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EFFECTIVENESS OF A FACE-TO-FACE WEIGHT LOSS INTERVENTION PAIRED WITH MOBILE TECHNOLOGY AMONG RURAL ADULTS IN KENTUCKY

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THESIS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Nutrition and Food Systems in the College of Agriculture, Food and Environment at the University of Kentucky

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ABSTRACT OF THESIS

EFFECTIVENESS OF A FACE-TO-FACE WEIGHT LOSS INTERVENTION PAIRED WITH MOBILE TECHNOLOGY AMONG RURAL ADULTS IN KENTUCKY

The obesity epidemic remains a serious issue in the United States leading to significant public health implications and costs. Few weight loss interventions paring mobile technology with face-to-face interventions have been conducted in rural communities. Yet, mobile technology interventions offer good potential for delivery but it is unclear if the combination of these weight loss strategies are beneficial. This study sought to examine how integrating mobile technology with face-to-face weight loss interventions in rural communities affects weight loss. Additionally, to determine if mobile technology paired with face-to-face interventions could increase autonomous and controlled motivation levels among adults in rural Kentucky. The addition of mobile technology with face-to-face intervention provided no significant interaction effect for weight loss compared to the mobile technology group alone. However, a group and time effect was observed for weight loss change. An interaction effect for autonomous motivation indicated that neither group changed independently, but comparing their change over time, the intervention group increased while the control group decreased. A time effect was found as controlled motivation decreased from baseline to final. Future research is required to develop weight loss interventions using technology and face-to-face strategies that may enhance motivation and weight loss outcomes.

KEYWORDS: Weight loss, Mobile Technology, Face-to-face, Intervention, Motivation

Thomas Michael Ard

December 5, 2017

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Chapter One: Introduction

Background

Obesity is the fifth leading cause of death in the world defined as a BMI (body mass index) ≥ 30.0. An estimated 650 million adults are obese while more than 1.9 billion adults are overweight world-wide (BMI between 25.9-29.9) [1], with 36.5% of U.S. adults obese [2]. The Centers for Disease Control and Prevention (CDC) estimates the prevalence of obesity will increase as Americans consume added sugars and saturated fats beyond the recommended levels [3-6]. In addition to diet, other factors such as physical inactivity, and stress are predictors for obesity prevalence [7-9] . Nevertheless, research efforts to reduce obesity epidemic through lifestyle intervention strategies remain an enormous challenge in the U.S. [10, 11].

Behavioral weight loss interventions are effective self-monitoring strategies for most people who seek treatment for obesity [12-14]. However, a common problem following successful weight loss is weight loss maintenance [15, 16]. Binge eating, eating restraint, and disinhibition are factors that contribute to weight regain post-intervention [8]. To combat these factors, weight loss interventions have enhanced treatment outcomes with face-to-face interactions for weight loss maintenance. This modification addresses the inconsistencies of original weight loss interventions by incorporating greater frequency of self-monitoring, goal setting, and feedback as an essential infrastructure of the intervention [16-19].

As an alternative to face-to-face interventions, mobile technology interventions have become more suited for delivering a weight loss intervention to a greater number

of people [18-20]. Mobile technology interventions utilize mobile apps, text messaging, and web-based portals as effective tools for communication [20-22]. Still, evidence suggests that mobile technology applications merely produce short-term weight loss [23, 24]. Limited data has been collected on whether mobile technology can successfully pair with face-to-face interventions that result in weight loss or weight loss maintenance [21, 25]. Therefore, the aim of this study was to determine the effectiveness of a face-to-face intervention paired with mobile technology in regards to weight loss.

Problem Statement

The increasing obesity rate is creating health disparities among adults in rural Kentucky. Current research illustrates the influence of mobile technology interventions and face-to-face interventions on weight loss separately. Limited research exists examining the effects of face-to-face interventions paired with mobile technology as a tool to increase weight loss.

Purpose

The current study seeks to examine how integrating mobile technology with face-to-face weight loss interventions in rural communities affects weigh loss [21, 25]. Therefore, the purpose of this study was to integrate mobile technology with a face-to-face intervention to improve weight loss in rural adults in Kentucky over an eight-week intervention. Additionally, we sought to determine if mobile technology paired with a face-to-face intervention could increase autonomous and controlled motivation levels among rural adults in an eight-week intervention.

Research Questions

1) How does a mobile technology weight loss intervention compared to a mobile technology weight loss intervention paired with face-to-face facilitation affect weight loss for adults in rural Kentucky?
2) How does a mobile technology weight loss intervention compared to a mobile technology weight loss intervention paired with face-to-face facilitation impact autonomous and controlled motivation levels for adults in rural Kentucky?

Hypothesis

1) Participants in the face-to-face facilitated intervention group paired with mobile technology will lose more weight in 8 weeks vs. participants using the mobile technology alone.
2) Participants in the face-to-face facilitated intervention group paired with mobile technology will increase autonomous and controlled motivation levels in 8 weeks vs. participants using the mobile technology alone.

Justification

In the past twenty years, the rate of overweight and obesity in adults has increased dramatically [1]. The estimated annual medical cost of obesity in the U.S. is $147 billion [26, 27]. As technology becomes more accessible, weight loss interventions attempting to fight increasing obesity rates can cultivate the use of mobile technology by adapting these interventions to serve a greater number of people. The facilitation of weight loss from face-to-face weight loss interventions is well known; however, integrating mobile technology within an intervention might improve weight loss by

utilizing easy self-monitoring trackers via phone to show the individual change over time [28-30]. The addition of mobile technology with a face-to-face intervention could potentially increase weight loss and improve autonomous motivational among rural Kentuckian adults. The results of the present study may provide insight into how rural Kentuckian adults lose weight with the combination of these two effective interventions.

Chapter Two: Literature Review

Introduction

The prevalence of overweight and obese adults has increased noticeably as has the risk for obesity-related comorbidities such as type two diabetes, metabolic syndrome, cardiovascular disease, hypertension, stroke, and various types of cancer [31, 32]. Disparities in obesity-related disorders are also related to geographic location issue [33]. Throughout the U.S., rural populations experience higher obesity prevalence, due to the lack of physical activity, access to primary health care preventions, and poor diet choices [33-36]. Obesity disproportionately affects different communities of high poverty levels, lower education levels, and ethnic minorities [37, 38]. Within these underprivileged communities, particular age groups are affected more than others. Middle age adults, ages 40-59, experience higher obesity rates at 41%, while adults age 60 and over have an obesity rate of 38.5%. Young adults, ages 20-39, have the lowest obesity rate at 34.3% [39]. The disparities of obesity prevalence on rural Kentuckian adults calls for a lifestyle intervention that may help lower the rates of obesity and health related risks.

