

Social-Cognitive Determinants of Success in Online Communities for Weight

Management

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of Doctor
of Philosophy in the Department of
Psychology and Neuroscience in the Graduate School
of Duke University

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ABSTRACT

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Abstract

Background: Online communities may be an effective, convenient, and relatively inexpensive intervention platform for individuals seeking assistance with weight management. Recent research suggests that these communities may be as effective as in-person treatments for weight management; however, very little is known about the characteristics that predict weight loss amongst those using an online community.

Methods: Within a social-cognitive framework, we sought to identify the psychosocial characteristics that are associated with successful weight management for users of MyFitnessPal, a popular online community for weight management. We recruited participants who were new to the online community and asked them to complete 2 surveys (one at baseline and one 3 months later) that assessed various psychosocial constructs as well as self-reported height and weight. **Results:** Participants in our sample reported losing, on average, 4.55 kg during the 3-month time period. We found that engaging in weight control behaviors (e.g., monitoring food intake, weighing oneself, etc.) fully mediated the relationship between several of our variables of interest (i.e., baseline self-efficacy and perceived social support within the community) and weight loss. We also found that participants who expected to lose more weight at baseline were significantly more likely to have lost more weight at follow-up.

Conclusions: On average, participants in our study lost a clinically meaningful amount

of weight. Predictors of weight loss within this community included perceived support within the community (mediated by weight control behaviors), baseline self-efficacy (mediated by weight control behaviors), and baseline outcome expectations. Results of this study can ultimately serve to inform the design of future eHealth interventions for weight management.

Dedication

I dedicate this dissertation to:

My husband, Zac, whose limitless support has made all the difference.

Our cats, Simba, Zeus, and Nathan Lane, who have never let me spend an all-nighter alone.

Our SJ, who makes it all worthwhile.

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1. Introduction and Background

The Internet has become an immensely popular venue for a range of activities, including information-seeking, interacting with educational and/or entertaining content, and engaging with others. Recent data suggest that 87% of U.S. adults currently use the Internet, while only 14% of U.S. adults reported using the Internet in 1995 (Pew, 2014). As Internet use has surged in popularity, there has also been a proliferation of “online communities,” i.e., electronic platforms where individuals with shared interests, hobbies, and/or health conditions can gather to give and/or receive informational and emotional support (Eysenbach, Powell, Englesakis, Rizo, & Stern, 2004). Online communities may be self-directed or professionally facilitated (i.e., by a health professional or another type of facilitator), and they can exist in various web-based venues, including message boards, chat rooms, Twitter feeds, and Facebook groups.

Online communities for health conditions appear to be surging in popularity. For example, in December 2012, Yahoo!Groups listed over 195,000 electronic support groups in its health and wellness section, over 14,000 of which are devoted specifically to fitness and nutrition (Yahoo!, 2012). These numbers are in stark contrast to the 25,000 health and wellness support groups on Yahoo!Groups reported in 2004 (Eysenbach et al., 2004). People participate in online communities in order to gain support for a variety of health conditions, including cancer, depression, eating disorders, HIV/AIDS, and diabetes

(Eysenbach et al., 2004; Eysenbach, 2008; McCormack, 2010; Mo & Coulson, 2008).

Recent data indicate that one in five of all Internet users have turned to the Internet as means of finding others with health concerns that are similar to their own, and this statistic climbs to one in four Internet users when considering those living with chronic health conditions (Pew, 2011).

Weight management is one area in which many individuals turn to the Internet for emotional and informational support (Ballantine & Stephenson, 2011; Chang, Chopra, Zhang, & Woolford, 2013; Hwang et al., 2007; Hwang et al., 2010). Online communities may present myriad potential benefits to people who are trying to lose weight, and recent research (to be discussed in greater detail below) suggests that participation in such communities is likely to lead to similar outcomes as participation in standard in-person treatments for weight management. However, little is known about the individual characteristics that are associated with successful outcomes in online communities for weight management. Such information could be of particular importance given the current rates of obesity in the United States.

1.1 Obesity in the United States

Obesity is a serious public health concern. Over one-third of U.S. adults are obese (Ogden, Carroll, Kit, & Flegal, 2014). The high proportion of obese adults in the United States is a cause for both medical and financial concern, as obesity is associated with a

wealth of negative health outcomes that can be costly to treat, including hypertension, diabetes mellitus type 2, hyperlipidemia, and certain types of cancer (Bray, 2004; Mokdad et al., 2003; Must et al., 1999). Moreover, rates of obesity in the United States are disproportionately higher for the socioeconomically disadvantaged (Ogden, Lamb, Carroll, & Flegal, 2010), as well as racial and ethnic minority groups, including African Americans and Hispanics (CDC, 2009). As of 1998, health care costs associated with obesity were estimated to account for 9.1% of medical expenses in the U.S., while these costs are estimated at 16% by the year 2030 if current obesity trends continue (Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008).

Promisingly, even a modest amount of weight loss (i.e., 3% of initial weight) is associated with significant improvements in health outcomes (Jensen et al., 2013), and the “gold standard” treatments for weight management have historically demonstrated average weight reductions of seven to nine percent of initial weight (Appel et al., 2003; Wadden, 2006). Standard in-person treatments for weight management typically consist of group-based meetings that are facilitated by a trained health professional and meet weekly or bi-weekly in groups of about 10 to 20 participants (Smith & Wing, 2000). This group-based treatment approach has been tested across a number of “gold standard” weight management trials that have demonstrated clinically significant weight outcomes (Appel et al., 2003; Espeland, 2007; Svetkey et al., 2008). Group-based treatments for weight management are largely beneficial due to social support’s demonstrated utility

as a key component of success in behavioral interventions for obesity (Wing & Jeffery, 1999).

Despite the positive outcomes demonstrated from these standard treatments, there are also a number of inherent limitations to in-person treatments for weight management (Wadden, Butryn, & Wilson, 2007). First, the in-person format of these group treatments can prove to be taxing on both time and resources. Additionally, participants may face a number of barriers to consistent therapy attendance, including constraints on availability, proximity to treatment location, transportation, and time. Because of the prevalent nature of obesity and the financial toll that it exacts, there exists a clear need for group-based weight loss interventions that can effectively reach broad populations while imposing limited constraints on time and cost. eHealth interventions have the potential to address these goals, and have gained in popularity in recent years.

1.2 eHealth Interventions for Weight Management

eHealth interventions for weight management exist in various forms, including text-messaging, interactive voice response phone calls, mobile applications, and web-based environments. The efficacy of eHealth interventions in producing clinically significant weight change has been reported in a number of recent reviews (Bennett & Glasgow, 2009; Neve, Morgan, Jones, & Collins, 2010; Weinstein, 2006). However, despite the promise of eHealth interventions for weight management, there are a

number of current challenges inherent in these interventions. Importantly, the degree of weight change in these interventions has typically been less than that found for in-person interventions conducted at the individual or group level (Neve, Morgan, & Collins, 2011). One potential reason for these findings is that the magnitude of weight change in eHealth interventions is largely dependent on the level of participant engagement with the intervention (Bennett & Glasgow, 2009; Neve et al., 2010).

