Effectiveness of Online Social Networks as an Alternative Delivery Platform for Weight Management Interventions

By

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Submitted to the graduate degree program in Health, Sport, and Exercise Sciences and the Graduate Faculty of the University of Kansas in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Abstract

The prevalence of overweight/obesity is high resulting from prolonged imbalance of energy intake and energy expenditure and has shown to be associated with significant co-morbidity in addition to increased economic costs. Current clinical guidelines recommend behavioral based programs, which target energy restriction and increasing energy expenditure to produce clinically relevant weight loss of 5% or more of initial body weight. However, weight loss continues to be problematic for individuals who are overweight or obese in part because of numerous barriers preventing participation in weight management programs, including cost, transportation, time, as well as family and job commitments. Alternate strategies to deliver weight management programs targeted to reduce the burden for both provider and participant in addition to reaching large groups of individuals are critical. Over recent years, the use of internet-delivered health care has greatly expanded. Similarly, there has been a dramatic increase in individuals pursuing information, sharing experiences, asking questions and providing support to peers about health online. The dramatic increase in technology has led to recent interest in online social networks as a possible delivery platform to deliver weight management programs that could have an impact on health care at the population level. However, the use of online social networks for delivery of weight management is in the early stages of development and the available literature on the effectiveness of this delivery system is limited.

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Do Weight Management Interventions Delivered by Online Social Networks Effectively Improve Body Weight, Body Composition, and Chronic Disease Risk Factors? A Systematic Review.

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Abstract

Introduction: Currently, no systematic review/meta-analysis has examined studies that used online social networks (OSNs) as a primary intervention platform for weight management interventions. Therefore the purpose of this review was to evaluate the effectiveness of weight management interventions delivered through OSNs. ***Methods*** PubMed, Embase, PsycINFO, Web of Science, and Scopus were searched (January 1990-May 2016) for studies with data on the effect of OSNs on weight loss. Only primary source articles that utilized OSNs as the main platform for delivery of weight management/healthy lifestyle interventions, were published in English language peer-reviewed journals, and reported outcome data on weight were eligible for inclusion in this systematic review. Five articles were included in this review. ***Results:*** One hundred percent of the studies (*n*=5) reported a reduction from baseline weight. Three of the five studies (60%) reported significant decreases in body weight when OSNs were paired with health educator support. Only one study reported a clinically significant weight loss of ≥5%. ***Conclusion:*** Using OSN for weight management is in its early stages of development and while these few studies show promise, more research is needed to acquire information about optimizing these interventions to increase their efficacy.

Keywords Online Social Network; Obesity; Systematic Review; Weight loss

INTRODUCTION

Approximately 69% of U.S. adults are classified as overweight (BMI ≥ 25 kg/m^2) while 35.1% are obese (BMI ≥ 30 kg/m^2) (Ogden, Carroll, Kit, & Flegal, 2014). Being overweight/obese is associated with significant co-morbidity, and it is estimated that for every one-point increase in BMI, health care costs increase by 8% (Algazy, Gipstein, Riahi, & Tryon, 2009). The current recommended paradigm for weight management emphasizes a lifestyle modification program consisting of strategies to reduce energy intake, increase physical activity, and provide cognitive behavior therapy to identify cues to unhealthy behaviors and restructure behavior to prompt healthy responses to these cues (Jensen et al., 2014). However, multiple barriers exist in delivering weight management interventions.

Changes in diet and physical activity facilitated by behavioral weight loss clinics are typically delivered face-to-face by a health educator (HE) to a group of 12-15 individuals (T.A. Wadden et al., 2000; T. A. Wadden, Butryn, & Byrne, 2004; Wing, 2004). However, this approach can require significant time commitments from participants and educators as well as considerable economic costs (i.e. facility usage fees, travel costs, payroll). To better address obesity, healthcare systems need to find methods that reach beyond the “walls” of clinics and hospitals, and include components of lifestyle modification in a cost-conscious way. The need to develop alternative strategies to deliver weight management programs has resulted in investigations examining the efficacy of programs delivered through the mail or email (Jeffery et al., 2003; Tate, Jackvony, & Wing, 2006; van Wier et al., 2009), internet (Harvey-Berino et al., 2010; Krukowski, Tilford, Harvey-Berino, & West, 2011; Manzoni, Pagnini, Corti, Molinari, & Castelnuovo, 2011), a combination of phone, internet, and email (Appel et al., 2011), individual phone counseling (Digenio, Mancuso, Gerber, & Dvorak, 2009; Hellerstedt & Jeffery, 1997; Jeffery et al., 2003; Neve, Morgan, & Collins, 2011; Rock et al., 2010; Sherwood et al., 2011), group phone counseling (Donnelly et al., 2013), and text messaging (Patrick et al., 2009). While

participants in these alternate delivery programs have demonstrated successful weight loss; the increase in use of technology and online social networks (OSNs) may present healthcare providers with innovative ways to deliver weight management programs that could have an impact on healthcare at the population level.

In 2013, Pew Internet survey reported that 70% of Americans over the age of 18 have high-speed internet in their homes (Zickuhr & Smith, 2013). Furthermore, as of 2014, 74% of adults report using OSNs (Sheet, 2014). An OSN as defined by Boyd and Ellison (2007) is a web-based services that allow individuals to: *"(1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system."* Due to this growth in technology and OSNs, individuals have started to acquire information, share experiences, ask questions and provide online support to peers about health (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004; Jayanti & Singh, 2010; Turner, Grube, & Meyers, 2001). Many individuals have reported feeling more comfortable and secure with expressing their problems and concerns remotely over the internet compared to talking FTF or over the phone (Hwang et al., 2010; Wu, Chen, & Chung, 2010). Additionally, the more interactive individuals are with the OSN the more successful they were at losing weight (Poncela-Casasnovas et al., 2015). For these reasons OSNs have generated recent interest as a delivery medium of health behavior change campaigns. Within the broad category of health issues, online support groups and communities have become an increasingly common way for individuals to share information and seek emotional support for issues surrounding weight loss (Wright, Rains, & Banas, 2010). Thus, creating an innovated platform to deliver health behavior change interventions.

Recent reviews of the efficacy of programs utilizing OSN components have found modest but significant evidence in improving health outcomes (Ashrafian et al., 2014; Maher et al., 2014). However, these reviews address studies that do not isolate the effect of OSNs; rather, they feature bulletin boards and chat rooms that were embedded within a larger intervention (Chang, Chopra, Zhang, & Woolford, 2013). Furthermore, data regarding the frequency of use of the OSN components were rarely reported (Chang et al., 2013). To date, no systematic review/meta-analysis has examined studies that used OSNs as a primary intervention platform for weight management. Therefore, the objective of this systematic review is to identify and evaluate studies that have utilized OSNs to assess the impact on body weight, body composition, and chronic disease risk factors.

METHODS

Eligibility Criteria

This systematic review was performed and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Liberati et al., 2009; Moher, Liberati, Tetzlaff, & Altman, 2009). Only primary source articles that utilized an OSN as the main platform for delivery of weight management or healthy lifestyle interventions and were published in English language peer-reviewed journals were eligible for inclusion in this systematic review. With the intention of isolating the effects of OSNs as a delivery system for weight management interventions at least one intervention group must have received all health education, materials, and recourses through an OSN. For example, if intervention groups were delivered by FTF, phone, or email, with OSN supplemented as a tool then they were excluded from this review. Specific eligibility included: *Participants*: Adults (age 18 years and above). Studies of participants with elevated chronic disease risk factors and/or type 2 diabetes were included. *Types of studies:* Both non-randomized and randomized studies. *Outcomes:* Body weight was required for inclusion. Other outcomes included body composition (fat mass, fat-free

mass, waist circumference) and chronic disease risk factors including total, HDL and LDL cholesterol, triglycerides, insulin, glucose, HbA_{1C}, and blood pressure.

Information Sources

Electronic database and related article reference lists were searched to identify studies for this review. The search was applied to PubMed (1990- present) and adapted for EMBASE, PsycINFO, Web of Science, and Scopus (1990-present). The last search was conducted on May 1st, 2016. The search was developed with consultation with a University of Kansas reference librarian. No attempts were made to contact study investigators or sponsors to acquire any information missing from the published article.

Search Strategy.

The following search terms were used for Pub Med to identify potential articles with abstracts for review: ("social media"[Title/Abstract] OR "social bookmarking"[Title/Abstract]) OR "social technology"[Title/Abstract]) OR "social technologies"[Title/Abstract]) OR ((wikis[Title/Abstract] OR wiki[Title/Abstract] OR wikipedia[All Fields]) AND (blog[Title/Abstract] OR blog'[Title/Abstract] OR blog's[Title/Abstract] OR blog06[Title/Abstract] OR blogett[Title/Abstract] OR blogged[Title/Abstract] OR blogger[Title/Abstract] OR blogger's[Title/Abstract] OR bloggers[Title/Abstract] OR bloggers'[Title/Abstract] OR blogging[Title/Abstract] OR bloggs[Title/Abstract] OR blogification[Title/Abstract] OR bloglines[Title/Abstract] OR blogm[Title/Abstract] OR blogo[Title/Abstract] OR blogorrhea[Title/Abstract] OR blogosphere[Title/Abstract] OR blogosphere'[Title/Abstract] OR blogosphere's[Title/Abstract] OR blogospheres[Title/Abstract] OR blogp[Title/Abstract] OR blogreg[Title/Abstract] OR blogroll[Title/Abstract] OR blogs[Title/Abstract] OR blogs'[Title/Abstract] OR blogsearch[Title/Abstract] OR blogsite[Title/Abstract] OR blogspot[Title/Abstract])) OR "social networking"[Title/Abstract]) OR YouTube[Title/Abstract]) OR ((twitter[Title/Abstract] OR tweet[All

Fields]) AND Title/Abstract[All Fields])) OR "social networks"[Title/Abstract]) OR "social network"[Title/Abstract]) OR "online community"[Title/Abstract]) OR "online communities"[Title/Abstract]) OR Facebook[Title/Abstract]) OR myspace[Title/Abstract]) AND (weight loss[Title/Abstract] OR weight maintenance[Title/Abstract] OR weight regain[Title/Abstract])

The search was then modified slightly for EMBASE, PsycINFO, and Scopus: ('social media'/exp OR 'social media' OR 'social bookmarking' OR 'social technology' OR 'social technologies' OR wikis OR wiki OR wikipedia OR blog OR 'social net working' OR youtube OR twitter OR tweet OR 'social networks' OR 'social network'/exp OR 'social network' OR online AND ('community'/exp OR community) OR online AND communities OR facebook OR myspace) AND ('weight loss' OR 'weight maintenance' OR 'weight regain') NOT (spinal OR paraplegia OR stroke OR athletes OR Alzheimer OR fibromyalgia OR wheelchair OR 'surgical procedures' OR 'genera surgery' OR cancer OR dialysis OR pregnant OR injury OR HIV or Parkinson OR depression OR Cancer OR pregnant)

The search was then slightly modified again for Web of Science: TI=("social media" OR "social bookmarking" OR "social technology" OR "social technologies" OR (wikis OR wiki OR wikipedia) OR blog OR "social networking" OR YouTube OR (twitter OR tweet) OR "social networks" OR "social network" OR "online community" OR "online communities" OR Facebook OR myspace) AND TI=((weight loss OR weight maintenance OR weight regain)) NOT TS =(spinal OR paraplegia OR stroke OR athletes OR Alzheimer's OR fibromyalgia OR wheelchair OR "surgical procedures, operative” OR "general surgery" OR cancer OR dialysis OR pregnant OR injury OR HIV OR Parkinson OR depression OR Cancer OR pregnant)

Study Selection

Retrieved abstracts were independently assessed for inclusion in the review by two colleagues and coded as “yes”, “no” or “maybe.” All investigators who participated in eligibility assessments were trained regarding study inclusion/exclusion criteria. Disagreements regarding eligibility for inclusion were resolved via development of consensus among all investigators. The author (EW) reviewed eligibility assessments of the abstracts. Full text articles for abstracts coded as “yes” or “maybe” were retrieved and reviewed independently by two colleagues prior to inclusion in the review. An excel spread sheet was developed and used to track eligibility status.

Data Collection

Extracted data was entered into the University of Kansas secure, REDCap (Research Electronic Data Capture, Version 4.14.5) database (Harris et al., 2009). A REDCap data extraction form was developed and has been used in previous reviews completed by our group (Donnelly et al., 2014; Washburn et al., 2014; Washburn et al., 2014). Relevant data were extracted from each manuscript by the author. Data were extracted from each article, and included basic study information including sample size, groups compared, OSN platform, compliance with interventions, participant characteristics (age, sex, BMI, minority and health status), and results.

Risk of Bias in Individual Studies

Risk of bias for studies was independently evaluated using the Cochrane risk of bias tool (Higgins & Green, updated March 2011). Risk of bias was assessed in the following domains: selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias. Studies were not excluded on the basis of risk of bias. Additionally, the present review attempted to summarize the strength of the available scientific evidence underlying the relationship of OSN based interventions and health related outcomes using the following evidence scoring categories (Berkman et al., 2013):

1. *Evidence Level High:* Confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has few or no deficiencies. The findings are stable, i.e., another study would not change the conclusions.
2. *Evidence Level Moderate:* Moderately confident that the estimate of effect lies close to the true effect for this outcome. The body of evidence has some deficiencies. The findings are likely to be stable, but some doubt remains.
3. *Evidence Level Low:* Limited confidence that the estimate of effect lies close to the true effect for this outcome. The body of evidence has major or numerous deficiencies (or both). Additional evidence is needed before concluding either that the findings are stable or that the estimate of effect is close to the true effect.
4. Evidence Level Insufficient: No evidence, unable to estimate an effect, or no confidence in the estimate of effect for this outcome. No evidence is available or the body of evidence has unacceptable deficiencies, precluding reaching a conclusion.

Synthesis of Results

There was considerable heterogeneity across studies for several important parameters including: 1) participant characteristics (age, sex, BMI, health status), 2) version of OSN platform, and 3) duration of the weight loss period. Given this heterogeneity, a meta-analysis was considered inappropriate. Results based on the extracted data were instead synthesized and presented grouped by interventions (e.g. physical activity, diet, diet+physical activity)

SEARCH RESULTS

The initial database search identified 231 unique records, 210 of which were excluded based on review of title and abstract. Full-text articles for the remaining 21 citations were reviewed. Sixteen articles did not satisfy the inclusion criteria and were excluded, thus five articles were included in the review (Figure 1). One study focused only on physical activity (Valle, Tate,

Mayer, Allicock, & Cai, 2013), four studies on both diet and physical activity (Greene, Sacks, Piniewski, Kil, & Hahn, 2012; Napolitano, Hayes, Bennett, Ives, & Foster, 2013; Pagoto et al., 2015; Sepah, Jiang, & Peters, 2014) and only one of the five studies in this review reported on weight maintenance after weight loss (Sepah et al., 2014). None of the studies focused on only diet. Collectively, the studies involved 707 participants, 521 of whom received an intervention utilizing OSNs. Study and baseline participant characteristics are presented in Table 1.