In Kentucky, current adult obesity rates are 34.2%. The prevalence of obesity for African American communities in Kentucky is 42.4% while non-Hispanic whites are only 33.4%. Adults 45-64 experience higher obesity rates (38.34%) compared to other age groups. Kentucky has the 7th highest obesity prevalence in the U.S. [40]. According to Better Policies for Healthier America, Kentucky's obesity rates have increased from 12.7% in 1990 to 34.2% in 2016 [40]. A telephone survey conducted found that 70% of

Kentuckian adults are interested in losing weight [41]. Prior to targeting the overweight and obese population immersed in this epidemic, studies need to understand the reasons this epidemic disproportionately impacts these populations to further reduce the overweight and obesity epidemic. These statistics support the need for an intervention to decrease overweight and obesity prevalence within Kentucky and other effected states.

The need for a weight loss intervention in rural Kentucky is apparent, however, understanding the drivers of behavioral factors for successful weight loss is extremely multifaceted. Diet and exercise are two paradigms often incorporated in an intervention, yet few interventions find lasting results due to the tremendous challenges of obtaining resources and require substantial time commitment for group counseling sessions [15]. Thus, alternative methods are being developed to utilize technology as a strategy to enhance the behavioral factors regardless of location [23, 42-44]. As an additional technology treatment option, mobile technology offers the individual autonomy, referring to ones' capacity to think and do for themselves according to internal values and goals which could facilitate greater weight loss [19, 45]. Still, limited research exists that pair mobile technology with a face-to-face weight loss intervention to improve weight loss among obese and overweight adults; furthermore, analyzing autonomous and controlled motivation levels in a mobile technology weight loss intervention. To address these obesity dipartites, mobile technology-based interventions must deliver feasible interventions that promote motivation to lose weight and maintain weight in rural communities.

Motivation Theory

The Incentive-Sensitization Theory of Addiction implies a clear dissociation of how much a reward is "wanted" versus how much the same reward is "liked" [46]. The wanted reward requires a large neural system that includes mesolimbic dopamine. The liking reward, which tends to use more fragile neural systems, does not require dopamine [47]. This dopamine-related motivation system contributes to the Self-Determination Theory by connecting a bridge to predicting self-regulated behaviors. The theory suggest that the quality of individuals motivation affects the extent to which individuals will engage in, and continue with behaviors [47]. These two theories generate an important framework for individuals seeking weight loss treatment and the motivation factors related to entering and completion of the treatment [45].

Qualitative evidence suggests that autonomous regulation is a key predictor of successful weight-loss outcomes [29]. Autonomous motivation is engaging in a behavior because it is consistent with intrinsic goals. By engaging in autonomous motivation, an individual is more likely to initiate and persist in a behavior without any external reinforcement and contingency. In contrast, controlled motivation is engaging in a behavior because of external reasons. Gaining rewards, avoiding punishment, and feelings of guilt are all forms of controlled motivation that lead to an obligation to persist in a behavior [48].

A theoretical framework for weight loss interventions include goal setting, social support, self-monitoring, and more recently motivational interviewing resulting in support of different domains of lifestyle behaviors. An intervention focused on lifestyle

modification using motivation for change in 100 overweight and obese outpatients was conducted. Pre- and post- intervention comprehensive evaluations to assess lifestyle changes. Prior to intervention the patients were open to physical activity and nutritional changes to improve health, the evaluations determined that post-intervention patients increased actions towards changing bad habits and acquiring good habits [49]. Various studies support these findings when interventions improve motivation, leading to greater physical activity and healthy dietary choices which may influence weight loss in overweight and obese individuals [50, 51].

A motivation-focused weight loss maintenance program conducted an alternative method for obesity treatment. The objective of the weight loss maintenance program was to determine whether specifically targeted novel motivation program could cease waning motivation to promote weight maintenance [52]. Overweight women (N=338) with urinary incontinence were randomized to two groups; lifestyle obesity treatment and control group (2:1 ratio). All participants were followed for 18 months, following the initial 6 month obesity treatment the lifestyle group (N=226) was equally randomized to a novel motivation-focused maintenance program or a standard skill-based maintenance approach. The control group (N=112) only received seven education sessions with general information regarding physical activity, healthy eating habits, and other health related topics. The skill-based maintenance program used current lifestyle behavioral factors such as goal setting, social support, and relapse prevention. The motivation intervention used the same behavioral goals as the skill-based group, however, the intervention sought to promote these goals using strategies

derived from motivational theories. With the five motivational goals the data reached comparable 18-month losses in motivation-focused and skill-based. These groups lost significantly more than the control group, p=.0012. In conclusion, the study offers an alternative approach to weight maintenance programs that produces similar results [52]. Understanding a participant's internal and external motivation factors throughout treatment helps create a healthy lifestyle change.

Adapting Behavioral Weight Loss Interventions

Over the years researchers have adjusted behavioral weight loss interventions to adapt to the current issues overweight and obese populations face. Advances in research, technology, counseling, and the growing obesity epidemic have all lead to the development of weight loss intervention modification. Researchers may use a conventional behavioral weight loss intervention combined with another intervention type to produce greater weight loss results based on certain overweight or obese populations [53]. Face-to-face interventions incorporate in-person facilitated group discussion to address various health-related behaviors [25]. Technology Based interventions promote access to tracking methods which leads to greater retention that could be promising for future interventions. Motivational-interviewing focuses on how motivation levels throughout the intervention interact with fundamental outcomes, like physical activity and diet, to produce an increase in health-related behaviors [54]. Table 2.1 contains a brief description of each intervention type that can be used to increase weight loss in overweight and obese populations.

Table 2.1 Intervention Type Synopsis

Weight-loss Intervention Type	Intervention Description
Behavioral Weight-loss Intervention (BWLI)*	Program that focuses on building weight loss maintenance skills. Lifestyle modifications are strategies incorporated to improve effectiveness of weight loss. Physical activity and nutritional aspects are a common foundation. Focused on self-monitoring, goal setting, and feedback.
Face-to-Face Intervention (FFI)*	In addition to BWLI, face-to-face includes in-person group sessions throughout the intervention.
Technology Based Intervention (TBI)*	In addition to BWLI, this intervention includes technology to facilitate improvement in health-related behaviors
Motivation Interviewing Intervention (MI)*	In addition to BWLI, motivational-interviewing uses motivation as a mean for change in health-related behaviors

*Types of interventions can be combined or stand-alone based on research design and outcomes.