Unfortunately, high rates of attrition and declining engagement over time and are both quite common in eHealth interventions. Several recent reviews have reported attrition rates of 40-50% or higher in eHealth interventions, as well as a stark decline in eHealth intervention engagement after the first few weeks of intervention (Bennett & Glasgow, 2009; Eysenbach, 2005). Given the association between engagement and weight outcomes, coupled with the low rates of engagement inherent in eHealth interventions, designing eHealth interventions that promote high engagement is a critical concern .

Investigators have employed a number of strategies to promote engagement and retention, including incentive programs, positive feedback, and human counselor support (Bennett & Glasgow, 2009). However, little is currently known about strategies that reliably promote user engagement. As Bennett and Glasgow asserted in a recent review (2009), "if site content is not continually made salient, participant interest may wane." Ultimately, there exists a need for eHealth modalities that are both engaging and interesting to participants over time.

1.3 Online Communities for Weight Management

As described above, one particularly promising area of eHealth interventions for weight management is the burgeoning availability of online communities, wherein people with shared goals and/or interests can gather online to both give and receive support. Unlike standard in-person group-based interventions for weight management, online communities for weight management are not usually created by trained interventionists; rather, they are often organically developed by Internet users with common interests and/or hosted by corporations. Further, trained facilitators are relatively uncommon in online communities for weight management; rather, these communities tend to be self-guided and heavily reliant on peer-to-peer interaction.

Despite the differences described above, there are a number of potential advantages of the use of online communities as compared with standard treatments for obesity. First, online communities may be an affordable and convenient treatment option for those seeking weight management services. As described above, various barriers exist to accessing commercial weight loss interventions, including constraints on finances, transportation, and time (Wadden et al., 2007); online communities can overcome these barriers. Online communities can be accessed at any time of day, meaning that people do not have to be concerned about fitting a potentially inconveniently timed meeting into their schedules. Additionally, participation in many online communities is free of charge, and people do not have to seek transportation in

order to participate, which eliminates many of the logistical and financial concerns associated with seeking treatment for weight management. These benefits may be particularly salient for those in more disadvantaged populations, who are at the highest risk for obesity.

In addition to the reduction or elimination of financial, transportation, and time-related barriers for participants, there are a number of other benefits that online communities may be able to provide. Some of these benefits are similar to those that can be derived from group therapy or peer-to-peer interventions. Across a variety of online communities, participants report social benefits, including sharing personal experiences and the provision and receipt of emotional and informational support, accountability, motivation, encouragement and advice. Online communities can foster a sense of recognition and belonging for community members, similar to that which might be gained from group therapy (Eysenbach et al., 2004a; Hwang et al., 2007; McCormack, 2010; Newman, Lauterbach, Munson, Resnick, & Morris, 2011).

There are also a number of unique benefits of online communities that cannot be gained from participation in group therapy or other in-person peer support interventions. First, online communities can afford people relative anonymity. This anonymity can be particularly helpful when discussing circumstances or conditions that one would normally find to be too taboo or sensitive to discuss in-person with others (Buchanan & Coulson, 2007; McCormack, 2010; Nonnecke & Preece, 2000). Similarly,

people who are reluctant to participate can gain passive support through these communities by “lurking” or reading the community information without actively adding anything. Nonnecke and Preece (2000), for example, found that almost half of subscribers to health-related e-mail lists were “lurkers” who did not post.

Online communities can also potentially facilitate access to a much wider and more heterogeneous group of people than in-person treatments, which can mean that there is the possibility for more information to be shared and learned, and greater potential for people to find others with similar goals or experiences to whom they can be accountable or give/receive advice (Newman et al., 2011). This can be particularly important for individuals who do not necessarily feel that they are receiving adequate support from their “in-person” peers, and may therefore turn to the Internet as a means of finding others who share similar goals and/or difficulties. Pagoto and colleagues (2014) found, for example, that adults who discussed their weight loss on Twitter reported more positive social influence and less negative social influence for their weight loss efforts from their online contacts (i.e., Twitter followers) as compared with their offline contacts (i.e., family, friends).

In addition to the proposed benefits of participation in an online community for weight management, there may be a number of potential downsides to such participation. Cummings and colleagues (2002), for example, have argued that, generally speaking, relationships formed online are more difficult to build and sustain than those

formed in-person. Additionally, while participants in online communities have the opportunity to give and receive support from their peers, most popular online communities lack support from a trained weight management coach or other health professional. This may adversely affect participant outcomes, as counseling and feedback from a coach can be a particularly advantageous component of weight management interventions (Khaylis, Yiaslas, Bergstrom, & Gore-Felton, 2010).

1.4 Online Communities and Social Cognitive Theory

When considering the potential benefits of online communities for weight management, it is useful to draw upon a social-cognitive framework. Social-cognitive theory is one of the most extensively used paradigms for behavior change interventions across a range of health outcomes, including weight (Anderson-Bill, Winett, & Wojcik, 2011). Broadly, social-cognitive theory asserts that the constant interactions between the individual, the environment, and behavior form the basis of human action (Figure 1).

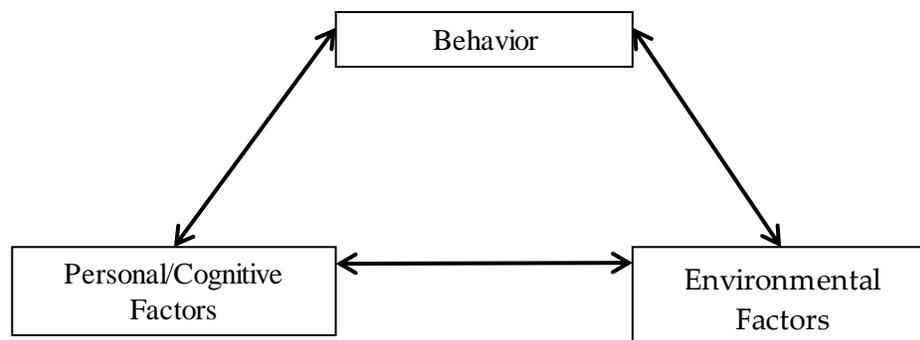


Figure 1. Basic schematic of Social Cognitive Theory

Operating within this framework, there are various theorized processes to consider when determining the likelihood of successfully accomplishing a certain goal (such as weight change). On the cognitive level, high levels of self-efficacy (or belief in one's own ability to perform certain tasks and/or achieve certain goals) and high expectations of the outcome of one's behavior are theorized to lead to higher amounts of self-regulatory behavior (such as weight control behaviors), thereby making it more likely that a person will accomplish a given goal. These theories are supported by a wealth of research demonstrating outcome expectations and self-efficacy as salient predictors of weight control behaviors and/or weight change (Finch et al., 2005; Linde, Rothman, Baldwin, & Jeffery, 2006; Shin et al., 2011; Teixeira et al., 2010). Environmentally, factors such as social support can also highly influence self-regulation, making an individual significantly more likely to achieve a desired outcome; the strong association between social support and weight change is well-established in the literature (Kindler, 2016; Wing & Jeffery, 1999).

