiency was associated with weight trajectory from 0-4 weeks (β=0.0760, p=0.0232) and 0-12 weeks (β=0.0451, p=0.0230), but only approached statistical significance from 0-8 weeks (β=0.0487, p=0.0561). At baseline, sleep quality, sleep duration, sleep disturbances, daytime sleep dysfunction, and sleep medications were not associated with the weight trajectory for 0-4, 0-8, or 0-12 weeks.

Table 4 Association between baseline Sleep Behavior (PSQI) and weight trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	92.2092	1.1919	<.0001	92.2144	1.1937	<.0001	92.0698	1.1899	<.0001
Total Sleep (PSQI)	-0.1215	0.3123	0.6974	-0.1046	0.3128	0.7381	-0.0971	0.3118	0.7555
Week Number	-0.6176	0.0412	<.0001	-0.6360	0.0311	<.0001	-0.5862	0.0280	<.0001
Total Sleep (PSQI) X Week Number	0.0255	0.0108	**0.0186**	0.0174	0.0082	**0.0330**	0.0146	0.0074	**0.0481**
Intercept	92.1054	0.8176	<.0001	92.1519	0.8186	<.0001	92.0228	0.8161	<.0001
Sleep Quality (PSQI)	-1.4062	1.6697	0.3999	-1.3713	1.6717	0.4121	-1.3319	1.6666	0.4243
Week Number	-0.5589	0.0284	<.0001	-0.5962	0.0213	<.0001	-0.5519	0.0191	<.0001
Sleep Quality (PSQI) X Week Number	0.0783	0.0580	0.1778	0.0632	0.0433	0.1443	0.0463	0.0391	0.2364
Intercept	91.5640	0.9459	<.0001	91.5996	0.9471	<.0001	91.4758	0.9441	<.0001
Sleep Duration	0.2981	0.9073	0.7425	0.3237	0.9084	0.7216	0.3305	0.9055	0.7151
Week Number	-0.5711	0.0328	<.0001	-0.6030	0.0249	<.0001	-0.5610	0.0223	<.0001
Sleep Duration X Week Number	0.04801	0.0314	0.1265	0.0357	0.0236	0.1304	0.0331	0.0213	0.1196
Intercept	92.7768	1.7095	<.0001	92.7870	1.7124	<.0001	92.6289	1.7068	<.0001
Sleep Disturbance	-1.1244	1.7457	0.5197	-1.0778	1.7487	0.5377	-1.0331	1.7429	0.5534
Week Number	-0.5656	0.0592	<.0001	-0.5835	0.0456	<.0001	-0.5284	0.0409	<.0001
Sleep Disturbance X Week Number	0.0294	0.0603	0.6261	0.0054	0.0464	0.9077	-0.0117	0.0416	0.7783

Intercept	91.2804	0.9129	<.0001	91.3016	0.9139	<.0001	91.1595	0.9109	<.0001
Sleep Latency	0.9201	1.0378	0.3755	0.9796	1.0389	0.3458	1.0236	1.0355	0.3230
Week Number	-0.5834	0.0315	<.0001	-0.6070	0.0238	<.0001	-0.5593	0.0214	<.0001
Sleep Latency X Week Number	0.0862	0.0367	**0.0189**	0.0547	0.0273	**0.0453**	0.0401	0.0247	**0.1041**
Intercept	91.9467	0.8298	<.0001	92.0020	0.8307	<.0001	91.8830	0.8282	<.0001
Sleep Daytime Dysfunction	-0.6416	1.7266	0.7103	-0.6466	1.7285	0.7084	-0.6615	1.7233	0.7011
Week Number	-0.5416	0.0287	<.0001	-0.5849	0.0216	<.0001	-0.5448	0.0194	<.0001
Sleep Daytime Dysfunction X Week Number	0.000720	0.06089	0.9906	0.007692	0.04594	0.8670	0.01299	0.04165	0.7552
Intercept	92.0948	0.7666	<.0001	92.1484	0.7675	<.0001	92.0293	0.7651	<.0001
Sleep Medication	-2.6817	1.8805	0.1542	-2.6867	1.8826	0.1537	-2.7018	1.8767	0.1501
Week Number	-0.5436	0.0267	<.0001	-0.5852	0.0201	<.0001	-0.5450	0.0181	<.0001
Sleep Medication X Week Number	0.0128	0.0639	0.8418	0.0268	0.0486	0.5809	0.0318	0.0435	0.4646
Sleep Efficiency (PSQI)	-0.6997	0.9804	0.4756	-0.6488	0.9817	0.5088	-0.6414	0.9786	0.5122
Week Number	-0.5692	0.0286	<.0001	-0.5978	0.0216	<.0001	-0.5562	0.0194	<.0001
Sleep Efficiency (PSQI) X Week Number	0.0760	0.0334	0.0232	0.0487	0.0255	0.0561	0.0451	0.0230	0.0497

4.4 Weight Status and History

Father overweight or obesity status was associated with less weight loss across 0-4 weeks (β=0.1192, p=0.0118), 0-8 weeks (β=0.1222, p=0.0006), and 0-12 weeks (β=0.0146, p=0.0030), but mother overweight or obesity status was not associated with weight loss. Results are shown in Table (5).

Table 5 Association between baseline parental weight status and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	95.9222	2.3917	<.0001	95.9800	2.3964	<.0001	95.7196	2.3899	<.0001
Father Weight Status	-2.6456	1.3675	0.0534	-2.6458	1.3702	0.0536	-2.5601	1.3665	0.0611
Week	-0.7314	0.0824	<.0001	-0.7799	0.0623	<.0001	-0.6953	0.0560	<.0001
Father Weight Status X Week	0.1192	0.0472	0.0118	0.1222	0.0357	0.0006	0.0954	0.0321	0.0030
Intercept	90.4433	2.2305	<.0001	90.4922	2.2349	<.0001	90.3989	2.2282	<.0001
Mother Weight Status	0.7384	1.4460	0.6097	0.7445	1.4489	0.6074	0.7282	1.4445	0.6142
Week	-0.5925	0.0775	<.0001	-0.6340	0.0589	<.0001	-0.6021	0.0528	<.0001
Mother Weight Status X Week	0.04065	0.0503	0.4197	0.0395	0.0382	0.3011	0.0448	0.0342	0.1910

The participant's overweight or obesity status as a child or adolescent was associated weight loss trajectory from 0-4 weeks (β=-0.0226, p=0.0423), 0-8 weeks (β=-0.0244, p=<.0001), and 0-12 weeks (β=-0.0192, p=<.0001). These results suggest that the greater the presence of overweight or obesity as a child or adolescent the greater the weight loss achieved. Results are shown in Table (6).

Table 6 Association between baseline child/adolescent weight status and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	74.6765	4.5704	<.0001	74.6981	4.5031	<.0001	74.7901	4.4624	<.0001
Child/ Adolescent Weight Status	1.1383	0.3701	0.0002	1.3874	0.3646	0.0001	1.3728	0.3613	0.0001
Week	-0.2628	0.1375	0.0562	-0.2927	0.0592	<.0001	-0.3239	0.0452	<.0001
Child/ Adolescent Weight Status X Week	-0.0226	0.0111	0.0423	-0.0244	0.0048	<.0001	-0.0192	0.0037	<.0001

A higher lifetime weight was associated a greater weight loss trajectory from 0-4 weeks (β=-0.0028, p=0.0002), 0-8 weeks (β=-0.0031, p=<.0001), and 0-12 weeks (β=-0.0026, p=<.0001). Moreover, lower lifetime weight was associated with less weight loss trajectory from 0-4 weeks (β=-0.0029, p=0.0060), 0-8 weeks (β=-0.0036, p=<.0001), and 0-12 weeks (β=-0.0027, p=0.0002). Results are shown in Table (7).

Table 7 Association between baseline highest and lowest lifetime weight and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	12.3100	1.8936	<.0001	12.2568	1.9033	<.0001	12.4824	1.9108	<.0001
Highest Lifetime Weight	0.3789	0.0089	<.0001	0.3795	0.0090	<.0001	0.3778	0.0090	<.0001
Week	0.0594	0.1601	0.7109	0.0769	0.1197	0.5209	0.0035	0.1080	0.9743
Highest Lifetime Weight X Week	-0.0028	0.0008	0.0002	-0.0031	0.0006	<.0001	-0.0026	0.0005	<.0001
Intercept	39.8621	3.3236	<.0001	39.7831	3.3284	<.0001	40.0625	3.3298	<.0001
Lowest Lifetime Weight	0.3702	0.0235	<.0001	0.3712	0.0235	<.0001	0.3683	0.0235	<.0001
Week	-0.1263	0.1502	0.4008	-0.0800	0.1117	0.4745	-0.1660	0.1010	0.1012
Lowest Lifetime Weight X Week	-0.0029	0.0011	0.0060	-0.0036	0.0008	<.0001	-0.0027	0.0007	0.0002

Higher intentional lifetime weight loss was associated with a greater weight loss trajectory from 0-8 weeks (β=-0.0003, p=0.0237), and approached statistical significance from 0-4 weeks (β=-0.0003, p=0.0810), and 0-12 weeks (β=-0.0002, p=0.0801). A higher frequency of lifetime intentional weight loss attempts was also associated with a greater weight loss trajectory from 0-8 weeks (β=-0.0063, p=0.0005) and 0-12 weeks (β=-0.0030, p=0.0308), but did not influence weight loss trajectory from 0-4 weeks (β=-0.0043, p=0.3054). Results are shown in Table (8).

Higher unintentional lifetime weight loss was associated with a greater weight loss trajectory from 0-8 weeks (β=0.0013, p=0.0078) and from 0-12 weeks (β=-0.0012, p=0.0067), but was not associated with the weight loss trajectory from 0-4 weeks (β=-0.0009, p=0.1477). Also, a higher frequency of lifetime unintentional weight loss occurrences was associated with weight loss trajectory from 0-4 weeks (β=-0.0219, p=0.0336), 0-8 weeks (β=-0.0288, p=<.0001), and 0-12 weeks (β=-0.0274, p=<.0001). Results are shown in Table (8).

Table 8 Association between baseline intentional and unintentional lifetime weight loss and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	88.6885	0.9499	<.0001	88.7450	0.9519	<.0001	88.6604	0.9496	<.0001
Intentional Lifetime Weight Loss	0.0225	0.0052	<.0001	0.0224	0.0052	<.0001	0.0222	0.0052	<.0001
Week	-0.4952	0.0342	<.0001	-0.5381	0.0257	<.0001	-0.0511	0.0232	<.0001
Intentional Lifetime Weight Loss X Week	-0.0003	0.0002	0.0810	-0.0003	0.0001	0.0237	-0.0002	0.0001	0.0801
Intercept	88.3679	1.0467	<.0001	88.4217	1.0314	<.0001	88.3819	1.0212	<.0001
Total Intentional Attempts	0.5382	0.1376	<.0001	0.5420	0.1356	<.0001	0.5342	0.1343	<.0001
Week	-0.5170	0.0313	<.0001	-0.5554	0.0138	<.0001	-0.5415	0.0106	<.0001
Total Intentional Attempts X Week	-0.0043	0.0042	0.3054	-0.0063	0.0018	0.0005	-0.0030	0.0014	0.0308
Intercept	91.8446	0.8051	<.0001	91.9060	0.8067	<.0001	91.7819	0.8044	<.0001
Unintentional Lifetime Weight Loss	-0.0184	0.0184	0.3177	-0.0186	0.0184	0.3126	-0.0182	0.0184	0.3210
Week	-0.5500	0.0280	<.0001	-0.5993	0.0211	<.0001	-0.5576	0.0189	<.0001
Unintentional Lifetime Weight Loss X Week	0.0009	0.0006	0.1477	0.0013	0.0005	0.0078	0.0012	0.0004	0.0067
Intercept	91.8314	0.8048	<.0001	91.9123	0.7926	<.0001	91.8172	0.7853	<.0001
Total Unintentional Attempts	-0.3165	0.3572	0.3757	-0.3221	0.3518	0.3600	-0.3166	0.3486	0.3638
Week Number	-0.5606	0.0234	<.0001	-0.6180	0.0103	<.0001	-0.5833	0.0079	<.0001
Total Unintentional Attempts X Week Number	0.0219	0.0103	0.0336	0.0288	0.0047	<.0001	0.0274	0.0036	<.0001

A higher weight goal was associated with a greater weight loss trajectory from 0-4 weeks (β=-0.0024, p=0.0103), 0-8 weeks (β=-0.0029, p=<.0001), and 0-12 weeks (β=-0.0025, p=0.0001). In addition, a higher weight loss goal was associated with a great weight loss trajectory from 0-4 weeks (β=-0.0060, p=0.0080), 0-8 weeks (β=-0.0058, p=0.0008), and 0-12 weeks (β=-0.0051, p=0.0012). Results are shown in Table (9).

Table 9 Association between baseline weight goal and weight loss goal and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	43.3921	3.2776	<.0001	43.3292	3.2830	<.0001	43.4036	3.2752	<.0001
Absolute Weight Goal	0.3174	0.0213	<.0001	0.3182	0.0213	<.0001	0.3169	0.0213	<.0001
Week	-0.1715	0.1431	0.2315	-0.1435	0.1083	0.1860	-0.1633	0.0978	0.0959
Absolute Weight Goal X Week	-0.0024	0.0009	0.0103	-0.0029	0.0007	<.0001	-0.0025	0.0006	0.0001
Intercept	77.4957	1.3993	<.0001	77.5594	1.4034	<.0001	77.4886	1.3994	<.0001
Weight Loss Goal	0.6363	0.0567	<.0001	0.6361	0.0569	<.0001	0.6340	0.0567	<.0001
Week	-0.4004	0.0562	<.0001	-0.4486	0.0427	<.0001	-0.4252	0.0385	<.0001
Weight Loss Goal X Week	-0.0060	0.0023	0.0080	-0.0058	0.0017	0.0008	-0.0051	0.0016	0.0012

Higher baseline BMI was associated with more weight at 0-4 weeks (β=2.7423, p=<.0001), 0-8 weeks (β=2.7391, p=<.0001), and 0-12 weeks (β=2.7323, p=<.0001). Higher baseline BMI influenced weight loss trajectory from 0-4 weeks (β=-0.0194, p=0.0036), 0-8 weeks (β=-0.0171, p=0.0007), and 0-12 weeks (β=-0.0149, p=0.0010). Results are shown in table (10).

