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A comparison of video conferencing and in-person health coaching approaches in combination with mHealth devices on weight loss, physical activity, and glycemic control

Kelly E. Johnson
University of New Mexico - Main Campus

Kelly E. Johnson
Candidate

Health, Exercise and Sport Sciences
Department

This dissertation is approved, and it is acceptable in quality and form for publication:

Approved by the Dissertation Committee:

Dr. Ann L. Gibson , Chairperson

Dr. Michelle G. Alencar

Dr. Len Kravitz

Dr. Christine Mermier

Dr. Damon Swift

Dr Fabiano Amorim

A COMPARISON OF VIDEO CONFERENCING AND IN-PERSON HEALTH COACHING APPROACHES IN COMBINATION WITH MHEALTH DEVICES ON WEIGHT LOSS, PHYSICAL ACTIVITY, AND GLYCEMIC CONTROL

BY

KELLY E JOHNSON

B.S., Exercise Science, Eastern Washington University, 2011

M.S., Exercise Physiology and Adult Fitness, University of Akron, 2013

Ph.D., Physical Education, Sports and Exercise Sciences,
University of New Mexico, 2017

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University of New Mexico, 2017

ABSTRACT

Background: Obesity prevalence is a global pandemic and a public health concern. One way to improve patient lifestyle behavior change is using health coaching. Most health coaching interventions have been delivered through telephone, web-based chatting, or a combination of face-to-face and web based instruction. Despite the potentially positive impact of group-based health coaching by video conferencing (VC) on weight loss and metabolic health, individualized VC sessions have yet to be studied. **Objective:** To assess changes in physical activity, body mass loss, metabolic markers (fasting blood, insulin, glucose, hemoglobin A1c [HbA1c], and HOMA-IR), and mHealth device adherence, in obese adults randomized into either a control group or one of two intervention groups using an individualized multidisciplinary health coaching approach. **Design:** Thirty adults (BMI≥30 kg/m^2) were randomly assigned into three groups (in-person [IP], video conference [VC], and control group [CG]) of 10 members each. Participants received a wireless accelerometer watch and body weight scale to synch with their personal smartphones and downloaded apps. Participants assigned to VC and IP received weekly individualized health coaching individualized based on data uploaded over the 12-wk intervention. Steps/day and weight loss were analyzed via analyses of covariance (ANCOVA). Between-group ANOVAs analyzed post-intervention changes in weight (kg), glucose, HbA1c, and HOMA-IR, WC, and mHealth adherence. **Results:** Weight loss was significant for VC (8.80±3.5kg; 7.7%), but not for IP (2.4±1.6kg; 3.4%) or CG (2.4±3.1kg; 3.5%). Steps/day was higher for VC compared to IP at week 4 and higher for VC than CG at weeks 6, 8, 9, and 11 ($p \leq .05$). No between-group differences were found for any glycemic control markers or for adherence with the

mHealth device uploads. However, there was a within-group decrease for HOMA-IR ($p \leq .05$) for in VC.

Conclusions: Our innovative, multidisciplinary, telemedicine health coaching delivered through video conferencing led to favorable changes in weight loss, physical activity, and HOMA-IR that surpassed changes when health coaching was delivered in person or was absent. Future studies using video conferencing to investigate health coaching delivered in group and individualized formats and for other population subgroups are needed as are studies investigating the impact of weight loss on other health outcomes (e.g. lipid profile, glycemic control, and inflammatory markers).

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SYMBOLS / ABBREVIATIONS

≥: greater than or equal to

≤: less than or equal to

<: less than

±: plus or minus

~: approximately

ANOVA: analysis of variance

ANCOVA: analysis of covariance

APPS: Applications for smartphone

BMI: body mass index

BW: body weight

CDC: Center for Disease Control

CG: control group

CM: centimeters

CVD: cardiovascular disease

DPP: Diabetes Prevention Program

ECW: eClinicalWorks®

EMR: electronic medical record

GLB: Group Lifestyle Balance

HbA1c: Hemoglobin A1c

HOMA-IR: Homeostasis Model Assessment estimate of insulin resistance

UNMIRB: University of New Mexico Institutional Review Board

IP: in-person group

KG: kilograms

KG/M^2: kilograms per meters squared

LMS: least mean squares

MG/DL: milligram per deciliters

mHealth: mobile health

OS: on-site group

OSN: on-line social network

PA: physical activity

SD: standard deviation

SE: standard error

UNM: University of New Mexico

US: United States

VC: video conference

WKS: weeks

YRS: years

Chapter I

Introduction

The Center for Disease Control (CDC) defines obesity as a body mass index (BMI) of ≥30 kg/m^2 in people 18 years or older (CDC, 2015). Currently in the United States, 66% of adults are overweight (BMI ≥25 kg/m^2) or obese according to that definition (Swift, Johannsen, Lavie, Earnest, & Church, 2014). Obesity is associated with a higher risk of elevated blood pressure, cholesterol, and cardiovascular disease risk, which can result in impaired glucose tolerance, sleep apnea and asthma, and fatty liver disease (CDC, 2015). According to Finkelstein et al. (2009) the medical costs pertaining to obesity in the United States in 2008 were $147 billion dollars with the estimated economical cost being $215 billion per year (Finkelstein, Trogdon, Cohen, & Dietz, 2009; Hammond & Levine, 2010).

Paralleling the escalation in obesity is the boom in "smart device" technology. In 2015, 64% of adults in the US owned a smartphone, highlighting the mass accessibility to health and fitness phone and internet applications (apps) among populations with and without access to traditional healthcare services (Pellegrini, Pfammatter, Conroy, & Spring, 2015). Many of the commercially available apps focus on both calorie counting and physical activity; the most popular apps in 2011 were MyFitnessPal, Lose it, Fat Secret's Calorie Counter, and SparkPeople (Garber et al., 2011). However, these apps are only used for personal monitoring and not are connected to a secure electronic database.

Telemedicine is the use of electronic information communication technologies to support long-distance delivery of clinical health care, patient and professional health-related education, public health, and health administration. In a 2011 study, participants

utilized telemedicine via a handheld device which presents a series of questions pertaining to each patient's diagnosis (Baker, Johnson, Macaulay, & Birnbaum, 2011). The participant's responses were sent to a web-based computer application and were reviewed by individual's case manager. Results of the study indicated a 19% decrease or a $312-$542 reduction in costs per patient per quarter (Baker et al., 2011). The applicability of telemedicine advances as the "triple aim" touted the clinical quality, affordability, and exceptional patient experiences provided by telemedicine services (Cryer, Shannon, Van Amsterdam, & Leff, 2012).The American Telemedicine Association (ATA) promotes the costs saving abilities of telemedicine within chronic disease settings (Gooden, 2016). Researchers have revealed positive weight management/weight loss outcomes using "classical telemedicine techniques" (Ahrendt, Kattelmann, Rector, & Maddox, 2014; Aldehaim, Alotaibi, Uphold, & Dang, 2015). Evidence regarding the effectiveness of "contemporary telemedicine" techniques (specifically, video conferencing) is amassing with systematic reviews revealing promising results in the management and prevention of various chronic diseases (Inglis et al., 2010; Pronk et al., 2011). The application of video conferencing (VC) has the potential to shift current clinical practice for medical weight management/weight loss from in-person medical office visits to remote delivery using VC. Through the integration of tools into a customized telemedicine platform, health care professionals can evaluate a participant's body weight, body composition, blood pressure, physical activity, and sleep patterns all through one convenient on-line platform. To our knowledge, no published studies investigating a fully on-line medically-monitored weight management/weight loss program utilizing VC have been published.

Innovative use of health coaching on changing health parameters

One possible way to improve patient lifestyle behavior change efforts is through the use of health coaching. The definition of the term "health coaching" remains equivocal, however; Palmer and colleagues defined health coaching as "the practice of health education and health promotion within a coaching context to enhance the wellbeing of individuals and to facilitate the achievement of their health-related goals'' (Olsen & Nesbitt, 2010). In a study which surveyed more than five hundred physicians on their practices and management regarding extreme obesity (BMI $\geq$40kg/m^2), the authors indicated that having a readily available nutrition and exercise physiologist would be helpful in improving quality of care in these patients (Ferrante, Piasecki, Ohman-Strickland, & Crabtree, 2009); this further highlights the benefits gained by using health coaches. Health coaching can be one-on-one or performed in a group setting. The latter has the capability to improve the quality and cost-effectiveness of chronic disease management. An extensive review by Kiveala et al. (2014) highlighted health coaching as being patient-centered with positive effects on physical activity, weight loss, and cardiovascular risk factors (fasting blood glucose, blood pressure, body mass index, cholesterol levels) (Kivela, Elo, Kyngas, & Kaariainen, 2014). The majority of health coaching intervention studies investigating behavior change have been personalized and conveyed to the individual participant through telephone (Eakin, Reeves, Winkler, Lawler, & Owen, 2010; Huber et al., 2015; Odnoletkova et al., 2014; Sacco, Malone, Morrison, Friedman, & Wells, 2009), web-based communication (G. G. Bennett et al., 2010; Hersey et al., 2012; Leveille et al., 2009), or a combination of face-to-face and web-based delivery (Appel et al., 2011; J. A. Bennett et al., 2005; Lisspers et al., 1999).

While the majority delivery of health coaching has been performed over the telephone, there also appears to be great variability between interventions in the type of health care professional utilized as health coaches, These include: nurses (J. A. Bennett et al., 2005; Leveille et al., 2009; Odnoletkova et al., 2014), health counselors (Hersey et al., 2012; Huber et al., 2015), diabetes educators (Sacco et al., 2009), registered dietitians (G. G. Bennett et al., 2010), or primary care providers (Appel et al., 2011; Eakin et al., 2010). Current evidence (Kivela et al., 2014) supports the use of a single health coach's ability to change behavior (Appel et al., 2011; G. G. Bennett et al., 2010; J. A. Bennett et al., 2005; Eakin et al., 2010; Huber et al., 2015; Leveille et al., 2009). However, there is a lack of literature reporting lifestyle behavior change using an integrated health coaching approach where a multidisciplinary team (medical doctor, registered dietitian, and exercise physiologist) is utilized. This is especially important as recent evidence has shown that increased collaboration between healthcare professionals may enhance patient adherence, education, and medical monitoring (Jeon & Park, 2015; Kim, Cho, & Yoon, 2015). In addition to using an integrated care health coaching approach, repeated contact also appears to be most effective for inducing greater patient behavior change (Eakin et al., 2010; Kroeze, Werkman, & Brug, 2006).

Mobile Health (mHealth) role on changing health parameters

In order to address the escalation in obesity and chronic diseases, a multitude of behavior change interventions that seek to improve behaviors such as physical activity (PA) and dietary choices as well as body weight and metabolic blood makers have been implemented (Kivela et al., 2014; Sweet & Fortier, 2010). Additionally, health professionals are always seeking ways to objectively monitor and improve their patients'

health and fitness, especially between patient visits. A potential way health professionals can monitor a patient's health metrics is through mHealth devices (Shaw et al., 2016; Steinhubl, Muse, & Topol, 2015). Essentially, these devices allow for self-monitoring by the patient and health professional. Mobile health devices include smartphones and wearable fitness trackers as well as wireless weight scales, blood pressure cuffs, and glucometers.

Currently, physical inactivity is a major risk factor for both obesity and cardiovascular disease; so, increasing physical activity appears to be a sensible strategy for tackling this obesity problem while also lowering the risk of cardiovascular disease (Patel et al., 2010). Traditionally, paper-based methods were used to track physical activity (Burke, Wang, & Sevick, 2011), subsequently followed by pedometer tracking, and, more recently, wearable physical activity technology such as the Fitbit Charge HR, Jawbone Up, and Nike Fuel Band. Recent evidence has suggested that using wireless fitness trackers allows for greater self-monitoring while also lowering the use of self-reported PA (Sanders et al., 2016). While studies have suggested greater self-monitoring by individuals, the current literature is mixed with some studies reporting significant increases in PA (Hickey & Freedson, 2016; Hurling et al., 2007) while (Wang et al. 2015) reported no significant differences in PA when using a wireless activity monitor.

In addition to tracking physical activity, tracking weight has been shown to act as a functional reinforcement while also providing the patient with an environmental cue (e.g. scale and tracking tool in the home) allowing for better self-engagement and motivation especially during weight loss (Linde et al., 2015). Currently, only four published studies reported the use of wireless scales to track weight loss (Greene, Sacks,

Piniewski, Kil, & Hahn, 2013; Luley, Blaik, Reschke, Klose, & Westphal, 2011; Martin et al., 2015).

Shaw et al. (2016) investigated the feasibility of healthy and chronically ill patients using multiple mHealth devices including the Fitbit activity tracker, iHealth pulse oximeter, iHealth weight scale, and iHealth blood pressure monitor over a 4-week period. Results of their study indicated that all participants decreased device usage; this was attributed to "device fatigue". The researchers suggested that reducing the number of devices might result in greater participant adherence (Shaw et al., 2016). In contrast, Martin et al. (2015) investigated the impact of a 12-week intervention with two groups. One group utilized smartphones and the SmartLoss™ app while the other was led by a health educator and considered the control group. Both groups incorporated counseling, wireless accelerometry and body weight scales to investigate weight loss and changes in waist circumference. The SmartLoss™ group experienced significantly greater weight loss (percent of initial weight) than did the control group. Participants in the SmartLoss™ group also had significant improvements in waist circumference changes at all time points compared to the control group ($p < 0.05$).While researchers (Pal, Cheng, Egger, Binns, & Donovan, 2009; Shaw et al., 2016) have reported that tracking just one behavior such as physical activity results in positive changes, the addition of at least two devices combined with personalized feedback may result in greater patient self-monitoring and health outcomes when compared to a control group (Gilmore, Duhe, Frost, & Redman, 2014; Luley et al., 2011; Martin et al., 2015).

Problem Statement

The use of VC appears to be effective in multiple subspecialties including clinical psychology (O'Reilly et al., 2007), cardiovascular disease (Winters & Winters, 2007), nutritional care (Rollo et al., 2015), and diabetic management/prevention (Davis et al., 2010). Its use in the area of weight loss and weight management is less well documented (Azar et al., 2015; Laitinen et al., 2010; Liou, Chen, Hsu, Chou, & Chiu, 2006; Vadheim et al., 2010). Furthermore, studies to date using VC have been group-based thereby limiting the understanding of how individual VC sessions may impact weight loss and weight management.

In conjunction with VC, the use of mHealth devices enables users to assess health metrics in "real-time"; this has the ability to transform care across numerous chronic disease populations, especially over time (Riley et al., 2011; Steinhubl et al., 2015). However, to leverage mHealth devices as tools to promote patient self-monitoring, the adoption of mHealth devices which collect, display, and secure data to a unified system is needed. To date, only one study (Shaw et al., 2016), examined the feasibility of using multiple mHealth devices which transmit data to a secure US Food and Drug Administration (FDA) database. One major limitation of the Shaw et al. (2016) study was that no feedback was provided to the patients. Overall, the literature on the use of mHealth platforms is limited in reference to weight management/weight loss and consequently warranting further investigation.

The majority of weight management/weight loss interventions have utilized telephone, internet chat, or text messaging to disseminate educational information or provide feedback to a patient (Appel et al., 2011; Baker et al., 2011; G. G. Bennett et al.,

2010; Huber et al., 2015; Kivela et al., 2014). Furthermore, no published studies investigating a fully on-line weight management/weight loss program utilizing VC as compared to an in-person group for distributing education or feedback have been published.

The use of health coaching appears to be promising in changing health-related behaviors (G. G. Bennett et al., 2010; J. A. Bennett et al., 2005; Eakin et al., 2010; Huber et al., 2015; Leveille et al., 2009); however, the majority of health coaching studies has been delivered via the telephone (Appel et al., 2011; Kivela et al., 2014; Leveille et al., 2009; Odnoletkova et al., 2014; Olsen & Nesbitt, 2010). More recently, researchers (Jeon & Park, 2015; Kim et al., 2015) have called for the expansion of collaboration between healthcare professionals which may improve team member awareness, decision making, and patient quality of care (Hughes, 2008). Therefore, the use of VC to implement health coaching while using a multidisciplinary healthcare team has yet to be explored.

Purpose of Study

The purpose of the present study is two-fold. The first is to assess changes in physical activity, body mass loss/management, and markers of glucose metabolism (fasting blood insulin, glucose and hemoglobin A1c) in overweight and obese adults randomized into either a control group or one of two intervention groups. One intervention group will receive VC counseling and feedback; whereas, the other will receive in-person counseling and feedback. The control group will receive no counseling or professional feedback. All groups will use the same mHealth devices throughout the 12-week intervention. The second purpose is to determine how the use of mHealth

devices (Withings® Smart Body Analyzer scale and Withings® Activite Pop accelerometer) influences behavior change without regard to group assignment.