In 2016, the American Heart Association issued guidelines on the treatment and prevention of obesity by implementing policies that provide adequate resources and healthy environments. These policies can assist with preventing the rise in obesity prevalence. Including treatment with these polices by incorporating physical activity, encouraging healthy diet choices, and face-to-face interventions [55]. The obesity epidemic remains multi-faceted but numerous weight loss interventions have included these strategies to facilitate change [10]. Various types of interventions have been

conducted to increase weight loss, yet the majority of those produce similar results. Physical activity and nutritional tracking are fundamental strategies integrated in weight loss interventions to lose weight, yet neither strategy is more effective than the other [8, 56]. Unick [57], assessed whether adding wearable physical activity monitors to a weight loss intervention for severely obese individuals would improve physical activity and self-monitoring following a 6-month randomized intervention. Participants (n=29) were randomly assigned a group: standard behavioral weight loss(SBWL) or SBWL+Technology (SBWL+TECH). The group effect on weight loss was modest but not significant [57]. The combination of physical activity and diet should be combined to create an effective weight loss intervention.

Earlier studies delivering behavioral weight loss interventions used face-to-face sessions to explore weight loss over time by group size demonstrating that large group (100 persons), small group (20 persons) both experienced significant weight loss [58]. A similar study assessing group size in relation to weight loss discovered that small group in-person sessions produced 3.3kg greater weight loss than large groups [59]. In-person techniques reinforce motivation, leading to higher retention; the need for these techniques paired with technology based interventions show promise in creating a bridge between autonomous motivations at home or in group session.

Systematic reviews analyzing behavioral weight loss interventions using in-person techniques support the effectiveness of weight loss and reducing health risks associated with being overweight [14]. A significant association between self-monitoring and weight loss was consistently found; however, limitations such as the homogenous

samples and reliance on self-report were common among studies [14]. Using face-to-face interventions produce weight loss, so combining this intervention with technology could address resource intensive weaknesses while maintaining or improving results.

Behavioral weight loss interventions may be superior to stress management programs when weight loss is the goal [60]. Most behavioral weight loss interventions use stress as a covariant, however, stress may be a significant influencer on weight loss and weight loss maintenance [61]. One potential theory behind the relationship of stress on weight loss is emotional eating [62]. Levoy, Lazaridou, Brewer, and Fulwiler (2017) discover a reduction in emotional eating after an eight-week mindfulness-based stress reduction program. Similarly, Webber [60] found that stress management programs yield equivalent weight loss results to behavioral weight loss programs. Moreover, the combination of the two programs could yield the most favorable results. Along with stress, depression can contribute to the overconsumption of added sugar and saturated fats [63].

Integrating Technology

In the United States, the internet reaches approximately 87% of the population widening the potential delivery methods of weight loss interventions at home using a smart phone, laptop, or computer [64]. 43.55% of adults reporting using the internet for health-related information [64], owing to the possibility that the internet could be a promising toll for weight loss [55]. The need and want for an intervention is well known, but the challenge facing internet weight loss interventions has been incorporating specific strategies [41].

In a 12-week (Health) texting intervention, the aim was to specifically design an intervention for a young (18-35 years) population. The 250 participants were split into two groups using a two-arm, parallel-group randomized controlled trail. The intervention group received 8 text messages weekly, 1 email, 5 personalized coaching calls, a diet booklet, and access to resource and mobile apps on a website. The control group received only 4 test messages, printed dietary and physical activity guidelines. The intervention group was 2.2 kg lighter than the controls after 12-weeks (p=.005) [18, 23]. The results revealed that the intervention participants choose healthier food options, lost more weight, and increased their total physical activity. A tailored intervention (intervention custom-made for each participant) geared towards a specific population is vital in current weight loss strategies [18]. Several interventions now use technology self-monitoring as a tailored tool to allow participants easy access to track certain behavioral factors important to them via phone [19, 65].

The effectiveness of traditional self-monitoring has been a cornerstone for weight loss interventions [66]. Features such as caloric intake and physical activity have remained the foundation of self-monitoring as it relates to weight loss. Ross et al. examined newer self-monitoring technology outside of in-person behavioral interventions over 6 months. A randomized, controlled pilot study consisting of 80 participants was conducted in 2016. Three groups were formed by randomization; standard self-monitoring tools (ST), technology-based self-monitoring (TECH) and technology based tools combined with phone-based intervention (TECH+PHONE). An interaction effect over the 6-month period for weight loss, p=.042, was observed. Each

group lost weight but the TECH+PHONE intervention lost more weight, followed by the TECH group, and ST group. The results for TECH+PHONE advocate usage of phone based intervention combined with self-monitoring technology because this method allows easy access to self-monitoring. Delivering self-monitoring tools via technology improves weight loss outcomes versus traditional methods [65].

A systematic review of technology assisted weight management interventions was conducted in 2014 by Allen and colleagues to determine whether the technology approach was an effective tool to improve weight management. Thirty-nine full-text articles were reviewed and eighteen were excluded based on risk of bias or repetition. It was concluded that technology-assisted interventions may be an effective tool for weight loss, especially using email, text messages, and feedback as support [67]. The limitations to this review include limited 10-year sample size, constrained reference databases, and heterogeneousness of intervention strategies. These limitations coincide with future research that needs to be investigated to better understand technology assisted weight loss intervention delivery methods and strategies [67].

Chapter Three: Methods

Introduction

This study used a mixed-effects repeated measure test to measure weight loss in a face-to-face weight loss intervention paired with mobile technology vs. mobile technology without a face-to-face component. The study took place over an 8-week period among rural adult Kentuckians. The study is based on mobile technology to examine how adults in rural Kentucky could be affected through an app focused on local community involvement, nutrition, and physical activity tracking. The Fit-Faceoff weight loss intervention app was developed at the University of Kentucky with the help of an independent contractor with support from a CDC grant.