Figure 1. Online Social Network Search Flow Diagram

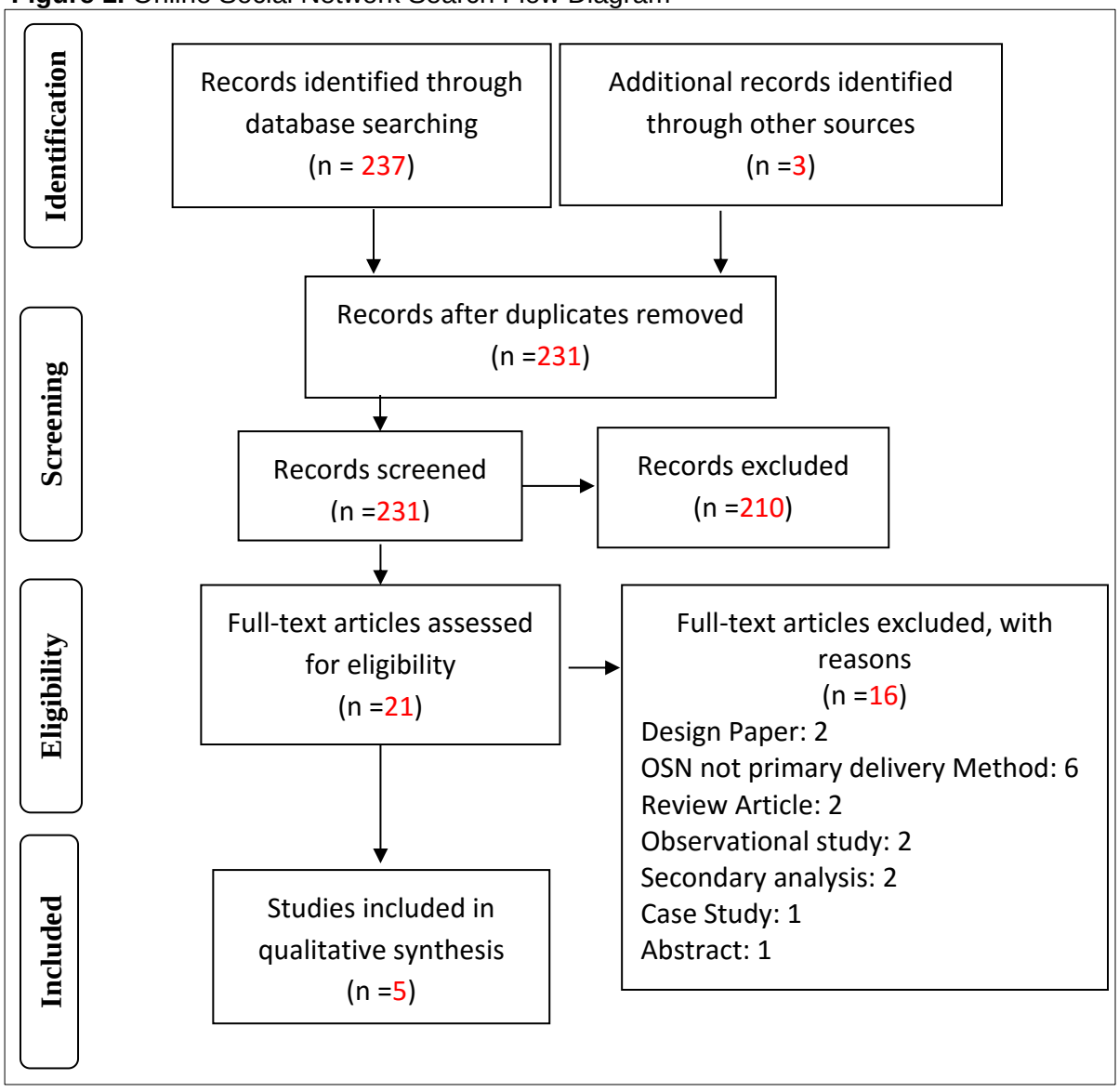

Table 1: Participant Baseline Characteristics

Reference	Intervention Groups	n	% Completion Rate	% Female	% Minority	Age (yrs.)	BMI (kg/m^2)	PA (min/wk.)	Health Status	Length weight loss	Length follow-up	Outcomes
PA Intervention												
Valle et al.	OSN: Self-help group	41	82.9	90.2	12.2	32.7 ± 4.2	29.1 ± 8.9	MVPA < 150	Previously diagnosed with cancer and had been in remission and completed treatment over 1 year ago. Participants could have no other medical conditions(s) or contraindications.	12 wks.	NA	Weight, BMI, PA
	OSN+Support	45	71.1	91.1	6.7	30.8 ± 5.7	28.4 ± 8.2					
PA+Diet												
Greene et al.	OSN Intervention	180	68.0	NR by group	NR by group.	NR by group.	NR	All PA = 2056	Healthy individuals	6 mos.	NA	Weight, triglycerides, LDL, HDL, PA
	Control	169	68.0	78.9	7.3	Range: 18-79		All PA = 1951				
Napolitano et al.	OSN	17	100	NR by group 86.5	NR by group 42.3	NR by group 20.5 ± 2.2	NR by group 31.36+-5.3	NR	Healthy individuals	8 wks.	NA	Weight, PA
	OSN+Support	18	88.9									
	Control	17	100									
Sepah et al.	Single group design: OSN Intervention	220	85	62.0	49.8	45.8 ± 9. 7	36.6 ± 7.5	NR	Self-reported diagnosis of prediabetes	16 wks.	12 mos.	Weight, HbA1C
Pagoto et al.	Single group design: OSN Intervention	12	100	92.0	25.0	43.6±12.4	34.1 ± 3.6	NR	Healthy individuals	12 wks.	NA	Weight

BMI: body mass index; OSN: online social network; PA: physical activity; LDL: low-density lipoproteins; HDL: high-density lipoproteins; MVPA: moderate-vigorous physical activity; NR: not reported

Physical Activity Interventions

Physical Activity Study Characteristics

Sample Size/Completion Rate: The sample size for the study using a physical activity intervention delivered using an OSN was 86. The proportion of randomized participants who completed the intervention and provided data for comparison was 77%.

Study Length: The length of the study was 12 weeks.

Intervention Components: Valle et al. (2013) randomized participants into an OSN: Self-help group or an OSN group facilitated by a HE (OSN+Support) with the primary aim to increase physical activity. An established publically available OSN platform (Facebook) was used. Both groups received weekly messages through the OSN that featured resources on physical activity, overcoming exercise barriers, goal setting, and social support. All participants also received a pedometer to self-monitor steps. The OSN+Support group received additional behavioral therapy materials as well as access to a separate online physical activity tracking site. HEs facilitated interaction with the OSN+Support group by posting discussion questions, links to videos, and weekly reminders.

Outcomes Assessed: In addition to weight, the study assessed changes in BMI, light physical activity, and moderate to vigorous physical activity.

Physical Activity Intervention Results

Physical Activity: Valle et al. (2013) reported a significant increase in moderate to vigorous physical activity (OSN: Self-help=46.3 min/wk.; OSN+Support=67.0 min/wk.), however, the between group difference was not statistically significant. Valle et al. (2013) reported a significant increase ($p < 0.05$) in light intensity physical activity in the OSN+Support group only.

Total physical activity significantly increased ($p < 0.05$) in both OSN groups, however there were no significant between group differences ($p > 0.05$). Additionally, the difference for change in physical activity between groups was not significant.

Body Weight: The mean weight loss was 0.1% for the OSN: Self-help group and 2.6% in the OSN+Support group. The weight change in the OSN+Support group was statistically significant ($p < 0.05$) from baseline to 12 weeks compared to no significant change over time in the OSN: self-help group. Weight change between groups was not significant.

BMI: The mean BMI modestly, yet significantly, decreased for the OSN+Support group (-0.6kg/m^2) while the OSN: Self-help group remained relativity unchanged (+0.01kg/m^2). BMI change between groups was not significant.

Chronic Disease Risk Factors: Valle et al. (2013) did not present data on any chronic disease risk factors

Diet and Physical Activity Interventions

Eighty percent of the studies selected for this review (n=4), included both diet and physical activity components (Greene et al., 2012; Napolitano et al., 2013; Pagoto et al., 2015; Sepah et al., 2014). Two studies compared weight loss between participants randomly assigned to an OSN intervention group/groups vs. a control group (Greene et al., 2012; Napolitano et al., 2013). One study was not randomized but provided data for both a weight loss and a self-guided weight maintenance intervention (Sepah et al., 2014). With the exception of the trial by Sepah et al (2014), who reported results from both efficacy and intent-to-treat analyses, all other randomized trials employed an efficacy approach.

Diet and Physical Activity Study Characteristics

Sample Size/Completion Rate: The range for sample size across the studies was 12-349. The range of participants who completed the intervention and provided data for weight loss was 68-100%.

Study Length: The range in intervention length of the studies was 8-24 weeks with one study conducting a follow-up after an eight-month maintenance intervention.

Intervention Components: Two of the four studies used an established publically available OSN platform (Facebook/Twitter) (Napolitano et al., 2013). Two other studies created a study-specific OSN accessible only by study participants (Greene et al., 2012; Sepah et al., 2014). These OSN allowed participants to connect ('friend") others in the network, send individual messages, make public group postings, view other group member's postings, and "like" comments of their peers to express social support and empathy.

Diet: All studies employed an energy restricted meal plan diet during the active intervention (Greene et al., 2012; Napolitano et al., 2013; Pagoto et al., 2015; Sepah et al., 2014). Only one study reported specific calorie goals given to participants (Napolitano et al., 2013).

Physical Activity: All studies provided exercise recommendations and encouraged participants to increase physical activity (Greene et al., 2012; Napolitano et al., 2013; Sepah et al., 2014). Two studies reported a specific exercise goal of gradually increasing moderate-vigorous physical activity to 150 minutes per week (Pagoto et al., 2015) and 250 minutes per week (Napolitano et al., 2013).

Self-Monitoring: One study provided both accelerometers and a wireless scale that had the capability to upload directly to the OSN for feedback (Greene et al., 2012). Sepah et al. (2014) supplied wireless scales that had capabilities to upload directly to the OSN and reported self-monitoring of physical activity and diet but did not specify the methods used to monitor these components (Sepah et al., 2014). Napolitano et al. (2013) randomized participants into two OSN groups. The first group had minimal contact with HE but received weekly podcasts, handouts, access to polls, and healthy activity events through the OSN. The second group received the same OSN content however they were given additional intervention targets (e.g. goal setting, self-monitoring), digital scale, and a pedometer to track steps as well as receiving personalized feedback from HEs through text messaging. Pagoto et al. (2015) required participants to have personal scales to qualify for the study. Self-reported weights were emailed to HEs and energy intake was report through a mobile app (MyFitnessPal).

Comparison Groups: Two of the three studies had randomized control groups (Greene et al., 2012; Napolitano et al., 2013). One study provided print materials to the control participants regarding sample meal plans, recommendations on serving sizes and physical activity, and information regarding the benefits of physical activity and healthy eating (Greene et al., 2012) while the other study had a no contact waitlist control (Napolitano et al., 2013). All other studies implemented a single group design (Pagoto et al., 2015; Sepah et al., 2014).

Outcomes Assessed: In addition to body weight, two of the four trials assessed physical activity levels via questionnaire (Greene et al., 2012; Napolitano et al., 2013), one study assessed HbA_{1C} (Sepah et al., 2014), and one study assessed triglycerides, low density lipoproteins (LDL), high-density lipoprotein (HDL) (Greene et al., 2012). One study with assessments after a long term maintenance period assessed HbA_{1C} (Sepah et al., 2014).

Diet and Physical Activity Intervention Results

Results for all studies diet and physical activity components are presented in Table 2.

Table 2: Comparison of change in weight, body composition, and chronic disease risk factors

Reference	Intervention Groups	Weight kg/%	BMI	Total Physical Activity (min/wk.)	Triglycerides	LDL	HDL	HbA_{1C}
Physical Activity								
Valle et al.	OSN: Self-help group	-0.1/-0.1^{NS}	+0.01^{NS}	76*	NA	NA	NA	NA
	OSN+Support	-2.1/-2.6*	-0.6*	237*	NA	NA	NA	NA
Physical Activity +Diet								
Greene et al.	OSN Intervention	-2.4/-2.8*	NA	+631^{NS}	+2.6^{NS}	+0.1^{NS}	-3.4^{NS}	NA
	Control	-0.7/-0.8^{NS}	NA	+298^{NS}	+6.1^{NS}	+4.2^{NS}	-3.0^{NS}	NA
Napolitano et al.	OSN	-0.63/NA^{NR}	NA	NS	NA	NA	NA	NA
	OSN+Support	-2.4kg/NA^{NR}	NA	NS	NA	NA	NA	NA
	Control	-0.24kg/NA^{NR}	NA	NS	NA	NA	NA	NA
Sepah et al.	Single group design:	WL: -5.0/-5.0*	NA	NA	NA	NA	NA	+0.03
	OSN+Support	WM: -4.9/-4.8*	NA	NA	NA	NA	NA	-0.37*
Pagoto et al.	Single group design: OSN+Support	-2.5/-3.0^{NR}	NA	NA	NA	NA	NA	NA

BMI: body mass index; OSN: online social network; LDL: low-density lipoproteins; HDL: high-density lipoproteins; NR: not reported; NA: not available; WM: weight maintenance; WL: weight loss

Body Weight: The range of weight loss for the four studies that provided both diet and physical activity components was -0.63 kg to -5.0 kg for the OSN intervention groups. Napolitano et al. (2013) reported significantly greater weight loss when OSN was supplemented with additional HE feedback (-2.4±2.5 kg) compared to a self-guided OSN group (-0.63±2.4kg) or a no treatment control (-0.24±2.6kg). Percent weight change was not reported and could not be calculated since baseline weight was not available. Greene et al. (2012) observed greater weight loss in the OSN intervention group (-2.4kg; 2.8%) compared to a no contact control group (0.73kg; 1.0%); however, these differences were not significant. Sepah et al. (2014) evaluated weight change following 16 weeks of active weight loss and a 12 month self-guided weight maintenance period. An intent-to-treat analysis indicated mean weight loss of 4.1% and 4.0% at 16 weeks and 12 months, respectively. Program engagement was strongly associated with weight loss. Weight loss (-5.6%) among participants who completed all lessons was significantly greater than weight loss (-3.2%) among participants who did not complete one or more lessons. Pagoto et al. reported a mean weight loss of 2.5 kg (3.0%). Clinically significant weight loss (i.e., ≥5% of baseline weight) was observed in 42% of the sample (5/12), 33% (4/12) lost < 5%, and 25% (3/12) gained weight (Pagoto et al., 2015).