Table 10 Association between baseline BMI and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	3.0381	4.1568	0.4653	3.1942	4.1752	0.4448	3.2942	4.1588	0.4289
Baseline BMI	2.7423	0.1276	<.0001	2.7391	0.1282	<.0001	2.7323	0.1277	<.0001
Week Number	0.0890	0.2176	0.6815	-0.0239	0.1639	0.8843	-0.0558	0.1475	0.7053
Baseline BMI X Week	-0.0194	0.0067	0.0036	-0.0171	0.0050	0.0007	-0.0149	0.0045	0.0010

4.5 Psychosocial Measures

4.5.1 Depression

Data for baseline depressive symptoms and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (11). Baseline depressive symptoms were not associated with weight at 0-4 weeks (β=0.0266, p=0.9115), 0-8 weeks (β=0.0332, p=0.8900), or 0-12 weeks (β=0.0345, p=0.8854). Higher baseline depressive symptoms influenced weight loss trajectory from 0-4 weeks (β=0.0190, p=0.0211), 0-8 weeks (β=-0.0157, p=0.0118), and 0-12 weeks (β=-0.0153, p=0.0065).

Table 11 Association between baseline depressive symptoms (CES-D) and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	91.5605	1.1343	<.0001	91.5885	1.1358	<.0001	91.4637	1.1321	<.0001
Total CES-D	0.0266	0.2396	0.9115	0.0332	0.2399	0.8900	0.0345	0.2392	0.8854
Week Number	-0.6058	0.0390	<.0001	-0.6332	0.0294	<.0001	-0.5909	0.0263	<.0001
Total CES-D X Week Number	0.0190	0.0082	0.0211	0.0157	0.0062	0.0118	0.0153	0.0056	0.0065

4.5.2 Health Related Quality of Life

Data for baseline health related quality of life and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (12).

Higher baseline emotional well-being was associated with a greater weight loss trajectory from 0-4 weeks (β=-0.0040, p=0.0372) and approached significance with the weight loss trajectory from 0-12 weeks (β=-0.0025, p=0.0626), but not from 0-8 weeks (β=-0.0024, p=0.1065). Additionally, baseline role mental and social function approached significantly influencing weight loss trajectory from 0-4 weeks (β=-0.0017, p=0.0845) and (β=-0.0029, p=0.0911) respectively. Baseline physical function, role physical, bodily pain, vitality, and general health did not influence weight loss trajectory.

Table 12 Association between baseline Health Related Quality of Life and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	98.5046	6.3677	<.0001	98.7729	6.3734	<.0001	98.5050	6.3535	<.0001
Physical Function	-0.07389	0.06843	0.2806	-0.07624	0.06850	0.2658	-0.07462	0.06828	0.2746
Week	-0.6360	0.2260	0.0052	-0.7929	0.1692	<.0001	-0.6986	0.1510	<.0001
Physical Function X Week	0.001070	0.002430	0.6598	0.002349	0.001821	0.1971	0.001760	0.001626	0.2791
Intercept	91.8119	3.7901	<.0001	91.9350	3.7955	<.0001	91.8594	3.7835	<.0001
Role Physical	-0.00076	0.03965	0.9848	-0.00152	0.03970	0.9694	-0.00199	0.03958	0.9598
Week	-0.3830	0.1308	0.0037	-0.4592	0.1018	<.0001	-0.4485	0.09157	<.0001
Role Physical X Week	-0.00165	0.001370	0.2283	-0.00125	0.001064	0.2390	-0.00094	0.000957	0.3279
Intercept	88.1697	4.0772	<.0001	88.2469	4.0825	<.0001	88.0236	4.0696	<.0001
Bodily Pain	0.04129	0.04701	0.3801	0.04098	0.04707	0.3841	0.04216	0.04693	0.3690
Week	-0.5828	0.1392	<.0001	-0.6333	0.1056	<.0001	-0.5586	0.09508	<.0001
Bodily Pain X Week	0.000494	0.001607	0.7583	0.000632	0.001220	0.6042	0.000242	0.001098	0.8259
Intercept	97.232	3.3738	<.0001	97.5989	3.3781	<.0001	97.3997	3.3677	<.0001
General Health	-0.08528	0.04662	0.0677	-0.08420	0.04668	0.0714	-0.08307	0.04654	0.0744
Week	-0.6759	0.1169	<.0001	-0.6641	0.08896	<.0001	-0.5952	0.08020	<.0001
General Health X Week	0.001963	0.001615	0.2244	0.001241	0.001227	0.3122	0.000834	0.001105	0.4504
Intercept	90.5859	2.3970	<.0001	90.6519	2.4000	<.0001	90.4648	2.3922	<.0001
Vitality	0.01980	0.04220	0.6391	0.01955	0.04225	0.6437	0.02079	0.04212	0.6215
Week	-0.4948	0.08407	<.0001	-0.5391	0.06314	<.0001	-0.4815	0.05653	<.0001
Vitality X Week	-0.00079	0.001476	0.5933	-0.00071	0.001112	0.5259	-0.00102	0.000994	0.3037
Intercept	86.7586	4.4817	<.0001	86.9850	4.4873	<.0001	87.0578	4.4734	<.0001
Social Function	0.05307	0.04870	0.2762	0.05113	0.04876	0.2946	0.04901	0.04861	0.3135
Week	-0.2794	0.1556	0.0734	-0.4132	0.1187	0.0006	-0.4207	0.1071	0.0001
Social Function X Week	-0.00286	0.001692	0.0911	-0.00180	0.001291	0.1624	-0.00128	0.001164	0.2721
Intercept	90.6645	2.6460	<.0001	90.8389	2.6495	<.0001	90.6749	2.6407	<.0001
Role Mental	0.01110	0.02845	0.6964	0.009733	0.02849	0.7327	0.01023	0.02840	0.7187
Week	-0.3865	0.09123	<.0001	-0.5011	0.07015	<.0001	-0.4425	0.06302	<.0001
Role Mental X Week	-0.00170	0.000981	0.0845	-0.00085	0.000753	0.2587	-0.00105	0.000676	0.1197

Intercept	89.8353	4.4477	<.0001	90.1317	4.4537	<.0001	89.9574	4.4390	<.0001
Emotional Well Being	0.02240	0.05574	0.6878	0.01929	0.05581	0.7296	0.01998	0.05563	0.7194
Week	-0.2204	0.1548	0.1553	-0.3901	0.1181	0.0011	-0.3432	0.1059	0.0013
Emotional Well Being X Week	-0.00404	0.001938	0.0372	-0.00238	0.001477	0.1065	-0.00247	0.001323	0.0626

4.5.3 Weight Loss Self-efficacy

Data for baseline weight loss self-efficacy and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (13). Higher total weight loss self-efficacy was associated with greater weight loss trajectory from 0-4 weeks (β=-0.0016, p=0.0139), 0-8 weeks (β=-0.0011, p=0.0003), and 0-12 weeks (β=-0.0010, p<.0001). Higher weight loss self-efficacy for the availability subscale was associated with a greater weight loss trajectory from 0-4 weeks (β=-0.0073, p=0.0209) and approached significance for the weight loss trajectory at 0-8 weeks (β=-0.0041, p=0.0880), but not weight loss trajectory from 0-12 weeks (β=-0.0031, p=0.1505). Weight loss self-efficacy for the positive activity subscale was also associated with a greater weight loss trajectory from 0-4 weeks (β=-0.0082, p=0.0351) and 0-12 weeks (β=-0.0054, p=0.0424); and approached significance for the weight loss trajectory from 0-8 weeks (β=-0.0056, p=0.0583). Weight loss self-efficacy for the physical discomfort subscale was associated with a greater weight loss trajectory from 0-12 weeks (β=-0.0054, p=0.0393) and approached significance for the weight loss trajectory from 0-8 weeks (β=-0.0056, p=0.0552), however not for 0-4 weeks (β=-0.0061, p=0.1165). Weight loss self-efficacy for negative emotions and social pressure subscales were not associated with the weight loss trajectory, although social pressure approached significance with the weight loss trajectory from 0-4 weeks (β=-0.0058, p=0.0747).

Table 13 Association between baseline weight loss self-efficacy and weight loss trajectory form baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	87.9782	2.7304	<.0001	88.1787	2.6899	<.0001	88.1175	2.666	<.0001
Total Weight Loss Self-Efficacy	0.0325	0.0228	0.1545	0.0314	0.0225	0.1624	0.0312	0.0222	0.1616
Week	-0.3556	0.0782	<.0001	-0.4705	0.0350	<.0001	-0.4466	0.0272	<.0001
Total Weight Loss Self-Efficacy X Week	-0.0016	0.0007	0.0139	-0.0011	0.0003	0.0003	-0.0010	0.0002	<.0001
Intercept	88.8288	1.9207	<.0001	88.8857	1.9230	<.0001	88.8088	1.9170	<.0001
Negative Emotion	0.1321	0.0821	0.1084	0.1319	0.0823	0.1091	0.1299	0.0820	0.1133
Week	-0.4627	0.0662	<.0001	-0.5050	0.0501	<.0001	-0.4784	0.0450	<.0001
Negative Emotion X Week	-0.0034	0.0029	0.2306	-0.0033	0.0022	0.1234	-0.0027	0.0019	0.1655
Intercept	89.7634	1.8021	<.0001	89.9100	1.8046	<.0001	89.8355	1.7989	<.0001
Availability	0.1057	0.09058	0.2437	0.1004	0.0907	0.2685	0.09793	0.0904	0.2789
Week	-0.4072	0.0622	<.0001	-0.5039	0.0473	<.0001	-0.4814	0.0426	<.0001
Availability X Week	-0.0073	0.0032	0.0209	-0.0041	0.0024	0.0880	-0.0031	0.0022	0.1505
Intercept	89.7757	2.3106	<.0001	89.9419	2.3136	<.0001	89.8437	2.3061	<.0001
Social Pressure	0.0819	0.0938	0.3828	0.0771	0.0939	0.4118	0.0762	0.0936	0.4156
Week	-0.4018	0.0796	<.0001	-0.5049	0.0606	<.0001	-0.4761	0.0546	<.0001
Social Pressure X Week	-0.0058	0.0033	0.0747	-0.0031	0.0025	0.2083	-0.0026	0.0022	0.2371
Intercept	86.5652	3.0209	<.0001	86.6534	3.0246	<.0001	86.5397	3.0150	<.0001
Physical Discomfort	0.1934	0.1108	0.0812	0.1921	0.1109	0.0835	0.1919	0.1106	0.0828
Week	-0.3776	0.1055	0.0004	-0.4299	0.0793	<.0001	-0.3950	0.0711	<.0001
Physical Discomfort X Week	-0.0061	0.0039	0.1165	-0.0056	0.0029	0.0552	-0.0054	0.0026	0.0393
Intercept	90.0851	2.9801	<.0001	90.2703	2.9842	<.0001	90.1424	2.9744	<.0001
Positive Activity	0.0635	0.1124	0.5723	0.0582	0.1125	0.6051	0.0585	0.1121	0.6019
Week	-0.3289	0.1033	0.0016	-0.4351	0.0780	<.0001	-0.3997	0.0703	<.0001
Positive Activity X Week	-0.0082	0.0039	0.0351	-0.0056	0.0030	0.0583	-0.0054	0.0027	0.0424

4.5.4 Physical Activity Self-efficacy

Data for baseline physical activity self-efficacy and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (14). Baseline physical activity self-efficacy was not associated with weight at 0-4 weeks (β=1.1355, p=0.2046), 0-8 weeks (β=1.1163, p=0.2128), or 0-12 weeks (β=1.1253, p=0.2075). Higher baseline physical activity self-efficacy approached significantly influencing weight loss trajectory from 0-12 weeks (β=-0.0409, p=0.0528), but did not influence weight loss trajectory from 0-4 weeks (β=-0.0500, p=0.1073) or 0-8 weeks (β=-0.0377, p=0.1098).

Table 14 Association between baseline physical activity self-efficacy and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	88.4061	2.6839	<.0001	88.5137	2.6873	<.0001	88.3674	2.6785	<.0001
Total PASE	1.1355	0.8945	0.2046	1.1163	0.8956	0.2128	1.1253	0.8927	0.2075
Week	-0.3927	0.0929	<.0001	-0.4678	0.0709	<.0001	-0.4179	0.0635	<.0001
Total PASE X Week	-0.0500	0.0310	0.1073	-0.0377	0.0236	0.1098	-0.0409	0.0211	0.0528

4.5.5 Weight Loss Outcome Expectations

Data for baseline weight loss outcome expectations and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (15). Baseline weight loss outcome expectations were not associated with weight at 0-4 weeks (β=-0.1145, p=0.2986), 0-8 weeks (β=-0.1118, p=0.3105), or 0-12 weeks (β=-0.1104, p=0.3151). However, weight loss outcome expectations influenced weight loss trajectory from 0-4 weeks (β=0.0101, p=0.0077), 0-8 weeks (β=0.0087, p=0.0023), and 0-12 weeks (β=0.0081, p=0.0016).

Table 15 Association between baseline weight loss outcome expectations and weight loss trajectory form baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	96.2808	4.4681	<.0001	96.2258	4.4736	<.0001	96.0485	4.4589	<.0001
Total Benefits	-0.1145	0.1101	0.2986	-0.1118	0.1103	0.3105	-0.1104	0.1099	0.3151
Week Number	-0.9408	0.1532	<.0001	-0.9244	0.1154	<.0001	-0.8585	0.1034	<.0001
Total Benefits X Week Number	0.0101	0.0038	0.0077	0.0087	0.0029	0.0023	0.0081	0.0026	0.0016

4.5.6 Physical Activity Outcome Expectations

Data for baseline physical activity outcome expectations and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (16). Baseline total physical activity benefits were not associated with weight at 0-4 weeks (β=-0.2628, p=0.8214), 0-8 weeks (β=-0.2833, p=0.8079), or 0-12 weeks (β=-0.2594, p=0.8233). In addition, the baseline subscales for image benefits, psychological benefits, and health benefits were not associated with weight at 0-4 weeks, 0-8 weeks, or 0-12 weeks.

Total physical activity benefits influenced weight loss trajectory from 0-8 weeks (β=0.0844, p=0.0053) and 0-12 weeks (β=0.0746, p=0.0059), and approached significance at 0-4 weeks (β=0.0736, p=0.0670). The subscale image benefits influenced weight loss trajectory from

0-4 weeks (β=0.0762, p=0.0284) 0-8 weeks (β=0.0872, p=0.0008), and 0-12 weeks (β=0.0642, p=0.0062). The subscale psychological benefits influence weight loss trajectory from 0-8 weeks (β=0.0434, p=0.0459) and 0-12 weeks (β=0.0470, p=0.0158), but did not influence weight loss trajectory from 0-4 weeks (β=0.0333, p=0.2467). In contrast, the health benefits subscale did not influence weight loss trajectory.