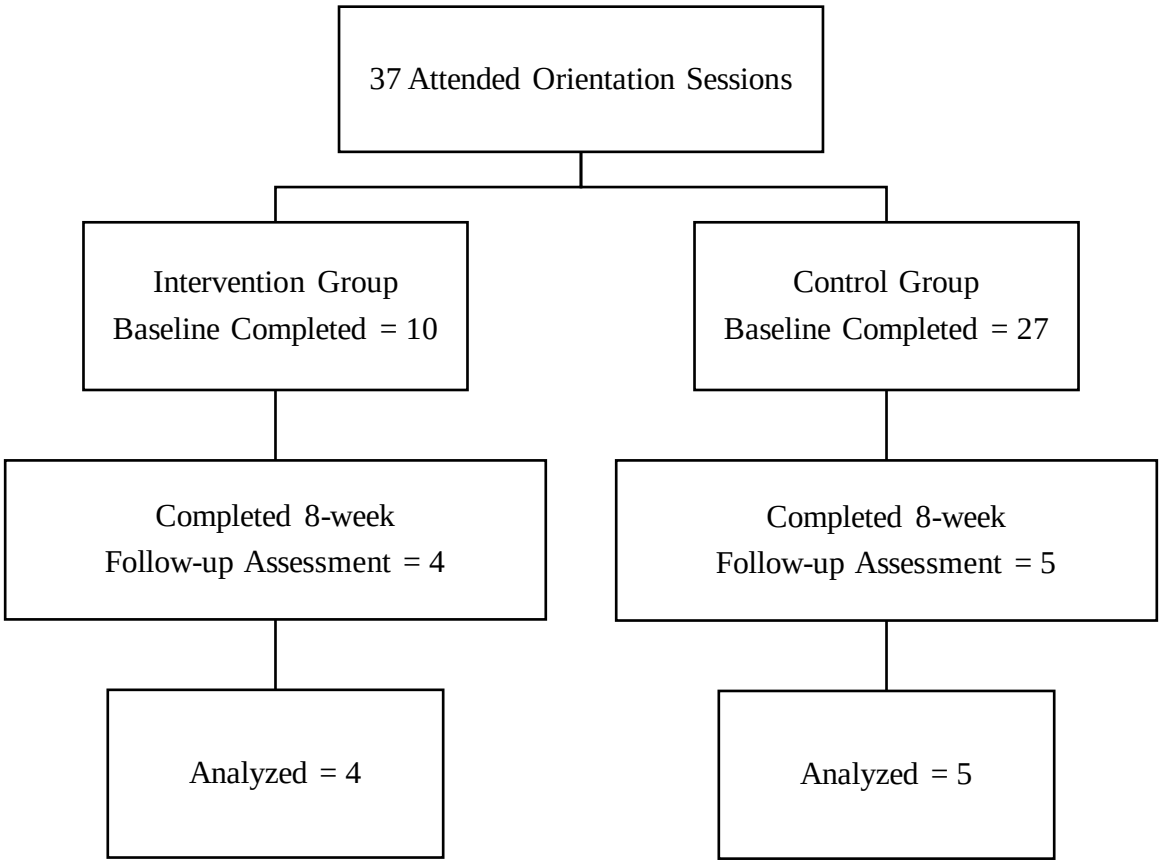
Study Population and Procedure

Study participants were overweight or obese adults (BMI 31.56 ± 5.65), aged 42-77, in rural Kentucky. Cooperative Extension Offices from three Kentucky counties, Clark, Bourbon, and Scott counties, were recruited to participate in this 8-week intervention. Cooperative Extension Agents in these three counties agreed to recruit volunteers to enter into the intervention. Participants were excluded if they were not 18 years of age or older, did not have access to internet via smart phone or computer, and could not participate if a physician did not recommend weight loss. A twenty-five-dollar incentive was received after the completion of the 8-week intervention. This study was approved by the University of Kentucky IRB.

Study Design

A two-factor experimental design was used, with group as the between subjects' factor and time (baseline, 8 week) as the within subjects' factor. A Research Assistant from the University of Kentucky conducted a pre-test survey and demonstrated each facet of the app thoroughly to each group after the signed IRB form was received. The intervention group, Clark county, received an 8-week face-to-face intervention paired with mobile technology. In addition to the app, participants in the intervention group received a weekly face-to-face intervention that consisted of a short lesson, food demonstration, and facilitated group discussion. The control group, Scott and Bourbon counties, only received the pre-test survey and demonstration of the mobile technology.

Figure 3.1 Flow Diagram of Participants



Measurements

Anthropometric Measurements

Demographics and anthropometric data were collected by a trained Research Assistant from the University of Kentucky. Body weight, height, and blood pressure were collected pre- and post- intervention. Body weight and height was measured using a digital scale and seca 213 mobile stadiometer with participants wearing street clothes and no shoes. An Omron 5 series upper arm electronic blood pressure monitor was used

to collect two blood pressure measurements. Participants were sitting upright properly in a chair while resting their forearm on the table with legs uncrossed.

Pre- and Post- Questionnaires

Several selected questionnaires were used in this intervention to collect data on stress, depression, motivation, physical activity, and diet choice frequency. Questionnaires taken pre- and post-intervention included the Perceived Stress Scale Survey (PSS) [68-70], The Center for Epidemiologic Studies Depression Scale (CES-D) [71, 72], NHANES 2009-2010 Dietary Screener [73], International Physical Activity Questionnaire (IPAQ) [74], and the Treatment Self-Regulation Questionnaire (TSRQ) [75]. Trained Research Assistants properly administered questionnaires verbally to adults in case of literacy issues. The PSS was used to measure the degree to which situations in one's life are appraised as stressful. The PSS is known to be valid and reliable in measuring correlation of how stress impacts life-even scores [69]. The CES-D is a 20-item measure that asks participants to rate how often over the past week they experienced symptoms associated with depression (i.e. feeling lonely, restless sleep, etc.) [71]. The CES-D is valid and continues to be used in the field [76]. The NHANES 2009-2010 Dietary Screener is a 26-item questionnaire which was used to assess dietary intake of adult participants. The items cover a variety of drink and food categories that estimate consumption frequencies over the previous month. Responses in the questionnaire can be converted into "real world" quantities to further assess dietary intake (i.e. cups, grams, tablespoons, etc.) [73]. The purpose of the IPAQ is to obtain comparable estimates of physical activity across cultural differences. The International

Physical Activity Questionnaire was valid when assessing levels and patterns of physical activity in adults [74]. The TSRQ is a set of questions concerning why people engage or would engage in some healthy behavior, try to change an unhealthy behavior, or follow a treatment regimen. The TSRQ was validated in an article published by Levesque and colleagues [75].

The first meeting for both the control and intervention groups took approximately an hour to complete with the explanation of the IRB form, collection of signed consent forms, and the completion of all surveys and anthropometric recordings. Following the 8-week intervention, participants met to complete the same surveys and measure new anthropometrics.

Fit Faceoff App

The Fit-Faceoff web-app was developed with the assistance of a local advertising agency in Lexington, Kentucky, called Cornett. Apax Software contributed to the development of the web-app software. The Fit-Faceoff app featured nutritional and physical activity tracking based on focus group assessments. As a community assessment, Fit-Faceoff featured individual or group competitions, recipes, physical activity videos, community calendars, and check-in points. All facets of the web-app were demonstrated to each group during the first meeting.