BMI: No trial reported end study data for BMI.

Chronic Disease Risk Factors: Two of the four studies reported changes in chronic disease risk factors (Greene et al., 2012; Sepah et al., 2014). Greene et al. (2012) reported no significant between or within group differences for change in triglycerides, or for LDL, or HDL values. Sepah et al. (2014) reported no significant change in HbA_{1C} levels following completion of the weight loss intervention (16 weeks). At end of the maintenance intervention (12 months) the within group change from baseline in HbA_{1C} were statistically significant. Napolitano et al. (2013), and Pagoto et al. (Pagoto et al., 2015) did not report disease risk factors.

Physical Activity: Two of the four studies reported changes in physical activity levels (Greene et al., 2012; Napolitano et al., 2013). Napolitano et al. (2013) reported no significant between or within group differences for physical activity level. Greene et al. (2012) reported the OSN intervention group significantly increased their leisure time walking (+164%) compared to the control group (+47%) however there was no significant between or within group differences for time spent in all physical activity.

Risk of Bias

The risk of bias is presented in Table 3. Of the three studies that used randomized design (Greene et al., 2012; Napolitano et al., 2013; Valle et al., 2013) the description of the procedures for random sequence generation were unclear in two of the studies (67%) (Greene et al., 2012; Napolitano et al., 2013). One study adequately described randomization procedures and was considered low risk of bias (Valle et al., 2013). No trials described procedures for allocation concealment. The blinding of participants and personnel is difficult in a study comparing delivery methods. While blinding of personnel performing outcome assessments is feasible, these procedures were not employed in any of the randomized studies (Greene et al., 2012; Napolitano et al., 2013; Valle et al., 2013) and is not feasible in studies using a single group design (Pagoto et al., 2015; Sepah et al., 2014). The risk of attrition bias was high in one trial where the study sample represented approximately 68% of those randomized at baseline (Greene et al., 2012). The most important other source of potential bias was inadequate statistical power. None of the studies included in this review (Greene et al., 2012; Napolitano et al., 2013; Pagoto et al., 2015; Sepah et al., 2014; Valle et al., 2013) reported adequate statistical power to detect between group differences for change in body weight.

Table 3: Study Risk of Bias

Reference	Random Sequence Generation (selection bias)	Allocation concealment (selection bias)	Blinding participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Physical Activity							
Valle et al.	Low Risk	NR	NA	NR	High Risk	Low Risk	Unclear
Physical Activity+Diet							
Greene et al.	Unclear	NR	NA	NR	High Risk	High Risk	Unclear
Napolitano et al.	Unclear	NR	NA	NR	High Risk	NA	Unclear
Sepah et al.	NA	NA	NA	NA	High Risk	Low Risk	Unclear
Pagoto et al.	NA	NA	NA	NA	Low Risk	Low Risk	Unclear

NA: Not Applicable. NR: Not Reported

DISCUSSION

Summary of Evidence

This paper provides a systematic review of five studies, which employed non-randomized and randomized study designs to address the question: Do weight management interventions delivered by OSNs effectively improve body weight, body composition, and chronic disease risk factors? As in previous reviews (Ashrafian et al., 2014; Chang et al., 2013; Maher et al., 2014), the literature search identified multiple internet-based behavioral studies that have utilized components of OSNs such as bulletin boards or chat rooms; however, the OSN was not the primary delivery method. Instead these components were used as add-ins or optional tools in the intervention so these studies were excluded. Based on this review, the literature on the effectiveness of weight management interventions delivered through OSNs is extremely limited. Thus, conclusions regarding the effectiveness of this weight management approach are currently not possible, and will require additional trials.

Although limited, available results suggest the potential for weight management delivered using OSNs. For example, weight loss, although modest, was statistically significant ($p < 0.05$) in the OSN groups independent of intervention length in all five studies included in this review. Both participant compliance in completing study modules, and interaction with the HE, appear to be associated with improved weight loss with an OSN intervention. For instance, both Napolitano et al. (2013) and Valle et al. (2013) reported participation of trained HEs, who provided professional advice and feedback, resulted in superior intervention effects compared to those who received a self-guided OSN intervention. Thus, OSN interventions may decrease the burden on healthcare staff conducting weight loss interventions; however, staff involvement appears to be an important component for success. In addition to weight loss, significant changes ($p < 0.05$) in physical activity were reported in the OSN arms in two of the three studies providing data on this outcome. However, physical activity in these studies was measured by

self-report questionnaire, and not in an objective manner. Thus, the physical activity results should be interpreted cautiously. Our review identified two studies that compared changes in chronic disease risk factors (Greene et al., 2012; Sepah et al., 2014). Greene et al. showed no beneficial changes in triglyceride, HDL, and LDL levels between individuals in the OSN group compared to controls (Greene et al., 2012). These results are most likely attributed to the minimal weight loss (-2.8%) in the OSN group. Although weight loss was relatively unchanged between weight loss (16 weeks; -5.0%) and weight maintenance (12 months; -4.8%), Sepah et al. observed no significant decrease in HbA_{1C}, levels following active weight loss; however, levels significantly decrease at end of weight maintenance intervention (Sepah et al., 2014). No studies were found that measured body composition or other chronic disease risk factors (e.g. blood pressure, waist circumference, insulin, glucose).

It has been hypothesized that OSNs, with their ability to reach large numbers of individuals, would provide a potentially cost-effective strategy for weight management. However, to date, the cost-effectiveness and feasibility of using OSN interventions in clinical weight management has not been evaluated.

Limitations in the Available Literature

Several important limitations in the literature were identified resulting in an Evidence Level of Low relative to addressing the primary question regarding OSNs interventions impact on body weight, body composition and chronic disease risk factors. First, the literature is limited by a lack of studies that have addressed this question. This review identified only five studies that satisfied inclusion criteria (Greene et al., 2012; Napolitano et al., 2013; Pagoto et al., 2015; Sepah et al., 2014; Valle et al., 2013). Second, the studies included in this review were of short duration (< six months) and were not statically powered to address the question of interest. Only one study had an active weight loss period of at least six months (Greene et al., 2012).

Additionally, only Sepah et al. (2014) reported any type of weight maintenance/follow-up results. Third, adherence to diet and physical activity recommendations, changes in caloric intake, or objectively measured changes in physical activity were not reported in any study. Fourth, there was a variety of OSNs utilized by each study, so no conclusions on effectiveness of individual OSN platform type can be concluded from this review. Examination of these factors would provide needed insight into whether or not OSN interventions produce measurable behavioral changes. Finally, no study has assessed the cost effectiveness of OSN interventions. As cost saving is the main appeal to using OSNs, a formal cost-analysis is important.

Limitations of This Review

These conclusions should be cautiously interpreted as they are based on data from a limited number of studies. In addition, authors were not contacted to obtain missing data or for clarification of any information presented in the published reports; therefore missing information may reflect reporting bias as opposed to any limitations in the conduct of the study.

Conclusions

The use of OSNs for weight management is in the early stages of development and evaluation. Although the results from the studies reviewed show promise for the OSN approach, more research is needed to acquire additional information regarding methods for optimizing and increasing the effectiveness of weight management delivered using OSNs. As previously discussed, the available literature on this topic is extremely limited and suffers numerous methodological shortcomings. Therefore, randomized trials to specifically evaluate the efficacy of OSN interventions on weight loss and chronic disease risk factors that include the following: 1) adequate statistical power to detect clinically significant differences, 2) assessment of measures such as caloric intake and physical activity using objective methods, 3) evaluation of

the cost-effectiveness, and 4) evaluation of the impact of participant characteristics (age, gender, BMI, race/ethnicity) are recommended.

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Distance Learning Strategies for Weight Management Utilizing Online Social Networks: Rationale and Design for a Randomized Study

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Abstract

Management of obesity in the context of the primary care physician visit is of limited efficacy, in part, because of limited ability to engage participants in sustained behavior change between physician visits. Therefore, healthcare systems must find methods to address obesity that reach beyond the “walls” of clinics and hospitals to provide lifestyle modification in a cost-conscious way. The dramatic increase in technology and online social networks may present healthcare providers with innovative ways to deliver weight management programs that could have an impact on health care at the population level. A randomized study was conducted on 70 obese adults (BMI 30.0-45.0 kg/m^2) to determine if weight loss (six months) was not significantly different between weight management interventions utilizing behavioral strategies by either a conference call or online social network approach. The primary outcome, body weight, was assessed at baseline and six months. Secondary outcomes including waist circumference, blood pressure, energy and macronutrient intake, and physical activity were assessed on the same schedule. In addition, a cost analysis and process evaluation was completed.

Keywords Online Social Network; Phone, Obesity; Methods; Distance Learning

INTRODUCTION

Approximately 69% of U.S. adults are classified as overweight or obese (BMI >25) (Ogden & Statistics, 2012). Obesity is associated with significant co-morbidity; it is estimated that for every one-point increase in body mass index (BMI), health care costs increase by 8% (Algazy, Gipstein, Riahi, & Tryon, 2009) and the estimated cost of obesity in the U.S. was $147 billion in 2008 (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Current clinical guidelines recommend behaviorally based programs, which include energy restriction and physical activity to produce clinically relevant weight loss of 5% or more of total body weight (Dietz et al., 2015; Donnelly et al., 2009; Jensen et al., 2014; Meckling, O'Sullivan, & Saari, 2004; Racette, Schoeller, Kushner, Neil, & Herling-Iaffaldano, 1994; Raynor & Champagne, 2016). Management of obesity in the context of the primary care physician visit is of limited efficacy (1.4 - 2.5kg weight loss at six months) (Wadden et al., 2013), in part because of limited ability to engage participants in sustained behavior change between physician visits. Furthermore, numerous barriers prevent individuals from participating in weight management programs, including (but not limited to) cost, transportation, time, family, and job commitments. These same barriers are frequently cited as reasons why individuals who do participate subsequently drop-out of treatment. Therefore, healthcare systems must find methods to address obesity that reach beyond the walls of clinics and hospitals and address the issues of lifestyle modification in a cost-conscious way.

Alternative strategies to deliver weight management programs have produced promising results. Delivery of weight management services through over-the-phone group visits with a health educator following a social cognitive theory-based curriculum on diet, exercise, and healthy lifestyle across 18 months has been shown to produce equivalent weight loss with significantly lower costs compared to traditional face to face delivery. (Donnelly et al., 2013). Over the past decade the use of internet-delivered health care/health behavior change interventions, including

weight management, has greatly expanded. With the increase in technology and online social networks (OSNs) individuals have started to pursue information, share experiences, ask questions and provide support to peers about health online (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004; Jayanti & Singh, 2010; Turner, Grube, & Meyers, 2001). OSNs may present healthcare providers with an innovative way to deliver weight management programs that could have an impact on health care at the population level by minimizing barriers such as cost, time to deliver materials, and access to hard-to-reach populations as 70% of all households in the United States report internet use and this will only increase in the future (File, 2013). Several short-term studies have shown that incorporating OSNs into weight loss interventions have led to favorable weight loss outcomes (Napolitano, Hayes, Bennett, Ives, & Foster, 2013; Turner-McGrievy & Tate, 2013; Valle, Tate, Mayer, Allicock, & Cai, 2013). Using OSN to produce health behavior change is in its early stages of development and, while several studies show promise, more research is needed to acquire information about optimizing these interventions to increase their efficacy.

MATERIALS AND METHODS

Overview of Study Design

The purpose of this feasibility study was to compare weight loss between an established cost effective weight management delivery system (group conference call) and OSN (Facebook©) delivered weight management intervention. Seventy obese men and women were randomly assigned to a six month weight loss program that was delivered by group conference call (n=34) or OSN (n=36). The behaviorally-based conference call group was considered the reference treatment in this study because this method has been shown to produce clinically significant weight loss while reducing barriers and cost (Donnelly et al., 2013). Behavioral group meetings for both the conference call and OSN groups were conducted weekly. Outcomes were assessed at baseline and at six months. Similar and clinically meaningful (≥5%) weight loss in both groups

was expected. Change in weight was selected as the primary outcome. Secondary outcomes include waist circumference as an indication of reduction in chronic disease risk, and measures of dietary intake and physical activity to help explain both group and individual differences in weight change. A cost analysis and extensive process evaluation was also completed. Approval for this study was obtained from the Human Subjects Committee at the University of Kansas Medical Center.

Participant Eligibility

To improve the generalizability of the results, individuals with chronic medical conditions were allowed to participate because they represent the population of individuals typically seeking weight management. For instance, individuals with hypertension or type 2 diabetes were not automatically excluded if their condition was controlled by medication. *Inclusion criteria:* 1) Age 21 to 70 years. This age range was chosen as weight management for young or older individuals typically employs different behavioral strategies. 2) Body mass index (BMI) of 30 to 45 kg/m^2. The sample is restricted to this BMI range because individuals with a BMI greater than 30 kg/m^2 are at a higher risk and weight loss would have the greatest cost savings (Cawley, Meyerhoefer, Biener, Hammer, & Wintfeld, 2015; Dietz et al., 2015; Jensen et al., 2014), and individuals with a BMI >45 kg/m^2 require more aggressive weight loss interventions than proposed (e.g., surgery or medication) (Jensen et al., 2014). 3) Have access to a computer, smart phone, or tablet with access to wireless internet or cellular data. The Fitbit activity tracker and wireless scale, which were provided to participants, require wireless internet or cellular data for real time data transferring. *Exclusion criteria:* 1) Unable to participate in moderate intensity physical activity (i.e., walking). 2) Participation in a weight loss or physical activity program in the previous six months as these proximal experiences may impact the results of this study. 3) Greater than 3, 30-min bouts of planned exercise/week. 4) Not weight stable ($\pm$4.6 kg) for 3 months prior to intake. 5) Unwilling to be randomized to one of the two study groups. 6) Report

being pregnant during the previous six months currently lactating, or planned pregnancy in the following six months 7) Serious medical risk such as cancer, recent cardiac event (i.e. heart attack, stroke, angioplasty) in the previous six months as determined by the study's medical director. 8) Current use of antipsychotics or untreated depression. Care of individuals with complex psychiatric illness can be challenging due to balancing medication side effects and is outside the scope of this study. 9) Adherence to specialized diet regimens, e.g., multiple food allergies, vegan, macrobiotic. 10) At risk for disordered eating assessed by the Binge Eating Scale (Gormally, Black, Daston, & Rardin, 1982) and Eating Attitudes Test (Garner, Olmsted, Bohr, & Garfinkel, 1982). Individuals with a Binge Eating Scale score ≥ 27 or an Eating Attitudes Test score > 20 or reporting uncontrollable eating binges (previous six months), made themselves sick to control weight (previous six months), used medications for weight loss (previous six months), past treatment for eating disorder, or recently thought of or attempted suicide were excluded from the study. 11) Lack of access to a grocery store. These individuals would not have the ability to make food choices on their own thus would not be able to follow the diet protocol.