Within the specific context of online communities for weight management, there are a number of unique ways in which the components of social-cognitive theory may boost weight control behaviors and ultimately affect weight loss outcomes. First, online community members often provide positive reinforcement to one another, as well as information about behaviors that have been helpful for their own weight management. This social communication might be beneficial for the creation of positive modeling

behaviors and it may also facilitate the communication of positive subjective norms. Such communication can also enhance a participant's sense of being "supported," thereby also potentially increasing weight control behaviors. Similarly, a perceived lack of support within one's offline community might increase motivation to receive participate within the online context; such motivation could theoretically lead to increased weight control behaviors and weight loss. Additionally, tracking the progress and weight-related behaviors of others can create a social comparison against which a person can evaluate his or her own behaviors. The ability to track others, coupled with the knowledge that others can track one's own progress, can lead to a sense of social accountability, potentially incentivizing people to behave in ways that are in accordance with other members of the group. Finally, the ability to track others' progress before even beginning one's weight loss efforts can instill a sense of self-efficacy to participate in the community, and can also produce positive expectations of one's weight loss outcomes while participating in the community, both of which would theoretically lead to positive weight outcomes.

1.5 Evidence for Online Communities

There have been a number of trials examining the effectiveness of online communities for a range of health-related concerns. A systematic review by Eysenbach and colleagues (2004) examined the health and social outcomes of health-related online

communities across a variety of conditions, including depression, social support, healthcare use, eating disorders, diabetes control, and weight loss. Ultimately, 38 studies were included in the review, including 20 randomized trials, 11 before and after studies, three non-randomized controlled trials, three meta-analyses of n of 1 trials, and one cohort study. After examining the 38 studies that were included in the review, the authors concluded that there was no robust evidence for the health benefits of online communities across all areas, nor was there any specific evidence for the effectiveness of online communities in any one area. Across the nine trials investigating the effectiveness of online communities for weight loss, results were mostly non-significant, with one trial indicating that an in-person support group produced significantly greater weight loss than an online community. Although these results provide some important and useful insights, it is difficult to generalize findings to make conclusions about the effectiveness of online communities for weight management. First, the Eysenbach review was written in 2004; the population penetration of computer technologies has grown dramatically since then, and the popularity of online communities, as well as familiarity with this modality, have both increased. Additionally, although weight loss interventions were included in the review, they were not the authors' primary focus. It is important to tease apart the efficacy of online communities for specific health conditions, as there are standard interventions for these different health conditions that may operate uniquely when delivered through an online community. Moreover, the review's methodology of

extracting generalizations across a variety of health outcomes has been established as problematic, as it “masks important variation that may be necessary to understand how to improve intervention effectiveness” (Bennett & Glasgow, 2009). Lastly, participant engagement within the online communities was not examined in the Eysenbach et al. review.

Based on the limitations described above, we conducted a systematic review (2013) to examine the effectiveness of online communities for weight loss or maintenance among overweight and obese adults. Further, we examined how participant engagement in these interventions varied as a function of study features and design, as well as the extent to which trials reported associations between engagement and weight loss outcomes. We identified nine randomized controlled trials that met the criteria for inclusion and were included in the review. Results from our systematic review indicated that most online communities were equally efficacious in promoting weight change as compared to the control arms, most of which were standard in-person group therapies for weight management. There was great heterogeneity in the reporting of engagement metrics; therefore, we were unable to make conclusions about the association between study features and engagement.

Ultimately, results from our review illuminated the potential utility of online communities as a potential alternative to standard in-person treatments for weight management. However, results also illuminated the need for future research examining

participant-level characteristics that may be associated with weight loss among those who participate in communities for weight management.

1.6 Rationale for the Present Study

While previous research provides some important information about the utility of online communities for weight management, as well as potential drawbacks, research in this area is still quite limited. Specifically, while research indicates that online communities may be effective in promoting weight loss, very little is known about the user characteristics that are associated with weight loss among those who participate in an online community. An increased understanding of these user characteristics is important, as this knowledge can help inform the design of future eHealth interventions for weight management. Such information can also allow investigators to tailor recruitment efforts towards individuals with specific characteristics.

There are numerous potential user characteristics that may be associated with successful weight management within the context of an online community. In order to begin to elucidate these characteristics, we find it useful to work within a social-cognitive framework, as described in greater detail above.

1.7 Study Aims

To summarize, this study is designed to assess the psychosocial characteristics that may be associated with weight loss among participants in an online community for

weight management. We will operate within a social-cognitive framework in order to help identify these characteristics. The specific aims and hypotheses are as follows:

Aim 1. To examine the association between participant engagement (operationalized as number of posts and type of posts) and weight outcomes among those using the online community. We hypothesize a positive association between engagement and weight outcomes, such that participants who are more highly engaged with the online community will report significantly greater weight loss, compared to those who are less engaged.

Aim 2a. To investigate the association between online community social support (as assessed by both self-report and content of replies that participants receive to their posts) and participants' weight loss outcomes. We hypothesize a positive association between social support and weight loss outcomes, such that participants who perceive greater amounts of support from the community will report significantly greater weight loss than those who report experiencing lesser amounts of support from the community.

Aim 2b. To investigate the association between participants' perceived level of offline social integration and weight loss outcomes. We hypothesize a negative association between offline social integration and weight loss outcomes, such that participants who perceive that they are less integrated within their offline communities will report significantly greater weight loss than those who perceive higher integration within their offline communities.

Aim 3. To explore the association between self-efficacy to manage weight control behaviors and weight loss outcomes. We hypothesize a positive association between baseline levels of self-efficacy and weight loss, such that participants who report higher levels of self-efficacy at baseline will report significantly greater weight loss than those who report lower levels of self-efficacy at baseline.

Aim 4. To examine the association between baseline expectations of weight loss (operationalized as percentage of weight that participants expect to lose) and weight loss outcomes. We hypothesize a positive association between weight loss expectations and weight loss outcomes, such that participants who expect to lose more weight will report significantly greater weight loss than those who expect to lose less weight.

Aim 5. To investigate the use of behavioral weight control strategies as a mediator for weight loss within the context of an online community for weight management. Given the importance of weight control behaviors for weight change, we hypothesize that the use of weight control strategies will mediate the relationship between our other variables of interest and weight loss outcomes.