Intervention

The intervention lasted 8 weeks from March 2016 to May 2016. The intervention group received the face-to-face intervention every week that consisted of a food demo, short lesson plan, and facilitated discussion led by a trained Research Assistant. Lessons

included information regarding portion sizes, importance of fruit and vegetable intake, cooking skills, increasing physical activity, and other common barriers that adults face daily when choosing what to eat. The curriculum for each session was adapted by *Weight-The Reality Series* created by Dr. Janet Tietyen from The University of Kentucky Extension Office Department of Nutrition and Food Science [77]. The information was updated to meet the current recommendation for different food groups and physical activity levels. *Weight-The Reality Series* incorporates interactive recipes to allow the participants to engage in a hands-on learning environment. Throughout the lessons participants were encouraged to talk through situations regarding life choices made throughout the week and potential threats to success in the weeks to come. The intervention group attended lessons once per week through the 8-week intervention (Table 3.1).

Table 3.1 Weekly Intervention Group Material and Activities

Week	Topic	Topic Description	Food Demo (Recipe)
1	Portion Control What Really Matters?	Discussed issues about portion control at home and on the go. What foods really matter in a diet.	No Demo
2	Design Your Plan	Broke down the different steps to focus on creating a plan that suits each person.	Smoothies
3	Cooking with Fruits and Vegetables	Discussed the importance of fruits and vegetables in a diet and how to cook with unfamiliar produce.	Salsa
4	Feeling Good About Food	Talked about the enjoyment of cooking; healthy eating doesn't always mean 'no flavor'.	Apple Crisp
5	Bodies in Motion	Explained the importance of physical activity in relation to nutrition.	Local Fresh Vegetables
6	Calories, Protein, Fat, and Carbohydrates	Broke down each food group, discussing the function and common myths.	Herb de Provence Chicken
7	Back to the Kitchen	Group discussion on eating local products; talked about the different meals of the day and what they consist of.	Local Fresh Fruits
8	Weight Loss that Lasts	How to continue to successfully lose weight without weekly meetings.	Different Yogurts

*Materials and Activities for Intervention Group Only

Statistical Analysis

Data were imported using JMP PRO 11 software to perform the statistical analysis. For all statistical analyses, alpha was set at $p<0.05$. All data collected were run through a mixed-effect repeated measures model to assess for group effect, time effect, and group x time interactions. The group effect observed the differences between intervention and control groups. The time effect examined participants change over time. The interaction effect evaluated if one group changed over time differently than the other group. Variables assessed included: physical activity, depression, stress, autonomous motivation, controlled motivation, dietary frequencies, weight loss, and blood pressure.

Chapter Four: Results

Participants

37 individuals were screened for eligibility; all 37 met inclusion criteria and completed baseline measurements. A total of 9 participants (mean age 56.78 years, mean weight 84 kg) completed follow-up measurements and were included in the analyses. 89% were white women. Sample population characteristics are shown in Table 4.1. Bourbon and Scott county were included in the control group (n=5). Clark county was the intervention group (n=4).

Table 4.1 Completers Participant Characteristics

Characteristics	Control n = 5	Intervention n = 4	Total n = 9
Weight, kg (mean ± SD)	75.12 ± 13.23	95.03 ± 5.12	83.96 ± 14.4
BMI, kg/m^2 (mean ± SD)	28.24 ± 4.82	35.73 ± 3.57	31.56 ± 5.65
Sex, female (%)	4 (80)	4 (100)	8 (89)
Age, years (mean ± SD)	59.6 ± 14.2	53.3 ± 11	56.8 ± 12.5
Race, white (%)	4 (80)	4 (100)	8 (89)

Statistics represent completers baseline measurements

Anthropometric Measurement Evaluation of Intervention Groups

Mixed-effects repeated measures model analyses were performed to determine if anthropometric measurements change from baseline to final. Tables 4.2-4.4 show the findings of anthropometric measurements between groups and interactions of groups over time. When examining participants baseline to final, both group and time differences were observed in weight change. Weight change (Table 4.2) was significant between groups and over time, meaning both groups started and ended at different

weights while both groups decreased total weight over time. However, Figure 4.1 shows the absence of an interaction effect as both groups are decreasing over time in a similar manner. There were no significance effects for systolic and diastolic pressures (Tables 4.3-4.4).

Table 4.2 Fixed-effects Parameter Estimates for Weight Change

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	184.7	7.77	<.0001*	(166.3, 203.1)
Group	21.6	7.77	**0.0274***	(3.211, 39.99)
Time	2.445	0.787	**0.0172***	(0.584, 4.306)
Group x Time	0.305	0.787	0.7099	(-1.556, 2.166)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.3 Fixed-effects Parameter Estimates for Systolic Pressure

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	122.36	3.954	<.0001*	(113, 131.7)
Group	-1.738	3.954	0.6736	(-11.09, 7.61)
Time	3.438	3.153	0.3117	(-4.017, 10.89)
Group x Time	-3.563	3.153	0.2957	(-11.01, 3.892)

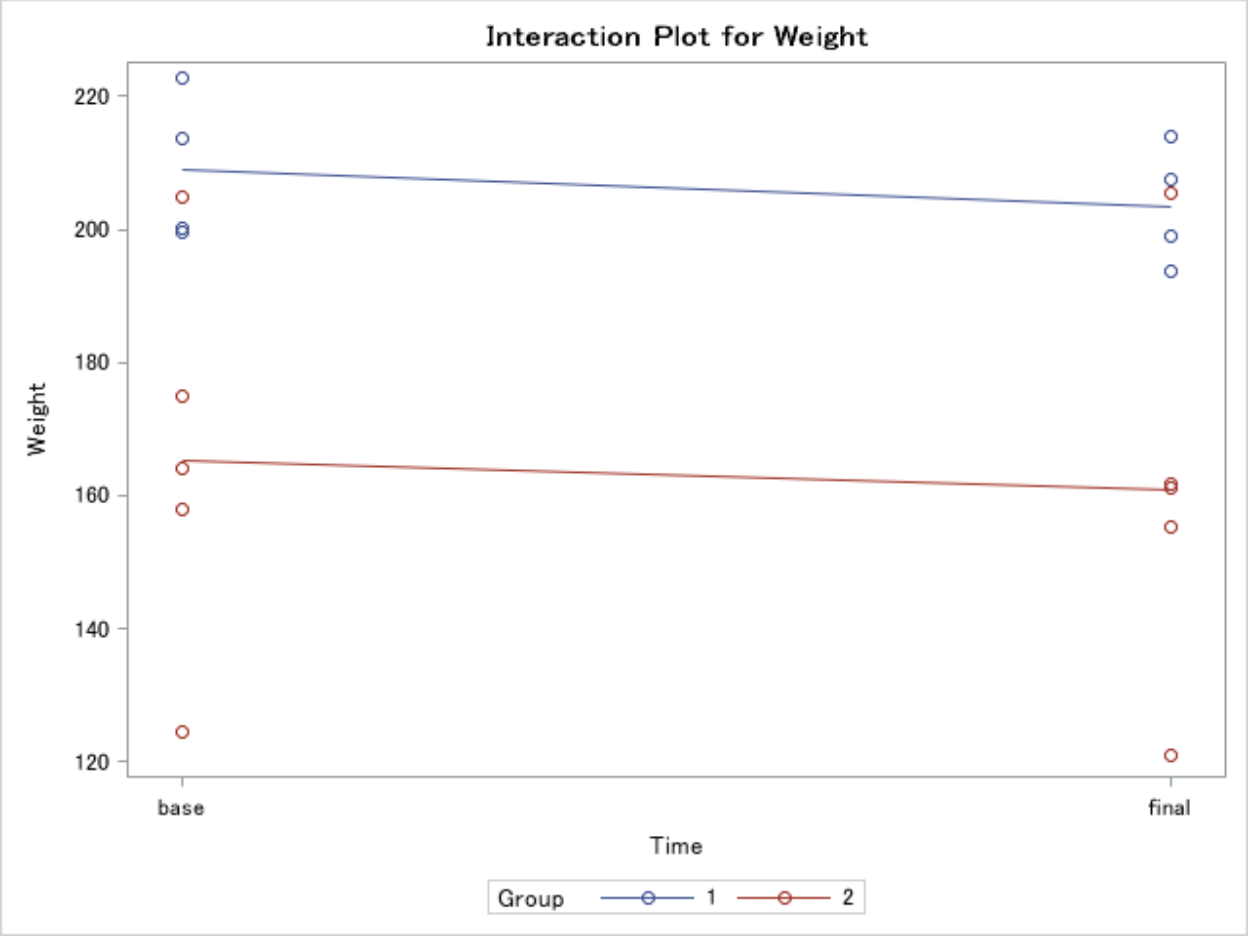
[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.4 Fixed-effects Parameter Estimates for Diastolic Pressure