Hypotheses

Four sets of hypotheses were tested. The first set of hypotheses compared metabolic health markers across groups. The second set compared body weight changes across groups. The third set of hypotheses focused on changes in physical activity as monitored through accelerometry. The fourth set investigates how mHealth device utilization affects program adherence. The expectation for each set of hypotheses is that there will be a significant difference between the control group and the two intervention groups and that there will be no differences between the two intervention groups. Statistical significance for all hypotheses is set at $p < .05$.

Hypothesis 1a. Hemoglobin A1c will decrease significantly in the VC group when compared to the control group.

Hypothesis 1b. Hemoglobin A1c will decrease significantly in the in-person group when compared to the control group.

Hypothesis 1c. There will be no significant differences in hemoglobin A1c between the VC and in-person groups.

Hypothesis 1d. Fasting blood glucose will decrease significantly in the VC group when compared to the control group.

Hypothesis 1e. Fasting blood glucose will decrease significantly in the in-person group when compared to the control group.

Hypothesis 1f. There will be no significant differences in fasting blood glucose between the VC and in-person groups.

Rationale: Laitinen et al. (2010) recruited obese (BMI $\geq$ 30kg/m^2), diabetic patients and reported no significant differences in fasting blood glucose, waist circumference, or BMI between a VC group and an in-person group utilizing group-based nutritional counseling. In another study, Luley et al. (2010) utilized patients with a BMI $\geq$ 30kg/m^2 and randomized them into a telemedicine group provided with wireless scales and accelerometers or to a control group that had no wireless devices; they reported significant decreases in fasting blood glucose and hemoglobin A1c (HbA1c) when compared to their control group (Luley et al., 2011).

Hypothesis 2a. There will be significantly greater weight loss in the VC group compared to the control group.

Hypothesis 2b. There will be significantly greater weight loss in the in-person group when compared to a control group.

Hypothesis 2c. There will be no differences in body weight between the VC and in-person groups.

Rationale: Vadheim et al. (2010) reported no significant differences in body mass following a 16-week weight loss program when comparing a VC and an onsite group; both groups utilized group-based health coaching. Additionally, the use of regular, individualized, and in-person feedback delivered by health professionals (medical doctor, dietitian, or exercise physiologist) resulted in greater reductions of weight in the VC group using a wireless scale compared to a control group (Luley et al., 2011).

Hypothesis 3a. A significantly greater number of steps/day will be taken in the VC group when compared to the control group.

Hypothesis 3b. There will be a significantly greater number of steps/day taken in the in-person group when compared to the control group.

Hypothesis 3c. There will be no differences in steps/day taken between the VC and in-person groups.

Rationale: Vadheim et al. (2010) reported no significant differences in self-reported physical activity (minutes per week) following a 16-week weight loss program for a VC group and an onsite group utilizing health coaching. In contrast, Hurling et al. (2007) reported significant increases in PA in the intervention group (Actiwatch® + Internet and mobile phone text messaging program) when compared to the control group (Actiwatch® with no support) (Hurling et al., 2007).

Hypothesis 4a. There will be significantly greater mHealth device adherence use in the VC group compared to the control group.

Hypothesis 4b. There will be significantly greater mHealth device adherence use in the in-person group when compared to a control group.

Hypothesis 4c. There will be no differences in mHealth device adherence use between the VC and in-person group.

Rationale: Currently, research investigating the adherence to the use of mHealth devices by research participants seeking to enhance lifestyle behavior change is limited. The existing literature suggests that the use of patient feedback leads to greater adherence in the use of mHealth devices (Luley et al., 2011; Martin et al., 2015); whereas, no feedback leads to a decrease in mHealth device use and lower patient adherence as shown by Shaw et al., (2016).

Assumptions

The following assumptions were made for this study:

1. All participants are English speaking adults between the ages of 18-65 years of age and having a baseline body mass index (weight to height ratio) ≥ 30 kg/m^2.
2. All participants will weigh-in weekly using a wireless scale and wearing the same attire as in all previous weigh-ins.
3. All participants will properly wear an accelerometer to monitor their daily physical activity.
4. All participants in the video conference and in-person groups will meet with a medical doctor monthly and a certified dietitian and a certified exercise physiologist weekly.
5. All participants will refrain from taking any medications/dietary supplements/substances that could modify body weight.
6. Control group participants will maintain their current physical activity and nutritional regimen.
7. All participants follow all pre-test guidelines for blood marker and body weight assessment.
8. All participants accurately and truthfully answer all questionnaires.

Limitations

1. There is a chance that not all participants have digital literacy when using some of the apps and wireless devices. However, all participants will be trained on how to connect to the various applications including American Well for video conferencing, Withings'® app, and MyFitnessPal app® and their functions.
2. The inability to obtain raw accelerometer data to determine intensity (moderate versus vigorous exercise intensity.
3. To our knowledge, the Withings® accelerometer has yet to be validated against a criterion method.
4. There was no blinding of team members to group assignment or during statistical analyses.

Significance of the Study

Video conferencing integration into a fully on-line, medically-monitored mHealth-based weight loss program has not yet been reported in the literature, making this study the first of its kind. The primary objective of the proposed research is to investigate if video conferencing can be successfully implemented within mHealth-based weight management for obesity treatment programs and produce similar results to a more traditional partially on-line (mHealth plus in-person feedback) program. There is limited evidence exploring the application of telemedicine in weight management/weight loss. For the field of obesity medicine, the significant improvements we anticipate from this study hold enormous implications. Successful telemedicine implementation represents the first step toward the utilization of technology as a means for cost-effective and convenient healthcare distribution to overweight and obese patient populations. The implications at the health system level could be remarkable for delivery of patient care, monitoring of disease states (i.e. diabetes and cardiovascular disorders), and patient counseling; in turn, this may potentially prompt a systematic restructuring of healthcare distribution.

Definition of Terms

Accelerometer: a device worn on the body (e.g. arm, wrist, waistline) and which measures the body in motion to estimate physical activity, steps taken, calories burned, and sleep patterns.

Body Mass Index: a weight divided by height ratio expressed as kg/m^2 and used as an indicator of obesity ($\geq 30\ kg/m^2$) and underweight ($<18.5\ kg/m^2$) status (CDC, 2015).

Contemporary Telemedicine: use of video conferencing to deliver health and educational information via the use of video and audio software through a smartphone app.

Classical Telemedicine: use of internet chatting, telephone, or text message to deliver technology interventions to patients.

Device Fatigue: the state of confusion and/or device usage overload resulting from using multiple (≥ 4) mobile health devices to self-monitor patient health outcomes (Shaw et al., 2016).

Fasting Blood Glucose: the measure of an individual's blood sugar level (mg/dL) after an 8-12 hour fast, used to diagnose prediabetes or diabetes.

Health Coaching: the practice of providing feedback and education pertaining to information on patient metabolic health, nutrition and exercise regimens through a multidisciplinary health professional coaching approach using a (medical doctor, dietitian, and exercise physiologist).

Hemoglobin A1c: a test which estimate the average blood sugar levels over a three-month period, reported as a percentage.

In-Person Counseling: the use of in-person communication to provide information, encouragement, and feedback.

MET Minutes: a measure of intensity measured and expressed as metabolic minutes of a task at a given intensity (METs), i.e. 5 METs x 30 minutes = 150 MET minutes.

Mobile Health: the use of smartphones and mobile wireless devices to allow for self-monitoring; may be used for monitoring lifestyle changes in physical activity, blood pressure, and body weight.

Moderate Physical Activity: exercising at 40-59% of maximal aerobic capacity, for most days of the week (Thompson, Arena, Riebe, & Pescatello, 2013).

Physical Activity: any body movement that requires energy.

Sedentary Activity: not partaking in physical activity of 30 minutes per week for at least 3 days per week for 3 consecutive months (Thompson et al., 2013).

Smart Device: any device such as a weight scale, accelerometer, blood pressure cuff, or smartphone which transmits information wirelessly to an app.

Telemedicine: remote use of technology to manage patient health by means of telecommunication

Video Conferencing: a real-time visual connection between two or more people from any location and while using both video and audio transmission.

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CHAPTER II

Review of Literature

This chapter is represented by a review manuscript entitled "Video Conferencing and the Mobile Health Device Self-Monitoring Boom: An Innovative Way to Improve Weight Loss and Health Outcomes" and is targeting the *Journal of Mobile Technology in Medicine* for publication. The manuscript is authored by Kelly Johnson, Michelle Kulovitz, Christine Mermier, Len Kravitz, Damon Swift, Fabaino Amorim, and Ann Gibson. This manuscript follows the formatting and style guidelines of the journal. References cited are provided at the end of the manuscript. The referred table follows the cited references, which is the formatting guideline for the submission to the *Journal of Mobile Technology in Medicine*.

Abstract

While obesity remains a worldwide health problem, there is also a rise in technology use by the general population. One technology technique widely being used by health professionals is video conferencing. However, the routine use of video conferencing in weight loss is scarce. Furthermore, the literature lacks cohesiveness in detailing the frequency and duration of video conferencing sessions and educational materials utilized, as well as duration of interventions (i.e. weeks' vs months). Additionally, much of the literature using video conferencing has self-reported dietary intake, physical activity, and body weight. To overcome the tendency of individuals self-reporting information, the use of mobile health devices should be greater utilized by patients. Currently there is clear a need to investigate whether the use of video conferencing, in combination with wireless devices, enhances health outcomes and

greater accuracy in self-monitoring by individuals. The integration of these two may allow for greater patient self-monitoring and better provider to patient feedback, lending itself to improved patient health outcomes. Therefore, the objective of the present review is to summarize the advantages and disadvantages of video conference on weight loss and mobile health devices, and the potential mobile health devices of enhancing weight loss and improving health outcomes.

Keywords
Obesity, mobile health, telemedicine, Bluetooth

Introduction

Globally, 39% of adults are overweight and 13% of adults are classified as obese with a body mass index (BMI) ≥ 30 kg/m^2 (Raaijmakers, Pouwels, Berghuis, & Nienhuijs, 2015). Obesity is often accompanied by deleterious effects on cardiometabolic risk factors (e.g. lipid abnormalities, hypertension, central adiposity, insulin resistance, and hyperglycemia) giving rise to an increased risk of mortality from coronary heart disease, stroke, certain types of cancer and diabetes (CDC, 2015). Parallel to this global obesity epidemic, the United States is experiencing a vast technological advancement in wireless devices (Cadmus-Bertram, Marcus, Patterson, Parker, & Morey, 2015) which may allow for greater patient-to-provider monitoring following a wide adoption of mobile health (mHealth) devices (Gilmore et al., 2014).

Telemedicine is the use of electronic communication technologies to support clinical healthcare, patient and professional health-related education, public health, and health administration (White, Krousel-Wood, & Mather, 2001) . Numerous studies have revealed favorable weight management/weight loss outcomes using “classical

telemedicine" interventions delivered via internet chatting, telephone, or text message (Ahrendt et al., 2014; Aldehaim et al., 2015; Appel et al., 2011; Azar et al., 2015). While the use of classical telemedicine practices may be beneficial for weight management, evidence regarding the effectiveness of "contemporary telemedicine" techniques (specifically video conferencing) is amassing with systematic reviews revealing promising results in the management of various chronic diseases (Inglis et al., 2010; Pronk et al., 2011).

Video conferencing (VC) has been used since the early 1990's as a tool to monitor symptoms of diseased individuals, and it also has been used in clinical care and education (Hubble, 1992; Hubble, Pahwa, Michalek, Thomas, & Koller, 1993; McGee & Tangalos, 1994) . Likewise, VC has been used in various subspecialties such as cardiovascular disease (Winters & Winters, 2007), nutritional care (Rollo et al., 2015), diabetic management/prevention (Davis et al., 2010), and psychiatric care (O'Reilly et al., 2007). Some modern VC telemedicine platforms allow for integration with mobile health (connected yet wireless) devices. These devices include blood pressure cuffs, body weight scales, and physical activity (PA) trackers.

Previous studies have focused on the ability of classical telemedicine techniques to detect weight changes and levels of adherence (Blomfield et al., 2014; Gilmore et al., 2014; Pagoto, Schneider, Jojic, DeBiasse, & Mann, 2014). The benefits of classical telemedicine techniques on weight loss have been extensively explored (Appel et al., 2011; Mehring et al., 2013; Napolitano, Hayes, Bennett, Ives, & Foster, 2013; Spring et al., 2013). Classical telemedicine's use appears to be gaining popularity especially in the

area of weight management/ weight loss for diabetic care (Ahrendt et al., 2014; Vadheim et al., 2010).

Grubaugh and colleagues found that patients in both rural and urban areas were receptive to using contemporary telemedicine health interventions via VC (Grubaugh, Cain, Elhai, Patrick, & Frueh, 2008). Similarly, Morrow et al. (Morrow, Bruce, Bruce, Dorrian, & Sim, 2011) investigated the feasibility of using VC with ten post-surgical bariatric patients to discuss post-surgical issues as well as patient satisfaction with the VC system via a patient Likert-type scale in terms of user friendliness and overall patient satisfaction. Morrow's team found that both patients and clinicians were satisfied with the user-friendliness of the technology (Morrow et al., 2011). Currently, however, there is no structured, telemedicine-based, weight management program using VC appearing in the literature. Research investigating optimal study duration, program delivery for weight management/loss, and influences on PA is also limited.

Findings from cornerstone clinical trials (Pounds Lost: the Diabetes Prevention Program and the Look AHEAD trial) revealed the need to include three key features in a weight management program: behavior modification, self-monitoring, and counseling feedback (Group, 2013; Sacks et al., 2009) Research has shown that self-monitoring is associated with greater weight loss when technology and in-person counseling are used as compared to no counseling and no technology (Tate, Jackvony, & Wing, 2006; Womble et al., 2004). This suggests that self-monitoring through technology may enhance commitment to behavior change and subsequent weight loss. This could lead to favorable health outcomes. Furthermore, data suggest a positive relationship between personalized feedback and weight loss (Perri et al., 2014). Personalized feedback allows for directed

and specific recommendations (Gilmore et al., 2014). Therefore, this review will summarize the pros and cons of video conferencing and mHealth devices, the use of VC for weight loss, and the efficacy of mHealth devices on promoting weight loss and improving health outcomes.

Pros and cons of video conferencing

Real-time VC has the ability to expand access to care for patients while offering the benefits of a face-to-face interaction from any location. It can help assist with the monitoring of patients in the comfort of their homes, saving time, eliminating the cost of travel, reducing loss of wages and related childcare costs, in addition to ensuring more efficient communication, all of which may help bridge the gap between patients and their healthcare providers (Azar et al., 2015; Meystre, 2005). The better monitoring of data to supervise patients' progress make help patients make better informed decisions. From the perspective of a healthcare organization, the use of VC has been shown to lower healthcare costs while also enabling timely services for those in need (Scalvini et al., 2005). One other major advantage of VC is the use of recent billing codes by the Center for Medicare and Medicaid for telemedicine services in 42 states, specifically as pertains to obesity counseling (Azar et al., 2015). Additionally, for rural or isolated regions, VC is considered a groundbreaking tool for patients who otherwise would not receive regular medical care (Gagnon, Duplantie, Fortin, & Landry, 2006).

One disadvantage of this technology includes "lag time in audio transmission". Another, although rare in society, is a lack of thereof computer and internet access (Azar et al., 2015). Additionally, other disadvantages might be that video removes the personal aspect of a conversation, and technological problems.

Pros and cons of mHealth technology

The consumer market is permeated with an array of mHealth-compatible tools designed to enhance self-monitoring and behavior change (Bassett Jr & John, 2010). Mobile health devices that monitor PA have become widespread. These devices utilize proprietary algorithms to estimate energy expenditure from PA by capturing measures such as steps taken or climbed and total minutes of movement per day, as well as sleep patterns (Georga, Protopappas, Bellos, & Fotiadis, 2014). The metrics are transferred through a smartphone or tablet via Bluetooth technology. The cost for these devices may limit their use by many consumers. In 2016, the cost for the Fitbit Charge HR and Nike Fuel band is approximately $150, while the Jawbone UP3 and Philips™ Actiwatch cost around $100. A recent review (Hickey & Freedson, 2016) has questioned the accuracy of these devices in capturing physical activity levels from different anatomical locations, stressing the need for additional research in this area. In example, it is also important to understand whether differences exist between data collected simultaneously at the hip and wrist, as the majority of these devices are designed to be worn on the wrist but may be placed elsewhere by the user. Other current drawbacks include issues synchronizing with Apple™ or Android™ smartphones and tablets, the two- to ten-day battery life of the devices, the ease of use, and compliance to wear (Shaw et al., 2016; Wang et al., 2015).