2. Method

This prospective observational study investigated the psychosocial characteristics associated with weight loss among individuals participating in the online community for MyFitnessPal, a popular application and website with weight management tools. Our primary outcome of interest was weight loss after three months of participation in the community. Our independent variables were participant engagement, self-efficacy, social support (both online and offline), weight loss outcome expectations, and weight control behaviors. Each of these constructs will be described in greater detail below.

2.1 Online Community

Participants were recruited from the MyFitnessPal online community. This community was selected for our study due to its high popularity among those seeking weight management applications. The MyFitnessPal food- and exercise-tracking application has more than 80 million registered users at present, and it is currently the most popular health and fitness application in the iTunes store. The online community component of MyFitnessPal is available through both the MyFitnessPal website and its companion mobile application, thus making it highly accessible to users. Given the high number of MyFitnessPal users and the accessibility of the online community component

of the application, we anticipated that we would have a large pool of potential participants.

2.2 Participants

Participants were overweight adult men and women who were recruited from the “Introduce Yourself” sub-forum of the MyFitnessPal online community, which is a sub-forum in which new members can introduce themselves to other members of the community. To be included in the study, participants were required to complete informed consent, be at least 18 years old, be a new member of the MyFitnessPal online community, and have a baseline body mass index (BMI) that placed them into the overweight or obese weight category ($\text{BMI} \geq 25 \text{ kg/m}^2$). Participants were excluded from the study if they reported any health conditions that were contraindicated with their participation in a weight loss program (i.e., eating disorder, pregnancy, cancer diagnosis). A full list of inclusion/exclusion criteria can be found in Table 1.

Table 1. Inclusion/Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Age ≥ 18 years	BMI $< 25 \text{ kg/m}^2$
BMI $\geq 25 \text{ kg/m}^2$	Eating disorder diagnosis
New member of the online community who introduced themselves within the “Introduce Yourself” sub-forum	Other serious health conditions (e.g., current cancer diagnosis)
	Current pregnancy

2.3 Recruitment and Follow-Up Procedures

We used G*Power 3.1.7 (Faul, Erdfelder, Lang, & Buchner, 2007) to calculate statistical power. In order to have 80% power to detect a small-to-medium effect at $p < 0.05$, we needed 156 participants. Given the fact that attrition is quite common in eHealth interventions, we assumed an attrition rate of at least 25-33%, and thus planned to recruit at least 200 participants.

We recruited participants from the “Introduce Yourself” sub-forum of the MyFitnessPal online community, which is a sub-forum where new members to the community are encouraged to introduce themselves to their fellow members. From July 2015 to September 2015, we recruited 214 participants who had recently (within 2 weeks of our initial contact date) posted a new thread in this sub-forum. Participants were recruited on a rolling basis, and we followed up with each participant three months after they were initially contacted (to be described in greater detail below).

To recruit participants, we contacted individuals using the “Send Message” feature on MyFitnessPal, which produced an internal (i.e., within the MyFitnessPal application) message to participants and was also linked to participants’ e-mail accounts. The message briefly explained the rationale for the study, and participants were asked to complete a brief survey via Qualtrics online survey system and to accept a “friend request” from the researcher. Participants were also informed that they would

receive a \$5 Amazon gift code for completing each survey (for a total of \$10 in gift codes by the end of the study).

For the follow-up survey, we contacted participants using the “Send Message” feature and asked them to complete a brief survey. Those participants whom we were unable to reach through MyFitnessPal were also contacted via the e-mail address that they provided on their baseline survey. Overall, we attempted to contact participants up to 10 times within a 2-week period, using a combination of participant e-mail address and MyFitnessPal accounts.

Measures will be described in greater detail below. Briefly, in the baseline survey (Appendix A), participants were asked to provide general demographic information, as well as baseline anthropometric data (i.e., weight, height). Participants were also asked to complete measures assessing their baseline self-efficacy, as well as their expectations for weight loss. In the 3-month follow-up survey (Appendix B), we asked participants to provide their current weight, their perceptions of the support that they received within the community over the past three months, and information about their weight control behaviors over the past three months. In addition to collecting this survey data, we also collected engagement and social support data from the MyFitnessPal search engine. See Table 2 for a list of all study measures.

Table 2. Data Collection Schedule and Description of Measures

BASELINE	
Variable	Measure
Demographics and History	Self-report
Baseline Weight and Height	Self-report
Self-Efficacy	Adaptation of Weight Efficacy Lifestyle Questionnaire (Clark, Abrams, Niaura, Eaton, & Rossi, 1991) <i>Total score and 5 subscales:</i> Negative Emotions Availability Social Pressure Physical Discomfort Positive Activities
Outcome expectations	Adaptation of the Goals and Relative Weights Questionnaire (Foster, Wadden, Vogt, & Brewer, 1997) Expected weight change after 3 months in online community
Social Integration	Social Network Index (Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997) <i>3 subscales:</i> # of high contact roles # of people in social network # of embedded networks
FOLLOW-UP	
Follow-Up Weight	Self-report
Social Support	Adaptation of Perceived Health-Related Social Support from Facebook Friends Measure (Oh, Lauckner, Boehmer, Fewins-Bliss, & Li, 2013) <i>4 subscales:</i> Appraisal Support Esteem Support Emotional Support Tangible Support
Weight Control Strategies	Adaptation of Weight Control Strategies Scale (Pinto, Fava, Raynor, LaRose, & Wing, 2013) <i>Total score and 4 subscales:</i> Dietary Choices Self-monitoring Strategies Physical Activity Psychological Coping
Engagement	Total number of posts Number and categories of posts started (diet, weight, exercise, health, intro, other) Number and categories of replies received (emotional support, companionship support, informational support)

2.4 Measures

2.4.1 Sociodemographic and Historical Information

We asked participants to provide basic demographic information (i.e., gender, age, race/ethnicity, education level, marital status, and employment status).

Additionally, participants were asked to include information about current and historical weight loss treatment.

2.4.2 Anthropometric Data

At both baseline and follow-up, we asked participants to weigh themselves at home on a level surface while wearing light clothing and with their shoes removed.

Participants had the ability to report their weight using either standard (lb.) or metric (kg.) measurements. At baseline, we also asked participants to provide their height in cm. or in. so that we could calculate BMI.