Recruitment/Randomization

Participants were recruited using university broadcast emails, flyers, and the General Medicine Clinic at the University of Kansas Medical Center. Potential participants were asked to contact study staff via phone or email. Interested individuals were directed to complete an initial eligibility questionnaire through Research Electronic Data Capture (REDCap) version 6.4.4 hosted at The University of Kansas Medical Center (Harris et al., 2009). Participants provided self-reported height and weight (BMI), medication use, previous attempts at weight loss, presence of chronic disease, current physical activity level, and special diet restrictions. Those satisfying the initial eligibility criteria were invited to an orientation session where the procedures were explained, the risks and benefits outlined, the commitments of the participants and

investigators explained, and all questions answered prior to obtaining written informed consent. Those who chose to participate were directed to fill out all the remaining screening surveys including a brief health history, eating attitudes (Garner et al., 1982), binge eating scale (Gormally et al., 1982), Global Physical Activity Questionnaire (Armstrong & Bull, 2006), and the Revised Center for Epidemiologic Studies Depression Scale (Eaton, Smith, Ybarra, Muntaner, & Tien, 2004) on REDCap. Eligible participants were enrolled in the study and randomized in 1:1 ratio to the phone or OSN group stratified by sex. After randomization participants were scheduled to attend a separate 45-minute testing appointment for collection of baseline measures by research assistants.

Intervention-Conceptual framework.

This feasibility study compared two approaches for the delivery of a behavioral weight management intervention (conference call and OSN) for weight loss. Similar to many current weight management programs, the intervention is grounded in social cognitive theory, problem-solving theory, and the relapse prevention model (Bandura, 1977, 2004; Marlatt & Gordon, 1985; Prochaska & Marcus, 1998; Prochaska et al., 1994). Key elements incorporated in both the phone and OSN interventions include: goal-setting, self-monitoring, direct reinforcement, interaction with health educators, and social support.

Standardized materials

To ensure that similar content is presented in both the conference call and OSN groups, all participants received identical lessons that provided a basic outline for the intervention. Therefore, the diets and physical activity protocols, behavioral lesson topics, experiential learning assignments and attention, (i.e. meeting and assessment schedules), were identical for both groups. The lessons included detailed instructions for weight loss including behavioral strategies, diet instructions, recipes, and guidelines for physical activity. The lessons were

organized by clinic session and contain handouts, worksheets, and assignments specific to each topic. The lessons also provided general information and guidelines for conduct and participation in the program. An outline of topics discussed by week are listed in Table 1.

Table 1: Outline of Weekly Intervention Topics

WEEK	TOPIC
1	Orientation to program Introduction to diet
2	Picking Healthy Food Items
3	Diet Review & Benefits of Exercise
4	Goals and Values
5	Food Labels – Your Tools to Healthy Eating
6	Exercise 101
7	Portion Distortion
8	Fruits and Vegetables
9	Healthy Cooking Tips and Techniques
10	Meal Planning
11	Surviving Social Situations
12	Warm-ups/Cooldowns & Injury Prevention
13	Eating Out & Snacking on the Go!
14	Antecedents, Behaviors, & Consequences
15	Frequency, Intensity, Time and Type of Exercise
16	Metabolism & Energy Expenditure
17	Energy Density
18	Mental Traps & Mindful Thinking
19	Fad Diets
20	Making Exercise a Habit
21	Knowing your Health Numbers
22	Exercise: The Biggest Predictor of Weight
23	Maintaining Motivation
24	Relapse Prevention

Diet - Weight Loss (months 0-6)

For participants in both the phone and OSN groups, total daily energy expenditure was estimated using the equation of Mifflin-St Jeor (1990) with an activity factor for sedentary/low active individuals of 1.15. Energy intake was reduced 500-700 kcal/d below the calculated estimated total daily energy expenditure. Participants were asked to consume a nutritionally balanced, reduced energy, high volume, lower fat (fat=20% energy) diet as recommended by the Academy of Nutrition and Dietetics (Cummings, Parham, & Strain, 2002) and the USDA's

MyPlate approach (U.S. Department of Agriculture, 2013). Participants were provided examples of meal plans consisting of suggested servings of grains, proteins, fruits, vegetables, dairy, and fats based on their energy needs and were counseled on appropriate portion sizes.

Physical Activity (months 0-6)

Participants in both the phone and OSN groups were prescribed a progressive moderate intensity physical activity program (walking, jogging, biking etc.) as recommended in the "2009 ACSM Position Stand on Physical Activity Interventions for Weight Loss and Prevention of Weight Regain in Adults,"(Donnelly et al., 2009). Physical activity progressed from 45 min/wk. in month one to 300 min/wk. at month four, and remain at 300 min/wk. for the duration of the study (Table 2). Fitbit wireless activity monitors were provided as a motivational tool, to track steps over the six months and as incentive to participation in the intervention.

Table 2: Exercise Progression

Week	Days per Week	Minutes per Day	Total for Week
1	3	15	**45**
2	3	20	**60**
3	4	20	**80**
4	4	25	**100**
5	4	30	**120**
6	5	25	**125**
7	5	30	**150**
8	5	40	**200**
9	5	45	**225**
10	5	50	**250**
11 and on	5	60	**300**

Health Educators

The potential for health educator bias was minimized by randomly assigning health educators to administer one conference call and one OSN group congruently to eliminate potential between-

group differences due to the health educator. Health educators had backgrounds in nutrition, exercise physiology, or behavioral counseling. The content of 20% of the recorded sessions were compared with a checklist of required content. Health educators failing to deliver ≥ 80% of the required content received additional training to assure standardized delivery of the two interventions.

Self-Monitoring

Self-monitoring is an important predictor of adherence and treatment outcomes in weight management. Therefore, participants in both the phone and OSN groups was asked to monitor body weight, diet/food consumed, minutes of exercise, steps, and completion of homework assignments. Diet: Participants logged all food and beverages consumed (meals/snacks) using the MyFitnessPal™ application. A MyFitnessPal™ account for each participant, with customized energy intake goals (see Diet above) was created. Participants logged all food and beverages consumed by entering the food name and selecting the portion size or by scanning the bar code of the food item using a smart phone. As a food was entered a bar showing the recommended dietary intake goal for each participant was displayed, which provided immediate feedback of how much food participants had consumed during the day and how much more or less they should consume. Physical activity: Participants wore a Fitbit Flex (Model: Flex tracker, Fitbit Inc. San Francisco, CA, size 35.5 x 28 mm) wireless activity tracker on their wrist. The Fitbit recorded time spent in moderate or vigorous physical activity that was automatically transferred to the MyFitnessPal™ application via Bluetooth connectivity when the device was near the smart phone or computer, thus eliminating the need for manual data recording. The MyFitnessPal™ application provided immediate feedback on a participant's accumulated physical activity relative to their goal via a graphic display. If a participant engaged in physical activity that could not be recorded by the Fitbit (e.g. biking), they logged the activity in the MyFitnessPal™ application and recorded the information. Reminders: The MyFitnessPal™

application allowed reminders to be programed to prompt participants to record their self-monitoring physical activity/diet data. Reminders were sent only if no information was reported for a given meal (e.g., breakfast, lunch, dinner) or goal (i.e., exercise time, steps, weight).
Weight: Participants' body weight was obtained weekly to provide feedback regarding weight loss/gain over the course of the trial. Participants self-weighed prior to each behavioral session using a calibrated wireless digital scale (Model: Withings Wireless Scale, WITHINGS, Inc. Cambridge, MA), which automatically synced with the MyFitnessPal™ application and updated a visual display of weight change.

Phone Conference Intervention

During baseline assessments participants randomized to the phone group were provided with written information explaining the basic logistics of the conference calls, which were conducted using the Maestro conferencing system (Oakland, CA). During the six months weight loss intervention conference calls were held once a week lasting approximately 60 minutes. Participants were asked to dial a toll-free number five minutes prior to the scheduled meeting time and then enter a unique identifying code number that allows them to "enter" the meeting. In the interest of safety, participants were asked to not call in situations where their attention is compromised, such as while driving or operating machinery. Specific procedures relative to the conduct of the conference call, such as how to request to speak, courtesy to group members, reporting data, and confidentiality were discussed during the first phone session. Each session included a check-in question to generate discussion regarding diet and physical activity, a review of compliance with the diet and physical activity protocols, a lesson on a weight management topic, and an experiential learning assignment that requires problem solving or the practice of behavioral weight management strategies to be completed prior to the next meeting. For example, assignments may include grocery shopping/meal planning to meet specific caloric or nutritional guidelines, eating in social situations or during holidays, food label reading, or

trying a new form of physical activity. Assignments were discussed at the subsequent meeting, and the health educator provided feedback.

OSN Behavioral Clinic

Participants randomized to the OSN group for weight loss were asked to join a private OSN group using their personal OSN accounts. The weight loss program was structured into online modules presented through the private OSN group of 12-18 individuals. Modules were one-week in length (i.e. module week of Monday through Sunday) for six months. Participants received contact information for study personnel, instructions and guidelines for appropriate online posting and discussion, detailed descriptions of the diet and physical activity prescriptions, instruction on how to track energy intake, F/V intake and physical activity on a daily basis, and handouts/worksheets/assignments specific to each meeting. In addition, each lesson included assignments and discussion forums that each participant must complete and submit to the OSN discussion board by the due date. As previously described, the meeting content was identical for both the phone and OSN groups. However, the OSN and phone conference interventions differ in several important aspects. OSN allowed for both lessons and audio recordings to be posted and accessed at any time by the participants, which is not possible on the phone conference call. Participants in the OSN group had access to materials 24 hours a day seven days a week and are able to work at a rate that is comfortable for them within the program guidelines. Participants who are subscribed to the group received a notification any time someone submitted a message and was able to comment or like the original post.

OUTCOME ASSESSMENTS

With the exception of physical activity, which was assessed by accelerometry during free-living activity, outcome data for both intervention groups was collected in the Center for Physical

Activity and Weight Management laboratory by trained staff at baseline and following weight loss (six months). At baseline assessments participants received the Fitbit physical activity tracking device, wireless scale, and a 30-minute orientation on how to use each device.

Anthropometrics (weight, height, and waist circumference)

Anthropometric assessments were obtained between the hours of 6:00 and 10:00 AM prior to breakfast and after attempting to void. Participants were weighed wearing shorts and a t-shirt using a digital scale accurate to ± 0.1 kg (Befour Inc. Model #PS6600, Saukville, WI). Height was measured using a stadiometer (Model PE-WM-60-84, Perspective Enterprises, Portage MI) and body mass index (kg/m^2) was calculated. Waist circumference, a measure used as a surrogate for abdominal adiposity, was measured using the procedures of Lohman et al. (1988). Three measurements were obtained and the average of the two closest measurements were used for analysis.

Energy and Macronutrient Intake

Baseline and end study (six months) energy and macronutrient intake was assessed using energy intake and macronutrient data obtained from the MyFitnessPal application for three days (two weekdays, one weekend day) prior to their scheduled clinic visit to identify dietary habits.

Physical Activity

Participants wore an ActiGraph GT1X portable accelerometer (ActiGraph LLC, Pensacola, FL) on a belt over the non-dominant hip for seven consecutive days at each assessment time point. Matthews et al. (2002) have shown that a seven day monitoring period provides measures of both physical activity and inactivity with a reliability of 90%. Accelerometer data was collected in one minute epochs with a minimum of ten hours constituting a valid monitored day. Day one of the seven day monitoring period began on the day following baseline data collection. At the completion of the seven day period, participants returned the ActiGraph accelerometer using a

padded postage-paid envelope provided by the investigators. The main outcome variable was the average ActiGraph counts/min over the seven day period. In addition, the average number of minutes/day over seven days spent at various activity levels was assessed using the cut-points used in the National Health and Nutrition Examination Survey as described by Troiano et al. (2008). A SAS data reduction program was used to complete the analyses described.

Questionnaires

Participants completed the Health Related Quality of life short form health survey [SF-36; α = 0.67 - 0.94] (Ware Jr & Sherbourne, 1992) and the Quality of life changes related to weight was assessed using the SHIELD-WQ-9 questionnaire (Grandy, Hashemi, Langkilde, Parikh, & David Sjostrom, 2014). Mediators of diet and physical activity change was assessed using the weight efficacy lifestyle questionnaire [α = 0.70 to 0.90 over the 5 domains] (Clark, Abrams, Niaura, Eaton, & Rossi, 1991), exercise self-efficacy scale [α = 0.92] (McAuley, 1993), barriers-specific self-efficacy scale [α = 0.89] (McAuley, 1992), and the physical activity self-regulation questionnaire [α = 0.79 – 0.94] (Michelle Renee Umstattd, Motl, Wilcox, Saunders, & Watford, 2009; Michelle Rene Umstattd, Wilcox, Saunders, Watkins, & Dowda, 2008). Changes in social support and OSN were assessed using the interpersonal self-evaluation list-12 [α = 0.80] (Cohen & Hoberman, 1983; Pittsburgh Mind Body Center, 2008) and the social network index [Test-Retest Reliability = 0.92; p<. 01] (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997).

Analysis Plan- Manuscript 1

Primary Outcomes. The primary goal of this feasibility trial was to evaluate weight loss achieved at six months with an intervention delivered by conference call compared to one delivered using OSN. Sample demographics and all outcome measures were summarized by descriptive statistics; means and standard deviations for continuous variables and frequencies and percentages for categorical variables. A two sample t-test was used to compare weight loss

from baseline to six months between groups randomized to conference call and OSN delivery. An intent-to-treat analysis for the primary comparison was used. All statistical analyses were conducted using SAS versions 9.4 or higher with a type 1 error rate of 5%.

Cost Analysis. A two-sample t-test were used to compare average costs for participants, providers, and the totals for the conference call and OSN groups. If adjustments for demographics were needed despite the randomization, the t-test was part of a regression model. This assumes that the OSN group has equal or better weight loss outcomes. If not, Wilan's (2006) approach to estimate the cost-effectiveness acceptability curve was used. For participants, the costs was primarily be time costs, but data on incidental costs was collected. Provider costs included personnel, communications, supply, and equipment costs. Total costs was the sum participant and provider costs.