Presently, wireless blood pressure cuffs use automatic tension and a series of oscillometric amplitudes to calculate systolic and diastolic blood pressure (Ilhan, Yildiz, & Kayrak, 2016). Recently, Ilhan and colleagues (2016) validated a new Withings' blood pressure monitoring system against a auscultation and manual sphygmomanometer for

sick (n = 18) and healthy individuals (n = 20). When the Withings' blood pressure monitoring system was compared to the manual sphygmomanometer with auscultation in a single measurement with the participant seated, the accuracy on average was 93.52% in sick individuals and 94.53% in healthy individuals (Ilhan et al., 2016). Unfortunately, the wireless accuracy and reliability of the prototype blood pressure monitoring during exercise remains unexplored. Additionally, the difference between wireless blood pressure monitors worn at the wrist and those worn on the upper arm also remains uncertain.

Just as the regular monitoring of blood pressure is important, frequent measuring of body weight has been associated with greater weight loss (Butryn, Phelan, Hill, & Wing, 2007). Shaffer et al. (2014) compared body weight values between a Fitbit Aria and Seca 769 clinical scale for 32 young healthy male and female participants. The weight from the FitBit Aria was 0.6 pounds heavier than from the Seca 769; this slight mathematical difference was statistically significant (Shaffer et al., 2014).

In summary, a benefit of the use of wearable technology (i.e. accelerometers), coupled with home medical devices (blood pressure monitors and weight scales) has the potential for capturing real-time health outcome measures. Access by providers to this information may help deliver additional feedback influencing behavior modification (i.e. changes in exercise, diet, or psychological issues) and patient adherence.

Use of Video Conferencing in Weight Loss/Weight Management

Video conferencing has been regularly utilized in the field of medicine. However, studies using VC in the weight management/weight loss setting, specifically those targeting obese or overweight populations, are scarce. Liou et al. (2006) conducted a 12-

week VC pilot study involving ten apparently healthy male subjects with a BMI of > 28 kg/m^2 (Liou et al., 2006) as shown in Table 1 was used to emulate the LEARN® behavioral program focused on weekly nutrition and behavioral sessions as well as two exercise sessions per week. The entire nutrition and behavioral program was conducted by a dietitian while the exercise sessions were led by a certified athletic trainer; both utilized VC for educational delivery. Although significant improvements in weight, BMI, and waist circumference were noted, the level of caloric restriction and exercise details (frequency, intensity, time, or type) were not specified. Additionally, body weight and nutritional information were self-reported.

Likewise, a 12-week program by Azar et al. (2015), delivered an intervention to men (N = 32) having a BMI ≥30 kg/m^2. The intervention consisted of weekly sessions of the Diabetes Prevention Program- (DPP-) based Group Lifestyle Balance (GLB) core curriculum consisting of nutritional education, physical activity education, and behavioral techniques including goal setting, self-monitoring, and problem solving (Azar et al., 2015; Kramer et al., 2010). The intervention group utilized virtual small groups through VC software. The control group received no VC and was not contacted by researchers for the duration of the study. The primary outcome variables included changes in body weight and BMI. Results indicated significant differences in weight lost, -3.6 kg for intervention group and -0.4kg for the control group. Correspondingly, significant decreases in BMI were noted for the intervention group when compared to the control group, $-1.4kg/m^2$ and $-0.4kg/m^2$, respectively. Laitinen et al. (2010) conducted a 6-month group-based program using VC with 33 diabetic patients. When comparing VC to traditional in-person group counseling, researchers found no significant between-group

difference for body weight, BMI and waist circumference. Likewise, no significant between-group differences were seen 14 months following the intervention (Laitinen et al., 2010).Vadheim et al. (2010) also utilized an adapted version of the DPP lifestyle curriculum in adults with a BMI of ≥25.0 kg/m^2; their participants were assigned to either a VC group (n = 14) or an in-person counseling group (n= 13). Physical activity (minutes per week), body weight, BMI and waist circumference were recorded at baseline and at 16 weeks post-intervention. The overall goals of the Laitinen and Vadheim interventions were to achieve the following DPP targets: at least 7% weight loss and moderate-intensity cardiovascular exercise of ≥150 minutes/per week (Vadheim et al., 2010). Both groups simultaneously participated in weekly 60-minute education sessions. Overall, PA was similar between groups with 40% of both groups achieving 7% weight loss in 16 weeks. The VC group lost more weight (-6.7 ± 3.7 kg) compared to the onsite group (-6.5 ± 3.1 kg); however, no significant differences were found between groups. Regardless, it is important, to note that dietary intake and PA were self-reported.

While the literature surrounding the use of VC for weight loss/weight management (Table 1) may be limited at this time, the future of long-term weight management care may be greatly influenced by the use of technology to improve medical care. Based on the evidence provided, it also appears that VC elicits an alternative to in-person visits. VC can provide evidence-based group or individual nutrition, behavior, and exercise education programs delivered by a multidisciplinary team targeting health-related outcome variables such as body weight, BMI, and waist circumference (Laitinen et al., 2010; Liou et al., 2006).

A reoccurring limitation in the weight management literature using VC includes self-reported nutritional information such as calories consumed; this makes these data difficult to accurately interpret. Furthermore, when individuals self-report, both obese and non-obese individuals commonly underreport caloric intake (Bandini, Schoeller, Cyr, & Dietz, 1990). Similar concepts can be related to the use of self-reported body weight. Body weight changes were also self-reported in all studies reviewed (Laitinen et al., 2010; Liou et al., 2006; Vadheim et al., 2010) except one (Azar et al., 2015); Azar and colleagues utilized a wireless scale to monitor the body weight of their participants. The innovative remote monitoring of body weight changes via a wireless scale demonstrates the potential for incorporating other self-monitoring mHealth tools that can decrease the dependence on self-reported data. Thus, there is clear need to investigate whether the use of VC, in combination with wireless devices, enhances health outcomes and greater self-monitoring by individuals.

mHealth Self-Monitoring Tools on Weight Loss and Health Parameters

The use of mHealth devices which track, analyze and provide feedback for various health parameters such as physical activity level, blood pressure, weight loss, and fasting blood glucose is gaining popularity. While such devices have the potential to improve one's health in some aspect, two reviews (Gilmore et al., 2014; Raaijmakers et al., 2015) have briefly highlighted the value of self-monitoring tools; however, neither review discussed the value of improving health outcomes. There is a lack of clarity as to whether these mHealth devices actually lead to favorable changes in physical activity, blood pressure, weight loss or weight management. For example, Wang and colleagues (2015) examined the impact of text message prompting over a 6-week period. They

utilized an intervention group (Fitbit One, Actigraph GT3X+, and short text messaging prompts) and a control group that used the Fitbit One only and did not receive text message prompting. Outcome variables included step count and minutes of physical activity per week. Step counts increased on average by 1,267 per week in the text-messaging intervention group over the first week, but regressed to near baseline values after week six. By the end of the intervention period, there were no group differences. In contrast, Hurling et al. (Hurling et al., 2007) evaluated the impact of a 9-week PA program using a testing group (Actiwatch® + Internet and mobile phone text messaging program) and a control group (Actiwatch® with no support). Significant increases in PA of 2 hr 18 mins per week were observed in the testing group when compared to the control group.

While wireless accelerometers by themselves appear to be promising in increasing physical activity, the impact of combining wireless devices such as accelerometers and weight scales is less well known. The literature is limited (Greene et al., 2013; Luley et al., 2011) when investigating the collective impact of combining wireless devices on weight loss and PA changes. Greene et al. (Greene et al., 2013) conducted a 6-month study using an intervention group (iWell on-line social network (OSN) group + wireless accelerometer and wireless scale) and a control group (self-reported physical activity and wireless scale only). They measured weight loss, physical activity level and clinical markers including triglycerides, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol. The iWell OSN platform allowed the intervention group to connect with friends, post public messages, view contacts' postings, set goals, and upload daily steps from an accelerometer and weight from the scale. The intervention group was

then able to view trends in physical activity and weight while also competing against others in the group (Greene et al., 2013). Significant differences in weight lost were reported between the intervention (-2.6 kg) and control (-0.6 kg) groups. Regardless, PA levels and all other clinical variables of interest were not different at 6 months. Luley et al. (Luley et al., 2011) examined the impact of a 6-month study on weight loss, fasting blood glucose, and hemoglobin A1c The intervention group (wireless accelerometer and wireless scale + physical activity program, received weekly feedback, and a low calorie diet preferably low in carbohydrates). The control group used no devices, had monthly weigh-ins, and was asked to follow conventional low fat diet; they also received the standard care according to recommendations issued by the Deutschen Diabetes-Gesellschaft (Luley et al., 2011). The intervention group also received weekly letters which included comments assessing results from the previous week's PA level and body weight measures. After 6 months, only the intervention group saw significant improvements for weight loss (-11.8 kg), fasting blood glucose (-1.0 mmol/l) and HbA1c (-0.8%) (Luley et al., 2011). The results of the studies reviewed suggest that mHealth self-monitoring tools are effective in increasing physical activity, weight loss, and decreasing metabolic markers (fasting blood glucose and hemoglobin A1c).

Future Directions

While VC is widely used in the cardiovascular, psychiatric, and nutritional health settings, reports of its routine use in the area of weight loss or weight management are scarce. Currently, the literature lacks cohesiveness in detailing the frequency and duration of sessions, educational materials, exercise prescription, as well as duration of interventions (i.e. weeks vs months). The majority of the literature reviewed using VC

has self-reported dietary intake (Laitinen et al., 2010; Liou et al., 2006), physical activity (Kramer et al., 2010; Vadheim et al., 2010), and body weight (Luley et al., 2011).

The use of mHealth devices provides opportunities to overcome limitations associated with self-reported data because device data is wirelessly uploaded to a database. Furthermore, researchers (Franklin, Lavie, & Arena, 2015; Lyons, Lewis, Mayrsohn, & Rowland, 2014) have suggested that the use of self-monitoring tools is effective for health behavior change, but only when combined with personalized feedback. The adoption of self-monitoring devices for weight loss and weight management is promising. However, their successful adoption by consumers and patients for routine self-monitoring remains unclear. Before, health professionals integrate technology into clinical weight management practice, researchers need to examine the accuracy and reliability, cost effectiveness, and patient barriers when using these devices. Ultimately, tackling these issues may help medical device companies design better tools to assist with health-related interventions and lifestyle improvement in overweight or obese individuals.

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Table 1. Summary video conferencing studies focusing on weight loss or weight management.

Reference	Intervention Group	Control Group	mHealth Devices	Time Points	Variables of Interest	Intervention	Pertinent Findings
Ahrendt et al. (2014)	VC MOVE! group: n = 60	n = 60	None	Baseline to 12 months	BW (kg) and BMI (kg/m^2)	VC Move Group: weekly classes taught on diet, physical activity, and behavioral modification provided various health professionals. Control Group: All were matched to the VC MOVE! group by location, baseline weight, and BMI. They received no VC or education classes.	Unadjusted difference for BW between VC MOVE! group (-3.3 ± 7.5 kg) vs control (+2.0 ± 4.4 kg)* Unadjusted difference for BMI between VC MOVE! group (-0.97 ± 2.4 kg/m^2) vs control (+0.68 ± 1.5 kg/m^2The VC MOVE! participants retained approximately 95% of weight loss from week 12 with a 1 yr follow up.
Azar et al. (2015)	Web-based VC group = 32; BMI ≥ 30 kg/m^2 21-60 yrs, men only	n = 32	a wireless scale	Baseline to 12 weeks	BW (kg) and BMI (kg/m^2)	Web-based VC Group: Consisted of the Diabetes Prevention Program (DPP) 12 weeks with body weight being measured weekly. Control Group: Received no DPP and only returned for pre and post body weight measurements in person.	Significant difference between Web-based VC group (-3.2 kg) vs control group (-0.4kg) for weight loss and BMI (-1.4 kg/m^2) vs control group (-0.4 kg/m^2), respectively
Laitinen et al. (2010)	Group-based VC n = 33; FF group n = 44; all Type II diabetics	None	None	Baseline to 6 and 21 months	BW (kg), BMI (kg/m^2), WC (cm), glucose, insulin, and serum lipids	Intervention: Both groups received the same intervention with the only difference being VC vs in-person communication. Group dietary counseling was provided and all participants were instructed to exercise regularly (at least 4 hours per week).	No significant changes or differences between groups for BW glucose, insulin or serum lipids, at 6 or 21 months
Liou et al. (2006)	VC pilot n =10 healthy males BMI >28 kg/m^2	None	None	Baseline to 12 weeks	Body weight (kg), BMI (kg/m^2), WC (cm)	Intervention: All participants used VC for both the group behavior modification (once weekly) and exercise sessions (twice weekly). The behavior modification sessions were held by a dietician and based on the Learn Program which focused on (lifestyle, exercise, attitudes, relationships, and nutrition. Weekly feedback by a dietician	Significant decreases in BW (-5.9 kg), BMI (-2.0 kg/m^2), and WC (-10.2 cm)

Abbreviations: BMI = body mass index, VC = video conferencing, BW = body weight, FF = face-to-face, PA = physical activity, WC = waist circumference, Telehealth = TH; Onsite = OS, Yr = years.

Chapter III

Research Manuscript

This chapter presents a research manuscript entitled "A comparison of video conferencing and in-person health coaching approaches in combination with mHealth devices on weight loss, physical activity, and glycemic control". This manuscript will be submitted to *Obesity*. It is authored by Kelly Johnson, Michelle Kulovitz, Kathryn Coakley, Damon Swift, Christine Mermier, Len Kravitz, Fabaino Amorim, and Ann Gibson. The research manuscript follows all formatting and style guidelines of the journal which requires that the figures and tables follow the cited references at the end of the chapter.

ABSTRACT

Background: Compare health coaching efficacy on weight loss, physical activity, and glycemic control between individualized video conferencing (VC), in-person (IP) and control (CG) groups of adults with high BMI.

Methods: Thirty adults (BMI≥30 kg/m^2) were randomly assigned to create three groups of 10 members each. Participants received a wireless accelerometer watch and weight scale to sync with their personal smartphones and downloaded apps. Participants assigned to VC and IP received weekly health coaching individualized based on data uploaded over the 12-wk intervention. Steps/day and weight loss were analyzed via analyses of covariance (ANCOVA). Between-group ANOVAs analyzed post-intervention changes in weight (kg), glucose, HbA1c, and HOMA-IR.

Results: Weight loss (8.23±4.5kg; 7.7%) was greater ($p<.05$) for VC than for IP (3.4±2.6kg; 3.4%) and CG (2.9±3.9kg; 3.3%) respectively. Steps/day differed

significantly between VC and IP at week 4 and between VC and CG at weeks 6, 8, 9, and 11 ($p \leq .05$); VC consistently had the higher step/day averages. No between-group differences were found for any glycemic control markers.

Conclusion: Individually-targeted video conferencing with our multidisciplinary health coaching team (M.D., registered dietitian [R.D.] and exercise physiologist) is a more effective approach for reducing weight, and HOMA-IR than is in-person health coaching.

Keywords: video conferencing, weight loss, mHealth, telemedicine, glycemic control

INTRODUCTION

Obesity is a global public health issue. Currently 66% of adults in the United States (U.S.) are overweight ($\geq 25 kg/m^2$) or obese ($\geq 30 kg/m^2$) by body mass index (BMI) (1, 2). Larger body masses dominated by high fat mass increase one's risk of developing type II diabetes (T2DM), hypertension, atherogenic lipid profiles, stroke, and some cancers (CDC, 2015). The 2009 economic burden of obesity was $147 billion for the U. S. (3). To reduce obesity and associated healthcare costs, extensive lifestyle changes in diet and exercise are needed (4, 5).

Current evidence suggests that clients participating in health coaching sessions for lifestyle modification demonstrate improved participant compliance, weight loss, and chronic disease-related health outcomes (6-10). Health coaching has been performed by various health care professionals: nurses (8, 10), health counselors (4, 11), diabetes educators (12), and primary care providers (12-14). Additionally, most health coaching interventions are delivered through telephone (4, 10, 12, 14), web-based chatting (8, 11), or a combination of face-to-face and web based features (15, 16). Despite the potentially positive impact of group-based health coaching by video conferencing (VC) on weight

loss and metabolic health (17-20), using individualized VC session interventions have yet to be studied.

The use of VC has the potential to shift medical weight management and weight loss clinical practice from in-person office visits to remote delivery. Consistent use of mHealth devices may result in convenient and timely monitoring of numerous relevant factors by clients and health care professionals. Evidence also suggests that increasing collaboration between healthcare professionals may enhance program adherence and medical monitoring (22).