Table 16 Association between baseline physical activity outcome expectations and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	92.7292	4.8135	<.0001	92.8654	4.8192	<.0001	92.6474	4.8028	<.0001
Total Benefits	-0.2628	1.1639	0.8214	-0.2833	1.1653	0.8079	-0.2594	1.1614	0.8233
Week	-0.8378	0.1639	<.0001	-0.9214	0.1247	<.0001	-0.8405	0.1116	<.0001
Total Benefits X Week	0.0736	0.0401	0.0670	0.0844	0.0302	0.0053	0.0746	0.0271	0.0059
Intercept	92.4026	3.0288	<.0001	92.5084	3.0325	<.0001	92.4341	3.0225	<.0001
Psych. Benefits	-0.2126	0.8355	0.7992	-0.2278	0.8365	0.7854	-0.2408	0.8337	0.7727
Week Number	-0.6544	0.1040	<.0001	-0.7294	0.0786	<.0001	-0.7014	0.0703	<.0001
Psych. Benefits X Week	0.0333	0.0288	0.2467	0.0434	0.0217	0.0459	0.0470	0.0195	0.0158
Intercept	94.2187	4.4533	<.0001	94.3656	4.4584	<.0001	93.9746	4.4441	<.0001
Image Benefits	-0.5872	1.0061	0.5596	-0.6089	1.0072	0.5456	-0.5469	1.0040	0.5860
Week	-0.8695	0.1533	<.0001	-0.9573	0.1151	<.0001	-0.8164	0.1035	<.0001
Image Benefits X Week	0.0762	0.0347	0.0284	0.0872	0.0261	0.0008	0.0642	0.0234	0.0062
Intercept	88.3925	5.5395	<.0001	88.4162	5.5459	<.0001	88.1642	5.5274	<.0001
Health Benefits	0.6992	1.1764	0.5524	0.7054	1.1777	0.5493	0.7337	1.1738	0.5320
Week	-0.7799	0.1919	<.0001	-0.7744	0.1454	<.0001	-0.6867	0.1299	<.0001
Health Benefits X Week	0.0520	0.0408	0.2027	0.0423	0.0309	0.1711	0.0322	0.0276	0.2443

4.5.7 Weight Loss Barriers

Data for baseline weight loss barriers and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (17). Baseline weight loss barriers were not associated with weight at 0-4 weeks (β=-0.0886, p=0.3151), 0-8 weeks (β=-0.0896, p=0.3100), or 0-12 weeks (β=-0.0895, p=0.3088). In addition, weight loss barriers did not influence weight loss trajectory from 0-4 weeks (β=0.0003, p=0.9187), 0-8 weeks (β=0.0009, p=0.6920), or 0-12 weeks (β=0.0007, p=0.7241).

Table 17 Association between baseline weight loss barriers and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	95.3534	3.8165	<.0001	95.4413	3.8191	<.0001	95.3186	3.8063	<.0001
Total Barriers	-0.0886	0.0881	0.3151	-0.0896	0.0882	0.3100	-0.0895	0.0879	0.3088
Week Number	-0.5519	0.1320	<.0001	-0.6135	0.0998	<.0001	-0.5653	0.0893	<.0001
Total Barriers X Week Number	0.0003	0.0030	0.9187	0.0009	0.0023	0.6920	0.0007	0.0021	0.7241

4.5.8 Physical Activity Barriers

Data for baseline physical activity barriers and weight loss trajectory from baseline to 4, 8, and 12 weeks are in table (18). Higher total baseline physical activity barriers were associated with low weight from 0-4 weeks (β=-3.2951, p=0.0071), 0-8 weeks (β=-3.2850, p=0.0073), and 0-12 weeks (β=-3.3424, p=0.0061). However, total baseline physical activity barriers did not influence the weight trajectory observed from 0-4 weeks (β=0.0070, p=0.8721), 0-8 weeks (β=-0.0012, p=0.7334), or 0-12 weeks (β=0.0080, p=0.7872) as represented by the Total Barriers X Week Number interaction.

A similar pattern was observed for both baseline physical activity effort barriers and baseline physical activity obstacle barriers. Baseline physical activity effort barriers were inversely associated with weight from 0-4 weeks (β=-2.0194, p=0.0396), 0-8 weeks (β=-1.9796, p=0.0439), and 0-12 weeks (β=-0.5555, p=.0400); however, the trajectory of weight loss from 0-4 weeks (β=0.0285, p=0.4066), 0-8 weeks (β=-0.0037, p=0.8875), and 0-12 weeks (β=0.0056, p=0.8098) did not differ by baseline physical activity barrier score.

Baseline physical activity obstacle barriers were inversely associated with weight from 0-4 weeks (β=-2.6613, p=0.0074), 0-8 weeks (β=-2.6586, p=0.0074), and 0-12 weeks (β=-2.7029, p=.0063); however, the trajectory of weight loss from 0-4 weeks (β=-0.0171, p=0.6226), 0-8 weeks (β=-0.0250, p=0.3419), and 0-12 weeks (β=-0.0102, p=0.6678) did not differ by baseline physical activity barrier score. Additionally, physical activity time barriers were not significantly associated with weight or weight loss trajectories.

Table 18 Association between baseline physical activity barriers and weight loss trajectory from baseline to 4, 8, and 12 weeks.

	Weight Change Weeks 0-4			Weight Change Weeks 0-8			Weight Change Weeks 0-12		
Effect	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value	Estimate	Standard Error	P-Value
Intercept	100.57	3.3337	<.0001	100.60	3.3378	<.0001	100.63	3.3254	<.0001
Total Barriers	-3.2951	1.2219	0.0071	-3.2850	1.2234	0.0073	-3.3424	1.2188	0.0061
Week	-0.5569	0.1178	<.0001	-0.5490	0.08947	<.0001	-0.5595	0.0806	<.0001
Total Barriers X Week	0.0070	0.04328	0.8721	-0.0112	0.0328	0.7334	0.0080	0.0295	0.7872
Intercept	95.2632	2.3427	<.0001	95.3819	2.3449	<.0001	95.3266	2.3367	<.0001
Time Barriers	-1.2954	0.8137	0.1117	-1.3187	0.8144	0.1056	-1.3418	0.8116	0.0984
Week	-0.5391	0.0822	<.0001	-0.6024	0.0623	<.0001	-0.5855	0.0558	<.0001
Time Barriers X Week	0.0014	0.0285	0.9614	0.0095	0.0216	0.6600	0.0180	0.0194	0.3535
Intercept	97.7703	3.0213	<.0001	97.7030	3.0262	<.0001	97.6739	3.0160	<.0001
Effort Barriers	-2.0194	0.9800	0.0396	-1.9796	0.9816	0.0439	-2.0101	0.9783	0.0400
Week	-0.6258	0.1059	<.0001	-0.5685	0.0803	<.0001	-0.5555	0.0721	<.0001
Effort Barriers X Week	0.0285	0.0344	0.4066	-0.0037	0.0260	0.8875	0.0056	0.0234	0.8098
Intercept	97.2411	2.2050	<.0001	97.2877	2.2079	<.0001	97.2611	2.1999	<.0001
Total Obstacle Barriers	-2.6613	0.9909	0.0074	-2.6586	0.9922	0.0074	-2.7029	0.9886	0.0063
Week	-0.5019	0.0772	<.0001	-0.5248	0.0585	<.0001	-0.5154	0.0528	<.0001
Obstacle Barriers X Week	-0.0171	0.0348	0.6226	-0.0250	0.0263	.3419	-0.0102	0.0237	0.6678

4.6 Standardized Beta Coefficient Results

A summary of the standardized beta coefficients for the association between each of the baseline variables examined with weight loss trajectory from baseline to 4, 8, and 12 weeks are shown in Tables (19-21). The beta coefficient represents the weight change per week for each one standard deviation change in the baseline variable. The weight change that would result from a one standard deviation in the variable is computed as the following:

Weight Change from Weeks 0-4 = beta coefficient * 4 weeks

Weight Change from Weeks 0-8 = beta coefficient * 8 weeks

Weight Change from Weeks 0-12 = beta coefficient * 12 weeks

For example, for Total Sleep (Table 19), with a higher score representing poorer sleep, findings suggest that on average, participants who are one standard deviation higher on total sleep lose approximately 0.24 kg, 0.34 kg, and 0.38 kg less weight over the first 4, 8, and 12 weeks, respectively. When the same method was applied to weight history factors (Table 20) such as weight loss goal, for example, a one standard deviation increase in this variable would result in 0.27 kg, 0.55 kg, and 0.77 kg more weight loss over the first 4, 8, and 12 weeks respectively. Moreover, for depressive symptoms (Table 21) measured by the CES-D, participants who are one standard deviation higher on depressive symptoms lose 0.23 kg, 0.32 kg, and 0.48 kg less per week, on average, across weeks 0-4, 0-8, and 0-12, respectively.

Table 19 Standardized beta coefficients for the association between baseline current eating, physical activity, and sleep behaviors with weight loss trajectory from baseline to 4, 8, or 12 weeks.

Category	Variable	Subscale	Weight Change per Week (kg)		
			Weeks 0-4	Weeks 0-8	Weeks 0-12
Current Behaviors	Eating Behavior		0.03096	0.03587	0.02848
	Physical Activity	Recreational MVPA	0.02117	0.03570	0.02719
		Home MVPA	-0.00966	-0.00260	-0.00674
		Occupational MVPA	-0.04537	-0.02072	-0.02705
		Sedentary Behavior	-0.02312	-0.02679	-0.01838
	Sleep	Total	0.06071	0.04233	0.03194
		Sleep Quality	0.03981	0.02349	0.01323
		Sleep Duration	0.02432	0.02608	-0.00820
		Sleep Disturbance	0.01327	0.00569	-0.00164
		Sleep Latency	0.06860	0.03961	0.02906
		Sleep Daytime Dysfunction	-0.01810	-0.00291	0.00472
		Sleep Medication	0.03719	0.02089	0.01822
		Sleep Efficiency	0.04034	0.02544	0.02420

Table 20 Standardized beta coefficients for the association between baseline weight history factors with weight loss trajectory from baseline to 4, 8, or 12 weeks.

Category	Variable	Subscale	Weight Change per week (kg)		
			Weeks 0-4	Weeks 0-8	Weeks 0-12
Weight History	Parental Weight Status	Father Overweight/Obesity Status	0.07482	0.06763	0.04558
		Mother Overweight/Obesity Status	0.00861	0.02069	0.02836
	Child / Adolescent Weight Status		-0.04432	-0.04789	-0.03771
	Lifetime Weight	Highest Lifetime Weight	-0.09535	-0.1057	-0.08831
		Lowest Lifetime Weight	-0.07472	-0.08687	-0.06588
	Lifetime Weight Loss	Intentional Lifetime Weight Loss	-0.08574	-0.05360	-0.02992
		Unintentional Lifetime Weight Loss	0.06277	0.05512	0.04891
	Lifetime Weight Loss Episodes	Intentional Lifetime Episodes	-0.02217	-0.03268	-0.01564
		Unintentional Lifetime Episodes	0.04319	0.05671	0.05399
	Absolute Weight Goal	Absolute Weight Goal	-0.06566	-0.07487	-0.07128
	Weight Loss Goal	Weight Loss Goal	-0.06641	-0.06833	-0.06404
	Baseline BMI	Baseline BMI	-0.07679	-0.07046	-0.06418

Table 21 Standardized beta coefficients for the association between baseline psychosocial factors with weight loss trajectory from baseline to 4, 8, or 12 weeks.

Category	Variable	Subscale	Weight Change per week (kg)		
			Weeks 0-4	Weeks 0-8	Weeks 0-12
Psychosocial Measures	Depressive Symptoms		0.05760	0.04401	0.04070
	Health Related Quality of Life	Physical Function	0.01404	0.03009	0.02887
		Role Physical	-0.02727	-0.00997	-0.01011
		Bodily Pain	0.00624	0.01001	0.00264
		General Health	0.03038	0.02369	0.01896
		Vitality	-0.01244	-0.00675	-0.01836
		Social Function	-0.04452	-0.03200	-0.01649
		Role Mental	-0.04324	-0.02125	-0.03090
		Emotional Well Being	-0.05078	-0.02235	-0.02868
	Weight Loss Self-efficacy	Total	-0.05134	-0.03341	-0.03090
		Negative Emotion	-0.03490	-0.02802	-0.02667
		Availability	-0.06034	-0.02909	-0.02294
		Social Pressure	-0.04671	-0.02216	-0.01895
		Physical Discomfort	-0.03928	-0.03269	-0.03093
		Positive Activity	-0.05206	-0.03011	-0.02919
	Physical Activity Self-efficacy		-0.04416	-0.03032	-0.03293
	Expected Weight Loss Benefits		0.06767	0.05540	0.05433
	Expected Physical Activity Benefits	Total	0.04502	0.05442	0.05509
		Psychological	0.02719	0.03971	0.04884
		Image	0.05571	0.06243	0.05128
		Health	0.03087	0.02924	0.02799
	Weight Loss Barriers		0.00265	0.00778	0.00620
	Physical Activity Barriers	Total	0.00699	-0.00996	0.00692
		Time	0.00544	0.00789	0.02301
		Effort	0.02135	-0.00276	0.00391
		Obstacle	-0.01439	-0.02428	-0.01034

5.0 Discussion

The purpose of this study was to examine baseline predictors of weight loss trajectory from 0-4, 0-8, and 0-12 weeks in a behavioral weight loss intervention. The results demonstrate there were several baseline factors that influenced initial weight loss trajectory, and these are shown in the summary table in Chapter 4 (Tables 19-21). Understanding baseline factors that predict initial weight loss trajectory within weight loss interventions is important because initial weight loss is predictive of long-term weight loss success [72]. In fact, the results from this current study also support that weight loss from 0-4, 0-8, and 0-12 weeks is associated with weight loss at 6 and 12 months. The relationship between early weight loss and long-term weight loss has led to the investigation of whether additional early support when offered to early non-responders impacts weight loss, with some limited studies demonstrating early non-responders still lose less weight compared to early responders across the intervention [53]. This may suggest that a better understanding of the factors that contribute to early non-response may be important for offering the appropriate type of early support, or it may be important to delay intervention until baseline factors associated with early response are addressed. Below a discussion of the findings and potential implications is provided.