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	77.806	2.155	<.0001*	(72.71, 82.9)
Group	1.006	2.155	0.6547	(-4.089, 6.102)
Time	2.456	1.589	0.1661	(-1.301, 6.214)
Group x Time	-0.6438	1.589	0.6975	(-4.401, 3.114)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Figure 4.1 Weight Change Interaction Effect



Group 1: Control (blue), Group 2: Intervention (red)

Questionnaire Evaluation of Intervention Groups

Mixed-effects repeated measures model analyses were performed to determine if questionnaire measurements change from baseline to final. Tables 4.5-4.12 show the results of questionnaire variables between groups, over time, and interactions of groups over time. When observing participants baseline to final, time effect was only observed for controlled motivation. Controlled motivation increased for both groups over time. For autonomous motivations, Figure 4.2 and Table 4.6 reveal no group or time effect but

show an interaction effect. Neither group changed independently, but comparing their change overtime, the intervention group increased much more than the control group. There were no significance effects for stress, physical activity, depression, fruit intake, vegetable intake, or added sugar (Tables 4.7-4.12).

Table 4.5 Fixed-effects Parameter Estimates for Controlled Motivation

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	2.083	0.197	<.0001*	(1.617, 2.548)
Group	-0.276	0.197	0.2041	(-0.741, 0.189)
Time	-0.483	0.175	**0.0284***	(-0.898, -0.068)
Group x Time	0.259	0.175	0.1836	(-0.156, 0.674)

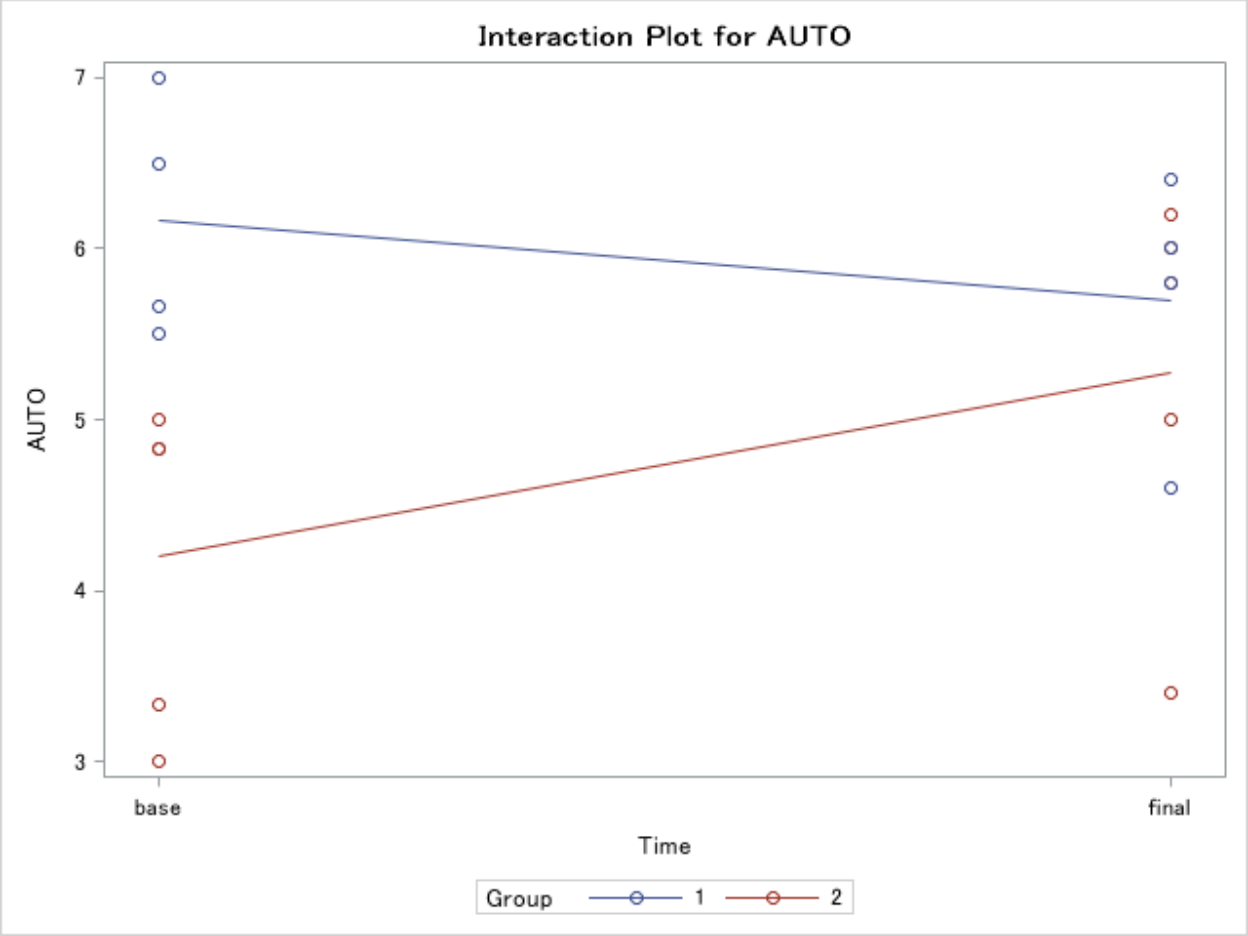
[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.6 Fixed-effects Parameter Estimates for Autonomous Motivation