Research on individually-tailored health coaching delivered via VC by a multidisciplinary team of healthcare professionals with individual specialties in medicine, exercise physiology, and nutrition is lacking. This study was designed to determine if didactically similar health coaching interventions delivered via video and during in-person meetings would similarly alter weight, fasting blood glucose, hemoglobin A1c (HbA1c), and HOMA-IR in adults with BMIs $\geq 30 kg/m^2$.

MATERIALS AND METHODS

Subjects/Recruitment

Thirty obese adults (BMI ≥ 30 kg/m^2, 22 – 55 yr; table 1) from the Albuquerque, New Mexico area volunteered for this study as approved by the University of New Mexico (UNM) Institutional Review Board. Recruitment was via flyer, email and word-of-mouth. Pre-participation screening via telephone determined volunteers' suitability for an invitation to participate.

Inclusion criteria required that participants were: English-speaking, not previously diagnosed with diabetes, ambulatory, less than 396 pounds in weight, currently following

a sedentary lifestyle (accumulating <7,000 steps/day) (23), not regularly engaging in moderate-intensity activities, having unrestricted access to an Apple® iPhone or Android smartphone, and able to travel to UNM for scheduled appointments. Individuals were excluded if they: used certain medications (i.e. steroids, etc.) or dietary supplements (i.e. ephedra, thermogenics, botanicals, etc.) that could affect body composition; had type II diabetes (T2DM); currently using nicotine products; lost > 3kg body weight or dramatically changed physical activity (PA) patterns within the past six months; were previously diagnosed with or treated for an immunodeficiency disorder, kidney disease, heart attack within the last 3 months, cancer, eating disorders, uncontrolled blood pressure, neurological or psychological disorders; or having undergone obesity-related surgery (i.e. gastric bypass, etc.) .

This 12-week intervention utilized a randomized, repeated measures, quasi-experimental design. Pre- and post-testing sessions conducted at similar times in the morning bookended the intervention (Figure 1).

Baseline and post-intervention sessions

Invited participants were scheduled for an individualized orientation and baseline visit. Participants were randomly assigned into three groups (VC or in-person [IP] interventions or control [CG]) stratified by sex and in a balanced fashion via the website https://www.randomlists.com/team-generator. Baseline and post-testing sessions took place at UNM's Exercise Physiology Lab (Lab). Upon arriving at the Lab, participants were consented and asked to complete a health history questionnaire and IPAQ short version physical activity questionnaire (24). Barefoot standing height (cm) was measured using a wall-mounted stadiometer (SECA®; Chino, CA, USA); after voiding,

participants obtained their nude weight (kg) on a digital scale (MedWeigh® MS-3900; Itin Scale Company, Brooklyn, NY, USA) and reported it to a research team member. All measures were taken in duplicate with the average recorded and used for statistical analyses. Venous blood was obtained as described below. These same procedures were used at post-intervention follow-up.

During the baseline session participants were issued and familiarized with the Withings® Body Analyzer weight scale and the Withings® Activite Steel step-tracking accelerometer watch (Withings, Inc., Cambridge, MA, USA). During this time, participants were also familiarized with three apps which they each downloaded free-of-charge onto their smartphone. The Withings® app housed the step and weight data from the accelerometer and scale integrated via Bluetooth™ to each participant's smartphone. The Healow app (eClinicalWorks®, eCW, Westborough, MA) transferred Withings app data to a secure electronic medical records (EMR) database (eClinicalWorks®), and all participants were to enter daily food and beverage intake into MyFitness pal. The number of calories prescribed per day was in accordance with the American Heart Association (AHA) diet (31). If the participants' weights were ≤ 250 pounds, they were to restrict calories to 1200/day; otherwise, they were to restrict calories to 1500/day. Also, VC members were familiarized with the video conferencing aspects of the Healow app. Following the baseline session, a one-week run-in period was implemented. Lastly, VC and IP participants were familiarized with the online curriculum manuals (created by a team of health professionals) which emphasized the nutrition needs for weight loss and physical activity progression for steps/day. Participants were instructed to use these materials at their leisure throughout the 12-week study.

Run-in Period:

The run-in served to familiarize participants with the mHealth devices and collect a baseline average of steps taken daily. During this period, participants were instructed to wear the accelerometer watch on their non-dominant wrist for at least 10 hours daily during their waking day (25) and to weigh themselves nude on the Withings® scale at least once per week after waking up and voiding.

The IP participants met individually at the Lab once a month with the medical doctor and weekly with the registered dietitian and exercise physiologist; health coaching was delivered during these meetings. The VC group participants followed these procedures but met virtually with research personnel via the Healow app.

Experimental procedures

mHealth Devices

Following standardized procedures at home, participants weighed themselves at the same time of the day shortly after having voided. Body weight from the Withings® scale was uploaded weekly; accelerometer step counts were uploaded daily. Data were transmitted wirelessly through their own smartphone to the EMR database which was only accessible by the research team and participants; participants could see their data in real-time via the Withings® app (Figure 2).

Blood sampling

During pre- and post-intervention assessments, participants reported to the Lab in the morning after a 12-hour fast with water *ad libitum*. A venous sample was acquired from a prominent antecubital vein. One sample (15 mL) was drawn into a heparinized tube; the other sample (20 mL) was drawn into a non-heparinized tube, allowed to clot,

and centrifuged (3500 rpm) at 6°C for 15 minutes to obtain serum. The samples were sent to a private laboratory (Quest®, Albuquerque, NM) for determination of glucose and insulin (serum) and HbA1c (whole blood). A Homeostasis Model Assessment estimate of insulin resistance (HOMA-IR) was calculated using the formula of Katsuki et al., (2001): HOMA-IR = fasting insulin × fasting glucose / 22.5.

Intervention

Following the run-in, participants were asked to continue uploading data from the mHealth devices. The watch was to be worn on the non-dominant wrist 24 hours/day every day, even when sleeping, bathing or swimming. Weight was monitored as it was during the run-in.

Control Group:

The participants assigned to CG received mHealth devices but no health coaching from the researchers. They completed the same baseline and post-intervention procedures described above.

Video Conference and In-Person Groups:

Those assigned to the VC and IP groups received didactically similar health coaching content as delivered by the same registered dietician and exercise physiologist. All participants had an initial visit with the research team's medical doctor to review medical history, weight loss goals, and daily caloric guidelines of the American Heart Association. All intervention group members received weekly health coaching and feedback throughout the intervention. All meeting sessions were delivered in accordance with group assignment.

During the dietician sessions, daily and weekly caloric intakes retrieved from the MyFitnessPal app were reviewed, discussed, with adjustments made as needed. During the health coaching sessions with the exercise physiologist, discussions included current exercise regimen, goal setting, and PA progression (i.e. more steps per day, more minutes per day). The project's medical doctor oversaw all dietary and exercise recommendations. All PA recommendations followed the American College of Sports Medicine guidelines of ≥ 30 minutes of moderate-to-vigorous-intensity physical activity five days per week for a targeted minimum of 150 minutes/week (26).

Statistical Analyses

An *a priori* power analysis was performed (G*Power Version 3.1.0, Franz Faul, Universitat Kiel, Germany) to determine sample size; the result was 24 participants. Thirty were recruited (10 per group) to retain statistical power in the event of attrition or unusable data. Separate between-group one-way ANOVAs for baseline weight, steps per day, blood glucose, insulin, HbA1c, and HOMA-IR were applied. We utilized separate mixed- model group x time (pre-post) analyses of covariance. Covariates included average run-in steps/day and baseline body weight (kg) in their respective models. Additionally, group-specific steps/day were summed and averaged by week and a one-way ANOVA applied to identify between-group differences from baseline to week 12. Separate one-way between-group ANOVAs were applied to identify post-intervention differences of HbA1c, glucose, insulin, and HOMA-IR. When significant main effects or significant differences were noted, *post hoc* analyses using the Bonferroni correction were performed. Values in table 1 are expressed as mean ± standard deviation (SD). Graph time points (weeks) are presented as adjusted least mean square (LMS) and

standard error (SE) to examine the treatment effect on weight loss and steps/day over time. All data were analyzed using R (27). Statistical significance was identified as $p \leq .05$

Results

There was no participant attrition. Baseline and post-testing values are shown in Table 1. No significant differences at baseline were found between groups for steps/day, weight, blood glucose, HbA1c, insulin, or HOMA-IR.

Steps/day

There was no main effect by time for steps/day [$F_{(11,394.28)} = 1.36$; $p = .18$]. However, there was a main effect by group for steps/day in the VC group [$F_{(2, 30.1)} = 3.75$; $p = .03$] with significant increases in steps/day (averaged by week) from baseline to week 12 (table 1). There was a significant interaction by time and group for steps/day with VC being higher than IP at week 4 (1519.5 steps/days), and VC being higher than CG at weeks 6, 8, 9, and 11 (2331, 1773, 2107, 1855 steps/day, respectively) [$F_{(22, 394.22)} = 1.62$; $p = .03$] (Figure 3; data presented as LMS ± SE). By week, VC took more steps/day ([$F_{(2)} = 14.5$; $p < .0001$) when compared to the IP and CG groups.

Weight Loss

For weight loss, there was a main effect by time [$F_{(11, 297.1)}$), = 20.4 $p = .001$] and by group for VC [$F_{(2, 33.3)} = 7.71$; $p = .01$]. There was a significant interaction by time and by group for weight loss for VC vs. IP, and VC vs CG for (weeks 6-12) [$F_{(22, 297.1)} = 1.88$; $p = .01$] (Figure 4; data presented as LMS ± SE). Additionally, there was a significant (*p*

<.001) difference for post-invention weight loss between VC (8.23kg) compared to IP (3.2kg) and CG (2.9kg) (Table 1).

Metabolic Markers

There were no within- or between-group differences for blood glucose or HbA1c, nor any group by time interactions for HbA1c. There was a significant within-group reduction for HOMA-IR in the VC group only (p =.05). Their baseline HOMA-IR values decreased significantly (1.7 units) by week 12.

Discussion

Our findings suggest using a multidisciplinary team to deliver one-on-one health coaching through video conferencing is a more effective approach for weight loss and increasing physical activity than is in-person health coaching. This within- and between-group repeated measures design investigated weekly similarities and differences in step counts and weight loss as well as differences between pre- and post-intervention fasting blood glucose, HbA1c, and HOMA-IR. Since the VC and IP groups received didactically similar health-coaching interventions and CG received no health coaching from the research team, all expectations were that the VC and IP groups would see similar changes over time and that CG results would differ significantly from those of the intervention groups. However, we found significantly greater improvements for VC in weight lost, steps/day, and HOMA-IR compared to IP and CG. There were no differences between the latter two groups.

Physical Activity

Baseline step counts for all groups were below 7,000 per day, the cutpoint for defining sedentarism (23). VC accumulated significantly more steps/day than did IP during week four and averaged significantly higher steps/day over the time course of the study. This is somewhat similar to Vadheim and associates' (2010) finding of non-significant differences between their VC and onsite health coaching groups for self-reported PA (minutes/week) following a 16-week weight loss program. Unlike the subjective self-reporting of PA by Vadheim's participants we objectively measured steps/day through accelerometry. Similarly, Hurling et al. (2007) reported significant increases in PA in their Actiwatch® + Internet + mobile phone text messaging group as compared to their Actiwatch® only group. Taken together, these results suggest that individually-tailored, video conference-based health coaching feedback contributes to increases in PA.

Significant differences in steps/day between VC and CG were found at weeks 6, 8, 9, and 12 with VC being the higher of the two for each comparison (Figure 3). Steps/day initially increased for IP but decreased after week 6 (Figure 3) as did their attendance at health coaching sessions. This supports previous comments (4, 11, 28) about a direct relationship between increasing efficacy in PA interventions and frequency of contact with health coaches. Also, time spent traveling to scheduled appointments may have competed with the available time IP participants had for exercising.

Weight Loss Outcomes

Our VC group achieved a significantly greater weight loss post-intervention than did the other groups (Table 1). Azar et al. (2015) investigated the efficacy of video conferencing for a diabetes prevention program (DPP) with a weight loss focus. Like us,

they reported significant weight loss differences between their VC (3.6 kg) and control (0.4kg) groups (17). A 12-wk group-based VC pilot study (Liou et al. 2016) for men with BMIs >28 kg/m^2 emulated the LEARN® (19) behavioral program with one dietitian-led nutrition and behavioral session weekly combined with two exercise sessions per week with a certified athletic trainer. Video conferencing was used for all education and exercise related delivery. Weight loss (5.9±3.5 kg) was statistically greater compared to the controls. In contrast, our results differ from those of Vadheim et al. (2010) who found that DPP participants assigned to IP (n = 13) and VC (n =14) groups achieved similar weight losses (6.5±3.1kg and 6.7±3.1kg, respectively). We unexpectedly found significant differences between our IP and VC groups. Absences from the in-person health coaching sessions may be one reason for the weight loss differences between our groups. Our VC members had perfect attendance for all health coaching sessions; those in our IP group attended, on average, 80% of the sessions. Average health coaching attendance of both groups was 77.5% in the Vadheim (2010) study. In-person group-based programs are considered a gold standard in behavioral treatment of individuals with BMIs ≥30kg/m^2 (13, 17); however, attendance at IP obesity counseling group sessions is known to drop over time (13, 17). Our individual IP session attendance likewise dropped. As previously mentioned, inconsistent attendance at face-to-face meetings may induce lapses toward goals. While these attendance drops may be due to challenges in scheduling and travel, understanding related underlying factors is an area for future research.

A possible explanation for the similar amount of weight lost for the IP and CG groups may be attributed to the proprietary feedback (notifications) from the

MyFitnessPal application. While this is plausible, a deeper investigation of the CG data indicated the (4 of 10) participants failed to upload their weight data for 10 of the 12 weeks. This deviation from instructions given at baseline precluded the majority of CG to benefit from the automated feedback about weight change from the previous weigh-in, macronutrient content of self-reported food intake, and a caloric restriction target. Even though we found no statistically significant changes between IP and CG for weight loss, it is important to mention that the positive outcome in weight loss for CG may attributed to the double-digit weight losses (in kgs) of 3 participants in that group.

Glycemic Control Outcomes

We found no between-group differences for insulin, glucose, HbA1c, and HOMA-IR resulting from our 12-week intervention. There was, however, a significant decrease (1.7 units) for HOMA-IR within our VC group. Our glycemic control results are similar to those of Latitinen et al. (2010) who recruited diabetics with BMIs ≥ 30kg/m^2 for a group-based nutritional counseling intervention; neither research team found significant fasting blood glucose differences between the VC and IP groups. Conversely, Luley et al. (2010) randomly assigned their participants (BMI ≥ 30kg/m^2) into a telemedicine (wireless scales + accelerometers) or a control (no wireless devices) group. Fasting blood glucose and HbA1c decreased significantly in their telemedicine group; whereas, neither of our intervention groups significantly decreased these variables. Of importance, though, are the participant medical history differences (diabetic status) and study duration (3 vs 6 months); we recruited non-diabetic adults for a 3-month intervention.

A 3-month intervention is too short for documenting pre-to-post intervention changes in HbA1c. Possible explanations for our participants showing no significant changes in glucose- and insulin-related variables might be found in insufficiently aggressive weekly exercise goals to match our aggressive dietary restrictions. According to the Look AHEAD study (29), intensive dietary and exercise alterations are needed to trigger significant changes in HbA1c in diabetics; since none of our participants were diabetic at baseline, an even more aggressive exercise program may have been needed to invoke change. We did not observe any differences between groups for glycemic control; although, weight loss ≥5% of body weight is known to reduce insulin levels and improve glycemic control (30). However, the significant improvement in HOMA-IR within our VC group suggests that our intervention resulted in improved insulin sensitivity for adults having HbA1c values below the diabetes criterion (6.5%). Even though our between-group changes in insulin and glucose were not statistically significant, the within-group decrease in HOMA-IR for VC may reduce the likelihood that these non-diabetic individuals will develop diabetes (30, 32). Furthermore, the slight decreases in HOMA-IR for IP and CG may be clinically significant.

Limitations

The 12-week duration of this study may have precluded attainment of significant diet- and exercise-induced changes for all variables of interest. Nonetheless, we report that individual sessions of health coaching by qualified professionals and delivered by video conference can unequivocally contribute to significant weight loss. We found no peer-reviewed literature validating the Withings® accelerometer against a criterion method; therefore, we relied on similar step tracking capabilities across the three groups.

We also did not have access to raw accelerometry data to determine our participants' frequency and duration of activity bouts. Consequently, we were unable to objectively confirm if activity bouts were periodically in the moderate- to vigorous-intensity range. Knowing the frequency, duration, and intensity of activity bouts would have allowed for a more specific recommendation regarding daily step goals.