5.1 Current Eating, Physical Activity, and Sleep Behaviors

Baseline eating behaviors, assessed by the Eating Behavior Inventory (EBI) were not associated with early weight loss (Table 1). Eating behaviors consist of adaptive eating behaviors such as carefully watching the quantity of food that you eat, daily self-weighing, recording the type and quantity of food that you eat, consciously trying to slow down eating rate, among others; while maladaptive eating behaviors include eating quickly compared to most other people, eating and just not being able to stop, emotions causing you to eat, watching TV, reading, working, or doing other things while eating, etc. Studies exploring eating behavior at baseline as assessed by the EBI typically report mixed results regarding the predictive ability of baseline EBI on weight loss outcomes. For example, of the two studies reporting an association between baseline EBI and weight loss, one study found lower baseline EBI was predictive of more weight loss [83], while another study found higher baseline EBI is predictive of more weight loss [93]. In contrast to baseline EBI scores, increases in EBI scores within a weight loss intervention are consistently associated with greater weight loss [66, 74, 81-86, 88-92]. Thus, this may suggest that the ability to alter eating behaviors within the intervention may be more predictive than the eating behaviors that exist prior to initiating a weight loss intervention.

In this study, baseline levels of physical activity and sedentary behavior generally were not predictive of early weight loss (Tables 2-3), and this included occupational, home, and recreational physical activity. A potential explanation for this finding is that this study recruited individuals who self-reported low levels of leisure-time physical activity and excluded highly active individuals. Thus, the lack of variability in the amount of baseline physical activity among study participants may have contributed to this finding, particularly as it relates to recreational activity. However, it is also important to highlight that even engagement in higher levels of baseline occupational or home activity was not predictive of early weight loss success. Moreover, sedentary behavior at baseline was not predictive of early weight loss. Again, this may be a result of the nature of the study sample that was recruited specifically due to their lack of regular and sufficient participation in moderate-to-vigorous leisure-time physical activity. Despite these findings, increasing physical activity within the context of a behavioral weight loss intervention is important and has been shown to enhance short-term weight loss and to be associated with improved long-term weight loss and weight loss maintenance [99, 101, 103-105].

A higher baseline score on the PSQI, considered a measure of overall sleep quality, was associated with less initial weight loss in this study (Table 4). This is consistent with a study by Thomson et al. that found poor baseline sleep quality attenuated the weight loss achieved in a behavioral weight loss intervention [146]. Two studies also found individuals who reported shorter baseline sleep duration and poor baseline sleep quality predicted less weight loss success compared to individuals who reported longer baseline sleep duration and higher baseline sleep quality [145, 146]. Interestingly, while total baseline sleep quality was associated with early weight loss in this study, the subscales of sleep duration and sleep quality were not associated with early weight loss (Table 4).

A higher baseline sleep efficiency score, reflective of more time spent in bed not sleeping, was associated with less weight loss from 0-4 weeks, 0-8 weeks, and 0-12 weeks (Table 4). In addition a higher baseline sleep latency score, reflective of the amount of time it takes to fall asleep, was associated with less weight loss from 0-4 weeks and 0-8 weeks, but not from 0-12 weeks. Because sleep was subjectively reported via questionnaire, it is possible participants are able to more accurately recall the amount of time they spend in bed not sleeping and the amount of time it takes to fall asleep, but may have more difficulty recalling information for other sleep subscales; and this may reflect why sleep efficiency and sleep latency influenced weight loss response more significantly. Successful weight loss has been shown to improve sleep quality in individuals diagnosed with sleep apnea [148, 297] and there is consistent evidence that poor sleep is associated with a blunted weight loss response [145, 146, 148]. Given these findings, sleep efficiency and sleep latency may need to be targeted prior to or early on within behavioral weight loss intervention for selective individuals.

5.2 Weight History

Studies have reported that children with parents with overweight or obesity have increased odds of becoming overweight in childhood [154-157], although there is limited evidence on the impact of parental overweight or obesity status on adults participating in a behavioral weight loss intervention. Our study found that a father with overweight or obesity was associated with less early weight loss for the adult participant, whereas having a mother with overweight or obesity did not appear to be associated with weight loss of the adult participant (Table 5). A study exploring parental weight status and the odds of becoming obese in childhood found children who had a father with overweight or obesity and mother of normal weight had an increased odds of becoming obese in childhood; however, the odds were not increased when the mother had overweight or obesity and the father was normal weight [298]. This may suggest that a father's weight status may influence the weight status in childhood, and the current study may support that the father's weight status may also be associated with early weight loss success in adults seeking weight loss through a behavioral intervention. Whether this is due to biological, environmental, or other influences is not clear and warrants additional investigation.

Participants in the current study who reported a greater presence of overweight or obesity prior to age 18 had a greater weight loss across 0-4 weeks, 0-8 weeks and 0-12 weeks (Table 6). One study exploring adolescent onset of overweight or obesity compared to adult onset found no association between the age of overweight or obesity onset and weight loss outcomes in a behavioral weight loss intervention [87]. However, another study found childhood obesity status was associated with less weight loss in a behavioral weight loss intervention [153]. These findings are in contrast to the result of this current study. While weight status as a child may influence weight loss within a behavioral intervention, the results do not appear to be consistent across studies the studies that have examined this research question. This may suggest that additional research is needed to understand if weight status as a child influences weight loss in adults with overweight or obesity.

Participants who reported a higher absolute adult lifetime weight had greater early weight loss in this study (Table 7). Moreover, participants who reported the lowest absolute adult lifetime weight had less early weight loss in this study (Table 7). To our knowledge, studies have not specifically reported on level of maximum or minimum lifetime weight as a predictor of weight loss; however, these findings may suggest that these are important factors to consider. These findings may suggest that a higher maximal lifetime weight will not hinder one's ability to lose weight within a behavioral program, at least across the initial 4 to 12 weeks. However, a lower minimal lifetime weight may contribute to less initial weight loss, yet the mechanism for this finding is not able to be determined within the context of this study, and this warrants additional investigation.

A higher number of prior intentional weight loss attempts was associated with greater early weight loss in this study (Table 8). In contrast, reviews have reported that fewer previous weight loss attempts are predictive of weight loss within a behavioral intervention [36, 38]. However, similar to the current study, others have also reported that more previous attempts is predictive of greater weight loss, particularly when the previous attempts have resulted in greater magnitudes of weight loss [198, 199]. Additionally, within the National Weight Control Registry, it appears that individuals who are successful with long-term weight loss report magnitudes of lifetime weight loss that are higher than the average typically reported by individuals who enter behavioral weight loss interventions [105, 293]. Consistent with these findings, in the current study, participants who reported a greater magnitude of lifetime weight loss at baseline had greater early weight loss across 0-8 weeks and approached statistical significance across 0-4 weeks and 0-12 weeks (Table 8). These findings may suggest that previous weight loss attempts and lifetime weight loss are important baseline factors that influence early weight loss trajectory, and interventions should consider whether past attempts at weight loss have been successful and use this information to better individualize behavioral interventions. For example, if intervention strategies to influence weight are similar to strategies that have been unsuccessful in the past it is likely that individuals will be unsuccessful at implementing these strategies and a different approach to weight loss is warranted.

Another interesting finding in this study is that participants who reported greater magnitudes of unintentional weight loss and a greater number of unintentional weight loss episodes across their lifespan had a less early weight loss across 0-8 weeks and 0-12 weeks (Table 8). While unintentional weight loss history within the context of weight loss treatment has not been explored, cross-sectionally unintentional weight loss is associated higher mortality and major cardiovascular events [299]. It is possible that unintentional weight loss may be reflective of poorer overall health, and this may partially explain why unintentional weight loss might be associated with less early weight loss within a behavioral weight loss intervention. Thus, it may be important to address the cause of the unintentional weight loss prior to behavioral intervention and future studies should explore the association between unintentional weight loss and weight loss outcomes.

Participants who reported a larger weight loss goal had greater early weight loss (Table 9). Reviews find mixed evidence of higher baseline weight change goals predicting weight loss, where higher goals predict more weight loss for some individuals and less weight loss for other individuals [36, 38]. It may be that higher weight loss goals that are achievable are beneficial for weight loss; however, factors to identify the magnitude of achievable weight loss for different individuals are unknown. Thus, based on these findings, in otherwise healthy adults with overweight or obesity, interventions to reduce weight loss goals do not appear justified, but rather enhancing the expectation of the weight loss that can be achieved may be more beneficial to enhancing weight loss success. Moreover, it may also be important to better understand for whom a higher or lower weight loss goal may be most beneficial within the context of a behavioral intervention.

Higher BMI at baseline was associated with greater early weight loss in the current study (Table 10). This is consistent with evidence found in literature reviews [36, 38], although some individual studies included in these reviews do not support this association [38]. In fact, there is some evidence that the predictive nature of baseline BMI may be most pronounced in studies where the baseline BMI is greater than 31 kg/m^2 [36], and the average baseline BMI in our study was 32.4 kg/m^2, which may have contributed to this finding. Thus, these findings may suggest that individuals with the highest levels of obesity can be very successful, at least during the initial weeks of a behavioral intervention; however, whether initial BMI is predictive of greater long-term weight loss success is not well understood and warrants additional research.

5.3 Psychosocial Measures

Individuals who had higher baseline depressive symptoms had a less weight loss across 0-4 weeks, 0-8 weeks, and 0-12 weeks (Table 11). This is in support of other studies that have found individuals who had higher baseline depressive symptoms were less adherent to behavioral weight loss interventions [279, 280, 282, 285], had higher dropout [280, 281, 283], and lost less weight [284, 285] compared to individuals who had lower baseline depressive symptoms. In contrast, reviews find mixed evidence of baseline depression being predictive of weight loss [36, 38]. However, reviews pool multiple measures of depression together such as the Beck Depression Inventory (BDI) and the Center for Epidemiological Studies Depression Scale (CES-D), and its possible the relationship between depression and weight loss may be sensitive to the scale used to measure depressive symptoms. For example, two large studies that used the BDI to measure depressive symptoms did not find baseline depressive symptoms were predictive of weight loss [194, 286, 287]. Conversely, two studies that used the CES-D to measure depressive symptoms found higher baseline depressive symptoms were associated with less weight loss [284, 285], and the current study also used the CES-D to assess depressive symptoms.

In this study, individuals with self-reported clinical depression were excluded; however, we still found that individuals with higher depressive symptoms at baseline experienced less initial weight loss compared to individuals who had lower depressive symptoms. In a study of individuals who were diagnosed with major depression, individuals randomized to the behavioral weight loss intervention with a depression treatment arm lost more weight than individuals who did not receive treatment for depression, and improvement in depressive symptoms was associated with more weight loss in the depression treatment arm [278]. Thus, it may be important to treat depressive symptoms before beginning a behavioral weight loss intervention or to consider treatment for depression symptoms within a behavioral weight loss intervention, which may enhance initial weight loss response.

Among health-related quality of life (SF-36) sub-scales, individuals with lower baseline emotional well-being had less initial weight loss (Table 12). Similar to depression symptoms, lower emotional well-being reflects a higher amount of time being a very nervous person, feeling so down in the dumps that nothing could cheer you up, not feeling calm or peaceful, feeling downhearted and blue, and not being happy over the last four weeks. This suggests individuals with lower emotional well-being may benefit from treatment targeting this domain before initiating or early within a behavioral weight loss intervention, and this may enhance their early weight loss response. The lack of other sub-scales within the mental health domain being associated with early weight loss response may reflect the nature of this sample, which was generally healthy and was not receiving treatment of psychological health concerns at baseline, and therefore should be interpreted with caution.

In contrast to the mental health domain, none of the physical domain sub-scales in health related quality of life were predictive of early weight loss trajectory. There is evidence from past research that the relationship between higher BMI and lower quality of life is more consistent in the physical domain compared to the mental health domain [255, 257, 258], and studies that find baseline quality of life predictive of weight loss success are limited to findings specific to the physical domain [39, 40, 244]. Higher physical function is related to reporting that you are not limited at all in activities ranging from bathing or dressing to vigorous activities such as running, lifting heavy objects or participating in strenuous sports. Participants in this study generally reported higher levels of physical function (Table 12). Additionally, participants reported high levels for role limitations, indicating physical health did not cut down on their time spent on work or other activities, limit their work or activities, cause difficulty at work or with activity, or cause them to accomplish less than they would like (Table 12). It is possible that because this population was a generally healthy sample of weight loss seeking participants, their physical quality of life was not very low and thus did not affect their response to treatment. The findings suggest that baseline physical health does not limit a generally healthy population of treatment seeking individuals and that other factors are likely more important in relation to weight loss.

Individuals who had higher total baseline weight loss self-efficacy had a weight loss trajectory indicative of greater weight loss from baseline to 4 weeks, 8 weeks, and 12 weeks (Table 13). In addition, individuals with higher scores in the sub-scales of positive activity, food availability, and physical discomfort also had a greater weight loss trajectory from baseline to 4 weeks, 8 weeks, and 12 weeks. Previous studies have found higher baseline weight loss self-efficacy is predictive of greater weight loss within a behavioral weight loss intervention [166, 194, 218-220], however studies pooled into reviews find mixed [36] and inconsistent evidence that weight loss self-efficacy predicts weight loss success [38].

Reviews typically examined total weight loss self-efficacy and do not consider individual sub-scales within the weight loss self-efficacy domain. However, in the current study, the sub-scales of weight loss self-efficacy were also examined. The sub-scale of positive activity reflects one's ability to resist eating while performing other activities such as watching television, eating, before going to bed, and when happy. In this current study, higher scores on this sub-scale were associated with a greater weight loss across weeks 0-4 weeks and 0-12 and approached significance for weeks 0-8 (Table 13). Two previous studies found higher baseline positive activity was predictive of weight loss success [210, 220]. Given these findings it may be beneficial to include additional intervention strategies specific to this domain of weight loss self-efficacy prior to engaging in weight loss or very early in the weight loss process, with a particular focus on those individuals who report low self-efficacy in these areas.

Self-efficacy for food availability reflects one's ability to control or resist eating on weekends, when presented with many different foods, when at a party, or when high calorie foods are available. In this study, higher self-efficacy for food availability was associated with greater weight loss across weeks 0-4 weeks and approached statistical significance from 0-8 weeks, but was not associated with greater weight loss across weeks 0-12. While we did not include a specific measure of dietary restraint, these findings are related to controlling or resisting eating and may be consistent with the dietary restraint literature demonstrating a similar association with weight loss [300-302]. Thus, these findings highlight the importance of addressing strategies to facilitate control of eating under a variety of circumstances and to particularly target these strategies to those individuals with lower levels of self-efficacy for food availability early in the intervention.

This study also showed that weight loss self-efficacy subscales for higher self-efficacy for physical discomfort was associated with weight loss across weeks 0-12 and approached significance across weeks 0-8, and self-efficacy related to social pressure approached significance from 0-4 weeks. The sub-scale of physical discomfort reflects the ability to resist eating when feeling run down, when experiencing a headache, when experiencing pain, or when feeling uncomfortable. The sub-scale of social pressure reflects the belief in one's ability to resist eating when needing to refuse food offered by others and refusing a second helping of food, when pressured to eat by others, or concern that others will be upset if you do not eat. Thus, it may be important to address the role of food and eating when attempting to cope with physical ailments and to address how to resist food when faced with social pressures to eat early in the weight loss process.