2.4.3 Psychosocial Predictors of Weight Management

In order to assess for potential psychosocial predictors of weight management, participants were asked to complete several social-cognitive measures of their health-related behaviors and beliefs within the specific context of the online community. Using these measures, we gathered information about the following constructs:

2.4.3.1 Self-efficacy

Using an adapted version of the Weight Efficacy Lifestyle Questionnaire (Clark, Abrams, Niaura, Eaton, & Rossi, 1991) we provided participants with a 20-question measure to assess their baseline level of self-efficacy. Using a 10-point scale (0-not at all confident to 9-very confident), participants were asked to rate their self-efficacy for controlling their eating behaviors as a function of participating in the community (i.e., "By participating in the MyFitnessPal online community, I am confident that I can..."). In addition to generating a total self-efficacy score, this measure addresses five categories of self-efficacy: Negative Emotions (i.e., self-efficacy for managing eating behavior when experiencing negative emotions, e.g., "I can resist eating when I am anxious."); Availability (i.e., self-efficacy for managing eating behavior when food is highly available, e.g., "I can resist eating even when I am at a party."); Social Pressure (i.e., self-efficacy for managing eating behavior when feeling pressured by others, e.g., "I can resist eating even when I think others will be upset if I don't eat."); Physical Discomfort (i.e., self-efficacy for managing eating behavior when experiencing physical discomfort, e.g., "I can resist eating even when I have a headache."); Positive Activities (i.e., self-efficacy for managing eating behavior when engaging in pleasant activities, e.g., "I can resist eating when I am watching TV.").

2.4.3.2 Outcome Expectations

Using questions adapted from the Goals and Relative Weights Questionnaire (Foster, Wadden, Vogt, & Brewer, 1997), we asked participants to indicate what they believed they would weigh after three months of participating in the online community. We then calculated the percentage of baseline weight that participants expected to lose after three months of participation.

2.4.3.3 Social Support in the Online Community

On the follow-up survey, we administered an adapted version of the Perceived Health-Related Social Support from Facebook Friends Measure (Oh et al., 2013). Using a 7-point scale (1-definitely false, 7-definitely true), participants were asked to rate the support that they have received within the context of the community. Four traditional domains of support are assessed in this measure: appraisal support (e.g., "If I have a weight-related problem, the members of the community will give objective feedback to me about how I'm handling my problem"), esteem support (e.g., "If I have a weight-related problem, the members of the community will show confidence in my ability to deal with that problem"), emotional support (e.g., "If I have a weight-related problem, the members of the community will provide encouragement to me.") and tangible support (e.g., "If I have a weight-related problem, the members of the community will buy me medicine if I ask them").

2.4.3.4 Social Integration

In order to assess for baseline social integration outside of the online community, participants were asked to complete the Social Network Index (Cohen et al., 1997), a brief measure that assesses participation in 12 kinds of social relationships. Three categories of social integration were assessed: number of high contact roles (i.e., number of social roles in which the participant has regular contact), number of people in social network (i.e., total number of people with whom the participant has regular contact), and number of embedded networks (i.e., number of different network domains in which a participant is active).

2.4.3.5 Weight Control Strategies

On the follow-up survey, we administered an adapted version of the Weight Control Strategies Scale (Pinto et al., 2013), a self-report measure of the use of specific behaviors thought to facilitate weight loss. In addition to providing a total weight control strategies score, four domains of behavior are assessed in the measure: dietary choices (e.g., "I had several servings of fruits and/or vegetables each day"), self-monitoring strategies (e.g., "I weigh myself daily"), physical activity (e.g., "I scheduled exercise into my day"), and psychological coping (e.g., "If I got off track with my eating or exercise, I encouraged myself by thinking positively"). Using a 5-point scale (1-never or hardly ever, 5-always or almost always), participants were asked to indicate the frequency with which they engaged in certain behaviors over the past three months.

2.4.4 Other measures

2.4.4.1 Engagement

We defined participant engagement in a number of ways. First, we examined the raw number of posts each participant made to the MyFitnessPal online community during the three-month study period. To gain a more nuanced understanding of the content and quality of participants' engagement within the online community, we also coded the topic of posts that participants initiated in the online community (i.e., whenever the participant started a new thread).

We developed our coding categories using both theory-driven and data-driven approaches. Specifically, we initially developed coding categories a priori based on our hypotheses about post topics within the online community, and then refined these categories after coding all of our data one time. We then recoded all of our engagement data using this refined set of categories. Because each initial post largely fell into one primary category, we only selected one category for any given post (i.e., we selected the dominant category for any given post). Our initial coding categories for initial posts were as follows: introduction (i.e., participant introduces him/herself), diet (posts related to nutrition and/or specific dieting programs), exercise (posts related to physical fitness), weight (posts related to weight loss progress and/or questions about weight loss), health (posts that that were related to overall health), and other (posts that did not fit into any of the above categories).

One coder (IL) coded all posts, while a second coder (EY) coded 20% of posts for fidelity. We calculated Cohen's Kappa to assess for interrater reliability, and resolved all disagreements by discussion and/or recoding.

2.4.4.2 Replies as a Measure of Social Support

Using the same coding strategy described above, we coded replies that participants received to their initial posts. During our first round of coding, we discovered that the majority of replies participants received were supportive in nature and fell into one of two support categories: emotional support (i.e., providing validation of participants' experiences, "cheerleading" the participant, offering to "friend" the participant, etc.) and informational support (i.e., providing information to answer a question the participant posed). Posts that did not fall within either of these two categories (i.e. "Other" posts) were largely either off-topic or continued the conversation without explicitly providing any type of support. Consistent with our coding of initial posts, we only coded one category for each reply (i.e., the dominant category), as we found that replies easily fell into one of our three categories (i.e., emotional support, informational support, and other).

2.5 Analyses

Data analyses were conducted using SPSS Version 23 (SPSS Inc., Chicago, IL, USA). First, we calculated descriptive statistics for all of our variables of interest. In

order to address Aims 1 through 4, we conducted multiple regression analyses to assess the association between each of our variables of interest and follow-up weight. In addition to adjusting for baseline weight. We also adjusted for any sociodemographic variables that were found to significantly affect the regression coefficient for our variable of interest when they were added to the model (i.e., variables that caused a change of at least 10% in the parameter estimate for our variable of interest). For each of our models, we assessed linearity through visual inspection of partial regression plots and a plot of studentized residuals against the predicted values. We assessed independence of residuals by evaluating whether the Durbin-Watson statistic was significantly different than 2.00. We assessed homoscedasticity by visual inspection of a plot of studentized residuals versus unstandardized predicted values. Multicollinearity was assessed by evaluating whether any tolerance values were greater than 0.1. We assessed whether there were any studentized deleted residuals greater than ± 3 standard deviations and determined whether to remove these data from the model. We also inspected any data that had a Cook's distance above 1, significant Mahalanobis distance value, or leverage value greater than $(3(k+1/n))$. Values that were deemed as highly influential were removed from our analyses. Finally, we assessed the assumption of normality by visual inspection of a Q-Q Plot.