A potential advantage to delivery of weight management by OSN may be lower fixed and variable costs for both participants and providers. Fixed costs are independent of the number of individuals participating while variable costs are directly associated with the number of participants enrolled (McLean, 1997). Costs depend on the resources used and the prices of those resources, and valid cost analyses are based on a clear understanding of the actual process being evaluated (Lee et al., 2003; McLaughlin & Kaluzny, 1999). Information about resource use was obtained by conducting structured interviews with providers (i.e. investigators/health educators) and survey of participants in the group conference call and OSN groups.

The cost of the conference line (Maestro) used to conduct the interventions was determined based on the monthly bill received from the company. The costs of provider time (i.e.

wages/benefits) was estimated as the number of hours worked obtained from provider maintained logs, multiplied by the provider's wage.

The cost of participant time associated attendance to the phone meetings was estimated from self-report of time spent in these activities multiplied by the median wage in the region.

Analysis Plan – Manuscript 2

The primary aim was to assess if participant characteristics, self-efficacy, self-regulation and self-monitoring (i.e. number of reports, number of reports within calorie range, physical activity) contributed to or detracted from intervention effects at baseline and six month in both the conference call and OSN groups. Best-subsets analysis was used to examine the impact of these variables to identify variables that explain weight loss at six months. Main effects by treatment were examined.

To compare the level of participation across the intervention groups, health educators recorded the following information over the course of the six month intervention collected from phone conference call or OSN group: 1) percent of weekly records submitted on MyFitnessPal™; 2) percent of diet records submitted on MyFitnessPal™ within + or - 100 kcals of the participants prescribed calorie goal; 3) physical activity (minutes and steps) each week collected by the Fitbit device; 4) the number of weights recorded with the wireless scale; and 5) attendance at scheduled meetings/OSN posts made.

DISCUSSION

There is a need for the development and evaluation of effective alternative strategies for producing weight loss that diminish or eliminate barriers and/or enhance approaches to behavioral weight loss interventions. The internet has become a popular platform for delivering

behavioral, health-related interventions as they may offer a cost-effective alternative to traditional interventions, with the potential to reach large numbers of individuals while reducing barriers to participation (e.g. travel, child care costs etc.). The dramatic growth in technology and OSN (i.e. Facebook©) has generated recent interest in OSN-based strategies as a delivery medium of health behavior change campaigns. OSN delivered programs have potential to be a cost effective approach by potentially lowering providers fixed costs to reach a large groups of individuals. Using OSN to produce health behavior change is in its early stages of development and while several studies show promise, more research is needed to acquire information about optimizing these interventions to increase their efficacy.

This paper describes the rationale and design for a randomized preliminary study to compare a behavioral weight loss intervention (six months) delivered by group phone conference call or OSN. Several conceptual aspects of intervention delivery through OSN suggest that this approach may be effective for weight loss. Behavior change in OSN is reinforced by social group support and distance learning strategies that continue to remove the time commitment barrier to delivery of weight loss interventions. The OSN learning environment allows for unlimited access to intervention materials that can be completed at a work rate that is comfortable for the individual and the ability for constant group feedback. For example, in OSN participants can post about their success and struggles with the intervention at any time during the day through the private group page.

Strengths of this study include: 1) A design specific to evaluating two potentially effective strategies for the delivery of a weight loss intervention. 2) Both technologies evaluated are readily available and accessible. Phone use is ubiquitous in the US and 70% of Americans over the age of 18 have high-speed internet in their homes (File, 2013) as well as 74% of adults report using OSN (Sheet, 2014).Thus, if successful, the interventions could be widely

disseminated. 3) Phone comparison group is a proven technology. Phone delivery of weight management has been previously shown to produce equal and significant weight loss compared to traditional face-to-face intervention with reduced cost and time burdens (Donnelly et al., 2013). 4) Inclusion of both cost and process analyses. While lower cost of delivery is commonly cited as a benefit to OSN delivered interventions to date the literature lacks a formal cost analysis for OSN interventions.

This study is not without its limitations. The purpose of this study is to inform future larger scale adequately powered trials. Due to funding and supply restraints limitations include: 1) sample size is relatively small and was not powered to detect between group differences, 2) lack of a weight maintenance follow-up period, 3) inability to blind health educators to treatment condition, and 4) potential differences in motivation to lose weight between participants who agree to participate in a research study and the general public.

Overall, the dramatic increase in technology and popularity of OSN has presented healthcare providers an innovative way to deliver weight management programs. This study provides an alternative technique, using distance learning strategies and readily available technology, to deliver weight management interventions.

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Distance Learning Strategies for Weight Management Utilizing Online Social Networks versus Group Phone Conference Call

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Abstract

Introduction: The increase in technology and online social networks (OSNs) may present healthcare providers with an innovative way to deliver weight management programs that could have an impact on health care at the population level. The objective of this study was to evaluate the feasibility and efficacy of using an OSN to deliver a weight loss program to inform future, large scale trials. ***Methods:*** Seventy obese individuals (age=47±12.4, minority=24.3%; BMI=36.2±4.0) completed a six month weight loss intervention and were randomized to either a conference call or OSN delivery group. Weight loss was achieved by reducing energy intake by 500-700 kcal/day below estimated total daily energy expenditure and physical activity that progressed to 300 minutes/week. Behavioral weight loss strategies were delivered weekly throughout the intervention. ***Results:*** Conference call and OSN groups produced clinically meaningful weight loss of ≥5% from baseline to six months (phone=-6.3±6.4%, OSN=-5.8±6.7%). There was no significant difference in weight change between groups (p=0.765). ***Conclusion:*** The phone and OSN groups met American Heart Association/American College of Cardiology/The Obesity Society's Guidelines by reducing baseline weight by 5-10% within six months. OSNs appear to be a viable delivery platform for weight loss interventions, however, larger scale adequately powered trials are needed.

Keywords: Online Social Networks, Weight Loss, Behavioral Intervention

INTRODUCTION

Online social networks (OSNs) such as Facebook© or Twitter© provide a platform where individuals can create public or semi-public profiles, connect ("friend") with other users, interact and obtain information, within a bounded system (Ellison, 2007). Furthermore, OSNs support the upload of files, photos, and audio recordings that can be accessed by only individuals in one's network or by anyone signed into the OSN. A recent Pew survey on internet use reported 84% of adults in the US are online with 74% reporting use of OSNs (Sheet, 2014). The popularity of OSNs suggests their potential as a platform for the delivery of health behavior change interventions, such as weight management, to large groups of individuals in a cost efficient manner. With the high prevalence of obesity in US adults (Ogden & Statistics, 2012) and obesity contributing to many comorbidities such as heart disease, hypertension, diabetes, and some cancers as well as psychosocial and economic difficulties (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993; Mokdad et al., 2003; Must et al., 1999), developing innovative methods to translate and deliver weight management interventions in diverse real-world settings is critical. Several alternatives to traditional face-to-face group delivery of weight management interventions including mail or email (Tate, Jackvony, & Wing, 2006; van Wier et al., 2009), internet (Krukowski, Tilford, Harvey-Berino, & West, 2011; Manzoni, Pagnini, Corti, Molinari, & Castelnuovo, 2011), a combination of phone, internet and email (Appel et al., 2011), individual phone counseling (Neve, Morgan, & Collins, 2011; Sherwood et al., 2011), group phone counseling (Donnelly et al., 2013), and text messaging (Patrick et al., 2009), have demonstrated clinically meaningful weight loss (Jensen et al., 2014). However, there is limited research on behavioral weight loss interventions delivered using OSNs (Greene, Sacks, Piniewski, Kil, & Hahn, 2012; Napolitano, Hayes, Bennett, Ives, & Foster, 2013; Pagoto et al., 2015; Sepah, Jiang, & Peters, 2014; Valle, Tate, Mayer, Allicock, & Cai, 2013). The majority of these trials used components of OSNs, such as bulletin boards or chat rooms in combination with traditional weight management intervention delivery rather than OSNs as the primary platform. The limited

number of trials that used OSNs as the primary delivery platform were of short duration (< six months), and used a variety of OSNs which makes it difficult to conclude the effectiveness of a specific OSN platform. Furthermore, the potential reduced cost of OSN delivered intervention has been cited as a major advantage (Ashrafian et al., 2014), however, a cost analysis for OSN interventions have yet to be completed.

Therefore, to evaluate the feasibility and efficacy of using an OSN to deliver a weight management program we conducted a six month randomized feasibility study comparing weight loss between an established cost effective weight management delivery system (group conference call) (Donnelly et al., 2013) compared to an OSN (Facebook©) delivery system. The primary aim was to determine if weight loss at six months was significantly different for participants randomized to group conference calls or OSN groups. Secondary outcomes included changes in waist circumference as an indication of reduction in chronic disease risk, dietary intake, and physical activity to help explain both group and individual differences in weight change. Lastly, a cost analysis of the group conference calls and OSN delivery was conducted.

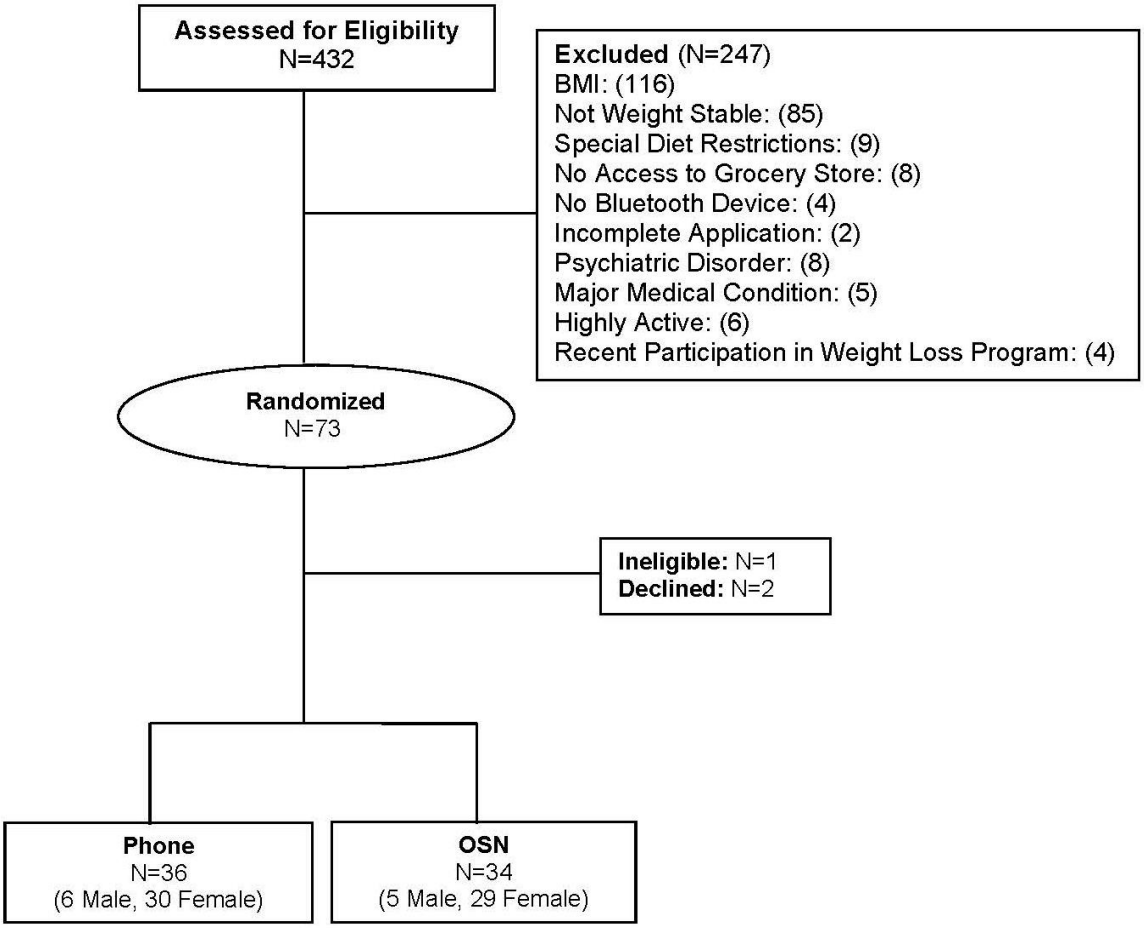
METHODS

The rationale, design and methods for this trial have been described in detail on pages 29 – 46. Information herein pertains to the current report.

Participants. Seventy-three adults with obesity (age = 21-70 yrs.; BMI = 30.0-45.0 kg/m^2) were randomized at a 1:1 ratio, stratified by sex, to either the conference call or OSN groups. Potential participants were excluded if they: 1) were unable to participate in moderate intensity physical activity (i.e., walking); 2) participated in a weight loss or physical activity program in the previous six months; 3) were participating in greater than 3, 30-min bouts of planned

exercise/week; 4) were not weight stable (±4.6 kg); 5) were unwilling to be randomized; 6) reported being pregnant during the previous six months, lactating, or planned pregnancy within six months; 7) had a serious medical risk such as cancer, recent cardiac event (i.e. heart attack, stroke, angioplasty) in the previous six months, as determined by the study's medical director; 8) used antipsychotics or had untreated depression; 9) adhered to a specialized diet regimen, e.g., multiple food allergies, vegan, macrobiotic; 10) were at risk for disordered eating as assessed by the Binge Eating Scale (Gormally, Black, Daston, & Rardin, 1982) and Eating Attitudes Test (Garner, Olmsted, Bohr, & Garfinkel, 1982); 11) did not have access to a grocery store. To improve the generalizability, individuals with chronic medical conditions were allowed to participate because they represent the population typically seeking weight management. For instance, individuals with hypertension or type II diabetes were not excluded if their condition was controlled by medication. Written informed consent was obtained from all participants prior to participation as approved by the Human Subjects Committee at the University of Kansas Medical Center. Participants were allowed to keep the Fitbit Flex wireless activity monitor used to self-monitor physical activity (described below) as compensation for participating in the trial. Figure 1 presents a modified Consolidated Standards of Reporting Trials. (CONSORTS) diagram (Moher et al., 2010) that described the number of potential participants assessed for eligibility, the number of participants excluded or screened out, reason for screening failure, and the number randomized to the conference call or OSN groups.

Figure 1: Consort Diagram



Intervention-Conceptual framework. We employed Social Cognitive Theory (Bandura, 1977, 2004), problem-solving, and the relapse prevention models (Bandura, 2004; Marlatt & Gordon, 1985; Prochaska & Marcus, 1998). Key elements of the intervention, incorporated through in-class/online discussions and out-of-class assignments to facilitate change in both diet and physical activity, included goal-setting, self-monitoring, direct reinforcement, interaction with health educators, and social support to facilitate change in diet and physical activity.