The same multidisciplinary team members delivered health coaching to the intervention groups. Baseline and week 12 assessments were conducted by the same research team member. Consequently, there was no blinding of team members to group assignment or during statistical analyses. However, health coaching for both intervention groups (IP and VC) was didactically similar. Individual participant motivation to change, or lack thereof, may have contributed to the weight loss and related outcomes, but we did not measure this. Using the Transtheoretical Change Model survey (Jossey-Bass, Inc, Hoboken, NJ, USA) at baseline and follow-up to identify participant readiness for change would enrich our understanding of our health coaching efficacy (18, 33, 34). Lastly, though fully powered, our sample size was small, limiting the extent of additional analyses. Therefore, our outcomes can be generalized only to adults who are middle aged (35-45 yrs) who are pre-diabetic and have BMIs $\geq 30 kg/m^2$.

Strengths

To our knowledge this is the first study to employ a multidisciplinary team approach to individualized health coaching by video conferencing. Additionally, the data transmitted from our mHealth devices (steps/day and nude weight/week) provided objective measures instead of the subjective self-report data captured in previous group-based video conferencing interventions (18-20). The remote tracking of body weight and

PA by intervention group members and research team personnel served to motivate the participants and provide the health coaches with up-to-date data critical for the individually-tailored conferencing sessions.

Conclusions

Our innovative, multidisciplinary, telemedicine health coaching delivered through video conferencing led to favorable changes in weight loss, physical activity, and HOMA-IR that surpassed changes when health coaching was delivered in person.

Suggestions for Future Research

Future studies evaluating the cost-effectiveness of a telemedicine intervention like ours would be beneficial. Additional comparisons (i.e. group vs individualized; diabetic vs non-diabetic) of our video conferencing approach to health coaching to investigate the impact on weight loss and other health outcomes (e.g. lipid profile, glycemic control, and inflammatory markers) are also needed. Following-up with participants post-intervention (i.e. at 6 wks, 6 mo, and 1 yr post-intervention) may provide insights into factors contributing to long-term health behavior changes.

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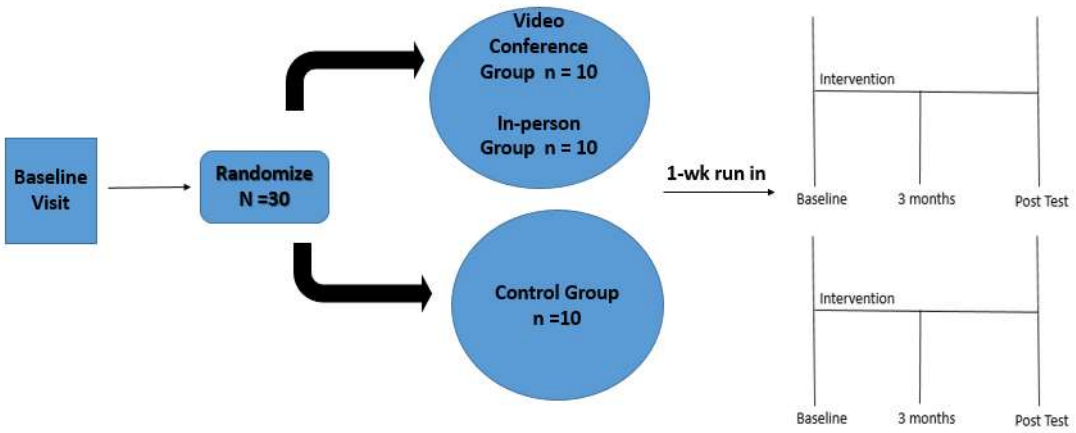


Figure 1. Schematic of the research design.

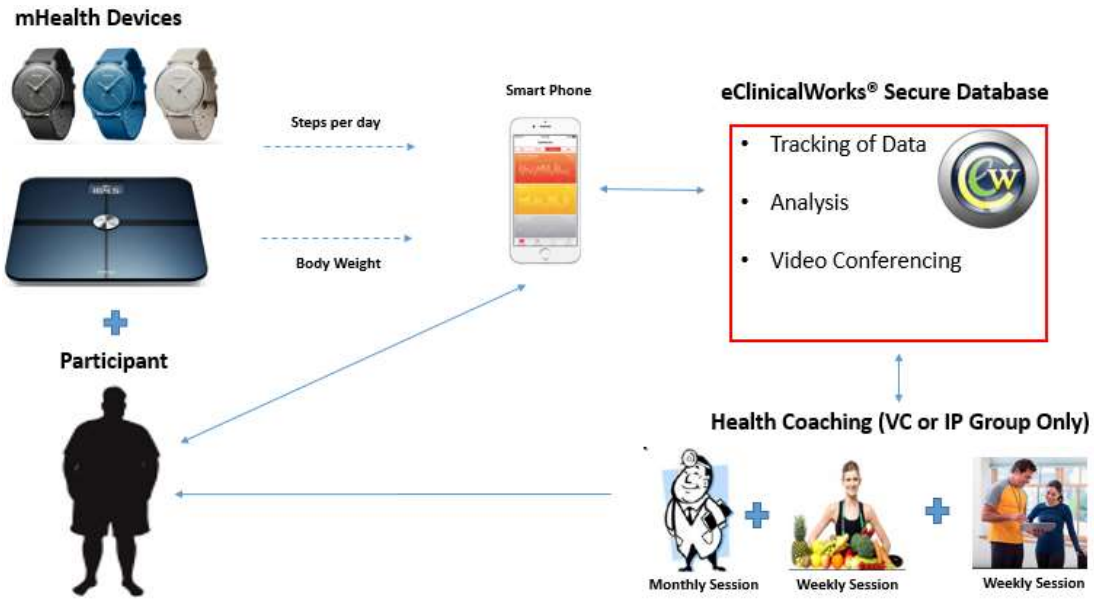


Figure 2. Mobile health device and telemedicine database framework.

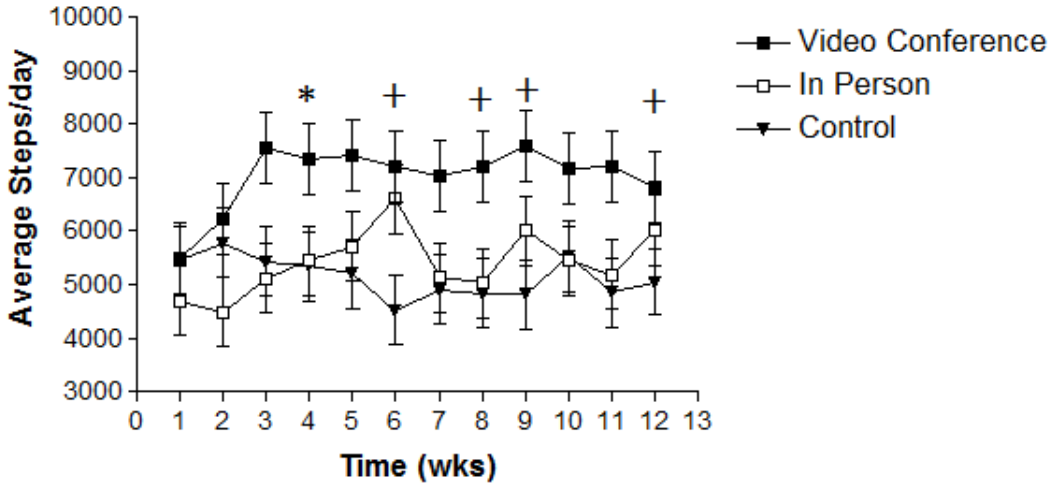


Figure 3. Comparison of daily step average per day by group.

Note: * = significant difference between VC and IP groups; + = significant difference between VC and control group; $p < .05$. Each time point (weeks) is presented as adjusted least mean square (LMS) and standard error (SE).

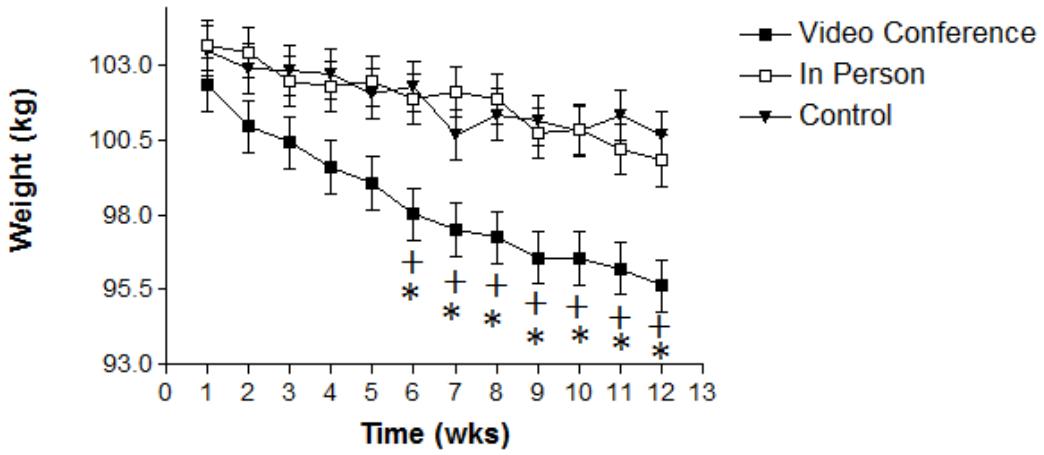


Figure 4. Comparison of weekly body weight in kilograms (kg) by group.

Note: * = significant difference between VC and IP group; + = significant difference between VC and control group; $p < .05$. Each time point (weeks) is presented as adjusted least mean square (LMS) and standard error (SE).

Table 1. Subject characteristics (mean ± SD)

	Control (n =10)		In Person (n = 10)		Video Conference (n = 10)	
	Baseline	12 weeks	Baseline	12 weeks	Baseline	12 weeks
Age (yrs)	44.5 ± 12.1	-	42.2 ± 10.2	-	43.0 ± 10.7	-
Body Weight (kg)	95.9 ± 16.4	92.9 ± 18.3	101.5 ± 21.5	98.2 ± 22.7	112.8 ± 25.8	104.7 ± 27.1
Weight loss (kg)	-	2.9 ± 3.9	-	3.2 ± 4.5	-	8.23 ± 4.5+
Weight loss (%)	-	3.3 ± 4.2	-	3.4 ± 2.6	-	7.7 ± 4.9
Met 5% of WL n =	-	3	-	1	-	6
Met 3% of WL n =	-	5	-	6	-	9
Height (cm)	167.9 ± 8.2	-	168.5 ± 9.4	-	171.5 ± 9.8	-
BMI (kg/m^2)	34.5 ± 5.3	33.2 ± 6.2	35.3 ± 5.2	34.4 ± 5.3	38.6 ± 9.8	35.8 ± 10.1
Glucose (mmol/L)	5.4 ± 0.43	5.1 ± 0.40	6.0 ± 2.4	5.5 ± 1.1	5.4 ± 0.37	5.1 ± 0.40
HOMA-IR	2.0 ± 1.7	1.8 ± 2.1	2.1 ± 1.5	2.0 ± .72	3.2 ± 3.1	1.5 ± 1.0*
HbA1C (%)	5.6 ± 0.20	5.5 ± 0.16	6.0 ± 2.4	5.8 ± 0.96	5.6 ± 0.20	5.5 ± 0.21
Insulin (mg/dL)	8.4 ± 7.2	7.1 ± 7.5	7.5 ± 3.3	8.1 ± 1.7	13.3 ± 12.5	6.8 ± 4.7
Steps/day	4324.3 ± 2000.7	5002.4 ± 2640.3	3641.7 ± 1167	6236.2 ± 2393.4	3755.1± 1610.2	7054.6 ± 2068.7+

yrs = years, kg = kilograms, % = percentage, WL = weight loss, n = sample that obtained respective % weight loss, cm = centimeters, BMI = body mass index, kg/m^2 = kilograms per meters squared, Mmol/L = millimoles per liter, HOMA-IR = Homeostatic Model Assessment of Insulin Resistance, HbA1C = hemoglobin A1c, mg/dL= milligrams per deciliter, * indicates a within-group significant difference for the VC group ($p \leq .05$). + indicates a significant difference from IP and CG ($p \leq .05$).

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY

The research manuscript titled "A comparison between video conferencing and in-person health coaching in combination with mHealth devices on weight loss, physical activity, and glycemic control" provides evidence that 12 weeks of individualized health coaching via video conferencing, when compared to an in-person health coaching or control group, results in significantly more weight loss. However, it did not result in statistically significant differences in physical activity, HbA1c, fasting blood glucose, insulin, or HOMA-IR. We observed 100% mHealth adherence with the devices uploads for all groups.

In terms of how well the intervention, as designed, performed in relation to our hypotheses (Chap 1):

- Hypothesis 1a (rejected) – there was no difference in HbA1c between VC and IP.
- Hypothesis 1b (rejected) - there was no difference in HbA1c between IP and CG.
- Hypothesis 1c (rejected) – there was no difference in HbA1c between VC and CG.
- Hypothesis 1d (accepted) - there was no difference in fasting blood glucose between VC and IP.
- Hypothesis 1e (rejected) - there was no difference in fasting blood glucose between VC and CG.

- Hypothesis 1f (rejected) - there was no difference in fasting blood glucose between IP and CG
- Hypothesis 2a (accepted) - VC lost significantly more weight than the CG.
- Hypothesis 2b (rejected) - VC s lost significantly more weight than the IP.
- Hypothesis 2c (rejected) – there was no difference in weight between the IP and CG.
- Hypothesis 3a (accepted) - VC did take significantly more steps/day than did CG;
- Hypothesis 3b (rejected) - there was no difference in steps/day between IP and CG;
- Hypothesis 3c (rejected) - there was a significant difference in steps/day between VC and IP at week 4.
- Hypothesis 4a (rejected) – there was no difference in mHealth adherence between VC and CG.
- Hypothesis 4b (accepted) - there was no difference in mHealth adherence between VC and IP.
- Hypothesis 4c (rejected) - there was no difference in mHealth adherence between IP and CG.

Even though not part of a formal hypothesis or included in the Chapter 3 manuscript, we also tracked changes in waist circumference (WC) pre- and post-intervention. Although WC is a challenging measure to make for obese individuals, we used the visibly narrowest portion of the torso as our site of measurement and recorded the average to two measurements within ±0.5cm. There was only one participant for which the measurement was taken at the superior border of the iliac crest; that deviation was noted on the data collection sheet so it could be repeated during post-intervention assessment. The same research team member that took a participant's baseline WC

measurement also took it during the post-intervention assessment appointment. There was a significant within-group difference ($p < .0001$) for WC in the VC group, but not ($p \geq .05$) for the IP and CG groups. The WC for the VC group was 114.2 ± 25.0 at baseline and 103.9 ± 20.1 post-intervention, and individually ranged from 87 to 140.3 cm at baseline and 87 to 134 cm at post-intervention. No significant between-group differences for WC were found at either the baseline or post-intervention time point.

CONCLUSIONS

This research adds significant findings to the scientific weight loss literature regarding the use of video conferencing for the purposes of health coaching, dissemination of educational information, and to provide feedback to an obese, non-diabetic clientele. To our knowledge, this is the first study to utilize a multidisciplinary health coaching team (M.D., R.D., and exercise physiologist). Also, we believe we are the first to directly compare the impact of individually-tailored and didactically similar health coaching delivered through video conferencing to that delivered in person. We hypothesized video conferencing and in-person health coaching would result in similar changes within the respective groups. However, our results indicate that delivery by video conferencing is superior in terms of affecting weight loss and HOMA-IR. Furthermore, our innovative study is, to our knowledge, the first study to incorporate mHealth devices into a customized telemedicine platform where health care professionals could evaluate a participant's body weight and physical activity (daily step count), through one convenient online platform.

Overall, the use of mHealth devices enables clients and practitioners to assess health metrics in "real-time" further demonstrating the potential for decreasing the

reliance on subjective self-report data (a common limitation in health coaching interventions) while increasing the capture of objective measurements. However, the lack of compliance entering information into MyFitnessPal by the majority of our control group participants reinforces the need for periodic personal feedback from health coaches.

RECOMMENDATIONS

While this study had many strengths, it may have been improved if researchers had access to raw data from the accelerometer so the frequency, duration, and intensity of physical activity bouts could have been included in the exercise prescription progressions. Additionally, had we provided the participants with a Transtheoretical Change Model survey at the start and end of the intervention, we would have been able to identify their readiness to change and how that may have changed over the 12 weeks. It would have also been interesting to measure blood pressure and lipid profile changes pre- and post-intervention as these play important roles in cardiometabolic health.

We have five recommendations for future studies that build upon this project's design.