For Aim 5 (assessing weight control strategies as a mediator between each of our other variables of interest and outcome weight), we utilized the PROCESS macro in SPSS

(Hayes, 2012). We used 10,000 bootstrapping samples for each of our models and included the same covariates that we had included in our original regression analyses. Significance of indirect effects was assessed by inspection of bias-corrected confidence intervals.

Finally, in order to account for the limitations inherent in collecting self-reported weight, conducted follow-up sensitivity analyses in which we adjusted for under-estimation of weight in our models (using procedures identified by Mozumdar & Liguori (2016)) in order to determine whether our results significantly differed from those those we originally obtained.

3. Results

3.1 Recruitment and Retention Results

Recruitment and retention rates are reported in Figure 2. We sent recruitment messages to 1973 MFP members with introductory posts in the “Introduce Yourself” sub-forum of MFP. 11.75% of MFP members that we contacted (n = 232) completed (or attempted to complete) the baseline survey¹. Of those, 18 individuals were screened out for meeting our exclusion criteria. Thus, we had 214 eligible participants who completed the baseline survey. Of those, 131 participants (61.21% of our sample) completed the 3-month follow-up survey.

¹ Given limitations in messaging capabilities within the MyFitnessPal website, participants were required to reply to our initial message before receiving the URL to complete the survey, which represented an additional step (and potential barrier) to survey completion.

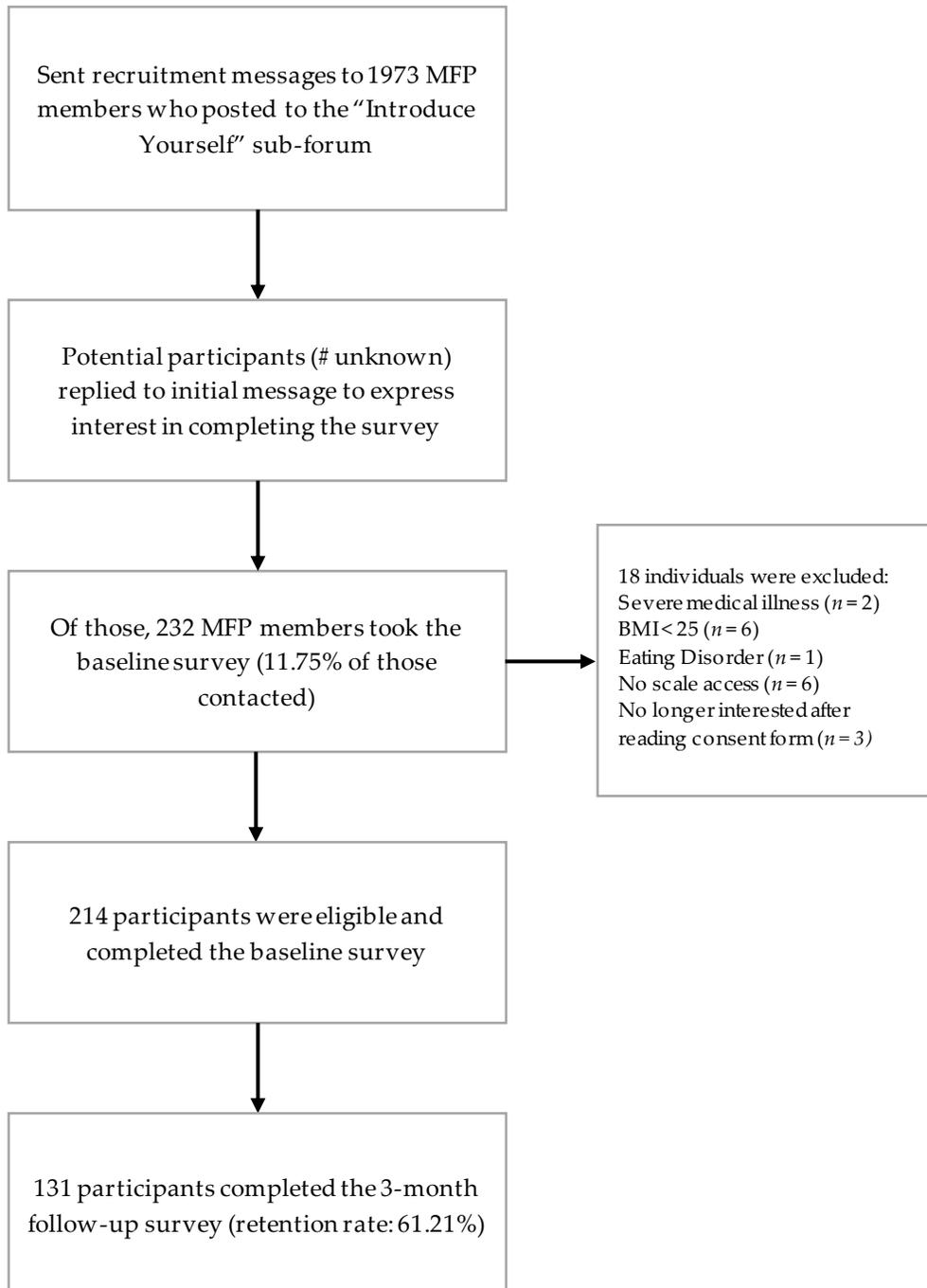


Figure 2. Recruitment and Retention Flowchart

3.2 Baseline Characteristics of All Study Participants

Baseline sociodemographic characteristics are reported in Table 3. Our sample predominantly consisted of White (non-Hispanic) married female participants. Participants had a mean age of 36 years (± 12.0). Average baseline weight across all participants was 104.82 kg. (± 27.21) and average baseline BMI was 38.42 kg./m² (± 11.0).

Table 3. Baseline Characteristics of All Study Participants

Characteristic	M(S.D.) or N(%)
Sex	
<i>Male</i>	29 (13.4%)
<i>Female</i>	185 (86.4%)
Race	
<i>White</i>	169 (79.0%)
<i>Black</i>	23 (10.7%)
<i>Other</i>	22 (10.3%)
Ethnicity	
<i>Hispanic or Latino/Latina</i>	17 (7.8%)
<i>Not Hispanic or Latino/Latina</i>	197 (90.8%)
Education	
<i>Some college or less</i>	101 (47.2%)
<i>Associate's degree or more</i>	113 (52.8%)
Employment	
<i>Employed</i>	149 (69.6%)
<i>Unemployed</i>	80 (37.4%)
Marital Status	
<i>Married/Domestic partnership</i>	134 (61.8%)
<i>Not Married</i>	80 (37.4%)
Age (yrs.)	36.48 \pm 12.0
Weight (kg.)	104.82 (27.21)
BMI (kg/m²)	38.42 (11.0)

3.3 Baseline Characteristics of Study Completers and Non-Completers

Baseline characteristics of participants who completed the 3-month follow-up survey (i.e., “completers”) and those who did not complete the follow up survey (i.e., “non-completers”) are presented in Table 4. Overall, participants who completed the follow-up survey lost an average of 4.55 kg. (± 8.06). Differences between groups were computed using chi-square tests (for categorical variables) or independent t-tests (for continuous variables). Those with higher education levels were significantly more likely to be completers than those with lower education levels, $\chi^2(1) = 6.154, p = .013$. However, the strength of this association was weak, $\phi = -.170$. We found no other significant differences between completers and non-completers on any other baseline sociodemographic variables.