Health Educator Training/Standardized Materials. Health educators who delivered the intervention were experienced in weight management and had backgrounds in nutrition, exercise physiology and/or behavioral counseling. Health educators trained to deliver the phone

intervention by listening to recordings of sessions delivered by phone from a previously completed trial (Donnelly et al., 2013) and participating in mock group sessions that simulated live groups. Health educators were randomly assigned to administer one conference call and one OSN congruently to reduce the potential for health educator bias. The diet and physical activity protocols, behavioral lesson topics, and experiential learning assignments were identical for both groups.

OSN Intervention. Participants joined a private OSN group of 12-18 individuals using their personal accounts. The OSN intervention was structured into weekly online modules for six months. Throughout the week the health educators posted lessons, audio recordings and comments in the discussion forum to highlight the major points of the lesson and problem solve if necessary. Intervention compliance for the OSN participants was determined by participants posting at least four comments in the discussion forum each week. The content and discussion topics were identical for both the phone and OSN group; however participants in the OSN group could access study materials and interact with group members 24 hours per day, seven days per week and were able to work through study materials at a rate that was comfortable for them within the one week module guidelines. Participants were encouraged to interact with each other and with the health educator using OSN.

Phone Conference Call Sessions. Sixty-minute group phone conference meetings of 12-18 participants were conducted one evening per week. Participants called a toll-free number five minutes prior to the scheduled meeting time and entered a unique identifying code that allowed them to join the meeting. Participates were expected to remain on the call for the duration of the 60-minute session. The meeting protocol included a check-in question to generate discussion regarding diet and physical activity, a review of compliance with the diet and physical activity protocols, a lesson on a weight management topic, and an experiential learning assignment that

required problem solving or the practice of behavioral weight management strategies to be completed prior to the next meeting. All calls were recorded and the audio posted for the private OSN group as optional learning material.

Weight Loss Diet for Phone and OSN Groups. Energy intake was reduced 500-700 kcal/d below estimated total daily energy expenditure using the equation of Miflin-St Jeor (1990). Nutritionally balanced, high volume, lower fat (fat=20%) diets as recommended by the Academy of Nutrition and Dietetics (Cummings, Parham, & Strain, 2002) and the USDA's MyPlate approach (U.S. Department of Agriculture, 2013) were prescribed for all participants. Participants were provided examples of meal plans consisting of suggested servings of grains, proteins, fruits, vegetables, dairy, and fats based on their energy needs and were counseled on appropriate portion sizes.

Physical Activity for Phone and OSN Groups. A progressive, moderate intensity physical activity program (walking, jogging, biking etc.) as recommended in the "2009 American College of Sports Medicine Position Stand on Physical Activity Interventions for Weight Loss and Prevention of Weight Regain in Adults,"(J.E. Donnelly et al., 2009) was prescribed. Physical activity progressed from 45 minutes/week in week one to 300 minutes/week at the end of week 16, and remained at 300 minutes/week for the duration of the study. Fitbit wireless activity monitor (Flex tracker, Fitbit Inc. San Francisco, CA, size 35.5 x 28 mm) were provided to track steps, in addition to acting as a motivational tool and an incentive for participation in the intervention.

Self-Monitoring. Participants in both the phone and OSN groups recorded body weight using a calibrated wireless digital scale (Withings Wireless Scale, WITHINGS, Inc. Cambridge, MA), diet/food consumed and minutes of physical activity using the MyFitnessPal™ application, and steps using a Fitbit activity monitor. Participants were instructed to record weight a minimum of

once per week, however, daily weighing was encouraged. Fitbit and MyFitnessPal™ data was to be submitted daily. All applications were synced to the MyFitnessPal™ application, which uploaded the data to a cloud server. Self-monitoring data was available for real time feedback to the participants through the applications as wells as downloaded by the health educator to provide participant feedback and education. Self-monitoring weights from the wireless scale were used only for participant feedback and not for outcome weight.

Assessments. Outcome measures were collected in our laboratory by trained staff at baseline and following weight loss (month six).

Body Weight, Height, BMI, and Waist Circumference. Body weight was recorded using a digital scale accurate to ±0.1 kg (Befour Inc Model #PS6600, Saukville, WI). All participants were weighed between the hours of six and 10 am prior to breakfast wearing a standard hospital gown after attempting to void. Height was measured using a stadiometer (Model PE-WM-60-84, Perspective Enterprises, Portage MI) and BMI (kg/m^2) was calculated. Waist circumference was measured using the procedures of Lohman et al. (1988).

Diet Intake. Baseline and six month energy and macronutrient intake was assessed using data obtained from the MyFitnessPal™ application for three days (two weekdays, one weekend day) prior to participants' scheduled assessment visit.

Physical Activity. Participants wore an ActiGraph GT1X portable accelerometer (ActiGraph LLC, Pensacola, FL) on a belt over the non-dominant hip for seven consecutive days at month six. Accelerometer data was collected in one minute epochs with a minimum of ten hours constituting a valid monitored day. The main outcome variable was the average ActiGraph counts/min over the seven day period.

Cost Analysis. Resources used were measured by surveying participants at the end of the intervention (six months) and by reviewing time logs maintained by health educators. Surveys were completed by 62 of the 70 participants (89%). Resource use data was converted to costs using standard prices (i.e., the median hourly wage in the area). A two-sample t-test was used to compare average costs for the conference call and OSN groups.

Statistics. The primary analysis was to compare weight loss at six months between phone and OSN groups using two-sample t-test. Our intention-to-treat approach for handling missing data used multiple imputation—i.e., 100 imputed datasets were generated and then analysis results from each imputed dataset were combined to make valid statistical inferences.

For secondary variables (change in BMI, percent change in weight, change in waist circumference, and energy and macronutrient intake) two-sample t-test was used to compare between the groups without imputation. We examined the distribution of weight loss based upon categories of change between the groups using a chi-square test of homogeneity. Diet compliance (number of complete records submitted on MyFitnessPal™ and number of diet records within ±100 kcals of the prescribed calorie goal) as well as self-report PA, steps (Fitbit), and accelerometer data were compared between the groups using two-sample t-test without imputation.

RESULTS

Participants. Baseline data for the 70 of the 73 eligible participants who initiated the weight loss intervention (OSN n=34, Phone, n=36) are presented in Table 1. Sixty participants (86%) provided weight data at both baseline and six months. The study sample had obesity (BMI ~36 kg/m^2), were middle age (~47 yrs.), predominantly female (~84%) and comprised of ~24% minorities.

Table 1. Participant Characteristics

		Phone			OSN		
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**p-value**
Age (yrs.)	36	47.6	11.7	34	46.8	13.2	0.807
Weight (kg)	36	100.0	15.2	34	98.8	13.7	0.719
BMI (kg/m^2)	36	35.6	3.8	34	36.8	4.1	0.234
Waist Circumference (cm)	36	101.8	10.9	34	102.9	11.7	0.687
Female (n, %)	30	83.3		29	85.3		0.822
Minorities (n, %)	8	22.2		9	26.3		0.770

BMI: Body Mass Index; OSN: Online Social Network

Body weight, BMI, waist circumference. Changes in weight, BMI, and waist circumference are reported in Table 2. Weight change (kg) from baseline to six months was not significantly different between groups (p=0.566). Weight change (%) from baseline to six months was -6.3±6.4% and -5.8±6.7% for phone and OSN groups, respectively (p=0.765). No significant group differences were observed for BMI and waist circumference. At six months, the proportions of participants who gained weight and those who lost 0-<5%, 5-<10%, and ≥10% weight also did not differ significantly between the phone and OSN groups (Table 3)

Table 2: Changes for Weight, BMI, and Waist Circumference.

	Phone		OSN		
Variable	**Mean**	**SD**	**Mean**	**SD**	**p-value**
Weight (kg)	-6.0	6.1	-5.9	6.9	0.566
% Weight	-6.3	6.4	-5.8	6.7	0.765
BMI (kg/m^2)	-2.1	2.2	-2.2	2.5	0.847
Waist Circumference (cm)	-3.6	4.9	-6.0	8.3	0.196

BMI: Body Mass Index; OSN: Online Social Network

Table 3. Categories of Weight Change.

	Phone		OSN		
	N	**%**	**N**	**%**	**p-value**
Weight category					0.643
Gained	4	11.1	4	11.8	
Lost 0 to 4.9%	11	30.6	13	38.2	
Lost 5 to 9.9%	12	33.3	6	17.7	
Lost 10% or more	5	13.9	5	14.7	
Dropped	4	11.1	6	17.7	

OSN = Online Social Network

Intervention compliance and dietary intake. Attendance for the phone group from baseline to six months was 77.7%. Engagement with the OSN group was quantified by the number of times participants “liked” a study-related post and a post by a peer or posted a comment. The average number of “likes” per person each week was 1.3. The average number of comments per person each week was 3.2. Compliance for the OSN group (≥4 comments/week) from baseline to six months was 29.5%. Participants in the OSN group reported listening to ~36% of the posted audio lectures. The proportion of diet records submitted on MyFitnessPal™, records within ±100 kcals of the prescribed calorie goal, physical activity minutes (self-report) and steps (Fitbit) each week are shown in Table 4. Diet records submitted within ±100 kcals of the prescribed calorie goal were significantly lower in the OSN group (22.0±21.2%) compared to the phone group (44.0±26.2; $p<0.001$). No significant differences were found between the groups for any other variables. Results of diet intake are shown in Table 5. There were no statistically significant differences between the phone and OSN groups for total energy, fat, carbohydrate, and protein intake at baseline or six months.

Table 4. Program Compliance

	Phone			OSN			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**p-value**
Steps/week	36	47675	19967	33	49354	23325	0.748
Physical activity minutes	32	118.8	91.1	32	103.1	149.7	0.775
Met Calorie Goal (%)	36	44.0	26.2	33	22.0	21.2	<0.001
Complete Weekly Reports (%)	36	37.6	27.4	33	34.7	28.9	0.561
Accelerometer data*							
counts/day	15	300.3	93	16	252.5	130	0.252

OSN: Online Social Network; Physical activity minutes: physical activity averaged across 0-6 months; *Accelerometry averaged for seven day period at six months.

Table 5. Daily Energy and Macronutrient Intake

	Phone			OSN			
Variable	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**p-value**
kcal/day							
Baseline	30	1678.5	409.1	30	1738.0	322.1	0.534
6 months	26	1294.2	275.4	20	1305.8	267.8	0.887
Carbohydrate (g)							
Baseline	30	182.3	56.3	30	184.4	43.6	0.874
6 months	26	140.1	34.6	20	154.8	35.5	0.165
Fat (g)							
Baseline	30	68.5	20.0	30	73.4	18.7	0.335
6 months	26	53.1	15.4	20	46.8	14.6	0.168
Protein (g)							
Baseline	30	68.6	19.1	30	72.6	16.1	0.390
6 months	26	61.2	14.2	20	61.6	10.3	0.929

OSN: Online Social Network

Physical Activity. The average target for minutes of physical activity was 232 min/week from baseline to six months due to ramp up of the progressive protocol to 300 min/week. Neither group achieved the average target during the six month intervention based on self-report data (phone: 118.8±91.1; OSN: 103.1.0±149.7). There were no significant differences between the groups for self-reported minutes of physical activity or steps (Fitbit). Results from the

accelerometer for counts per day indicated no significant group difference at six months (Table 4).

Cost Analysis. Participant time required for the intervention was significantly higher for the phone group (1050.6±226.8 minutes) compared to the OSN group (476.4±481.2 minutes; $p < 0.01$) over the course of the 6 months. However, participant time represented a small portion of the total cost (phone, $310.28/person; OSN, $163.37/person). Health educator costs per participant for the six month intervention were similar for the two groups ($46.76 phone; $50.26 OSN). Equipment costs (Fitbit, wireless scale, lesson binders [phone only]) were comparable between phone group ($10,680) and the OSN ($10,500). The total cost per participant for the six-month intervention was ~30% higher for the phone group ($512.05) compared to the OSN group ($363.63).

DISCUSSION

Results from this pilot study indicated that weight loss from an intervention delivered through an OSN was not significantly different ($p < 0.05$) compared to an established cost effective weight loss delivery system (group phone conference call). Both phone and OSN groups met American Heart Association/American College of Cardiology/The Obesity Society's Guidelines (Jensen et al., 2014) by reducing baseline weight by 5-10% within six months. These results compare favorably with results from Sepah et al. who examined participant's receiving a weight management intervention through a study-specific OSN that incorporated small-group support, health coaching, the Diabetes Prevention Program curriculum, and digital tracking tools. At 16 weeks participants lost 5.0% of their baseline weight and maintained 4.8% weight loss after 15 months (Sepah et al., 2014).

Of the limited studies that utilize OSN delivery, not all have found promising results. A review by Ashrafian et a. (2014) found that interventions that have used OSN components for weight management produce a modest 1.4% greater reduction in body weight compared to control participants. Greene et al. (2012) reported a 6-month intervention using a study-specific OSN platform, combining education materials on diet and physical activity with OSNs verses a control group receiving only education materials produced 2.8% and 0.8% weight loss, respectively. Similarly, Pagoto et al. (2015) examined participants who received a weight loss program using an established OSN (Twitter©) and reported weight loss of 3% from baseline to 12-weeks. The inconsistencies in results for studies using OSNs to deliver weight management are partially attributed to the variation in intervention design. From the available studies, factors that influence the magnitude of weight loss (e.g., intervention duration, levels of energy restriction, type of diets, and amount of physical activity) vary greatly or are not reported.

Attendance could not be directly compared between groups due to the variation of the delivery methods and expectations. However, from baseline to six months, participants in the phone group attended ~78% of the scheduled meetings while participants in the OSN group met the minimum four post recommendation per week criteria ~30% of the time. Participants in the OSN group reported a lack of familiarization with other members limited their comfort of sharing information in the OSN group. Future studies need to address this issue. Possible solutions would have participants meet for a small number of face-to-face or video conferencing sessions prior to starting the OSN intervention or throughout the OSN intervention to gain familiarity with one another. Additionally, planning of outside events/activities for participants could also increase the familiarity with each other and increase interaction between group members in the OSN. Compliance of weekly data reporting of steps, physical activity, weight, and energy intake did not differ between groups. However, compliance with logging was low with both groups only submitting complete reports ~36% of the time and reporting of energy intake data being the

most frequently missed. Alternate diet strategies such as portion-controlled meals may be beneficial by reducing the barrier of tracking specific foods consumed.

In the attempt to automate the intervention, energy intake outcome assessments and weekly data reporting were completed using the MyFitnessPal™ application. Participants were instructed not to change their diet and were not given a reduced calorie goal prior to the first session. However, due to the low energy intake values recorded at baseline and six months, it appears that nutritional feedback from the MyFitnessPal™ application may have resulted in participants either underreporting or altering their diet during the assessments. Thus, the values of energy intake should be interpreted with caution. Validated measures of energy intake such as photo assisted dietary assessments may be used to measure daily energy and macronutrient intake and likely would improve the accuracy of dietary assessment (Ptomey et al., 2015). Furthermore, participants indicated problems understanding how to sync and navigate devices within their mobile applications. As participants became frustrated with the applications they discontinued utilizing them. This could explain the low numbers seen with data reporting. Future studies might improve results with data compliance by increasing the frequency or by implementing longer duration technology trainings.