The weight loss self-efficacy subscale of negative emotions reflects one's belief in their ability to resist eating when anxious, depressed, angry, or when they experienced failure. This study showed that self-efficacy for negative emotions did not influence weight loss trajectory across any of the early weight loss periods. This finding is not consistent with other studies that have shown an association between weight loss self-efficacy for negative emotions and weight loss [220]. However, the study conducted by Presnell et al. was conducted on patients enrolled in a residential obesity treatment program, whereas the current study was conducted as an outpatient weight loss program, and these differences may have influenced the findings. Given that the current study also showed that depressive symptoms and emotional well-being were associated with weight loss, additional consideration may need to be given to addressing how to control or resist eating in response to a variety of emotional stimuli for some patients when entering a weight loss program.

Baseline physical activity self-efficacy was not significantly associated with early weight loss observed across 0-4 or 0-8 weeks, and only approached significance with weight loss across 0-12 weeks (Table 14). The measure of physical activity self-efficacy used in this study examined the confidence one has that they can be physically active when they are tired, in a bad mood, do not feel they have the time, are on vacation, or when it is raining or snowing. The lack of an association between baseline physical activity and self-efficacy and weight loss in the current study may reflect the nature of the questions used to assess this domain, which may not capture the key aspects that influence physical activity self-efficacy in sedentary adults with overweight or obesity who are initiating a behavioral weight loss intervention.

The evidence from reviews suggests baseline physical activity self-efficacy is not consistently associated with weight loss success [36, 38]. However, in contrast, several individual studies have found an association of baseline physical activity self-efficacy and weight loss [39, 166, 194, 227]. In other studies baseline physical activity self-efficacy has been found to predict weight loss at 8 weeks [227] and at 2-3 years [194], but not at 6 months [194, 227], it may be important to consider additional factors that may explain when baseline physical activity self-efficacy may be important. Thus, it appears that additional research is needed to understand the association between physical activity self-efficacy and weight loss within the context of a behavioral intervention.

Participants who had higher expectations of the benefits of weight loss had a lower weight loss trajectory across weeks 0-4, 0-8, and 0-12 (Table 15). Given this finding, it may be important to better understand why individuals with greater knowledge of the benefits of weight loss lose less weight early within a behavioral weight loss intervention. However, there is limited information in the literature to support whether outcome expectations of weight loss are predictive of weight loss success. Moreover, the questionnaire used in this study to assess expected benefits of weight loss has not been tested for validity, reliability, or other psychometric properties, and this may have also impacted the results. Thus, additional research appears to be warranted to better understand how to assess expectations of weight loss and whether this is predictive of initial weight loss in adults participating in a behavioral intervention.

Higher total physical activity outcome expectations was associated with lower weight loss trajectory across weeks 0-8 and 0-12, and approached significance for weeks 0-4 (Table 16). While few studies have explored physical activity outcome expectations within the context of weight loss treatment, there is some evidence that higher baseline body image benefits is modestly associated with weight loss at 6 months [235]. However, this study found higher baseline body image benefits was associated with lower weight loss across weeks 0-4, 0-8, and 0-12 (Table 16).

Higher scores in the sub-scale for body image reflects belief that increased physical activity will improve appearance, enhance self-image and confidence, and help maintain proper body weight. Moreover, the sub-scale for psychological benefits was associated with lower weight loss across weeks 0-8 and 0-12 (Table 16). Higher scores in the psychological benefits sub-scale reflects the belief that a benefit of physical activity is positive psychological effects, reducing stress and helping to be more relaxed, fun and enjoyment, and helping to cope with life's pressures. This suggests that a better understanding of why individuals who have higher beliefs about the psychological benefits of physical activity are less successful early in losing weight is warranted. Because individuals who believe physical activity will contribute to body image and psychological benefits prior to starting a weight loss intervention appear to be less successful at losing weight early in a behavioral program, it may also be important to see if this finding is consistent across studies.

In contrast, the health benefits sub-scale was not associated with early weight loss in this study. It has been suggested that individuals enter behavioral weight loss interventions have on average high expectations of the health benefits of physical activity, which may influence the ability to detect associations with weight loss [235]. In this study the subscale of health benefits resulting from physical activity had a mean score of 4.67 on a scale of 1 to 5 (1 = strongly disagreeing physical activity is beneficial to health, 5 = strongly agreeing that physical activity is beneficial to health). Thus, it appears that the individuals entering this study already had high expectations of the health benefits of physical activity. However, of interest, despite reporting that physical activity is associated with health benefits, the adults recruited to participate in this study self-reported low levels of physical activity upon study entry. This may suggest that factors other than knowledge of the health benefits may be important to consider with regard to physical activity participation in adults with obesity.

In this study both baseline weight loss barriers and baseline physical activity barriers were not associated with early weight loss (Table 17-18). Weight loss barriers were examined as part of a questionnaire that has not been validated prior to this study, and only total weight loss barriers were available to analyze. This may partially explain the lack of an association between weight loss barriers and early weight loss, as it might be expected that more weight loss barriers would be associated with less weight loss, but that finding was not observed. Moreover, total physical activity barriers along with the sub-scales of time, effort, and obstacle barriers were not associated with early weight loss trajectory in this study (Table 18). This finding of a lack of an association between physical activity barriers and weight loss is not consistent with some of the scientific literature that has reported an association [36, 38].

While this study showed that baseline weight and physical activity barriers do not appear to predict weight loss outcomes, behavioral weight loss interventions are effective in reducing physical activity barriers [208, 235, 239, 241, 245] and it has been observed this reduction is at the greatest magnitude during the active phase of the intervention [240, 246]. Additionally, decreasing physical activity barriers is associated with greater weight loss compared to individuals who do not reduce physical activity barriers [208, 235, 240, 247]. This may suggest that the reported barriers at baseline may not be as predictive as whether barriers change in response to the weight loss intervention.

5.4 Limitations and Future Directions

While this study adds to the literature regarding pretreatment predictors of weight loss within a behavioral weight loss intervention, there are limitations that impact the interpretation of the results. The limitations should be considered within future research design in the study of pretreatment predictors. These include:

1. This study was a secondary analysis of existing data from a behavioral weight loss intervention study. Thus, the measures included may not have been specifically selected to be used for the purpose of examining baseline predictors of early weight loss as they were used in this study. Moreover, there may be other domains that should be considered as potential predictors of early weight loss success that were not included in this study. Therefore, future studies should be designed to examine baseline factors to predict early weight loss success as a-priori hypotheses with measures specifically selected for this purpose.
2. The sample for this study included individuals with overweight or obesity, but otherwise healthy. Excess body weight is associated with poorer health factors [1, 2] that include coronary heart disease, hypertension, and type 2 diabetes [3-5]. Our study excluded individuals who had or were currently being treated for: Coronary heart disease related co-morbidities, hypertension, and diabetes mellitus. Results may not be generalizable to individuals with poorer health who seek and would benefit from a weight loss intervention. Future studies should recruit individuals with overweight or obesity who also have additional comorbidities that may be more reflective of the general population.

3. This study excluded participants who reported limitations that prohibited walking, and this may influence the generalizability of these findings given that adults with obesity may suffer from functional limitations. For example, individuals with obesity at 25 years of age have more functional limitations and are less active in older age [303]. Moreover, individuals who have functional limitations and are less active may still benefit from weight loss. Future studies should consider recruitment across a broader range of physical function.
4. This study recruited individuals with a maximum age of 55 years, which may limit the generalizability of the findings that are reported. Future studies should consider recruiting a wider age range to determine if the findings from this study are consistent across a broader age range of participants with overweight or obesity.
5. Potential participants who were diagnosed with clinical depression and or receiving treatment for depression were excluded from this study. However, we found even individuals with non-clinical levels of depression experienced lower early weight loss trajectories. This suggests that individuals with clinical levels of depression may not be as successful in weight loss interventions compared to participants without depressive symptoms. Although it is also possible that individuals undergoing treatment for depression may not experience the blunted weight loss responses experienced by individuals with depressive symptoms and no treatment. Given the potential of higher levels of depression that may be present in adults with overweight or obesity, future studies should be conducted that include individuals with medically controlled depression to examine if the findings are consistent with the current study.

6. Baseline factors in this study were subjectively assessed via questionnaires and their subjective reports may not reflect objectively measured values. Future studies should determine if objectively assessed baseline factors, when these are available to be used, are predictive of weight loss outcomes similar to what was observed in this study.
7. This study used validated questionnaires similar to other studies, however studies use different questionnaires to measure similar baseline factors and it is possible two different questionnaires may respond differently. For example, in this study the CES-D was used to measure depressive symptoms, however other studies utilize the BDI. Thus, future studies should consider examining whether different measures of the same domains result in consistent findings.
8. In this study we excluded individuals with a BMI $\geq$40 kg/m^2. Thus, the results may not be generalizable to some individuals with a BMI above this level who also can benefit from behavioral weight loss interventions. This is important because we found that higher baseline BMI was associated with greater initial weight loss, but it is unclear if this would be consistent when examining adult with a BMI $\geq$40 kg/m^2. Thus, future studies should consider including a wider range of BMI for inclusion.
9. After analysis of the data is was determined that some of the baseline variables examined were significantly correlated with each other. Thus, future studies should examine the data with additional statistical methods such as factor analysis or other techniques to address this potential concern and its impact on the interpretation of the findings.

5.5 Summary and Implications

Prior research has demonstrated that early weight loss, within the initial 4 to 12 weeks, is associated with longer-term weight loss in adults enrolled in behavioral weight loss interventions. This current study also reported this finding with weight loss achieved at 4, 8, and 12 weeks being associated with weight loss at both 6 and 12 months. These findings suggest that enhancing initial weight loss may be important to enhance long-term weight loss in adults with overweight or obesity. This was the focus of the current study.

Findings from this study did demonstrate that there are baseline factors that may influence individual response to a behavioral weight loss intervention, and these factors may be an area for early intervention that may enhance initial weight loss response. Some of these factors may be modifiable whereas others may not be modifiable, which may influence which of the factors can be the target of early intervention. There were factors statistically shown to be important and that may be of clinical importance, such as poor sleep or the presence of depressive symptoms, which may be important clinical targets for early intervention. For example, this may suggest that someone who is having difficulty sleeping, specifically taking a longer time to fall asleep or spending more time in bed not sleeping, may benefit from addressing their sleep problems before initiating their weight loss efforts. Moreover, individuals with depressive symptoms, reflective of poorer mood, seeking treatment for depressive symptoms before attempting to lose weight would potentially improve their early weight loss. However, while this study identified a number of baseline factors that may be modifiable, this study also found that each of these individual factors might have very modest effects on weight loss achieved across the initial 4, 8, or 12 weeks of a behavioral intervention. This may suggest that a combination of these factors may be important to consider to have a greater influence on initial weight loss.

This study also found that there were factors that are not easily modifiable prior to initiating a weight loss program, such as factors in the domains of weight history, which may also contribute to initial weight loss success. For example, individuals with a father who was overweight or obese lost less early weight compared to individuals who did not report their father to be overweight or obese. However, it would not be possible to modify a father's weight just prior to an individual participating in a weight loss program, but rather it may be important to understand how a father's weight can influence a participant's weight loss behaviors and then target specific intervention strategies that may address these concerns. Thus, these may be areas of future investigation and may reflect biological, environmental, behavioral or other influences rather than a direct influence of a father's body weight on the weight loss that is achieved by one of their children as an adult within the context of a behavioral weight loss program.

In summary, this study contributes to the literature supporting that early weight loss success is associated with long-term weight loss success. Moreover, this study has examined baseline factors reflective of current behaviors, weight history, and psychosocial domains and whether these are associated to initial weight loss. These findings provide potential targets for intervention that may enhance early weight loss that ultimately contributes to improve long-term weight loss. Further examination of these factors should be the focus of future research in efforts to enhance weight loss success for adults with overweight or obesity.

Appendix A Correlation Coefficients Between Baseline Variables

Correlation Matrix of Current Behaviors (Eating Behavior, Physical Activity, Sedentary Behavior, Sleep) [continuous variables = Pearson Correlation Coefficients; categorical variables = Spearman Rank Order Correlation Coefficients].

Legend *r or r_s* *p-value* *N*	**Eating Behavior**	**Recreational MVPA**	**Home MVPA**	**Occupational MVPA**	**Sedentary Behavior**
Eating Behavior		0.09867 0.0583 369	0.01810 0.7293 368	-0.07362 0.1593 367	0.04270 0.4103 374
Recreational MVPA	0.09867 0.0583 369		0.11118 0.0325 370	0.04814 0.3564 369	-0.12975 0.0119 375
Home MVPA	0.01810 0.7293 368	0.11118 0.0325 370		0.46079 <.0001 367	-0.24281 <.0001 374
Occupational MVPA	-0.07362 0.1593 367	0.04814 0.3564 369	0.46079 <.0001 367		-0.25276 <.0001 373
Sedentary Behavior	0.04270 0.4103 374	-0.12975 0.0119 375	-0.24281 <.0001 374	-0.25276 <.0001 373	
PSQI – Total	0.02125 0.6857 365	-0.04293 0.4128 366	0.00817 0.8764 365	-0.05718 0.2766 364	-0.04293 0.4128 366
PSQI – Sleep Quality	0.01385 0.7903 371	-0.10614 0.0408 372	-0.05430 0.2969 371	0.01612 0.7573 370	0.07109 0.1683 377
PSQI – Sleep Duration	-0.02705 0.6020 374	-0.10532 0.0415 375	0.01588 0.7595 374	0.10470 0.0433 373	0.06148 0.2319 380
PSQI – Sleep Disturbance	0.01385 0.7903 371	-0.03258 0.5321 370	0.03864 0.4593 369	-0.00532 0.9190 368	0.01591 0.7588 375
PSQI – Sleep Latency	-0.01482 0.7752 374	-0.10283 0.0466 375	0.01457 0.7788 374	0.00886 0.8646 373	0.03623 0.4814 380
PSQI - Sleep Daytime Dysfunction	-0.04232 0.4164 371	-0.03661 0.4814 372	-0.05756 0.2688 371	-0.06617 0.2041 370	0.03636 0.4815 377