1. Investigate individualized video conferencing combined with mHealth devices for examining weight loss, lipid profile, glycemic control, and inflammatory markers.
2. Continue research on video conferencing with follow-up appointments after the initial 12 weeks and incorporate behavioral change techniques such as self-monitoring, goal setting, behavior modification, cues and triggers, problem solving, stress management, and lapse prevention.

3. Compare health coaching through video conferencing for other clinical populations (i.e. Type II diabetics, bariatric surgery patients).
4. Utilize a valid wireless activity tracker that allows a more granular assessment of objectively captured physical activity levels (i.e. steps/minute, frequency of activity bouts in the moderate- to vigorous-intensity physical activity [MPVA] range, etc.) to better prescribe exercise in the MPVA range.
5. Introduce additional research team contacts (i.e. via telephone) mid-intervention with IP participants to determine the effect on the IP session attendance rates.

APPENDICES

A. HIPPA

B. Informed Consent

C. Health History

D. Physical Activity Questionnaire: IPAQ short version

E. Dietary Quality Survey

F. Flyer

G. Control group exit survey

H. Intervention Group exit survey

I. Data collection sheet

J. Exercise manual

K. Nutrition manual

APPENDIX A

The impact of mobile health devices in combination with video conferencing versus in-person health coaching on weight loss/weight management, physical activity, metabolic health

Authorization to Access Protected Health Information for Research Purposes

PRINCIPAL INVESTIGATOR:	**Dr. Ann Gibson, PhD**
CONTACT INFORMATION:	**Ann Gibson University of New Mexico Department Health, Exercise and Sport Sciences Johnson Center, MSC04 2610 University of New Mexico, Albuquerque, New Mexico 87131**
FUNDING AGENCY:	**N/A**

What is the purpose of this form?

You have been asked to take part in a research study. The consent form for this study describes your participation, and that information still applies. This extra form is required by the federal Health Insurance Portability and Accountability Act (HIPAA)[1]. The purpose of this form is to get your permission (authorization) to use protected health information about you that is created by or used in connection with this research.

What if I don't want my personal health information (PHI) to be used in this research study?

You do not have to give this permission. Your decision not to sign this form will not change your ability to get health care outside of this research study. However, if you do not sign, then you will not be allowed to participate in the study.

What PHI am I allowing to be used for this research?

The information that may be used includes: medical and physical activity history, dietary analysis, height, age, weight, waist circumference, blood glucose, hemoglobin A1c, and insulin.

In addition to researchers and staff at UNM and other groups listed in this form, there is a chance that your health information may be shared (re-disclosed) outside of the research study and no longer be protected by federal privacy laws. Examples of this include disclosures for law enforcement, judicial proceeding, health oversight activities and public health measures.

Where will researchers go to find my PHI?

We may ask to see your personal information in records at hospitals, clinics or doctor's offices where you may have received care in the past, including but not limited to facilities in the UNM health care system.

Who will be allowed to use my information for this research and why?

The researchers that will be allowed to see and use your health information for this research study include: Dr. Ann Gibson, PhD, Kelly Johnson, PhD(abd), Dr..Kathryn Coakley, PhD, Dr Christine Mermier, and James Steier, M.D. It may be used to check on your progress during the study, or we may analyze it along with information from other study participants. Sometimes research information is shared with collaborators or other institutions. Your records may also be reviewed by: people from the research sponsor/funding agency or federal regulatory agencies to check for quality, safety or effectiveness; or the IRB for the purposes of oversight and subject safety and compliance with human research regulations.

Will my information be used in any other way?

In addition to researchers and staff at UNM and other groups listed in this form, there is a chance that your health information may be shared (re-disclosed) outside of the research study and no longer be protected by federal privacy laws. Examples of this include disclosures for law enforcement, judicial proceeding, health oversight activities and public health measures.

What if I change my mind after I give this permission?

You can change your mind and withdraw this permission at any time by sending a written notice to the Principal Investigator at the contact information listed at the top of this form to inform the researcher of your decision. If you withdraw this permission, the researcher may only use and share your information that has already been collected for this study. No additional health information about you will be collected by or given to the researcher for the purposes of this study.

What are the privacy protections for my PHI used in this research study?

HIPAA regulations apply to personal health information in the records of health care providers and other groups that share such information. There are some differences in how these regulations apply to research, as opposed to regular health care. One difference is that you may not be able to look at your own records that relate to this research study. The HIPAA privacy protections may no longer apply once your PHI has been shared with others who may be involved in this research.

How long does this permission allow my PHI to be used?

If you decide to be in this research study, your permission to access and use your health information in this study may not expire, unless you revoke or cancel it. Otherwise, we will use your information as long as it is needed for the duration of the study.

If you have questions about the privacy practices of the entity from which your PHI is being collected, you can request a Notice of Privacy Practices from your provider.

AUTHORIZATION

I am the research participant or the personal representative authorized to act on behalf of the participant. By signing this form, I am giving permission for my protected health information to be used in research as described above. I will be given a copy of this authorization form after I have signed it.

Name of Research Participant	Signature of Participant	Date
Name of Researcher	Signature of Researcher	Date

APPENDIX B

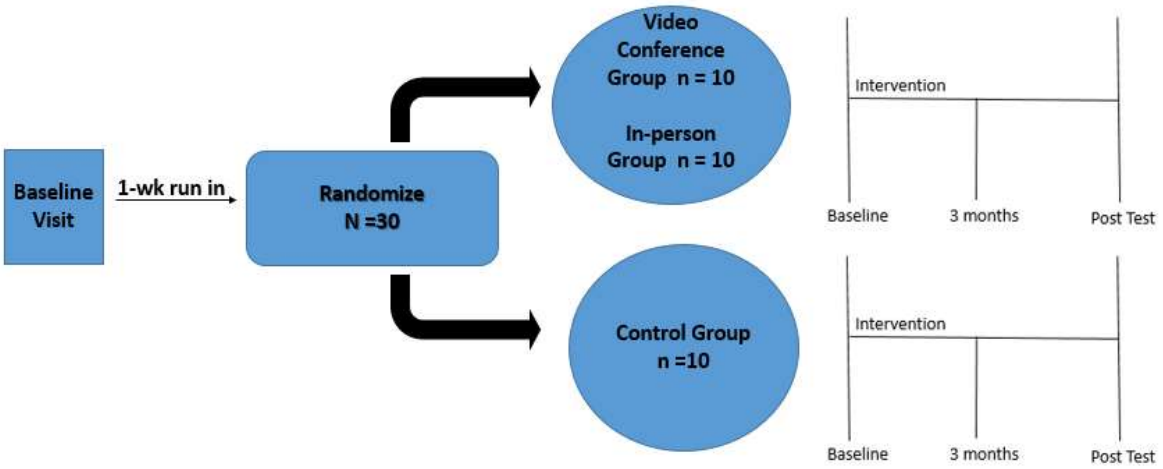
The impact of mobile health devices in combination with video conferencing versus in-person health coaching on weight loss, physical activity, and metabolic health

Consent to Participate in Research
04/20/2017

Purpose of the study: You are being asked to participate in a research study that is being conducted by Dr. Ann Gibson, the Principal Investigator, and her associates. This study is not currently funded by any organization. The purpose of this study is to determine how 12 weeks of health coaching with individualized feedback and education in combination with mobile health devices (a digital wireless body weight scale and wireless activity tracker) influences body weight, waist circumference, physical activity levels, and select blood-borne markers of health (fasting blood glucose, hemoglobin A1c, and insulin). The individualized health coaching, education, and feedback will be delivered by either video conferencing or direct, in-person consultation. You will be randomly assigned into one of two intervention groups (a video conferencing or in-person group) or a control group. You are being asked to take part in this study because you are an English speaker, an adult between the ages of 18-65 years, non-diabetic, have a body mass index (weight to height ratio) ≥ 30, take less than 7,000 steps per day, and have an iPhone or Android® smartphone .

This form will explain what to expect when joining the research study, as well as the possible risks and benefits of participation. If you have any questions, please ask one of the study researchers at any time.

What you will do in the study:



Baseline testing:

1. For your first visit, you will arrive at the Exercise Physiology Laboratory (Lab) in Johnson Center on the University of New Mexico campus in an 8-12 hour fasted state

(no eating or drinking anything other than water). When you arrive, a member of the research team will meet you, answer any questions you may have about the study, and ask you to complete brief questionnaires about your medical history, physical activity, and dietary habits. You will also need to provide written informed consent by signing this form before continuing. You will be asked to use the bathroom and void your bladder. You will then weigh yourself without any clothing on; this will be done in a private room with no one present. You will get dressed and report your weight to a research team member.

2. We will draw about 10ml (approximately 2.0 teaspoons) of blood from an arm vein.
3. We will ask you to raise the tail of your shirt so we can measure your waist circumference.
4. You will then meet with the study coordinator who will show you how to use the free eClinicalWorks® application (Service key JOHNSONUNMSTUDY), Withings® app, and the MyFitnessPal® app. You will also be trained on how to connect these applications and mobile health devices (described below) to your iPhone® or Android® smart phone.
5. You will then be provided with two Withings® Bluetooth-ready devices (see below) to use during the study.
   a. Body Weight Smart Scale: This device will record your body weight. We ask that you measure your nude weight every week. You should take your weight first thing in the morning after using the bathroom and before you shower.
   b. Activity Monitor: You are asked to wear this watch all day and night around the clock, and can wear it while showering. This device will track your physical activity and calories burned during physical activity throughout the 3-month study. This activity monitor should be worn on the left wrist if you are right-handed (and vice versa).

6. Run-In period: You will then begin a 7-day run-in period. This run-in period will serve two purposes. First, it will allow you to become familiar with the required use and operation of the mobile health devices and phone apps. Secondly, it will allow us to get a good idea about your daily physical activity routines (i.e. steps taken). During the run-in period, you will be asked to wear the Withings® Activite Pop activity monitor watch on your non-dominant wrist for 24 hours per day, 7 days a week. You will also take your nude weight on the Smart Scale at least once during the run-in period; this should be done in the morning after using the bathroom and before you bathe. This is the same protocol you will follow for the remaining 3 months of the study. Following the run-in period, you will be randomly assigned to one of three groups (described below).

Groups

There are a total of three groups for which you have an equal chance of being assigned. One is the Control Group. The second is the Video Conferencing (VC) group. The third one is the In-Person (IP) group.

Control Group

If you are randomly assigned to the Control Group, you will use the activity monitor watch and Smart Scale just like you did during the run-in period. You will upload your body weight once every week and your physical activity information every day; otherwise, you will not need to complete any other study activities. You will, however, be required to return the devices at the end of the 12-week period if you do not complete the whole study. Additionally, at the end of the 12-week period you will return to the Exercise Physiology Lab (Lab) in Johnson Center on the University of New Mexico campus in the morning following the same preparation described above for your first (Baseline) visit. The same measurements performed at baseline will be repeated. Including the baseline and follow-up assessments and inputting your of inputting nutritional information into MyFitnessPal, your overall time commitment for the 12 weeks of the study is approximately 44 hours. Additionally, you be asked to fill out an exit survey which will ask various questions about how you liked the research study.

Video Conference Group

If you are randomly assigned to the Video Conference (VC) Group, you will also receive instruction on using your iPhone or Android smart phone and eClinicalWorks, LLC app for video conferencing with the research team. Other than for the baseline and follow-up assessments, all of your interactions with the research team will be made through video conferencing on your iPhone.

At the end of the run-in period, you will "meet" with the medical doctor. This "meeting" will take place through the Apple iPhone or Android® and eClinicalWorks® apps on your iPhone or Android smart phone. During this meeting, you will be provided with a targeted number of calories to consume per day and a macronutrient ratio (percentages of your daily calories that should come from protein, fat, and carbohydrates). You will also learn how to count your calories during this time. The daily number of calories prescribed for you is what is recommended by the American Heart Association (Jensen et al. 2014). If you weigh less than 250 pounds, you be asked to consume 1200 calories per day. If you weigh more than 250 pounds, you will be asked to consume 1500 calories per day. After the first "meeting", you will "meet" with the medical doctor once during month two, month three, and at the end of the 12-week study. These visits will be scheduled during convenient times for you and will each take 20-30 minutes of your time. During all of these visits, you and the medical doctor will review your medical history and changes that may occur as a result of the study.

You will be required to return the activity monitor and Smart Scale devices at the end of the 12-week period if you do not complete the study; otherwise the devices are yours to keep. Additionally, following the 12-week period you will return to the Lab in Johnson Center on the University of New Mexico campus in the morning following the same preparation described above for your first visit. The same measurements performed at baseline will be repeated.

Health Coaching Sessions for Video Conferencing Group:

Week 1: Following the initial baseline visit you will receive weekly individualized video health coaching sessions through the video conference feature of the eClinicalWorks®, app on your Apple iPhone® or Android® smart phone. These health coaching sessions will be separate video conferences with the research team's registered dietitian (RD) and exercise physiologist. During your first sessions the RD will make an individualized meal plan based on the calories set by the medical doctor. This will then be given to you. You will also meet with the exercise physiologist to discuss a plan for physical activity. Each meeting (with the RD an exercise physiologist) should last about 20 minutes each for a total of 40 minutes. Each meeting will be scheduled during convenient times for you.

Weeks 2-12: For the rest of the study, you will continue to meet with the RD and exercise physiologist one time per week via your eClinicalWorks® telehealth app. Each week, the RD will review your progress including calories per day, macronutrient ratio, and make changes to your meal plan if needed. Additionally, the exercise physiologist will discuss your physical activity program and progress it as needed (i.e. increase the number of steps per day). Each health coaching session with both the RD and exercise physiologist will last approximately 20 minutes each resulting in a subject time commitment of 40 minutes per week. During these weekly telehealth sessions, you will receive educational information about nutrition and fitness. During all sessions, you will have time to express any concerns or questions you may have. You will meet 12 times with the registered dietitian and exercise physiologist during the study. All video conferencing health coaching sessions will take place at your convenience weekly.

Including the baseline and follow-up assessments and video conference meetings with our study providers, your overall time commitment for the 12 weeks of the study is approximately 54 hours. Additionally, you be asked to fill out an exit survey which will ask various questions about how you liked the research study.

In-Person Group

If you are randomly assigned to the In-Person (IP) Group, you will meet, in person and by appointment, with research team members in accordance with the study time line (below). All of your interactions with the research team will be made in person at the Lab.

At the end of the run-in period, you will "meet" with the medical doctor. This "meeting" will take place in the Lab. During this meeting, you will be provided with a targeted number of calories to consume per day and a macronutrient ratio (percentages of your daily calories that should come from protein, fat, and carbohydrates). You will also learn how to count your calories during time. The daily number of calories prescribed for you is what is recommended by the American Heart Association (Jensen et al. 2014). If you weigh less than 250 pounds, you be asked to consume 1200 calories per day. If you weigh more than 250 pounds, you will be asked to consume 1500 calories per day. After the first meeting, you will meet with the medical doctor once during month two, month three, and at the end of the 12-week study. These visits will be scheduled during

convenient times for you and will each take 20-30 minutes of your time. During all of these visits, you and the medical doctor will review your medical history and changes that may occur as a result of the study.

You will be required to return the activity monitor and Smart Scale devices at the end of the 12-week period if you do not complete the whole study; otherwise the devices are yours to keep.Additionally, following the 12-week period you will return to the Lab in Johnson Center on the University of New Mexico campus in the morning following the same preparation described above for your first visit. The same measurements performed at baseline will be repeated. You will also be asked to fill out an exit survey which will ask various questions about how you liked the research study.

Health Coaching Sessions for In-Person Group:

Week 1: Following the initial baseline visit you will receive weekly individualized health coaching sessions in person during scheduled appointments. These health coaching sessions will be separate face-to-face sessions with the research team's registered dietitian (RD) and exercise physiologist. During your first session with the RD, you will receive an individualized meal plan based on the calories set by the medical doctor. You will also meet with the exercise physiologist to discuss a plan for physical activity. Each meeting should last about 20 minutes.

Weeks 2-12: For the rest of the study, you will continue to meet in person with the RD and exercise physiologist in the Lab one time per week. Each week, the RD will review your progress including calories per day, macronutrient ratio, and make changes to your meal plan if needed. Additionally, the exercise physiologist will discuss your physical activity program and progress it as needed (i.e. increase the number of steps per day). Each health coaching session with both the RD and exercise physiologist will last approximately 20 minutes each resulting in a time subject commitment of 40 minutes per week. During these weekly in person sessions, you will receive educational information about nutrition and fitness. During all sessions, you will have time to express any concerns or questions you may have. You will meet 12 times with the registered dietitian and exercise physiologist during the study.

Including the baseline and follow-up assessments and face-to-face meetings with our study providers, your overall time commitment for the 12 weeks of the study is approximately 54 hours. This time commitment does not include travel time for your home or workplace or to and from the lab.