Table 4. Baseline and Follow-Up Characteristics of Study Completers and Non-Completers

Characteristic	Completers N(%) or M(S.D.)	Non-Completers N(%) or M(S.D.)	<i>p</i> -value
Sex			
<i>Male</i>	19 (8.9%)	10 (4.7%)	0.61
<i>Female</i>	113.2 (52.3%)	73 (34.1%)	
Race			
<i>White</i>	103.55 (47.7%)	67 (31.3%)	0.62
<i>Black</i>	15 (7.0%)	8 (3.7%)	0.68
<i>Other</i>	14 (6.5%)	8 (2.7%)	0.81
Ethnicity			
<i>Hispanic or Latino/a</i>	11 (5.1%)	6 (2.8%)	0.76
<i>Not Hispanic or Latino/a</i>	120 (56.1%)	77 (36.0%)	
Education			
<i>Some college or less</i>	53 (24.8%)	48 (22.4%)	0.01*
<i>Associate's degree or more</i>	78 (36.4%)	35 (16.4%)	
Employment			
<i>Employed</i>	87 (40.7%)	62 (29.0%)	0.20
<i>Unemployed</i>	44 (20.6%)	21 (9.8%)	
Marital Status			
<i>Married/Domestic partnership</i>	82 (38.3%)	52 (24.3%)	0.99
<i>Not Married</i>	49 (22.9%)	31 (14.5%)	
Age (yrs.)	35.76 (11.56)	37.60 (12.64)	0.28
Baseline Weight (kg.)	106.74 (27.55)	101.80 (26.55)	0.19
Baseline BMI (kg/m²)	38.66 (10.27)	38.04 (12.10)	0.69
Follow-Up Weight (kg.)	102.19 (27.70)		
Follow-Up BMI (kg/m²)	36.99 (10.18)		
Weight Change (kg. lost)	4.55 (8.06)		
<i>Note. *p<.05</i>			

3.4 Engagement

Cumulatively, participants initiated posts (i.e., started a new thread) 335 times (Table 5) over the 3-month period. On average, each participant initiated 1.57 (± 1.52) posts. The majority of posts initiated by participants (58.51%) were introductory posts. Participants also replied to others' posts within the online community. Overall, participants wrote 1318 replies to others' posts; on average, each participant wrote 6.16 (± 18.66) replies to other community members' posts. When considering both initiated posts and replies to others' posts, participants cumulatively wrote 1653 total posts. On average, each participant wrote 7.72 (± 19.62) total posts over the 3-month period. Over one-third of participants (33.6%) wrote a total of 1 post or less within the online community. There was a high amount of variability in total posts, with a range of 0-228 total posts for individual participants.

Table 5. Descriptive Statistics of Engagement for All Study Participants

	<i>N</i> (%) or <i>M</i> (<i>S.D.</i>)	Median	Range	Interquartile Range	Total
Posts initiated by participants	1.57 (1.52)	1.00	0-11	1.00	335
Replies participants wrote to others' posts	6.16 (18.66)	2.00	0-220	4.00	1318
Total posts by participants (initiated + replies)	7.72 (19.62)	3.0	0-228	5.00	1653
Categories of posts initiated by participants					<i>N</i>(%)
Intro posts	.92 (.58)	1.00	0-4	0.00	196 (58.51%)
Diet-related posts	.23 (.64)	.00	0-5	0.00	49 (14.63%)
Exercise-related posts	.07 (.29)	.00	0-2	0.00	15 (4.48%)
Weight-related posts	.13 (.52)	.00	0-6	0.00	28 (8.36%)
Health-related posts	.04 (.30)	.00	0-26	0.00	8 (2.39%)
Other posts	.18 (.64)	.00	0-6	0.00	39 (11.64%)

3.4.1 Association Between Number of Total Posts and Weight Loss

As described above, there was significant variability in the total number of posts, with over one-third of participants writing one post or less over the 3-month period. Given the highly skewed distribution of this variable, total # of posts was analyzed as a tertile predictor (with 3 categories: 0-1 posts, 2-4 posts, 5 or more posts). We found no significant association between number of posts and weight loss (Table 6).

Table 6. Association Between Number of Total Posts and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	-1.07 (-5.56, 3.42)	2.27	
Gender (ref = females)	-1.15 (-4.17, 1.87)	1.53	-.02
Education (ref = Associates Degree or more)	.14 (-2.05, 2.34)	1.11	.00
Baseline Weight	.98 (.94, 1.02)	.02	.98***
2-4 total posts (ref = 0 posts)	-1.79 (-4.49, .91)	1.36	-.03
5 or more total posts (ref = 0 posts)	-1.60 (-4.21, 1.00)	1.31	-.03
<i>Note.</i> † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient			

3.4.2. Association Between Initiated Posts and Weight Loss

Given that over half of posts initiated by participants were introductory in nature, we also assessed the association between number of non-introductory posts and weight loss. Given this variable's highly skewed distribution, we analyzed this variable as a dichotomous categorical predictor (i.e., 0 non-introductory posts, at least 1 non-introductory post). We found no significant association between number of non-introductory posts to the community and weight loss, after adjusting for baseline weight, gender, and education level (Table 7).

Table 7. Association Between Non-Introductory Posts and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	-1.87	2.27	
Gender (ref = females)	-1.03 (-4.08, 2.02)	1.54	-.01
Education (ref = Associates Degree or more)	-.034 (-2.23, 2.17)	1.11	-.00
Baseline Weight	.98 (.94, 1.02)	.021	.98***
1 or more non-introductory posts (ref = 0 non-introductory posts)	-.74 (-3.89, 2.39)	1.58	-.01
<i>Note.</i> † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient			

3.5 Social Support/Social Integration

3.5.1 Association Between Social Integration and Weight Loss

We found no significant association between any of the three subscales of social integration (i.e., number of high contact roles, number of people in social networks, and number of embedded networks) and weight loss, after adjusting for covariates (Table 8).

Of note, there is no total score provided for this measure.