Legend ***r or r_s*** ***p-value*** ***N***	**Eating Behavior**	**Recreational MVPA**	**Home MVPA**	**Occupational MVPA**	**Sedentary Behavior**
PSQI – Sleep Medication	0.05709 0.2721 372	0.02860 0.5819 373	0.00350 0.9464 372	0.06125 0.2392 371	0.05757 0.2642 378
PSQI – Sleep Efficiency	0.01603 0.7574 374	-0.13906 0.0070 375	-0.00509 0.9218 374	0.08567 0.0985 373	-0.03213 0.5323 380

Legend ***r or r_s*** ***p-value*** ***N***	**PSQI – Total**	**PSQI – Sleep Quality**	**PSQI – Sleep Duration**	**PSQI – Sleep Disturbance**	**PSQI – Sleep Latency**
Eating Behavior	0.02125 0.6857 365	0.01385 0.7903 371	-0.02705 0.6020 374	-0.03993 0.4444 369	-0.01482 0.7752 374
Recreational MVPA	-0.04293 0.4128 366	-0.10614 0.0408 372	-0.10532 0.0415 375	-0.03258 0.5321 370	-0.10283 0.0466 375
Home MVPA	0.00817 0.8764 365	-0.05430 0.2969 371	0.01588 0.7595 374	0.03864 0.4593 369	0.01457 0.7788 374
Occupational MVPA	-0.25276 <.0001 373	0.01612 0.7573 370	0.10470 0.0433 373	-0.00532 0.9190 368	0.00886 0.8646 373
Sedentary Behavior	0.07203 0.1662 371	0.07109 0.1683 377	0.06148 0.2319 380	0.01591 0.7588 375	0.03623 0.4814 380
PSQI – Total		0.56849 <.0001 373	0.69188 <.0001 373	0.51236 <.0001 373	0.61660 <.0001 373
PSQI – Sleep Quality	0.56849 <.0001 373		0.41236 <.0001 379	0.20437 <.0001 374	0.32274 <.0001 379
PSQI – Sleep Duration	0.69188 <.0001 373	0.41236 <.0001 379		0.13609 0.0081 377	0.23389 <.0001 382
PSQI – Sleep Disturbance	0.51236 <.0001 373	0.20437 <.0001 374	0.13609 0.0081 377		0.22583 <.0001 377
PSQI – Sleep Latency	0.61660 <.0001 373	0.32274 <.0001 379	0.23389 <.0001 382	0.22583 <.0001 377	
PSQI - Sleep Daytime Dysfunction	0.37142 <.0001 373	0.17374 0.0007 378	0.08546 0.0967 379	0.18420 0.0003 374	0.06890 0.1807 379
PSQI – Sleep Medication	0.34895 <.0001 373	0.25125 <.0001 379	0.14008 0.0062 380	0.17250 0.0008 375	0.13637 0.0078 380
PSQI – Sleep Efficiency	0.63797 <.0001 373	0.32246 <.0001 379	0.46865 <.0001 382	0.24259 <.0001 377	0.38532 <.0001 382

Legend ***r or r_s*** ***p-value*** ***N***	**PSQI - Sleep Daytime Dysfunction**	**PSQI – Sleep Medication**	**PSQI – Sleep Efficiency**
Eating Behavior	-0.04232 0.4164 371	0.05709 0.2721 372	0.01603 0.7574 374
Recreational MVPA	-0.03661 0.4814 372	0.02860 0.5819 373	-0.13906 0.0070 375
Home MVPA	-0.05756 0.2688 371	0.00350 0.9464 372	-0.00509 0.9218 374
Occupational MVPA	-0.06617 0.2041 370	0.06125 0.2392 371	0.08567 0.0985 373
Sedentary Behavior	0.03636 0.4815 377	0.05757 0.2642 378	-0.03213 0.5323 380
PSQI – Total	0.37142 <.0001 373	0.34895 <.0001 373	0.63797 <.0001 373
PSQI – Sleep Quality	0.17374 0.0007 378	0.25125 <.0001 379	0.32246 <.0001 379
PSQI – Sleep Duration	0.08546 0.0967 379	0.14008 0.0062 380	0.46865 <.0001 382
PSQI – Sleep Disturbance	0.18420 0.0003 374	0.17250 0.0008 375	0.24259 <.0001 377
PSQI – Sleep Latency	0.06890 0.1807 379	0.13637 0.0078 380	0.38532 <.0001 382
PSQI - Sleep Daytime Dysfunction		0.11368 0.0269 379	0.06373 0.2157 379
PSQI – Sleep Medication	0.11368 0.0269 379		0.14896 0.0036 380
PSQI – Sleep Efficiency	0.06373 0.2157 379	0.14896 0.0036 380	

Correlation Matrix of Weight History Variables [continuous variables = Pearson Correlation Coefficients; categorical variables = Spearman Rank Order Correlation Coefficients].

Legend ***r or r_s*** ***p-value*** ***N***	**Father Overweight / Obesity Status**	**Mother Overweight / Obesity Status**	**Child / Adolescent Weight Status**	**Highest Lifetime Weight**	**Lowest Lifetime Weight**
Father Overweight / Obesity Status		0.17541 0.0006 377	-0.10336 0.0464 372	-0.09203 0.0743 377	-0.14785 0.0040 377
Mother Overweight / Obesity Status	0.17541 0.0006 377		-0.07357 0.1567 372	0.02592 0.6159 377	0.02851 0.5811 377
Child / Adolescent Weight Status	-0.10336 0.0464 372	-0.07357 0.1567 372		0.25486 <.0001 372	0.34737 <.0001 372
Highest Lifetime Weight	-0.09203 0.0743 377	0.02592 0.6159 377	0.25486 <.0001 372		0.69776 <.0001 377
Lowest Lifetime Weight	-0.14785 0.0040 377	0.02851 0.5811 377	0.34737 <.0001 372	0.69776 <.0001 377	
Intentional Lifetime Weight Loss	-0.11590 0.0254 372	-0.05455 0.2940 372	0.15377 0.0031 367	0.30494 <.0001 372	0.12958 0.0124 372
Unintentional Lifetime Weight Loss	0.11941 0.0204 377	-0.00948 0.8545 377	-0.05580 0.2831 372	0.05794 0.2617 377	0.00044 0.9932 377
Intentional Lifetime Weight Loss Episodes	-0.11880 0.0219 372	-0.06424 0.2164 372	0.17174 0.0010 367	0.27864 <.0001 372	0.13307 0.0102 372
Unintentional Lifetime Weight Loss Episodes	0.12078 0.0190 377	0.04761 0.3566 377	-0.07285 0.1608 372	0.03565 0.4901 377	0.00483 0.9255 377
Absolute Weight Goal	-0.06997 0.1752 377	0.04761 0.3566 377	0.04769 0.3590 372	0.60895 <.0001 377	0.62576 <.0001 377
Weight Loss Goal	-0.08256 0.1095 377	-0.02750 0.5946 377	0.20414 <.0001 372	0.44606 <.0001 377	0.12846 0.0125 377

Legend ***r or r_s*** ***p-value*** ***N***	**Father Overweight / Obesity Status**	**Mother Overweight / Obesity Status**	**Child / Adolescent Weight Status**	**Highest Lifetime Weight**	**Lowest Lifetime Weight**
Baseline BMI	-0.08054 0.1185 377	-0.04931 0.3397 377	0.28916 <.0001 372	0.69121 <.0001 377	0.36705 <.0001 377

Legend ***r or r_s*** ***p-value*** ***N***	**Intentional Lifetime Weight Loss**	**Unintentional Lifetime Weight Loss**	**Intentional Lifetime Weight Loss Episodes**	**Unintentional Lifetime Weight Loss Episodes**	**Absolute Weight Goal**
Father Overweight / Obesity Status	-0.11590 0.0254 372	0.11941 0.0204 377	-0.11880 0.0219 372	0.12078 0.0190 377	-0.06997 0.1752 377
Mother Overweight / Obesity Status	-0.05455 0.2940 372	-0.00948 0.8545 377	-0.06424 0.2164 372	-0.01794 0.7284 377	0.04761 0.3566 377
Child / Adolescent Weight Status	0.15377 0.0031 367	-0.05580 0.2831 372	0.17174 0.0010 367	-0.07285 0.1608 372	0.04769 0.3590 372
Highest Lifetime Weight	0.30494 <.0001 372	0.05794 0.2617 377	0.27864 <.0001 372	0.03565 0.4901 377	0.60895 <.0001 377
Lowest Lifetime Weight	0.12958 0.0124 372	0.00044 0.9932 377	0.13307 0.0102 372	0.00483 0.9255 377	0.62576 <.0001 377
Intentional Lifetime Weight Loss		0.12968 0.0123 372	0.93318 <.0001 372	0.11649 0.0247 372	0.07264 0.1621 372
Unintentional Lifetime Weight Loss	0.12968 0.0123 372		0.13979 0.0069 372	0.95885 <.0001 377	-0.01316 0.7989 377
Intentional Lifetime Weight Loss Episodes	0.93318 <.0001 372	0.13979 0.0069 372		0.12606 0.0150 372	0.06132 0.2380 372
Unintentional Lifetime Weight Loss Episodes	0.11649 0.0247 372	0.95885 <.0001 377	0.12606 0.0150 372		-0.00272 0.9581 377
Absolute Weight Goal	0.07264 0.1621 372	-0.01316 0.7989 377	0.06132 0.2380 372	-0.00272 0.9581 377	
Weight Loss Goal	0.21446 <.0001 372	-0.04483 0.3854 377	0.19724 0.0001 372	-0.05101 0.3233 377	-0.33745 <.0001 377
Baseline BMI	0.27252 <.0001 372	-0.03942 0.4454 377	0.26329 <.0001 372	-0.04029 0.4354 377	0.24031 <.0001 377

Legend ***r or r_s*** ***p-value*** ***N***	**Weight Loss Goal**	**Baseline BMI**
Father Overweight / Obesity Status	-0.08256 0.1095 377	-0.08054 0.1185 377
Mother Overweight / Obesity Status	-0.02750 0.5946 377	-0.04931 0.3397 377
Child / Adolescent Weight Status	0.20414 <.0001 372	0.28916 <.0001 372
Highest Lifetime Weight	0.44606 <.0001 377	0.69121 <.0001 377
Lowest Lifetime Weight	0.12846 0.0125 377	0.36705 <.0001 377
Intentional Lifetime Weight Loss	0.21446 <.0001 372	0.27252 <.0001 372
Unintentional Lifetime Weight Loss	-0.04483 0.3854 377	-0.03942 0.4454 377
Intentional Lifetime Weight Loss Episodes	0.19724 0.0001 372	0.26329 <.0001 372
Unintentional Lifetime Weight Loss Episodes	-0.05101 0.3233 377	-0.04029 0.4354 377
Absolute Weight Goal	-0.33745 <.0001 377	0.24031 <.0001 377
Weight Loss Goal		0.66175 <.0001 377
Baseline BMI	0.66175 <.0001 377	

Correlation Matrix of Psychosocial Factors [continuous variables = Pearson Correlation Coefficients; categorical variables = Spearman Rank Order Correlation Coefficients].

Legend ***r or r_s*** ***p-value*** ***N***	**Eating Behavior**	**Recreational MVPA**	**Home MVPA**	**Occupational MVPA**	**Sedentary Behavior**
Eating Behavior		0.09867 0.0583 369	0.01810 0.7293 368	-0.07362 0.1593 367	0.04270 0.4103 374
Recreational MVPA	0.09867 0.0583 369		0.11118 0.0325 370	0.04814 0.3564 369	-0.12975 0.0119 375
Home MVPA	0.01810 0.7293 368	0.11118 0.0325 370		0.46079 <.0001 367	-0.24281 <.0001 374
Occupational MVPA	-0.07362 0.1593 367	0.04814 0.3564 369	0.46079 <.0001 367		-0.25276 <.0001 373
Sedentary Behavior	0.04270 0.4103 374	-0.12975 0.0119 375	-0.24281 <.0001 374	-0.25276 <.0001 373	
PSQI – Total	0.02125 0.6857 365	-0.04293 0.4128 366	0.00817 0.8764 365	-0.05718 0.2766 364	-0.04293 0.4128 366
PSQI – Sleep Quality	0.01385 0.7903 371	-0.10614 0.0408 372	-0.05430 0.2969 371	0.01612 0.7573 370	0.07109 0.1683 377
PSQI – Sleep Duration	-0.02705 0.6020 374	-0.10532 0.0415 375	0.01588 0.7595 374	0.10470 0.0433 373	0.06148 0.2319 380
PSQI – Sleep Disturbance	0.01385 0.7903 371	-0.03258 0.5321 370	0.03864 0.4593 369	-0.00532 0.9190 368	0.01591 0.7588 375
PSQI – Sleep Latency	-0.01482 0.7752 374	-0.10283 0.0466 375	0.01457 0.7788 374	0.00886 0.8646 373	0.03623 0.4814 380
PSQI - Sleep Daytime Dysfunction	-0.04232 0.4164 371	-0.03661 0.4814 372	-0.05756 0.2688 371	-0.06617 0.2041 370	0.03636 0.4815 377

Legend *r or r_s* *p-value* *N*	**Depressive Symptoms**	**HRQOL – Physical Function**	**HRQOL – Role Physical**	**HRQOL – Bodily Pain**	**HRQOL – General Health**
Depressive Symptoms		-0.05969 0.2489 375	-0.11088 0.0318 375	-0.17595 0.0006 377	-0.29886 <.0001 376
HRQOL – Physical Function	-0.05969 0.2489 375		0.31192 <.0001 373	0.38553 <.0001 375	0.26597 <.0001 374
HRQOL – Role Physical	-0.11088 0.0318 375	0.31192 <.0001 373		0.42317 <.0001 375	0.26287 <.0001 374
HRQOL – Bodily Pain	-0.17595 0.0006 377	0.38553 <.0001 375	0.42317 <.0001 375		0.21513 <.0001 376
HRQOL – General Health	-0.29886 <.0001 376	0.26597 <.0001 374	0.26287 <.0001 374	0.21513 <.0001 376	
HRQOL – Vitality	-0.40375 <.0001 378	0.16373 0.0014 376	0.25366 <.0001 376	0.26816 <.0001 378	0.38138 <.0001 377
HRQOL – Social Function	-0.36542 <.0001 375	0.16218 0.0017 373	0.20942 <.0001 373	0.25627 <.0001 375	0.19515 0.0001 375
HRQOL – Role Mental	-0.36258 <.0001 377	0.07798 0.1317 375	0.17754 0.0006 375	0.11292 0.0284 377	0.08396 0.1041 376
HRQOL – Emotional Well Being	-0.58584 <.0001 377	0.03845 0.4578 375	0.15090 0.0034 375	0.18738 0.0003 377	0.28489 <.0001 376
Weight Loss Self-Efficacy – Total	-0.18297 0.0004 375	0.09764 0.0596 373	0.14301 0.0057 373	0.16563 0.0013 375	0.21788 <.0001 374
Weight Loss Self-Efficacy – Negative Emotion	-0.16975 0.0009 377	0.06608 0.2017 375	0.13853 0.0072 375	0.17254 0.0008 377	0.17259 0.0008 376
Weight Loss Self-Efficacy - Availability	-0.14581 0.0045 378	0.09492 0.0660 376	0.09714 0.0599 376	0.09671 0.0603 378	0.21526 <.0001 377