Risks:

It is possible that changes to your diet may cause constipation and/or diarrhea as well as light-headedness. In an effort to minimize these possible side effects, you will have 24-hour telephone access to a research team member who can contact the team's medical doctor. There are also risks of physical stress, emotional distress, and inconvenience associated with the project.

There is a risk of brief lightheadedness (dizziness) during the blood draws. You may also experience associated discomfort, bruising at the site, and a small risk of infection. These risks will be minimized since only trained personnel using standard sterile techniques will draw your blood, and a pressure bandage will be applied immediately when the blood draw is finished.

Exercising, even if walking, causes heart rate and breathing rate to go up. This is a normal response to physical activity and should become less noticeable within the first few minutes after you slow down or stop. Another response to physical activity, especially if you are new to exercise, is sore muscles. This is also a temporary response and should become less noticeable as physical activity becomes more of a routine part of your day. Also, if you are exercising in the natural environment (i.e. a park, Bosque trail, your neighborhood), there is a likelihood you could step on an uneven surface and twist your ankle or fall. Exercising in a well-lighted environment will help reduce such a risk.

In addition, participating in this study could result in loss of privacy. However, the loss of privacy is very rare as all of your transmitted data (i.e. body weight and physical activity) will be secured through a database managed by a business (eClinicalWorks®) that is obligated to comply with the Health Insurance Portability and Accountability Act (HIPAA). You will be given a special identification number to use in place of your name on all data sheets and in the electronic database. Information resulting from this study will be used for research purposes and may be published; however, you will not be identified by name in any publications.

There is a likelihood that you may experience emotional distress stemming from some of the values recorded during your baseline and follow-up assessments. The members of the research team are professionals in their fields and have many years of experience counseling weight loss/weight management clients.

Some possible issues with the technology used in this study may arise. For example, the connection between the phone apps and the secured database may be temporarily lost or disrupted. Likewise, the digital weight scale and activity tracker may need to be resynchronized with your smart phone. If such connectively is lost, you will quickly receive a call on the number you provided within one minute of being disconnected. You will also have 24-hour access by phone to a research team member who can help troubleshoot the problem. You allowed to keep the two Bluetooth devices (the digital weight scale and physical activity monitor) which have a combined value of $335 as long as you complete the whole study

Benefits:

There may be no direct benefits to you as a result of your participation in this study. However, you may become more aware of your health and how lifestyle choices you make influence your body. Should you want a copy of your blood tests results they will be made available for you to pick up at the Lab at your convenience upon completion of the study. Overall, the results of this study may prove beneficial to professionals involved in health care delivery in states like New Mexico because it is sparsely populated and covers a large geographic area.

Confidentiality of your information:

Any information obtained in this study that can identify you personally will remain confidential and will be disclosed only with your permission or as required by law. Additionally, all efforts will be made to ensure that your privacy is maintained in accordance with HIPAA guidelines. Your name and other identifying information will be kept in a file cabinet in a locked office, available for the duration of the study to authorized members of the research team. A unique identification (ID) number will be used instead of your name. Your name or other identifying information (i.e. street address, date of birth) will not be used. All hard copy data will be destroyed 2 years after data analysis is complete. The electronic data may be kept indefinitely. Any personal identifying information and record linking that information to study ID numbers will be destroyed when the study is completed. Information resulting from this study will be used for research purposes and may be published; however, you will not be identified by name in any publications.

We will take measures to protect the security of all your personal information, but we cannot guarantee confidentiality of all study data. The University of New Mexico Institutional Review Board (IRB) that oversees human subject research may be permitted to access your records.

Payment:

There is no compensation for taking part in this study.

Right to withdraw from the study:

Your participation in this study is completely voluntary. You have the right to choose not to participate or to stop participating at any point without penalty. Any data which may have been previously collected will be destroyed if you do decide to withdraw from the study.

If you have any questions, concerns, or complaints about the research study, please contact:

Ann Gibson, Ph.D.
University of New Mexico Department Health, Exercise and Sport Sciences
Johnson Center, MSC04 2610
1 University of New Mexico

Albuquerque New Mexico 87131
(505) 277-2248
alg@unm.edu

If you would like to speak with someone other than the research team or have questions regarding your rights as a research participant, please contact the IRB. The IRB is a group of people from UNM and the community who provide independent oversight of safety and ethical issues related to research involving people.

UNM Office of the IRB, (505) 277-2644, irbmaincampus@unm.edu. Website: http://irb.unm.edu/

CONSENT

You are making a decision whether to participate in this study. Your signature below indicates that you have read this form (or the form was read to you) and that all questions have been answered to your satisfaction. By signing this consent form, you are not waiving any of your legal rights as a research participant. A copy of this consent form will be provided to you.

I freely agree to participate in this study.

_____ _____

Name of Adult Participant Signature of Adult Participant Date

Researcher Signature ***(to be completed at time of informed consent)***

I have explained the research to the participant and answered all of his/her questions. I believe that he/she understands the information described in this consent form and freely consents to participate.

_____ _____

Name of Research Team Member Signature of Research Team Member Date

Would you like a copy of your pre and post blood results? (please circle one) **Yes** or **No**

APPENDIX C

HEALTH & PHYSICAL ACTIVITY QUESTIONNAIRE

Family history questions are included because certain conditions of your first degree relatives may incur risk to you during maximal exercise.

Subject #_____ Date___/___/___

Phone (H or cell)_____

Age____ Sex_____ Ethnicity_____

Emergency contact (name, phone #)_____

MEDICAL HISTORY

Physical injuries:_____
_____

Limitations_____
_____

Have you ever had any of the following cardiovascular problems? Please check all that apply.

Heart attack/Myocardial Infarction	____	Heart surgery	____	Valve problems	_____
Chest pain or pressure	____	Swollen ankles	____	Dizziness	_____
Arrhythmias/Palpitations	____	Heart murmur	___	Shortness of breath	_____

Have you ever had any of the following? Please check all that apply.

High blood pressure	_____		
Asthma	_____	Total cholesterol >200 mg/dl	_____
Diabetes (specify type)	_____	HDL cholesterol <35 mg/dl	_____
Emphysema	_____		
Stroke	_____	LDL cholesterol >135 mg/dl	_____
		Triglycerides>150 mg/dl	_____

Do immediate blood relatives (biological parents & siblings **only**) have any of the conditions listed above? If yes, list the problem, and family member age at diagnosis.

_____

Do you currently have any other medical condition not listed?
Details_____

_____

Indicate level of your overall health. Excellent ____ Good ____ Fair ____ Poor_____

Are you taking any medications, vitamins or dietary supplements now? Y N

If yes, what are
they?_____
_

Are you allergic to latex? Y N

Have you ever experienced any adverse effects during or after exercise (fainting, vomiting, shock, palpitations, hyperventilation)? Y N If yes, elaborate._____

LIFESTYLE FACTORS

Do you now or have you ever used tobacco? Y N If yes: type _____

How long?_____ Quantity____/day Years since quitting_____

EXERCISE HISTORY

Endurance training

Days per week (circle one): <3 3-5 6-7

Minutes per day (circle one): 30-60 60-240 240-360 >360

Hours per week (circle one): 1-2 3-5 6-8 >8

Training background (in years) (circle one): <1 1-3 4-5 6-15 >15

Race days/yr (circle one): 0-10 10-20 20-100 >100

Exercise mode (i.e. bike, run, etc)_____

Resistance training

Times per week (circle one): <3 3-5 6-7

Minutes per day (circle one): 30-60 60-240 240-360 >360

Hours per week (circle one): 1-2 3-5 6-8 >8

Training background (in years) (circle one): <1 1-3 4-5 6-15 >15

Training mode _____

(strength 2-6 reps, heavy load; hypertrophy 6-15 reps, moderate-heavy load)

Do you participate in other sports? Yes No (circle one)

If so, how often? (describe) _____

APPENDIX D

Physical Activity Questionnaire: IPAQ Short Version

1. **During the last 7 days, how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?**
   _____days per week
   No vigorous physical activities, *Skip to question 3*

2. **How much time did you usually spend doing vigorous physical activities on one of those days?**
   _____hours per day _____minutes per day
   Don't know/not sure

3. **During the last 7 days, on how many days did you do moderate physical activities like gardening, carrying grocery bags to your car, bicycling at a somewhat hard pace, or swimming? Do not include walking.**
   _____days per week
   No moderate physical activities, *Skip to number 5*

4. **How much time did you spend doing moderate physical activities on one of those days?**
   _____hours per day _____minutes per day
   Don't know/not sure

5. **During the last 7 days, on how many days did you walk for at least 10 minutes at a time?**
   _____days per week.
   No walking, *Skip to number 7*

6. **How much time did you usually spend walking on one of those days?**
   _____hours per day _____minutes per day
   Don't know/not sure

7. **During the last 7 day, how much time did you spend sitting on a week day?**
   _____hours per day _____minutes per day
   Don't know/not sure

APPENDIX E

APPENDIX A.
Dietary Quality Survey

Circle ONE option to indicate how much you agree or disagree with each statement. Whenever I have a choice of the food I eat…

SD = Strongly Disagree D = Disagree DS = Disagree Slightly AS = Agree Slightly A = Agree SA = Strongly Agree

1. I find it difficult to choose healthy fats (such as olive or canola oil, avocado, or nuts) instead of foods high in saturated fats (such as butter, fatty meats, or cheese).

SD D DS AS A SA

2. I find it easy to choose a healthy snack when I eat in between meals (for example, fruit, vegetable, yogurt, or nuts).

SD D DS AS A SA

3. I believe I have the knowledge and ability to choose/prepare healthy snacks.

SD D DS AS A SA

4. I find it difficult to choose healthy meals/ snacks when I am eating out with my friends.

SD D DS AS A SA

5. I find it easy to eat at least 3 servings of fruit each day.

SD D DS AS A SA

6. I find it easy to eat at least 4 servings of vegetables/ salad each day.

SD D DS AS A SA

7. I find it easy to have healthy portion sizes during meals (e.g. not eating till I feel full).

SD D DS AS A SA

Intentions scale

Circle one response for each question.

In the next THREE MONTHS do you…

1. …INTEND to eat at least 3 servings of fruit each day?

Not at all true of me | Not very true of me | Somewhat true of me | Very true of me

2. …INTEND to eat at least 4 servings of vegetables/ salad each day?

Not at all true of me | Not very true of me | Somewhat true of me | Very true of me

3. …INTEND to choose healthy fats (such as olive or canola oil, avocado, or nuts) instead of saturated fats (such as butter, fatty meats, or cheese) whenever you have a choice?

Not at all true of me | Not very true of me | Somewhat true of me | Very true of me

4. …INTEND to choose drinks and foods that are low in added sugar whenever you have a choice?

Not at all true of me | Not very true of me | Somewhat true of me | Very true of me

5. …INTEND to eat healthier portion sizes during meals (e.g. not eating till you feel full)?

Not at all true of me | Not very true of me | Somewhat true of me | Very true of me

Situation scale

Circle ONE option to indicate how much you agree or disagree with each statement:

SD = Strongly Disagree **D = Disagree** **DS = Disagree Slightly** **AS = Agree Slightly** **A = Agree** **SA = Strongly Agree**

1. At home there are healthy snacks available to eat.

SD | D | DS | AS | A | SA

2. At home there are healthy drinks available (such as cold water in the fridgesparkling water with lemon, or unsweetened tea).

SD | D | DS | AS | A | SA

3. At home fruit is always available to eat (including fresh, canned or dried fruit).

SD | D | DS | AS | A | SA

4. At home vegetables are always available to eat (including fresh, frozen or canned vegetables).

SD | D | DS | AS | A | SA

Behavioral strategies scale

Circle ONE option for each question. In the past THREE MONTHS…

N = Never R = Rarely S = Sometimes O = Often A = Always

1. …did you choose healthy fats (such as olive or canola oil, avocado, or nuts) instead of foods high in saturated fats (such as butter, fatty meats, or cheese)?

N R S O A

2. …rather than choose sugary drinks such as fruit juice or soft drink, did you choose water, sparkling water with lemon, or unsweetened tea?

N R S O A

3. …did you leave food on your plate once you felt full during a meal?

N R S O A

4. …did you prepare healthy snacks and meals for yourself that included a fruit, vegetable, and/or whole grain?

N R S O A

5. …did you try preparing new recipes for meals and snacks that included a fruit, vegetable, and/or a whole grain?

N R S O A

6. …did you do things to make eating fruits and vegetables more enjoyable (e.g. try a new recipe or blend fruit to make a fruit smoothie)?

N R S O A

Social support scale

Select ONE option for each question. In the past THREE MONTHS how often…

N = Never R = Rarely S = Sometimes O = Often A = Always

1. …were fruit and vegetables available at home?

N R S O A

2. …were healthy snacks available at home?

N R S O A

3. …did you (or if you live with someone else in your household) prepare a healthy home-cooked dinner?

N R S O A

4. …did your friends/family/significant other encourage you to eat fruits and vegetables (if you live alone please leave the question blank)?

N R S O A

5. …did you prepare healthy snacks or meals with your friends/family/significant other (if you live alone please leave the question blank)?

N R S O A

Outcome expectations and expectancies scale

Please select ONE option to indicate how much you agree or disagree with each benefit and how important each benefit is to you:

1a. Healthy eating can reduce my risk for some illnesses and diseases (e.g. heart disease, diabetes, some cancers etc).

Strongly Disagree Disagree Partly Disagree Partly Agree Agree Strongly Agree

1b. How important is reducing your risk for illness and disease to you?

Not at all important Only slightly important Important Extremely Important

2a. Healthy eating can help me to feel better physically.

Strongly Disagree Disagree Partly Disagree Partly Agree Agree Strongly Agree

2b. How important is feeling better physically to you?

Not at all important Only slightly important Important Extremely Important

3a. Healthy eating can help me to control my weight.

Strongly Disagree Disagree Partly Disagree Partly Agree Agree Strongly Agree

3b. How important is controlling your weight to you?

Not at all important Only slightly important Important Extremely Important

4a. Healthy eating (e.g. not skipping meals) can help to improve my concentration.

Strongly Disagree Disagree Partly Disagree Partly Agree Agree Strongly Agree

4b. How important is improving your concentration to you?

Not at all important Only slightly important Important Extremely Important

5a. Healthy eating can help me to feel more energetic throughout the day

Strongly Disagree Disagree Partly Disagree Partly Agree Agree Strongly Agree

5b. How important is feeling more energetic to you?

Not at all important Only slightly important Important Extremely Important

APPENDIX F

Seeking 30 subjects for a research project at the UNM Exercise Physiology Lab
IRB #21816

What is the study about?

- 12 weeks of health coaching + mobile health devices influences body weight, physical activity levels, and select blood-borne markers of health (fasting blood glucose, hemoglobin A1c, and insulin.
- Random assignment into one of two intervention groups (a video conferencing or in-person group) or a control group.

subject wears an activity tracker and all activity is reported to the doctor's portal via wifi

Who can volunteer?

- Healthy adults 18-65 years old with a BMI of ≥ 30 BMI kg/m^2
- Take less than 7,000 steps per day
- Have an iPhone® or Android® smart phone

How much time is required?

- Control group = 44 hrs (2 hrs for pre- and post-testing, and 3.5 hrs of MyFitnessPal inputting per week)
- Intervention groups = 54 hrs (2 hrs for pre- and post-testing, 3.5 hrs of MyFitnessPal inputting per week, 9.5 hrs of health coaching)

subject steps on scale at home and results are sent to the doctor's portal via wifi

Is there any compensation for completing this study?

- There will be no monetary compensation. However, if subjects complete the whole study they will be allowed to keep the devices (activity tracker and weight scale)

For more information contact:

- Kelly Johnson (phone:505-322-5715; kjohnson4@unm.edu) or
- Dr. Ann Gibson (phone: 505-277-2248; alg@unm.edu)

APPENDIX G

UNM Research Participant Exit Control exit Survey

For each of the following, please choose the answer that best describes how ***satisfied*** you were with that area of the research study. Please mark your answer by circling the number.

HOW *SATISFIED* WERE YOU WITH:	Very Dissatisfied	Moderately Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Moderately Satisfied	Very Satisfied
1. Your Withings ® watch device	1	2	3	4	5	6
2. Your Withings ® body weight scale device.	1	2	3	4	5	6
3 The connectivity guides for your Withings® devices.	1	2	3	4	5	6
4. Overall method of communication to schedule pre and post	1	2	3	4	5	6
5. Did using MyFitnessPal® make you more aware of your eating?	1	2	3	4	5	6
6.Using the Withings® watch made me move more?	1	2	3	4	5	6

7. What did you enjoy most about the research study?_____

8. Anything you didn't like about the research? _____

9. Please provide feedback for the research team on any of the above items. Feel free to also comment on other aspects of the study (Diet, physical activity, activity trackers, etc

_____

APPENDIX H

UNM Research Participant Exit Survey

For each of the following, please choose the answer that best describes how ***satisfied*** you were with that area of the research study. Please mark your answer by circling the number.