Strengths of this study include: 1) a design specific to evaluating two potentially effective strategies for the delivery of a weight loss intervention. 2) Both technologies evaluated are readily available and accessible. Thus, the interventions could be widely disseminated. 3) Phone comparison group is a successful technology for weight loss intervention delivery (Donnelly et al., 2013). 4) Use of an established OSN. Using and existing popular OSN reduces the training required to maneuver through the site as majority of the public is already familiar with the site. Additionally, it reduces the barrier of participants having to log into additional sites to get information. However, this study is not without its limitations. Due to funding and supply

restraints, limitations include: 1) sample size is relatively small and the study was not powered to detect between group differences; 2) lack of a weight maintenance follow-up period; 3) inability to blind participants and health educators to treatment condition; 4) potential differences in motivation to lose weight between participants who agree to participate in a research study and the general public. Despite these limitations both groups did achieve the recommend weight loss of >5% within six months (Jensen et al., 2014).

Conclusion

The purpose of this study was to inform future, larger scale, adequately powered trials. The primary finding from this investigation was that a weight loss intervention delivered using group conference calls and OSN resulted in clinically meaningful weight loss. Although self-monitoring components essential to weight loss (such as reporting diet and physical activity) were low, these components were used equally across the groups. Future research is needed to determine ways to increase engagement and utilization of the intervention and self-monitoring methods to increase adherence and weight loss success. Furthermore, with minimal resources required to administer a behavioral weight loss intervention through OSNs, its utility for disseminating weight loss interventions to the public and supporting long-term weight loss maintenance should continue to be explored.

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Behavioral and Demographic Associations Impacting Participation in an Online Social Network Weight Management Program

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Abstract

Introduction: Identifying characteristics associated with successful behavior change interventions could inform the development of more effective interventions to address the growing obesity crisis. The objective of this analysis was to assess association of on weight change from baseline to six months. ***Methods:*** A randomized study of group phone counseling behavioral weight loss intervention verses online social network delivery was conducted over six months. Measures included body weight, self-efficacy of exercise, barriers to exercise, weight loss self-efficacy, and self-regulation constructs. Rates of intervention compliance and self-monitoring were also quantified. Best subset multiple regression was used to identify factors associated with successful weight loss. ***Results:*** Weight loss was not significantly different between phone (-6.0 ± 6.1 kg) and online social network (-5.9 ± 6.9; p = 0.950) groups. Best subset multiple regression identified percent met daily calorie goal and number of times individuals recorded weight in the phone group and change in exercise barriers self-efficacy score, submitting complete weekly data reports, and number of comments posted on the online social network page in the online social network group as significant predictors of successful weight loss. ***Conclusion:*** Program adherence measures appear to be the primary factor in achieving successful weight loss. Future interventions should aim to decrease burden of tracking and focus on increasing compliance with health behavior data.

Keywords: Weight management, Self-efficacy, Adherence, Obesity

INTRODUCTION

The high prevalence of obesity in the US (Ogden, Carroll, Kit, & Flegal, 2014) has translated into obesity prevention and treatment becoming a top public health priority. Successful interventions have used a variety of components, including both group and individual counseling/education along with a variety of self-monitoring techniques delivered through face-to-face meetings, phone calls, text messaging, internet and email. However, for these programs to be affective, individuals must first complete and comply with the program's requirements. Identifying characteristics associated with successful behavior change interventions could inform the development of more effective interventions to address the growing obesity crisis (Fontaine & Cheskin, 1997). With recent advances in mobile and wireless technologies, real-time assessments of health behaviors and their influences on individual's success in reaching their weight loss goals have become readily available (Riley, Serrano, Nilsen, & Atienza, 2015). Due to the variety of behavioral interventions, these assessments are able to be utilized to determine individual characteristics and behaviors associated with successful weight loss specific to intervention design.

Data from our recently completed six month randomized study, which compared identical behavioral weight management interventions delivered by group phone conference calls or OSNs provided an opportunity to explore the influence of participant characteristics that may contribute to or detract from intervention effects in both the conference call and OSN groups. For the detailed description of the study design refer to pages 29-46 and results for the primary outcomes refer to pages 51-69. Briefly, results indicated clinically significant weight loss (>5%) at six months for both group phone conference call and OSN groups. Weight loss between groups were not significantly different. However, there was considerable inter-individual variability in weight change with 53% losing < 5% and 17% losing > 10% from baseline to six months. Therefore, the objective of this analysis was to assess the association of participant

characteristics (age, sex, self-efficacy, and self-regulation) and intervention adherence factors (percent complete weekly reports, reports within ± 100 calories of daily goal, number of weights submitted, and steps) on weight change from baseline to six months. The variables selected for this analysis were based on a previously demonstrated association with the weight change response to behavioral weight loss interventions (Choo & Kang, 2015; Fitzpatrick et al., 2014; Nackers, Ross, & Perri, 2010; Purcell et al., 2014; Szabo-Reed et al., 2015; Wadden et al., 2009).

METHODS

Participants. Participants were obese men and women (age 21- 70 yrs., BMI 30.0-44.9 kg/m^2) who were willing to be randomized to one of the two study groups. Written informed consent was obtained prior to engaging in any aspects of this trial. Approval for this investigation was obtained from the Human Subjects Committee at The University of Kansas Medical Center.

Intervention. Behavioral sessions, based on Social Cognitive Theory (Bandura, 1977, 2004), with groups of 12-18 participants were delivered via group phone conference call or a private OSN group for six months. Sessions were conducted by health educators experienced in weight management and had backgrounds in either nutrition, exercise physiology and/or behavioral counseling. Energy intake was reduced 500-700 kcal/d below estimated total daily energy expenditure. Energy expenditure was estimated using the equation of Miflin-St Jeor (Mifflin et al., 1990). Participants were instructed to consume a nutritionally balanced, reduced energy, high volume, lower fat (fat=20%) diet as recommended by the Academy of Nutrition and Dietetics (Cummings, Parham, & Strain, 2002) and the USDA's MyPlate approach (U.S. Department of Agriculture, 2013). A progressive moderate intensity physical activity program (e.g. walking, jogging, biking) was proscribed which progressed from 45 minutes/week in week one to 300 minutes/week at the end of week 16, and remained at 300 minutes/week for the

duration of the study. Data reports of body weight (Withings Wireless Scale, WITHINGS, Inc. Cambridge, MA), diet and self-report exercise minutes (MyFitnessPal™) as well as steps (Fitbit, Fitbit Inc. San Francisco, CA) were uploaded to a cloud server daily by the participant and used by health educators for feedback and education.

Assessments.

Weight, Height, and BMI. Anthropometric assessments were obtained between the hours of 6:00 and 10:00 AM prior to breakfast and after attempting to void. Participants were weighed wearing a standard hospital gown using a digital scale accurate to ± 0.1 kg (Befour Inc. Model #PS6600, Saukville, WI). Height was measured using a stadiometer (Model PE-WM-60-84, Perspective Enterprises, Portage MI) and body mass index was calculated as weight (kg) divided by height (m^2). All measures were collected at both baseline and six months.

Online Questionnaires. At baseline, questionnaires covering demographics, self-efficacy, and self-regulation were administered online, using a university secured RedCap database (Harris et al., 2009), At six months questionnaires were again administered for self-efficacy and self-regulation in both phone and OSN participants.

Self-efficacy. Self-efficacy for weight management was assessed using the Weight Efficacy Life-Style Questionnaire (WELS) (Clark, Abrams, Niaura, Eaton, & Rossi, 1991). The WELS consists of 20 items that are clustered in 5 domains: Negative Emotions (e.g., I can resist eating when I am anxious (nervous), Food Availability (e.g., I can resist eating even when I am at a party), Social Pressure (e.g., I can resist eating even when I feel it's impolite to refuse a second helping), Physical Discomfort (e.g., I can resist eating when I feel physically run down), and Positive Activities (e.g., I can resist eating just before going to bed.). Items are scored on a 10 point Likert scale from 0 (not confident) to 9 (very confident). Subscale scores were summed to

calculate the total WELS score. Chronbach's alpha ranged from 0.70 to 0.90 over the five domains assessed (Clark et al., 1991).

Self-efficacy of exercise was assessed using the Exercise Self-Efficacy Scale (EXSE) (McAuley, 1993). The EXSE consists of eight items that assesses an individual's beliefs in their ability to continue exercising on a three time per week basis at moderate intensities for 40+ minutes per session in the future. Items are scored in 10 point increments, ranging from 0%-100%. Total strength for each measure of self-efficacy is then calculated by summing the confidence ratings and dividing by the total number of items in the scale, resulting in a maximum possible efficacy score of 100. Chronbach's alpha was 0.92 (McAuley, 1993).

Self-efficacy of exercise when faced with commonly identified barriers was assessed by the Barriers Self-Efficacy Scale (BARSE) (McAuley, 1992). Participants indicate their confidence to execute the behavior on a 100-point percentage scale comprised of 10-point increments, ranging from 0% (not at all confident) to 100% (highly confident). Total strength for each measure of self-efficacy is then calculated by summing the confidence ratings and dividing by the total number of items in the scale, resulting in a maximum possible efficacy score of 100. Chronbach's alpha was 0.89 (McAuley, 1992).

Self-regulation. Use of physical activity self-regulatory strategies was assessed by the 12-item Physical Activity Self-Regulation scale (PASR-12) (Michelle Renee Umstattd, Motl, Wilcox, Saunders, & Watford, 2009; Michelle Rene Umstattd, Wilcox, Saunders, Watkins, & Dowda, 2008). The PASR-12 is composed of six strategy subscales including self-monitoring, goal setting, eliciting social support, reinforcement, time management, and relapse prevention. Items are rated from 1 (never use strategy) to 5 (use strategy very often). Chronbach's alpha of the subscales ranged from 0.79 – 0.94 (Michelle Rene Umstattd et al., 2008).

Intervention Compliance. To compare the level of participation across the intervention groups, the following information was recorded over the course of the six month intervention. For phone participants, attendance was recorded at each session, and each individual's percent attendance for the six month intervention was calculated. For OSN participants, compliance was calculated by number of comments posted in the private OSN page. Participants were instructed to post a minimum of four times each week. Additionally, participants in both groups were to upload their Fitbit and diet data to MyFitnessPal™ daily and upload a weight using the wireless scale at least once per week. These weekly submissions were used to calculate percent complete reports, percent diet records submitted on MyFitnessPal™ within ±100 kcals of the participants prescribed calorie goal, and number of times participants weighed themselves.

Statistical Analysis

Sample demographics and all outcome measures were summarized by descriptive statistics—means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Fitbit steps/day were examined to identify equipment malfunctions and extreme or unusual values (i.e., < 1000 and >25,000 steps/day) (Tudor-Locke, Bassett, Shipe, & McClain, 2011). To assess differences between groups, two sample independent t-tests were conducted for quantitative variables and chi-squared test for categorical variables. Best subset multiple linear regression analysis identified the best model for predicting weight loss from baseline to six months. To focus on predictors of weight loss beyond the contribution attributable to sex, baseline weight, and age, these three variables were forced into all regression models (Batra et al., 2013). We identified the best model separately for each group because of the differences in intervention delivery and measures of compliance. The fitted models were compared using adjusted R^2, Mallow's Cp criterion and Bayesian Information

Criterion to model the joint relationship of the independent variables assessing demographic, behavioral and psychosocial factors to weight change. Statistical significance was determined at 0.05 alpha level, and all analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

Participants. The study sample consisted of adults (age: 47.2 ± 12.4 yrs.) with obesity (BMI: 36.1 ± 4.0 kg/m^2); 22% minorities, and 83% female. There were no statistically significant baseline differences between participants randomized to phone or OSN for age, weight, sex, BARSE, EXSE, WELS, or PASR-12 scores. Baseline and six month weight measurements were completed on 85.7% of the participants randomized at baseline. Approximately 14% (n = 10) of participants withdrew or were lost to follow-up. While more withdrew from the OSN group (n=6) than the phone group (n=4), this difference was not significant (p = 0.508). There were no significant differences between completers and those who were lost to follow-up by baseline weight, age, sex or total BARSE, EXSE, WELS, PASR-12 scores (all p-values > 0.05). Due to participants failing to complete the online questionnaires this report includes complete baseline and end study BARSE, EXSE, WELS, and PASR-12 questionnaire data from 49, 51, 54, and 54 participants, respectively. Baseline descriptive characteristics of the 60 participants with baseline and end study weights that were included in this analysis are presented in Table 1.

Table 1: Baseline Characteristics

	Phone n=32		OSN n=28	
	Mean	SD	Mean	SD
Age	48.5	11.1	47.8	12.7
Height (in.)	65.8	3.0	64.6	3.0
Weight (kg)	98.4	15.1	98.3	12.8
BMI (kg/m^2)	35.0	3.4	36.5	4.0
Sex				
Male (n, %)	5	15.6	5	17.9
Female (n, %)	27	84.4	23	82.1

OSN: Online Social Network. M: mean. SD: standard deviation

Weight. Table 2 shows the self-efficacy, self-regulation and body weight values at baseline and six months for phone and OSN groups. Mean weight change for individuals in the study was -6.0 ± 6.1 kg in phone participants and -5.9 ± 6.9 kg in OSN participants. The mean percent weight loss was 6.3% in the phone participants and 5.8% in the OSN participants. There were no statistically significant differences in change scores for any of the self-efficacy or self-regulation constructs between participants in the phone group compared to the OSN group.

Table 2: Change in efficacy constructs for phone and OSN groups

	Phone									OSN									
	Baseline			6-month			Δ			Baseline			6-month			Δ			Between group difference for change over time
	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	N	M	SD	p-value
Weight (kg)	32	98.4	15.1	32	92.4	16.8	32	-6.0	6.1	28	92.4	12.3	28	98.3	12.8	28	-5.9	6.9	0.950
Total BARSE Score	30	77.9	16.6	28	55.8	20.1	27	-21.0	24.2	24	65.6	22.9	24	48.9	22.6	20	-16.2	31.3	0.556
Total EXSE Score	30	89.8	16.7	29	77.2	22.1	27	-13.1	21.1	27	87.8	16.6	24	69.9	26.6	24	-17.2	32.6	0.605
Total WELS Score	32	120.6	41.5	30	120.2	40.5	30	1.6	27.5	28	109.5	38.9	24	121.2	32.9	24	13.3	38.9	0.202
Total PASR-12Score	32	33.7	9.5	30	40.9	8.1	30	7.0	10.8	28	34.2	10.1	24	41.1	9.5	24	7.1	10.1	0.965

OSN: online social network. M: mean. SD: standard deviation. BARSE: Barriers Self-Efficacy Scale. WELS: Weight Efficacy Life-Style Questionnaire. PASR-12: 12-item Physical Activity Self-Regulation scale. EXSE: Exercise Self-Efficacy Scale.