Legend ***r or r_s*** ***p-value*** ***N***	**Depressive Symptoms**	**HRQOL – Physical Function**	**HRQOL – Role Physical**	**HRQOL – Bodily Pain**	**HRQOL – General Health**
Weight Loss Self-Efficacy – Social Pressure	-0.11493 0.0256 377	0.03552 0.4929 375	0.06693 0.1960 375	0.07165 0.1650 377	0.17182 0.0008 376
Weight Loss Self-Efficacy Physical Discomfort	-0.18393 0.0003 378	0.09465 0.0668 376	0.15685 0.0023 376	0.16994 0.0009 378	0.20770 <.0001 377
Weight Loss Self-Efficacy – Positive Activity	-0.17997 0.0004 377	0.13263 0.0101 375	0.14751 0.0042 375	0.20206 <.0001 377	0.16093 0.0017 376

Legend ***r or r_s*** ***p-value*** ***N***	**Depressive Symptoms**	**HRQOL – Physical Function**	**HRQOL – Role Physical**	**HRQOL – Bodily Pain**	**HRQOL – General Health**
Physical Activity Self-Efficacy	**-0.15594** **0.0024** **377**	**0.09764** **0.0596** **373**	0.11020 0.0329 375	0.08026 0.1198 377	0.18373 0.0003 376
Expected Weight Loss Benefits	**0.12608** **0.0143** **377**	**-0.04876** **0.3477** **373**	-0.10581 0.0406 375	-0.03442 0.5052 377	-0.06523 0.2070 376
Expected Physical Activity Benefits – Total	**0.08275** **0.1082** **378**	**0.22894** **<.0001** **376**	-0.01361 0.7925 376	0.05811 0.2598 378	0.00440 0.9321 377
Expected Physical Activity Benefits – Psychological	0.14090 0.0061 378	0.14583 0.0046 376	-0.06611 0.2009 376	0.03047 0.5548 378	-0.03658 0.4789 377
Expected Physical Activity Benefits – Image	0.03162 0.5400 378	0.18726 0.0003 376	0.03308 0.5225 376	0.05306 0.3035 378	0.03356 0.5160 377
Expected Physical Activity Benefits – Health	-0.04620 0.3704 378	0.29376 <.0001 376	0.04990 0.3345 376	0.08169 0.1128 378	0.05264 0.3080 377
Weight Loss Barriers	**0.10463** **0.0429** **375**	**-0.04876** **0.3477** **373**	-0.05094 0.3265 373	-0.03503 0.4989 375	-0.09321 0.0718 374
Physical Activity Barriers – Total	**0.09698** **0.0613** **373**	-0.10875 0.0363 371	-0.08813 0.0901 371	-0.10457 0.0436 373	-0.11423 0.0276 372
Physical Activity Barriers – Time	-0.00791 0.8785 376	0.01404 0.7867 374	0.05759 0.2666 374	0.00595 0.9084 376	-0.04311 0.4052 375
Physical Activity Barriers – Effort	0.14655 0.0045 375	-0.05813 0.2628 373	-0.10256 0.0478 373	-0.07876 0.1279 375	-0.13300 0.0100 374
Physical Activity Barriers - Obstacle	0.06536 0.2049 378	-0.21817 <.0001 376	-0.16627 0.0012 376	-0.17435 0.0007 378	-0.06084 0.2386 377

Legend *r or r_s* *p-value* *N*	**HRQOL – Vitality**	**HRQOL – Social Function**	**HRQOL – Role Mental**	**HRQOL – Emotional Well Being**	**Weight Loss Self-Efficacy – Total**
Depressive Symptoms	-0.40375 <.0001 378	-0.36542 <.0001 375	-0.36258 <.0001 377	-0.58584 <.0001 377	-0.18297 0.0004 375
HRQOL – Physical Function	0.16373 0.0014 376	0.16218 0.0017 373	0.07798 0.1317 375	0.03845 0.4578 375	0.09764 0.0596 373
HRQOL – Role Physical	0.25366 <.0001 376	0.20942 <.0001 373	0.17754 0.0006 375	0.15090 0.0034 375	0.14301 0.0057 373
HRQOL – Bodily Pain	0.26816 <.0001 378	0.25627 <.0001 375	0.11292 0.0284 377	0.18738 0.0003 377	0.16563 0.0013 375
HRQOL – General Health	0.38138 <.0001 377	0.19515 0.0001 375	0.08396 0.1041 376	0.28489 <.0001 376	0.21788 <.0001 374
HRQOL – Vitality		0.34323 <.0001 376	0.28440 <.0001 378	0.61273 <.0001 378	0.27851 <.0001 376
HRQOL – Social Function	0.34323 <.0001 376		0.45046 <.0001 375	0.43274 <.0001 375	0.13043 0.0117 373
HRQOL – Role Mental	0.28440 <.0001 378	0.45046 <.0001 375		0.42230 <.0001 377	0.20102 <.0001 375
HRQOL – Emotional Well Being	0.61273 <.0001 378	0.43274 <.0001 375	0.42230 <.0001 377		0.32857 <.0001 375
Weight Loss Self-Efficacy – Total	0.27851 <.0001 376	0.13043 0.0117 373	0.20102 <.0001 375	0.32857 <.0001 375	
Weight Loss Self-Efficacy – Negative Emotion	0.29080 <.0001 378	0.19093 0.0002 375	0.22151 <.0001 377	0.35321 <.0001 377	0.85153 <.0001 377
Weight Loss Self-Efficacy - Availability	0.26997 <.0001 379	0.07719 0.1352 376	0.14455 0.0049 378	0.26380 <.0001 378	0.87522 <.0001 377

Legend ***r or r_s*** ***p-value*** ***N***	**HRQOL – Vitality**	**HRQOL – Social Function**	**HRQOL – Role Mental**	**HRQOL – Emotional Well Being**	**Weight Loss Self-Efficacy – Total**
Weight Loss Self-Efficacy – Social Pressure	0.15381 0.0027 378	0.06748 0.1923 375	0.19128 0.0002 377	0.22164 <.0001 377	0.83288 <.0001 377
Weight Loss Self-Efficacy Physical Discomfort	0.24742 <.0001 379	0.13253 0.0101 376	0.15875 0.0020 378	0.31471 <.0001 378	0.84586 <.0001 377
Weight Loss Self-Efficacy – Positive Activity	0.19514 0.0001 378	0.06563 0.2048 375	0.10850 0.0352 377	0.22792 <.0001 377	0.79341 <.0001 377

Legend *r or r_s* *p-value* *N*	HRQOL – Vitality	HRQOL – Social Function	HRQOL – Role Mental	HRQOL – Emotional Well Being	Weight Loss Self-Efficacy – Total
Physical Activity Self-Efficacy	0.28146 <.0001 378	0.10863 0.0355 375	0.17692 0.0006 377	0.32771 <.0001 377	0.38898 <.0001 375
Expected Weight Loss Benefits	-0.13496 0.0086 378	-0.24830 <.0001 375	-0.14994 0.0035 377	-0.23848 <.0001 377	-0.14505 0.0049 375
Expected Physical Activity Benefits – Total	-0.05687 0.2694 379	-0.18244 0.0004 376	-0.14955 0.0036 378	-0.13916 0.0067 378	-0.07620 0.1403 376
Expected Physical Activity Benefits – Psychological	-0.07902 0.1246 379	-0.21571 <.0001 376	-0.20409 <.0001 378	-0.18610 0.0003 378	-0.07587 0.1420 376
Expected Physical Activity Benefits – Image	-0.06460 0.2096 379	-0.10694 0.0382 376	-0.06772 0.1889 378	-0.10416 0.0430 378	-0.11199 0.0299 376
Expected Physical Activity Benefits – Health	0.05756 0.2636 379	-0.06323 0.2213 376	-0.01780 0.7302 378	0.03893 0.4505 378	0.04638 0.3698 376
Weight Loss Barriers	-0.22968 <.0001 376	-0.05661 0.2755 373	-0.10079 0.0512 375	-0.15659 0.0024 375	-0.28785 <.0001 373
Physical Activity Barriers – Total	-0.30777 <.0001 374	-0.02319 0.6562 371	-0.11133 0.0316 373	-0.15427 0.0028 373	-0.26119 <.0001 371
Physical Activity Barriers – Time	-0.11621 0.0240 377	0.11932 0.0210 374	-0.04047 0.4339 376	-0.03163 0.5410 376	-0.13017 0.0117 374
Physical Activity Barriers – Effort	-0.37152 <.0001 376	-0.10487 0.0430 373	-0.13719 0.0078 375	-0.23559 <.0001 375	-0.29732 <.0001 373

Legend ***r or r_s*** ***p-value*** ***N***	**HRQOL – Vitality**	**HRQOL – Social Function**	**HRQOL – Role Mental**	**HRQOL – Emotional Well Being**	**Weight Loss Self-Efficacy – Total**
Physical Activity Barriers - Obstacle	-0.17234 0.0008 379	-0.05509 0.2867 376	-0.05409 0.2942 378	-0.05314 0.3028 378	-0.14364 0.0053 376

Legend ***r or r_s*** ***p-value*** ***N***	**Weight Loss Self-Efficacy – Negative Emotion**	**Weight Loss Self-Efficacy - Availability**	**Weight Loss Self-Efficacy – Social Pressure**	**Weight Loss Self-Efficacy Physical Discomfort**	**Weight Loss Self-Efficacy – Positive Activity**
Depressive Symptoms	**-0.16975** **0.0009** **377**	-0.14581 0.0045 378	-0.11493 0.0256 377	-0.18393 0.0003 378	-0.17997 0.0004 377
HRQOL – Physical Function	0.06608 0.2017 375	0.09492 0.0660 376	0.03552 0.4929 375	0.09465 0.0668 376	0.13263 0.0101 375
HRQOL – Role Physical	0.13853 0.0072 375	0.09714 0.0599 376	0.06693 0.1960 375	0.15685 0.0023 376	0.14751 0.0042 375
HRQOL – Bodily Pain	0.17254 0.0008 377	0.09671 0.0603 378	0.07165 0.1650 377	0.16994 0.0009 378	0.20206 <.0001 377
HRQOL – General Health	0.17259 0.0008 376	0.21526 <.0001 377	0.17182 0.0008 376	0.20770 <.0001 377	0.16093 0.0017 376
HRQOL – Vitality	0.29080 <.0001 378	0.26997 <.0001 379	0.15381 0.0027 378	0.24742 <.0001 379	0.19514 0.0001 378
HRQOL – Social Function	0.19093 0.0002 375	0.07719 0.1352 376	0.06748 0.1923 375	0.13253 0.0101 376	0.06563 0.2048 375
HRQOL – Role Mental	0.22151 <.0001 377	0.14455 0.0049 378	0.19128 0.0002 377	0.15875 0.0020 378	0.10850 0.0352 377
HRQOL – Emotional Well Being	0.35321 <.0001 377	0.26380 <.0001 378	0.22164 <.0001 377	0.31471 <.0001 378	0.22792 <.0001 377
Weight Loss Self-Efficacy – Total	**0.85153** **<.0001** **377**	0.87522 <.0001 377	0.83288 <.0001 377	0.84586 <.0001 377	0.79341 <.0001 377
Weight Loss Self-Efficacy – Negative Emotion		0.65984 <.0001 379	0.57618 <.0001 378	0.70302 <.0001 379	0.59227 <.0001 378
Weight Loss Self-Efficacy - Availability	0.65984 <.0001 379		0.73247 <.0001 379	0.62028 <.0001 380	0.64907 <.0001 379

Legend ***r or r_s*** ***p-value*** ***N***	**Weight Loss Self-Efficacy – Negative Emotion**	**Weight Loss Self-Efficacy - Availability**	**Weight Loss Self-Efficacy – Social Pressure**	**Weight Loss Self-Efficacy Physical Discomfort**	**Weight Loss Self-Efficacy – Positive Activity**
Weight Loss Self-Efficacy – Social Pressure	0.57618 <.0001 378	0.73247 <.0001 379		0.64549 <.0001 379	0.52950 <.0001 378
Weight Loss Self-Efficacy Physical Discomfort	0.70302 <.0001 379	0.62028 <.0001 380	0.64549 <.0001 379		0.63420 <.0001 379
Weight Loss Self-Efficacy – Positive Activity	0.59227 <.0001 378	0.64907 <.0001 379	0.52950 <.0001 378	0.63420 <.0001 379	

Legend ***r or r_s*** ***p-value*** ***N***	**Weight Loss Self-Efficacy – Negative Emotion**	**Weight Loss Self-Efficacy - Availability**	**Weight Loss Self-Efficacy – Social Pressure**	**Weight Loss Self-Efficacy Physical Discomfort**	**Weight Loss Self-Efficacy – Positive Activity**
Physical Activity Self-Efficacy	0.31945 <.0001 377	0.40583 <.0001 378	0.33111 <.0001 377	0.27867 <.0001 378	0.30340 <.0001 377
Expected Weight Loss Benefits	-0.15233 0.0030 377	-0.07055 0.1711 378	-0.10465 0.0423 377	-0.15633 0.0023 378	-0.10586 0.0399 377
Expected Physical Activity Benefits – Total	-0.14187 0.0057 378	0.01469 0.7755 379	-0.06814 0.1862 378	-0.09291 0.0708 379	-0.00243 0.9625 378
Expected Physical Activity Benefits – Psychological	-0.14155 0.0058 378	0.05190 0.3136 379	-0.08261 0.1088 378	-0.09944 0.0531 379	-0.02785 0.5893 378
Expected Physical Activity Benefits – Image	-0.16346 0.0014 378	-0.06485 0.2078 379	-0.07000 0.1744 378	-0.11126 0.0303 379	-0.03027 0.5575 378
Expected Physical Activity Benefits – Health	0.01572 0.7606 378	0.03783 0.4627 379	0.02857 0.5798 378	0.03212 0.5330 379	0.10402 0.0433 378
Weight Loss Barriers	-0.24334 <.0001 375	-0.27783 <.0001 376	-0.24986 <.0001 375	-0.23100 <.0001 376	-0.18414 0.0003 375
Physical Activity Barriers – Total	-0.25120 <.0001 373	-0.26082 <.0001 374	-0.18539 0.0003 373	-0.22413 <.0001 374	-0.12898 0.0127 373
Physical Activity Barriers – Time	-0.14386 0.0052 376	-0.11372 0.0273 377	-0.11454 0.0264 376	-0.12901 0.0122 377	-0.01022 0.8435 376
Physical Activity Barriers – Effort	-0.26233 <.0001 375	-0.33754 <.0001 376	-0.21051 <.0001 375	-0.23208 <.0001 376	-0.18325 0.0004 375
Physical Activity Barriers - Obstacle	-0.14564 0.0045 378	-0.10815 0.0353 379	-0.07455 0.1480 378	-0.13419 0.0089 379	-0.09109 0.0769 378