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	5.337	0.27	<.0001*	(4.698, 5.975)
Group	0.597	0.27	0.0629	(-0.042, 1.235)
Time	-0.1533	0.1579	0.3640	(-0.527, 0.2201)
Group x Time	0.3867	0.1579	**0.0442***	(0.0132, 0.7601)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Figure 4.2 Autonomous Motivation Levels Interaction effect



Group 1: Control (blue), Group 2: Intervention (red)

Table 4.7 Fixed-effects Parameter Estimates for Stress

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	15.025	2.019	<.0001*	(10.25, 19.79)
Group	-0.775	2.019	0.7124	(-5.548, 3.998)
Time	-0.15	0.503	0.7746	(-1.341, 1.041)
Group x Time	-0.35	0.503	0.5097	(-1.541, 0.841)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.8 Fixed-effects Parameter Estimates for Depression

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	17.79	1.193	**<.0001***	(14.97, 20.61)
Group	0.5875	1.193	0.6373	(-2.232, 3.407)
Time	-1.337	1.148	0.2821	(-4.051, 1.377)
Group x Time	-0.5375	1.148	0.6538	(-3.252, 2.177

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.9 Fixed-effects Parameter Estimates for Physical Activity

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	448.1	82.31	<.0001*	(253.61, 642.9)
Group	-35.75	82.31	0.6771	(-230.4, 158.9)
Time	-17.25	13.15	0.2309	(-48.34, 13.84)
Group x Time	-24.75	13.15	0.1018	(-6.338, 55.84)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.10 Fixed-effects Parameter Estimates for NHANES Daily Fruit Intake

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	1.095	0.056	<.0001*	(0.962, 1.227)
Group	-0.097	0.056	0.1273	(-0.229, 0.036)
Time	-0.0594	0.1227	0.6431	(-0.349, 0.231)
Group x Time	-0.186	0.1227	0.1726	(-.0476, 0.1037)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.11 Fixed-effects Parameter Estimates for NHANES Daily Vegetable Intake (Including legumes excluding French fries)

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	2.712	0.1187	<.0001*	(2.432, 2.993)
Group	0.0096	0.1187	0.9377	(-0.2709, 0.2902)
Time	-0.1802	0.1664	0.3148	(-0.5737, 0.2133)
Group x Time	-0.2371	0.1664	0.1972	(-0.6303, 0.1564)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Table 4.12 Fixed-effects Parameter Estimates for NHANES Daily Intake of Added Sugar

Primary Outcome Model[a]	Parameter Estimates	SE	*P*	95% CI (Lower, Upper)
Intercept	16.605	1.648	<.0001*	(12.71, 20.501)
Group	-0.9	1.648	0.6018	(-4.796, 2.996)
Time	1.194	1.389	0.4186	(-2.091, 4.478)
Group x Time	1.033	1.389	0.1867	(-1.251, 5.318)

[a] Group is coded for control (2) and intervention (1); base for baseline data, final or final data. *Indicates p-value <0.05

Chapter Five: Discussion

The purpose of this study was to assess if a face-to-face intervention paired with mobile technology could improve weight loss among adults in rural Kentucky. Additionally, this study examined the intervention's effect on autonomous and controlled motivation levels in participants. Both groups lost weight over time demonstrating that each group started at a different weight but lost weight at the same rate over the 8-week period regardless of group. Furthermore, autonomous motivation revealed an interaction effect, while the intervention group increased autonomy over time, the control group decreased. Since the beta was negative, controlled motivation decreased slightly over time for both groups, showing a time effect. These results indicate that motivation was found to have a more positive impact on each group as weight loss change was consistent regardless of group.

Research has examined a positive relationship between in-person weight loss intervention using technology and modest weight loss [78]. The hypothesis of improving weight loss for adults in rural Kentucky using mobile technology paired with face-to-face intervention coincides with previous internet studies [78, 79]. However, the Keyserling [78] study found substantial improvement in diet, physical activity, and blood pressure which the current study did not. A group effect was observed because both groups initiated at different mean weights and finished at different mean weights. Relevant to the findings on weight loss change by group, in a randomized trial, Dutton [59] examined the effect of group size on weight loss treatment. Results show obesity treatment in smaller groups (n=12 member/group) may promote greater weight loss

[59]. Comparable weight loss results were discovered in the current study for the intervention group and control group over time. Over the 8-week intervention, the control and intervention groups started at two different mean weights but both groups decreased weight at the same pace over time which indicates that weight loss was not influenced differently between groups over time. Controversially, a mobile technology-based behavioral study found different results [30]. The randomized 24 months three group design examined the effect on weight in a mobile app intervention for young adults (ages 18-35 years). The three groups consisted of technology alone, personal coaching with technology, and a control group. The findings revealed no significant interaction effect differences between groups or over time. These contradicting results demonstrate the importance of group size for face-to-face interventions. The current study was successful at losing weight between groups and over time while the latter study had no change between groups or over time. Group size is a very important aspect to consider when creating an intervention for a large number of people. Group size may also play a role in autonomous and controlled motivation, as participants initiated into the two groups at different motivation levels.

There were no changes in physical activity measured by the IPAQ from baseline to 8-weeks. Both groups maintained similar physical activity throughout the intervention although the intervention group discussed physical activity as a topic during week 5. The Academy of Nutrition and Dietetics' position paper on weight loss interventions for treatment of overweight and obese adults recommends a goal of 150 to 420 minutes per week of moderate to vigorous activity [80]. Low physical activity is a

characteristic of individuals with obesity. Preliminary reports establish physical activity as a tool to improve health outcomes and weight maintenance [81-83]. In addition to maintaining physical activity levels, physical activity monitors may be one strategy for increasing physical activity but physical activity is a co-factor for weight reduction in the obese population [57]. Exercise behavior can be influenced by exercise reinforcement, determining the amount of work that the individual will complete to reach the desired behavior [84]. The reinforcement behaviors stimulate motivational effects that facilitates their reinforcing value. In this study, physical activity was measured pre- and post- but throughout the intervention an individual's motivation to incorporate physical activity in their treatment was solely their decision. Alternatively, the participant had the option to be sedentary. The current study supports this motivation theory of exercise reinforcement since both groups had the different options of active or sedentary lifestyles but instead both lost weight while physical activity levels remained consistent.