Attendance and Self-Monitoring. The mean attendance to group sessions was 81.8 ± 11.8% for participants in the phone group during the six month intervention. Participants in the OSN group, on average, posted 3.7 comments to the private OSN page each week. Over the course of the intervention, participants submitting complete reports, Fitbit data, and weights were not significant between groups (Table 3). However, participants in the phone group (44.9 ± 26.5%) were within 100 calories of their daily goal significantly more often than those in the OSN group (25.0 ± 21.6%; $p = 0.003$). Adherence and self-monitoring predictors accounted for more than 70% of the variability in weight change (Table 5). Although, after accounting for other predictors, only number of weights submitted was significantly associated with weight change from baseline to six months.

Correlations. Correlations between weight change and outcome variables are presented in Table 4. Weight, age, sex, as well total BARSE, EXSE, WELS, and PASR-12 scores at baseline were not significantly associated with weight change from baseline to six months. In the OSN group, weight change was moderately correlated with percent complete reports submitted ($r = -0.67$; $p < 0.001$), total steps ($r = -0.64$; $p < 0.01$), number of weights submitted ($r = -0.79$; $p < 0.001$) and number of “likes” per week ($r = -0.54$; <0.01). In the phone group, weight change was highly correlated with percent complete reports submitted ($r = -0.83$; $p < 0.001$) and number of weights submitted ($r = -0.89$; $p < 0.001$) as well as moderately correlated with percent of reports within calorie range ($r = -0.58$; $p < 0.001$) and total steps ($r = -0.62$; $p < 0.001$). Results from the best subset regression are presented in Table 5; all models were adjusted for baseline weight, sex, and age.

Table 3: Compliance factors associated with weight change

	Phone n=32		OSN n=28		
	M	SD	M	SD	
Met Calorie goal (%)	44.9	26.5	25.0	21.6	0.003
Complete Reports (%)	42.5	28.9	43.1	28.1	0.938
Physical Activity (Steps)	51251	19254	56680	20481	0.295
Number of weights recorded	55.0	32.6	71.6	32.3	0.053
Attendance	81.8	11.8			
Likes			1.4	1.2	
Posts			3.7	2.2	

OSN: online social network. M: mean. SD: standard deviation.

Table 4. Pearson correlations between weight change and outcome variables

	Phone		OSN	
	Baseline r	Outcome r	Baseline r	Outcome r
Age (yrs.)	0.15		-0.28	
Weight (kg)	0.10		-0.35	
Met Calorie goal (%)		-0.58***		-0.26
Complete Reports (%)		-0.83***		-0.67***
Physical Activity (Steps)		-0.62***		-0.60***
Number of weights recorded		-0.89***		-0.79***
Attendance		-0.05		
Likes				-0.54**
Posts				-0.32
Total BARSE Score	-0.21	0.02	-0.23	-0.37
Total EXSE Score	-0.16	-0.20	-0.12	-0.13
Total WELS Score	-0.21	0.37	-0.08	-0.33
Total PASR-12 Score	-0.14	-0.12	-0.03	-0.34

*<0.05; **<0.01; ***<0.001. OSN: online social network. M: mean. SD: standard deviation. BARSE: Barriers Self-Efficacy Scale. WELS: Weight Efficacy Life-Style Questionnaire. PARSE-12: 12-item Physical Activity Self-Regulation scale. EXSE: Exercise Self-Efficacy Scale.

Table 5. Pearson correlations between weight change and outcome variables

	Phone							OSN						
	Coefficients				Model Summary			Coefficients				Model Summary		
	β	SE	t	p-value	R^2	Adj R^2	p-value	β	SE	t	p-value	R^2	Adj R^2	p-value
Baseline Efficacy Scores					0.20	0.08	0.175					0.75	0.65	<0.001
Total BARSE Score								-0.06	0.04	-1.59	0.131			
Total EXSE Score								0.15	0.06	2.48	0.025			
Total WELS Score	-0.03	0.03	-1.26	0.220										
Total PASR-12 Score								0.15	0.09	1.57	0.137			
Change Efficacy Scores					0.43	0.32	0.012					0.56	0.43	<0.01
Δ *BARSE Score*														
Δ *EXSE Score*	-0.10	0.05	-1.87	0.075				-0.01	0.04	-0.37	0.718			
Δ *WELS Score*	0.11	0.04	2.83	0.010										
Δ *PASR-12 Score*								-0.12	0.13	-0.97	0.345			
Attendance/Adherence					0.84	0.79	<.0001					0.81	0.73	<0.0001
Met Calorie goal (%)	-0.03	0.03	-0.89	0.383				-0.04	0.04	-1.02	0.320			
Complete Reports (%)														
Physical Activity (Steps)	-0.00005	0.00003	-1.34	0.193				0.00	0.00	-1.44	0.167			
Number of weights recorded	-0.15	0.02	-6.17	<.0001				-0.11	0.03	-4.43	<0.001			
Attendance	0.07	0.05	1.48	0.153										
Likes								-1.35	0.66	-2.03	0.056			
Posts								-0.36	0.36	-1.00	0.331			
Overall Model					0.91	0.95	<.0001					0.97	0.92	<0.0001
Total BARSE Score								-0.08	0.04	-2.1	0.069			
Total EXSE Score	0.08	0.04	1.95	0.0698										
Total WELS Score	-0.03	0.01	-1.76	0.0991										
Total PARSE Score								0.09	0.06	1.64	0.140			
Δ *BARSE Score*								-0.07	0.03	-2.34	0.048			
Δ *EXSE Score*	0.03	0.03	0.95	0.357										
Δ *WELS Score*														
Δ *PARSE Score*	0.02	0.05	0.33	0.748				-0.11	0.06	-1.91	0.092			
Met Calorie goal (%)	-0.07	0.03	-2.31	0.036				0.07	0.03	2.31	0.050			
Complete Reports (%)								-0.11	0.03	-3.77	0.006			
Physical Activity (Steps)	-0.00007	0.00004	-1.71	0.108										
Number of weights recorded	-0.13	0.03	-5.06	<0.001				0.06	0.03	1.91	0.093			
Attendance	0.10	0.06	1.66	0.118										
Likes														
Posts								-1.07	0.31	-3.47	0.008			

OSN: online social network. BARSE: Barriers Self-Efficacy Scale. WELS: Weight Efficacy Life-Style Questionnaire. PARSE-12: 12-item Physical Activity Self-Regulation scale. EXSE: Exercise Self-Efficacy Scale.

Baseline self-efficacy and self-regulation. The results for the best subset multiple regression analysis suggested baseline total WELS score to be the best fit for predicting weight loss in the phone group (model Adj $R^2 = 0.08$; $p = 0.175$) and total baseline BARSE, EXSE, and PASR-12 scores to be the best fit for predicting weight loss the OSN group (model Adj $R^2 = 0.65$; $p < 0.001$). The multivariate model for baseline efficacy scores were not significantly associated with weight change for participants in the phone group and only total EXSE score was significantly associated with weight change over six months in the OSN group.

Change self-efficacy and self-regulation. The results for the best subset multiple regression analysis suggested change in both total EXSE and WELS scores to be the best fit for predicting weight loss in the phone group (model Adj $R^2 = 0.32$; $p=0.012$) and change in total EXSE and PASR-12 to be the best fit for predicting weight loss in the OSN group (model Adj $R^2 = 0.43$; $p < 0.01$). However, after accounting for other predictors only change in total WELS score was significantly associated with weight change over six months for participants in the phone group.

Overall Model. The results for the overall model suggested baseline total EXSE and WELS scores, change total EXSE and PASR-12 scores, percent met calorie goal, average steps, number of weights recorded, and attendance the best fit for predicting weight loss in the phone group (model Adj $R^2 = 0.95$; $p <0.0001$). Similarly, total baseline BARSE and PASR-12 scores, change in total PASR-12 score, percent complete reports, number of weights recorded, and posts were the best fit for predicating weight loss in the OSN group (model Adj $R^2 = 0.92$; $p <0.0001$). After adjusting for other predictors, percent met calorie goal and number of weights submitted (phone) and change total BARSE score, percent complete reports, and posts were significantly associated with weight change from baseline to six months.

DISCUSSION

The objective of this study was to examine measures of self-efficacy, self-regulation, and program adherence as predictors of weight change for two different group delivery methods, phone conference call and OSN. Similar to many current weight management programs, the interventions were grounded in social cognitive theory, problem-solving theory, and the relapse prevention model (Bandura, 1977, 2004; Marlatt & Gordon, 1985; Prochaska & Marcus, 1998; Prochaska et al., 1994) Key elements of the interventions were: reduced energy intake and increased physical activity through goal-setting, self-monitoring of daily diet and physical activity, direct reinforcement, interaction with health educators, and social support. Although both groups achieved clinically significant weight loss (Jensen et al., 2014) there was large inter-individual variability in weight change.

As anticipated, based on the previous reports (Batra et al., 2013; Hollis et al., 2008; Meffert & Gerdes, 2010; Poncela-Casasnovas et al., 2015; Svetkey et al., 2012), program compliance factors were the main predictors of weight loss success. For participants in the phone group, a higher frequency of meeting the calorie goal and submitting weights were significantly associated with increased weight loss. Additionally, and in contrast to previous studies evaluating adherence as predictors of weight loss (Batra et al., 2013; Byrne, Barry, & Petry, 2012; Fitzpatrick et al., 2014; Hollis et al., 2008; Szabo-Reed et al., 2015; Wadden et al., 2009; Williamson, Anton, Han, Champagne, Allen, LeBlanc, Ryan, McManus, et al., 2010; Williamson, Anton, Han, Champagne, Allen, LeBlanc, Ryan, Rood, et al., 2010), we found no association between session attendance and weight change for participants in the phone group. This lack of association can possibly be explained by the homogeneity in session attendance observed. On average, participants in the phone group included in this analysis attended 19.6 ± 2.8 of the 24 treatment sessions and 85% of participants attended 17 or more of the scheduled sessions. In contrast, the OSN group showed a higher frequency of overall complete reports and OSN

comments posted to be significantly associated with increased weight loss. If these results are replicated in other samples, future studies may want to focus on improving participant compliance using these mobile and wireless technologies for logging data.

Many participants reported technology issues and lack of familiarity with the devices as a primary barrier for submitting self-report data. As participants became frustrated with the applications they discontinued using them. Although all participants received identical 30 minute training at the beginning of the program on how to use the devices and applications additional trainings should be provided so individuals are more accustomed to the technology. Furthermore, the time and dislike of entering the required daily diet data was continually cited as a burden to submitting weekly reports. Individuals who became overwhelmed with entering diet data daily reported lack of motivation to log any weekly data. Alternate diet strategies, such as portion controlled meals, may be beneficial by reducing the barrier of tracking specific foods consumed and increase overall reporting.

We found no significant association between self-efficacy for exercise barriers, self-efficacy for weight management, exercise self-efficacy or physical activity self-regulation and weight change at baseline; however, higher self-efficacy for exercise barriers across the intervention was a significant predictor of success in the OSN group. Previous results regarding self-efficacy and self-regulation constructs and weight loss have varied. The finding of no baseline associations is consistent with some reports on exercise barriers self-efficacy for weight management, exercise self-efficacy, and physical activity self-regulation in regards to weight change (Teixeira et al., 2002; P. J. Teixeira et al., 2004; Byrne et al., 2012; Szabo-Reed et al., 2015; Wingo et al., 2013); however, several reports have shown these constructs to be associated with improved weight loss during treatment and at follow-up (Bas & Donmez, 2009; Latner, McLeod, O'Brien, & Johnston, 2013; Linde et al., 2006; Shin et al., 2011). In accordance with previous research,

(Byrne et al., 2012; Choo & Kang, 2015; Szabo-Reed et al., 2015; Wingo et al., 2013), we also found increased exercise self-efficacy during a behavioral intervention to be associated with improved weight loss These results adds evidence that changes in self-efficacy may be more important than baseline self-efficacy in the achievement of weight loss.

This study provides important information about predictors of successful weight loss, however this study is not without its limitations. This secondary analysis was limited to only those with complete data on all outcome variables. This resulted in the sample size being small. Additionally, the current study was a group-randomized pilot study that was not powered for weight loss. Finally, this study did not include a long-term follow-up. Whether or not sustained weight loss maintenance is associated with these variables is an important issue that future studies need to address.

In conclusion, participants in both phone and online social network groups achieved clinically meaningful weight loss; however, there was high variability in weight loss within groups. Program adherence measures appear to be the primary factor in achieving successful weight loss. Future interventions should focus on increasing compliance with health behavior data reporting.

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The University of Kansas Medical Center

Human Research Protection Program

APPROVAL OF PROTOCOL

June 11, 2015

Lisa Vansaghi
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Dear Lisa Vansaghi:

On 6/11/2015, the IRB reviewed the following submission:

Type of Review:	Initial Study
Reviewing IRB:	KUMC
IRB#:	STUDY00002758
Title:	Remote Delivery of Weight Management by Phone and Social Media
Investigator:	Lisa Vansaghi
Funding:	Name: Kansas City Area Life Sciences Institute
Expedited Category(ies):	(7)(b) Social science methods
Documents submitted for the above review:	• A4. Questionnaires.pdf • Study Flyer • Vansaghi_Protocol • Initial Eligibility questionnaire • A3 Application Screen Captures.docx • A1 Eligibility Questionnaires.docx • Grant Application • Expedited Project Description March 2015 PROTECTED.doc • RESEARCH CONSENT FORMv.2.docx • A2 Exercise Progression.doc • Award letter.pdf • RESEARCH CONSENT FORM_Track_changes.docx

The IRB approved the study from 6/11/2015 to 6/10/2016 inclusive. Before 6/10/2016 or within 30 days of study closure, whichever is earlier, you are to submit a continuing review with required explanations. You can submit a continuing review by navigating to the active study and clicking Create Modification / CR. If continuing review approval is not granted before the expiration date of 6/10/2016, approval of this study expires on that date.

The University of Kansas Medical Center

Human Research Protection Program

Your approved, stamped consent documents are found under the Documents tab, in your protocol. The consent forms posted in our electronic system are the only valid versions for documenting informed consent.

In conducting this protocol, you are required to follow the requirements and Standard Operating Procedures posted on our website at: http://www.kumc.edu/compliance/human-research-protection-program/institutional-review-board.html

Sincerely,

Jennifer Pennington

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