Legend *r or r_s* *p-value* *N*	**Physical Activity Self-Efficacy**	**Expected Weight Loss Benefits**	**Expected Physical Activity Benefits – Total**	**Expected Physical Activity Benefits – Psychological**	**Expected Physical Activity Benefits – Image**
Depressive Symptoms	0.32771 <.0001 377	0.12608 0.0143 377	0.09698 0.0613 373	-0.00791 0.8785 376	0.14655 0.0045 375
HRQOL – Physical Function	0.06867 0.1845 375	0.00497 0.9235 375	-0.10875 0.0363 371	0.01404 0.7867 374	-0.05813 0.2628 373
HRQOL – Role Physical	0.11020 0.0329 375	-0.10581 0.0406 375	-0.08813 0.0901 371	0.05759 0.2666 374	-0.10256 0.0478 373
HRQOL – Bodily Pain	0.08026 0.1198 377	-0.03442 0.5052 377	-0.10457 0.0436 373	0.00595 0.9084 376	-0.07876 0.1279 375
HRQOL – General Health	0.18373 0.0003 376	-0.06523 0.2070 376	-0.11423 0.0276 372	-0.04311 0.4052 375	-0.13300 0.0100 374
HRQOL – Vitality	0.18373 0.0003 376	-0.13496 0.0086 378	-0.30777 <.0001 374	-0.11621 0.0240 377	-0.37152 <.0001 376
HRQOL – Social Function	0.18373 0.0003 376	-0.24830 <.0001 375	-0.02319 0.6562 371	0.11932 0.0210 374	-0.10487 0.0430 373
HRQOL – Role Mental	0.17692 0.0006 377	-0.14994 0.0035 377	-0.11133 0.0316 373	-0.04047 0.4339 376	-0.13719 0.0078 375
HRQOL – Emotional Well Being	0.32771 <.0001 377	-0.23848 <.0001 377	-0.15427 0.0028 373	-0.03163 0.5410 376	-0.23559 <.0001 375
Weight Loss Self-Efficacy – Total	0.38898 <.0001 375	-0.14505 0.0049 375	-0.26119 <.0001 371	-0.13017 0.0117 374	-0.29732 <.0001 373
Weight Loss Self-Efficacy – Negative Emotion	0.31945 <.0001 377	-0.15233 0.0030 377	-0.25120 <.0001 373	-0.14386 0.0052 376	-0.26233 <.0001 375
Weight Loss Self-Efficacy - Availability	0.40583 <.0001 378	-0.07055 0.1711 378	-0.26082 <.0001 374	-0.11372 0.0273 377	-0.33754 <.0001 376

Legend ***r or r_s*** ***p-value*** ***N***	**Physical Activity Self-Efficacy**	**Expected Weight Loss Benefits**	**Expected Physical Activity Benefits – Total**	**Expected Physical Activity Benefits – Psychological**	**Expected Physical Activity Benefits – Image**
Weight Loss Self-Efficacy – Social Pressure	0.40583 <.0001 378	-0.10465 0.0423 377	-0.18539 0.0003 373	-0.11454 0.0264 376	-0.21051 <.0001 375
Weight Loss Self-Efficacy Physical Discomfort	0.27867 <.0001 378	-0.15633 0.0023 378	-0.22413 <.0001 374	-0.12901 0.0122 377	-0.23208 <.0001 376
Weight Loss Self-Efficacy – Positive Activity	0.30340 <.0001 377	-0.10586 0.0399 377	-0.12898 0.0127 373	-0.01022 0.8435 376	-0.18325 0.0004 375

Legend *r or r_s* *p-value* ***N***	**Physical Activity Self-Efficacy**	**Expected Weight Loss Benefits**	**Expected Physical Activity Benefits – Total**	**Expected Physical Activity Benefits – Psychological**	**Expected Physical Activity Benefits – Image**
Physical Activity Self-Efficacy		-0.06632 0.1989 377	0.02310 0.6544 378	0.00058 0.9910 378	-0.00787 0.8789 378
Expected Weight Loss Benefits	-0.06632 0.1989 377		0.70286 <.0001 378	0.68077 <.0001 378	0.57013 <.0001 378
Expected Physical Activity Benefits – Total	0.02310 0.6544 378	0.70286 <.0001 378		0.87230 <.0001 379	0.82899 <.0001 379
Expected Physical Activity Benefits – Psychological	0.00058 0.9910 378	0.68077 <.0001 378	0.87230 <.0001 379		0.50535 <.0001 379
Expected Physical Activity Benefits – Image	-0.00787 0.8789 378	0.57013 <.0001 378	0.82899 <.0001 379	0.50535 <.0001 379	
Expected Physical Activity Benefits – Health	0.10547 0.0404 378	0.35344 <.0001 378	0.70548 <.0001 379	0.38569 <.0001 379	0.61455 <.0001 379
Weight Loss Barriers	-0.23288 <.0001 375	0.10579 0.0406 375	0.05935 0.2510 376	0.10180 0.0485 376	0.05630 0.2762 376
Physical Activity Barriers – Total	-0.29345 <.0001 373	0.04226 0.4158 373	0.05229 0.3132 374	0.08478 0.1016 374	0.04079 0.4316 374
Physical Activity Barriers – Time	-0.15898 0.0020 376	0.01154 0.8235 376	0.08502 0.0993 377	0.11398 0.0269 377	0.04865 0.3461 377
Physical Activity Barriers – Effort	-0.32925 <.0001 375	0.08109 0.1170 375	0.03918 0.4487 376	0.00575 0.9115 376	0.10962 0.0336 376

Legend ***r or r_s*** ***p-value*** ***N***	**Physical Activity Self-Efficacy**	**Expected Weight Loss Benefits**	**Expected Physical Activity Benefits – Total**	**Expected Physical Activity Benefits – Psychological**	**Expected Physical Activity Benefits – Image**
Physical Activity Barriers - Obstacle	-0.14917 0.0037 378	0.00665 0.8974 378	0.00863 0.8670 379	0.11667 0.0231 379	-0.08228 0.1098 379

Legend ***r or rs*** ***p-value*** ***N***	**Expected Physical Activity Benefits – Health**	**Weight Loss Barriers**	**Physical Activity Barriers – Total**	**Physical Activity Barriers – Time**	**Physical Activity Barriers – Effort**
Depressive Symptoms	-0.04620 0.3704 378	0.10463 0.0429 375	0.09698 0.0613 373	-0.00791 0.8785 376	0.14655 0.0045 375
HRQOL – Physical Function	0.29376 <.0001 376	-0.04876 0.3477 373	-0.10875 0.0363 371	0.01404 0.7867 374	-0.05813 0.2628 373
HRQOL – Role Physical	0.04990 0.3345 376	-0.05094 0.3265 373	-0.08813 0.0901 371	0.05759 0.2666 374	-0.10256 0.0478 373
HRQOL – Bodily Pain	0.08169 0.1128 378	-0.03503 0.4989 375	-0.10457 0.0436 373	0.00595 0.9084 376	-0.07876 0.1279 375
HRQOL – General Health	0.05264 0.3080 377	-0.09321 0.0718 374	-0.11423 0.0276 372	-0.04311 0.4052 375	-0.13300 0.0100 374
HRQOL – Vitality	0.05756 0.2636 379	-0.22968 <.0001 376	-0.30777 <.0001 374	-0.11621 0.0240 377	-0.37152 <.0001 376
HRQOL – Social Function	-0.06323 0.2213 376	-0.05661 0.2755 373	-0.02319 0.6562 371	0.11932 0.0210 374	-0.10487 0.0430 373
HRQOL – Role Mental	-0.01780 0.7302 378	-0.10079 0.0512 375	-0.11133 0.0316 373	-0.04047 0.4339 376	-0.13719 0.0078 375
HRQOL – Emotional Well Being	0.03893 0.4505 378	-0.15659 0.0024 375	-0.15427 0.0028 373	-0.03163 0.5410 376	-0.23559 <.0001 375
Weight Loss Self-Efficacy – Total	0.04638 0.3698 376	-0.28785 <.0001 373	0.09698 0.0613 373	-0.00791 0.8785 376	0.14655 0.0045 375
Weight Loss Self-Efficacy – Negative Emotion	0.01572 0.7606 378	-0.24334 <.0001 375	-0.25120 <.0001 373	-0.14386 0.0052 376	-0.26233 <.0001 375
Weight Loss Self-Efficacy - Availability	0.03783 0.4627 379	-0.27783 <.0001 376	-0.26082 <.0001 374	-0.11372 0.0273 377	-0.33754 <.0001 376

Legend ***r or r_s*** ***p-value*** ***N***	**Expected Physical Activity Benefits – Health**	**Weight Loss Barriers**	**Physical Activity Barriers – Total**	**Physical Activity Barriers – Time**	**Physical Activity Barriers – Effort**
Weight Loss Self-Efficacy – Social Pressure	0.02857 0.5798 378	-0.24986 <.0001 375	-0.18539 0.0003 373	-0.11454 0.0264 376	-0.21051 <.0001 375
Weight Loss Self-Efficacy Physical Discomfort	0.03212 0.5330 379	-0.23100 <.0001 376	-0.22413 <.0001 374	-0.12901 0.0122 377	-0.23208 <.0001 376
Weight Loss Self-Efficacy – Positive Activity	0.10402 0.0433 378	-0.18414 0.0003 375	-0.12898 0.0127 373	-0.01022 0.8435 376	-0.18325 0.0004 375

Legend ***r or r*** ***p-value*** ***N***	**Expected Physical Activity Benefits – Health**	**Weight Loss Barriers**	**Physical Activity Barriers – Total**	**Physical Activity Barriers – Time**	**Physical Activity Barriers – Effort**
Physical Activity Self-Efficacy	0.10547 0.0404 378	-0.23288 <.0001 375	-0.29345 <.0001 373	-0.15898 0.0020 376	-0.32925 <.0001 375
Expected Weight Loss Benefits	0.35344 <.0001 378	0.10579 0.0406 375	0.04226 0.4158 373	0.01154 0.8235 376	0.08109 0.1170 375
Expected Physical Activity Benefits – Total	0.70548 <.0001 379	0.05935 0.2510 376	0.05229 0.3132 374	0.08502 0.0993 377	0.03918 0.4487 376
Expected Physical Activity Benefits – Psychological	0.38569 <.0001 379	0.10180 0.0485 376	0.08478 0.1016 374	0.11398 0.0269 377	0.00575 0.9115 376
Expected Physical Activity Benefits – Image	0.61455 <.0001 379	0.05630 0.2762 376	0.04079 0.4316 374	0.04865 0.3461 377	0.10962 0.0336 376
Expected Physical Activity Benefits – Health		-0.08820 0.0876 376	-0.05203 0.3156 374	-0.00040 0.9938 377	-0.02565 0.6201 376
Weight Loss Barriers	-0.08820 0.0876 376		0.62306 <.0001 371	0.51679 <.0001 374	0.49126 <.0001 373
Physical Activity Barriers – Total	-0.05203 0.3156 374	0.62306 <.0001 371		0.75552 <.0001 374	0.79486 <.0001 374
Physical Activity Barriers – Time	-0.00040 0.9938 377	0.51679 <.0001 374	0.75552 <.0001 374		0.33170 <.0001 374
Physical Activity Barriers – Effort	-0.02565 0.6201 376	0.49126 <.0001 373	0.79486 <.0001 374	0.33170 <.0001 374	

Legend ***r or r_s*** ***p-value*** ***N***	**Expected Physical Activity Benefits – Health**	**Weight Loss Barriers**	**Physical Activity Barriers – Total**	**Physical Activity Barriers – Time**	**Physical Activity Barriers – Effort**
Physical Activity Barriers - Obstacle	-0.11443 0.0259 379	**0.38663** **<.0001** **376**	0.70016 <.0001 374	0.39931 <.0001 377	0.33373 <.0001 376

Legend ***r or r_s*** ***p-value*** ***N***	**Physical Activity Barriers - Obstacle**
Depressive Symptoms	0.06536 0.2049 378
HRQOL – Physical Function	-0.21817 <.0001 376
HRQOL – Role Physical	-0.16627 0.0012 376
HRQOL – Bodily Pain	-0.17435 0.0007 378
HRQOL – General Health	-0.06084 0.2386 377
HRQOL – Vitality	-0.17234 0.0008 379
HRQOL – Social Function	-0.05509 0.2867 376
HRQOL – Role Mental	-0.05409 0.2942 378
HRQOL – Emotional Well Being	-0.05314 0.3028 378
Weight Loss Self-Efficacy – Total	-0.14364 0.0053 376
Weight Loss Self-Efficacy – Negative Emotion	-0.14564 0.0045 378
Weight Loss Self-Efficacy - Availability	-0.10815 0.0353 379

Legend ***r or r_s*** ***p-value*** ***N***	**Physical Activity Barriers - Obstacle**
Weight Loss Self-Efficacy – Social Pressure	-0.07455 0.1480 378
Weight Loss Self-Efficacy Physical Discomfort	-0.13419 0.0089 379
Weight Loss Self-Efficacy – Positive Activity	-0.09109 0.0769 378
Physical Activity Self-Efficacy	**0.08353** **0.1068** **374**
Expected Weight Loss Benefits	**0.00665** **0.8974** **378**
Expected Physical Activity Benefits – Total	0.00863 0.8670 379
Expected Physical Activity Benefits – Psychological	0.11667 0.0231 379
Expected Physical Activity Benefits – Image	-0.08228 0.1098 379
Expected Physical Activity Benefits – Health	-0.11443 0.0259 379
Weight Loss Barriers	0.38663 <.0001 376
Physical Activity Barriers – Total	0.70016 <.0001 374

Legend ***r or r_s*** ***p-value*** ***N***	**Physical Activity Barriers - Obstacle**
Physical Activity Barriers – Time	0.39931 <.0001 377
Physical Activity Barriers – Effort	0.33373 <.0001 376
Physical Activity Barriers - Obstacle	

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