HOW *SATISFIED* WERE YOU WITH:	Very Dissatisfied	Moderatelv Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Moderately Satisfied	Very Satisfied
1. Content of dietitian visits?	1	2	3	4	5	6
2. Content medical doctor visits?	1	2	3	4	5	6
3 Content of the exercise physiologist visits?	1	2	3	4	5	6
4. The ability of the program to help you attain your goals.	1	2	3	4	5	6
5. The amount of time alloted for your visits?	1	2	3	4	5	6
6. Overall technology and connectivity of the Eclincalworks portal?	1	2	3	4	5	6
7. The quality of your health and dietary coaching?	1	2	3	4	5	6
8. The flexibility of your dietitian's schedule.	1	2	3	4	5	6
9. The flexibility of the study doctor's schedule.	1	2	3	4	5	6
The flexibility of the exercise physiologist schedule	1	2	3	4	5	6
10. Your meal plan and nutrition guide.	1	2	3	4	5	6
11. Your exercise plan and exercise guide.	1	2	3	4	5	6
11. Your Withings ® watch device	1	2	3	4	5	6
12. Your Withings ® body weight scale device.	1	2	3	4	5	6
13. The connectivity guides for your Withings® devices.	1	2	3	4	5	6
14. Overall method of communication to schedule visits	1	2	3	4	5	6

APPENDIX I

Data Sheet
Study #:

Subject #_____ Group Assignment: VC Group IP group Control

Baseline Data:

Height (cm): _____ Weight (kg): _____ BMI (kg/m^2): _____
Blood Glucose (mg/dL): _____ Hemoglobin A1C (%): _____
Insulin: mIU/L: _____ Waist circumference (cm): _____

Run- Period:

Average Steps per week: _____

Post Intervention Data:

Weight (kg): _____ BMI (kg/m^2): _____
Blood Glucose (mg/dL): _____ Hemoglobin A1C (%): _____
Insulin: mIU/L: _____ Waist circumference (cm): _____

APPENDIX J

LET'S
— get —
MOVING!

Welcome!

EXERCISING IS AN IMPORTANT PIECE OF YOUR WEIGHT LOSS JOURNEY.

Although having a healthy, balanced, reduced-calorie diet is often the biggest component to losing weight, exercise is just as important for your overall health.

It's important to incorporate cardiovascular endurance, muscular strength, flexibility, and de-stressing techniques in order to develop and maintain a well-rounded physically active lifestyle.

But don't worry it doesn't mean you need to hit the gym everyday, or even AT ALL. This exercise guide will help you develop a physically active lifestyle thats tailored to you!

Let's Get Started!

inhealthonline @inhealthonline inhealthonline

Contents Exercise Guide

FUNDAMENTALS OF EXERCISE

Exercising for Weight Loss

Exercise is vital for maintaining muscle mass during active weight loss. Furhtermore, exercise is important for your health and overall well-being.

Building your exercise habits starts now!

Cardiovascular exercise is the foundation of our pyramid; this will be tracked by how many steps you take a day. Taking more steps is not only proven to help with weight loss, but it also improves the health of our hearts. The second part of our base is strength training.

Strength Training will start during Week 3 of your program. This will include your choice of bodyweight, weightlifting, or resistance band exercises. The routines are created in a circuit to not only to help you maintain muscle mass as you lose weight, but to also link strength training to the cardiovascular foundation of our pyramid.

Plan your exercise!

Flexibility helps to reduce tightness during both our exercises and everyday lives. Tight muscles cause us to compensate in the movements we make, eventually causing alterations in body position and reduced mobility. Regularly moving and stretching has been proven to increase flexibility and limit immobility as we age.

Down time, while seemingly less significant, it is still very important for our bodies to rest and recover. Even though we are limiting down time in this program, a good night's sleep and de-stressing is still a vital part of the program.

CARDIOVASCULAR TRAINING

Cardio *does not* have to be intense

Walking is linked to better heart health and overall reduced risk of disease.

Walk for Heart Health!

Walking is an excellent form of cardiovascular exercise. Your health educator will help you select the appropriate step goal for you to attain each day.

As the weeks go on, challenge yourself to move more throughout the day. To the right is a step guide for the ***minimum amount of steps*** you should aim for on a daily basis.

You can meet these step goals doing whatever you like to do, be it watching TV on the treadmill, walking the dog, or playing a game with the kids.

*Remember to wear your Withings Activite Pop Watch at all times to monitor your steps and sleep

WEEK	1-4	4-8	8-12
Daily Step Count	4,000 +	6,000+	8,000+

Suggestions for increasing your step counts

Park farther away from the entrance to your home, work, and stores.

Ask a friend, family member or colleague to go for a walk after lunch or dinner.

Get up from your desk every half hour to loosen up.

Window shop! Walk around town or the mall.

Take a stroll in the park or on the beach.

Walk on the treadmill while you watch your favorite show or team.

Explore a park or an area you've never been before! Many places have walking trails so that you can take in the sights while you bump up your step count.

MUSCULAR STRENGTH

Strength training is recommended to be done 2-5x per week. The reason we strength train is to maintain muscle mass during our weight loss journey.

In fact, the more muscle we have, the more calories we burn on a daily basis. One pound of muscle burns approximately 50 calories a day; that's before counting the calories burned through exercise!

Two terms often used with strength training are repetitions (reps) and sets.

Repetitions indicate how many times you perform the motion in a single bout. For example, if you did 10 push-ups right now you would have done 10 reps.

Sets indicates how many times you performed the same bout of exercise. This means that if you did those 10 push-ups, took a break, and then did another 10 you would have just completed 2 sets of 10 reps.

To start, pick a routine in our guide that appeals to you and start there!

Did it feel hard? Wait a day or two and try it again.

Take the time you need to complete all the repetitions instead if rushing yourself. Did it feel easy? Reduce the break time between exercises to 15 seconds, 10 seconds, or no seconds.

If you're working with weights, try to increase the weight 5 or 10 pounds each time you feel like the workout wasn't challenging enough or try the modifications in the examples within this guide.

YOUR STRENGTH CONDITIONING PROGRAM WILL BEGIN AT THE START OF WEEK 3

The chart below is intended to guide you through your weekly goals of how many days to perform a routine within your strength conditioning program. In your guide you'll find a more extensive guidebook to the exercises seen in your videos, along with examples of how to progress your routine.

WEEKS	3-4	5-6	7-8	9-10	11-12
Times per wk to Train	2	2 or 3*	3	3 or 4*	4

* Indicates transition weeks that allow for you to choose to do the extra day based on if you feel good (excited, determined, energetic, etc.) or run down (tired, sore, overwhelmed, etc).

See Results

Body Weight Strength Conditioning

For those who are new to strength training, body weight conditioning is a great place to start. The required equipment is minimal, so these exercises can be done anywhere.

Your first exercise video will go through the exercises shown below. Please read through this page for additional instructions and pointers that may help get you started. The following page provides an easy-to-follow chart with the number of repetitions and sets for each exercise. You'll want to follow the body weight conditioning program to the best of your ability, and follow up with your health educator if you have any questions or concerns.

Watch the VIDEO TUTORIAL AT: www.inhealthonline.com/fitness

MODIFIED PUSH-UP

1. Rest on knees to perform push up. Arms should be below shoulders, either shoulder width apart of slightly wider.
2. Back should remain neutral. This can be done by activating or by squeezing the core to stabilize spine.

CHAIR SQUAT

1. Use a stationary and stable (not rolling) chair.
2. Slowly lower body until you feel the chair. Do not sink into into a full sit before standing back up.
3. Keep spine neutral and avoid excessive forward lean.

HIP BRIDGE

1. When lifting hips, body should create a 45 degree angle (see image)
2. When hips are fully raised, squeeze glutes and hold before lowering hips back to the ground.

BIRD DOG

1. Hands should be directly below shoulders and knees should be directly below the hip joint.
2. Do not raise limbs above joints (bottom image).
3. Move slowly and hold top.

SUPERMAN

1. Squeeze glutes to help raise torso and legs higher. Hold this squeezed position
2. If too easy, exercise can be performed with light weights in hands or on ankles.

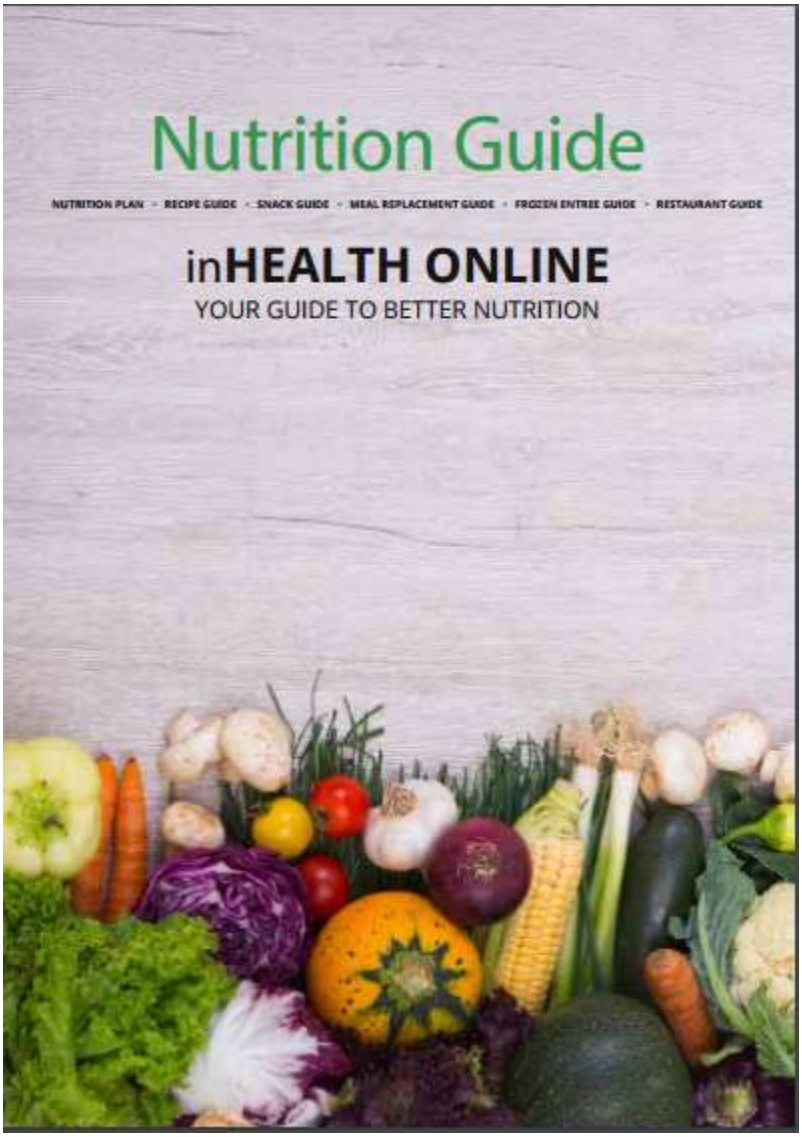
RESISTANCE BAND CHEST FLY

1. Elbows should be slightly bent throughout the motion. They should not fully extend or bend in.
2. Keep hands at shoulder height throughout motion.

RESISTANCE BAND SEATED ROW

1. Loop resistance band around low, stable object or feet.
2. Focus on keeping the shoulders from shrugging up.
3. You should feel your shoulder blades pinching together as if squeezing a pen between them.

APPENDIX K



Navigating Your Meal Plan

When choosing your meals, follow the diagram of the pyramid (below).

Read the pyramid from the bottom up to guide you through more ideal meal choices to less favorable, grab-n-go meal choices. For example, prep and cook your own food, based off of the **Recipe Guide found on pages 8-11** and the **Snack Guide found on pages 12-14**, wherever possible. If cooking isn't an option, move up to the next level and eat a frozen entree from the **Frozen Entree Guide found on pages 15-17.**

Eating out at restaurants should be kept to a minimum while you are in the active weight loss phase of your program. Refer to the **Restaurant Guide on pages 15-17** to make healthy restaurant and food selections that fit within your meal plan. Start off with casual/sit-down restaurants in the restaurant guide. If you need something with faster service, choose a fast casual restaurant listed, like Panera Bread.

As a LAST RESORT, take a look at our fast food options, like Subway, for healthy choices that will fit within your meal plan.

MEAL REPLACEMENTS ARE ALWAYS A GREAT CHOICE

Contents

Here's to Your Health!

Tips & Helpful Information

Program Essentials!

1. Remember to weigh, measure, and record all of your food.
2. Continue taking all medications as prescribed by your prescribing doctor.
3. Herbal and green tea helps in times of craving or thinking you are hungry.
4. Eat slowly. Remember, it takes 20 minutes for your stomach to send the "full" message to your brain.
5. Traveling? Get packing. Choose portable, healthy snacks for work or short travel. Pre- measure snacks using plastic sandwich bags.

Menu Planning!

1. Plan ahead. Buy all the foods you'll need to prepare a week's menu. Use the recipes, frozen entrée guides, and shopping list to help you plan.
2. Short cuts. When you get home, rinse and cut up raw vegetables for quick salads and snacks.

Shopping!

1. Go organic! Look for foods (fresh or frozen) and seasonings that are USDA-certified organic.
2. Roam wild & free. Select wild caught salmon over farm-raised (artificial colors/ chemicals). Choose free-range and hormone-free chicken, turkey, and beef (grass fed).

Create Flexibility in your Plan!

1. Combine your snacks with meals if you prefer larger meals or do not typically snack during the day.
2. Combine snacks together (if your plan allows for 2+ snacks). For example, you can consume two snacks together instead of eating two separate snacks at different times.

   +

   Combine meals together. For example,
3. if your plan allows for 4 meals; you can consume a breakfast-lunch combo (consuming 2 meals together).

Dining Out!

1. Bring your Restaurant Guide with you so that you can chose an item on your plan or what closely resembles your plan item.
2. Control portions. Order items a-la-carte! Restaurants are often very accommodating, so just ask for what you need and most can make it happen!
3. Hide from unnecessary calories. Skip the bread basket, chips, and house appetizers. Opt for a green salad with olive oil and vinegar on the side.

You're *on your way* to Better Health!

DAILYPLAN

Meal Planning

Let's face it, our lives are busy, but it's important to stick to your meal plan for the best results. Your practioner and health educator will guide you to the the right plan for you.

It's important for you to stay within the caloric prescription designed for you.

tips

1. Consume your allocated number of meals and snacks per day.
2. Separate or combine your Meals and Snacks to suit your preference.
3. Pay attention to your hunger cues throughout the day.

so, what is a meal and what is a snack?

A meal can consist of the following items:

1. A recipe you prepare from the **Recipe Guide.** P. 8
2. A Metagenics Meal Replacement from our **Meal Replacement Guide.** P. 15
3. A Frozen Entree from the **Frozen Entree Guide.** P. 17 (bring this guide along when you grocery shop)
4. A meal selected from the **Restaurant Guide.** P. 20

A snack can consist of the following items:

1. Appropriate snack options are listed in the **Snack Guide.** P. 12 (each item lists a portion size that is equivalent to one snack)

The sample meal plans on the following page provide a foundation for combining meals and snacks while staying within your recommended meal plan.

The Meal Plan

YOUR HEALTH EDUCATOR WILL GUIDE YOU

1200 Calorie Plan

Designed for you

3 MEALS, 1 SNACK

BREAKFAST
Meal Exchange P. 8 or
Meal Replacement

MIDMORNING SNACK-
Snack Exchange
P. 12

LUNCH
Meal Exchange P. 8
or Meal Replacement.

DINNER
Meal Exchange P. 8
or Meal Replacement.

1500 Calorie Plan

Create Flexibility in your plan

3 MEALS, 3 SNACKS ***OR*** 4 MEALS NO SNACKS

BREAKFAST
Meal Exchange P. 8 or
Meal Replacement P. 15

MIDMORNING SNACK-
Snack Exchange P. 12

LUNCH
Meal Exchange P. 8 or
Meal Replacement

AFTERNOON SNACK
Snack Exchange P. 12

DINNER
Meal Exchange or
Meal Replacement P. 8

EVENING SNACK
Snack Exchange P. 12

Sample 1200 Calorie Day Menu!

Check out the Recipe guide

BREAKFAST
Strawberry Supreme Meal
Replacement Smoothie
P. 16

SNACK
1 individual container of
nonfat Greek yogurt P. 12

LUNCH
Mediterranean Pita, P. 11

DINNER
Walnut Crusted Salmon,
P. 11