Eating behaviors did not change and were measured by the NHANES dietary screener questionnaire, though the intervention group received additional dietary sessions through weekly meetings. Various topics were covered throughout the 8-weeks (i.e. portion control, macronutrients, increasing vegetable and fruit intake, etc.). These lessons, created by Dr. Janet Tietyen [77], were geared toward obese individuals desiring to lose weight. Contrastingly, Timmerman and Brown have suggested that educating populations on mindfulness eating can improve healthy dietary choices [85]. By educating the intervention group on reducing mindfulness behaviors, reducing

calories and fat, the study found that women in the intervention group lost significantly more weight [85]. According to National Heart, Lung and Blood Institution and the United States Department of Agriculture regular physical activity and healthy dietary choices are mandatory for a successful weight loss intervention [56, 86]. With contrasting results, the current study's intervention length and completer size may have influenced the findings. Ideal intervention lengths for weight loss programs are longer than twelve weeks according to in-person facilitation guidelines set by the AHA/ACC/TOS [55]. Furthermore, a recommendation of 14 visits over six months, or monthly for 12 months [55]. The current study lasted only 8-weeks with one weekly visit. In order to discover changes in dietary choices interventions need to educate more and last longer for said changes to occur in post-testing.

The results displayed an interesting interaction effect for autonomous motivation. With the small sample size, neither group changed independently, however, comparing their change overtime the intervention group increased while the control group decreased. A time effect for controlled motivation was observed as both groups decreased controlled motivation over time. Referring to the Self-Determined Motivation Theory for this study, these two distinctive motivations exhibited different driving forces but were not conclusive for this study. Autonomous motivation is engaging in a behavior due to intrinsic goals or outcomes; the behavior is self-determined. The intervention group received optional weekly group sessions that included facilitated group discussion, food demos, and short lessons on various health-related topics while the intervention group received the app alone. The focused lifestyle intervention group

increased autonomous motivation while decreasing controlled motivation which is consistent with previous motivational interventions [45, 49]. This research supports the notion that motivation throughout the lifestyle intervention can support changes in domains like physical activity and nutritional behaviors [49]. Using motivation interviewing may be an effective approach to increase physical activity and decrease risk of cardiovascular disease in high risk overweight and obese patients [50].These findings support other's work mounting evidence that motivational interviewing improves health behaviors for various health outcomes [45, 48-51]. Motivation-focused weight loss interventions may influence greater weight loss maintenance which offers another effective approach to initially losing weight [52]. Additional research looking at internal and external cues that signify hunger would be useful to see how participants preferences decide their motivation levels.

Although, no changes in stress or depression were observed in the current study, psychological stress and depression can trigger consumption of sweet and high fat foods, leading to overall weight gain [62, 63]. Previous studies agree that stress and depression can be a significant influencer on weight loss, but incorporating a stress program or mindfulness eating can modestly improve weight loss and deter individuals from making bad dietary choices [60, 61].

Limitations

The limitations in this study were recruitment strategies, sample size, diversity, and self-reported bias. A larger sample size would have provided a more adequate representation of the rural population. In addition, the lack of diversity among

participants gender, sex, and race may influence the generalizability. Only 9 participants completed the intervention; 8 participants were white women. The absence of variety in socioeconomic factors limits the generalizability to rural Kentucky and nationwide. Additionally, the questionnaires were extremely lengthy and due to the questions centered around depression and anxiety, a number of participants felt uncomfortable. Finally, the questionnaire responses were self-reported and social desirability bias may have influenced participant responses.

Implications

These findings indicate that mobile technology paired with face-to-face weight loss interventions do not yield greater weight loss vs mobile technology alone. Each group started and ended at a different weight over time but the treatment or non-treatment did not influence greater weight loss. The interaction effect of autonomous motivation showed that the intervention group increased motivation while the control group decreased. This interesting interaction effect supports the claim that in-person weight loss interventions help create a healthy environment for autonomy. Additionally, the time effect presented a decrease in controlled motivation over time while observing no group effect suggesting external and introjected regulation played a role in completing the intervention for both groups. Although, the hypothesis was rejected, both forms of motivation levels changed, establishing the need for future researchers to discover the links between autonomous and controlled motivation in obese populations for weight loss intervention.

Recommendations for Future Studies

Statistics confirm that obesity prevalence continues to grow nationally [39, 40]. Rural communities are burdened to fend for themselves due to the lack of access to healthcare prevention and treatment of obesity. In-person weight loss interventions result in increased weight loss by focusing on self-monitoring, personal feedback, and goal setting. Today, weight loss interventions are now using technology as a tool to enhance these behavioral strategies known to produce greater weight loss outcomes. Studies have long-established the relationship between weight loss interventions and weight loss, as well as the relationship between technology's benefit as an effective tool in a weight loss intervention. Yet, a gap in the literature exists examining the relationship between a face-to-face weight loss intervention paired with app technology vs. app technology alone to increase weight loss in rural populations. To explore this relationship, more research is needed. Future research should expand upon the results found in this study to create a more effective treatment strategy for weight loss in overweight and obese adults. One recommendation is to increase the in-app features, future interventions should use text messaging alerts to improve nutritional and physical activity tracking. Similar studies should conduct interventions with longer periods of time to investigate the impact of mobile technology with an in-person weight loss intervention on weight loss and lifestyle changes that may improve overall well-being. Contradicting results demonstrate the importance of time length in regards to a weight loss interventions effectiveness. Intervention lengths for weight loss programs are longer than twelve weeks with frequent group sessions according to in-person

facilitation guidelines set by the AHA/ACC/TOS [55]. Lastly, future research could examine the effects of introducing motivational techniques after initial weight loss on long-term weight maintenance in the overweight and obese population. Incorporating these methods into mobile technology assisted in-person weight loss interventions may lead to increased weight loss.

Appendix

Perceived Stress Scale Survey (PSS):

http://www.mindgarden.com/documents/PerceivedStressScale.pdf

The Center for Epidemiologic Studies Depression Scale (CES-D):

http://cesd-r.com

NHANES 2009-2010 Dietary Screener:

https://epi.grants.cancer.gov/nhanes/dietscreen/questionnaires.html

International Physical Activity Questionnaire (IPAQ):

http://www.sdp.univ.fvg.it/sites/default/files/IPAQ_English_self-admin_long.pdf

Treatment Self-Regulation Questionnaire (TSRQ):

http://selfdeterminationtheory.org/health-care-self-determination-theory/

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