Table 8. Association Between Offline Social Integration and Weight Loss

# of embedded networks				# of high contact roles				# of people in social network			
Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	1.64	2.45		Intercept	1.54	2.89		Intercept	1.49	2.60	
	(-3.20, 6.48)				(-4.18, 7.27)				(-3.65, 6.63)		
Gender (ref = females)	-0.13	1.55	-0.00	Gender (ref = females)	-0.15	1.57	-0.00	Gender (ref = females)	-0.14	1.58	-0.00
	(-3.20, 2.50)				(-3.26, 2.97)				(-3.28, 3.00)		
Baseline Weight	0.94	0.02	0.96***	Baseline Weight	0.95	0.02	0.97***	Baseline Weight	0.95	0.02	0.96***
	(.91, .99)				(.91, .99)				(.91, .99)		
Race: Black (ref = White)	3.49	1.78	0.04†	Race: Black (ref = White)	2.83	1.73	0.03	Race: Black (ref = White)	3.49	1.78	0.04†
	(-.039, 7.012)				(-.60, 6.25)				(-.037, 7.02)		
Race: Other (ref = White)	-2.96	1.71	-0.03†	Race: Other (ref = White)	-2.93	1.72	-0.03†	Race: Other (ref = White)	-2.96	1.72	-0.03†
	(-6.35, .43)				(-6.34, .48)				(-6.35, .44)		
# of embedded networks	-0.16	0.5	-0.01	# of high contact roles	-0.07	0.31	-0.01	# of people in social network	-0.01	0.07	-0.00
	(-1.15, .82)				(-.69, .54)				(-.16, .13)		

Note. †*p* < .10, **p* < .05, ***p* < .005, ****p* < .0005; *B* = unstandardized regression coefficient; *SE_B* = standard error of the coefficient; β = standardized coefficient

3.5.2 Association Between Perceived Social Support in the Online Community and Weight Loss

After adjusting for baseline weight and race, we found a significant association between perceived esteem support and weight loss, such that a 1-unit increase in esteem support was associated with a 0.30 kg decrease in weight at follow-up ($p < .05$). We also found a significant association between perceived tangible support and weight loss, such that a 1-unit increase in tangible support was associated with a 0.45 kg decrease in weight at follow-up ($p < .05$). We found no significant association between perceived appraisal support or perceived emotional support and weight loss (Tables 9 and 10).

Table 9. Association Between Perceived Support in the Online Community and Weight Loss, Part 1

Appraisal Support				Esteem Support			
Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	0.97	2.52		Intercept	4.13	2.51	
	(-4.01, 5.95)				(-.84, 9.10)		
Race: Black (ref = White)	1.82	1.60	0.02	Race: Black (ref = White)	2.15	1.61	0.03
	(-1.35, 4.99)				(-1.04, 5.34)		
Race: Other (ref = White)	-3.31	1.73	-0.04†	Race: Other (ref = White)	-3.09	1.75	-0.03†
	(-6.74, .12)				(-6.56, .37)		
Baseline Weight	0.97	0.02	0.97***	Baseline Weight	0.96	0.02	0.97***
	(.93, 1.01)				(.92, 1.00)		
Perceived Appraisal Support	-0.17	0.13	-0.03	Perceived Esteem Support	-0.30	0.13	-0.04*
	(-.43, .09)				(-.56, -.03)		
<p><i>Note.</i> †<i>p</i> < .10, *<i>p</i> < .05, **<i>p</i> < .005, ***<i>p</i> < .0005; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient</p>							

Table 10. Association Between Perceived Support in the Online Community and Weight Loss, Part 2

Emotional Support				Tangible Support			
Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	1.35	2.64		Intercept	1.66	2.27	
	(-3.87, 6.57)				(-2.84, 6.16)		
Race: Black (ref = White)	1.71	1.61	0.02	Race: Black (ref = White)	1.85	1.57	0.02
	(-1.47, 4.88)				(-1.27, 4.96)		
Race: Other (ref = White)	-3.43	1.72	-0.04*	Race: Other (ref = White)	-2.79	1.69	-0.03
	(-6.83, -.03)				(-6.13, .55)		
Baseline Weight	0.97	0.02	0.97***	Baseline Weight	0.96	0.02	0.97***
	(.93, 1.01)				(.92, 1.01)		
Perceived Emotional Support	-0.17	0.13	-0.03	Perceived Tangible Support	-0.45	0.16	-0.06*
	(-.42, .081)				(-.76, -.14)		
<p>Note. †$p < .10$, *$p < .05$, **$p < .005$, ***$p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient</p>							

3.5.3 Association Between Replies to Posts and Weight Loss

Overall, participants received 1256 replies to their posts ($M = 5.66 \pm 14.40$) (Table 11). However, there was wide variability in amount of replies each participant received, with a range of 0-128 replies. About half of all participants (49%) received a total of one reply or less to their posts.

About half of all replies participants received were supportive in nature, while the remainder of replies fit into an “other” category (i.e., off-topic, continuing the conversation without providing additional support, etc.). Given this distribution of supportive vs. “other” replies, we examined supportive replies as a dichotomous predictor (i.e., received any (i.e., > 0) supportive replies to posts, did not receive any supportive replies to posts). We found no significant association between presence of supportive replies to posts and follow-up weight, after adjusting for baseline weight, race, and gender (Table 12).

Table 11. Numbers and Categories of Replies Received by Participants

	<i>N</i> (%) or <i>M</i> (<i>S.D.</i>)	Median	Range	Interquartile Range	Total
Total replies received by participants	5.66 (14.40)	1.00	0-128	4.00	1256
Categories of replies received by participants					<i>N</i> (%)
Emotional support	1.54 (3.70)	.00	0-26	2.00	297 (23.65%)
Informational Support	1.39 (5.10)	.00	0-54	0.00	329 (26.19%)
Other reply	2.94 (10.75)	.00	0-101	0.00	630 (50.16%)

Table 12. Association Between Supportive Replies and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	-.91 (-5.31, 3.49)	2.22	
Gender (ref = females)	-1.26 (-4.19, 1.67)	1.48	-.02
Race: Black (ref = White)	1.98 (-1.31, 5.26)	1.66	.24
Race: Other (ref = White)	-2.92 (-6.25, .41)	1.68	-.04†
Baseline Weight	.97 (.93, 1.01)	.02	.97***
1 or more supportive replies (ref = 0 supportive replies)	.96 (-1.14, 3.05)	1.06	.02

Note. †*p* < .10, **p* < .05, ***p* < .005, ****p* < .0005; *B* = unstandardized regression coefficient; *SE_B* = standard error of the coefficient; β = standardized coefficient

We also categorically examined the association between number of total replies and weight loss outcomes. We examined this variable as a dichotomous predictor (i.e., 0-1 replies, more than 1 reply). We found no significant association between number of replies to posts and follow-up weight, after adjusting for baseline weight, age, and race (Table 13).

Table 13. Association Between Number of Replies to Posts and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	-1.54 (-7.12, 4.04)	2.82	
Age	.02 (-.07, .11)	.05	.01
Race: Black (ref = White)	2.11 (-1.20, 5.42)	1.67	.03
Race: Other (ref = White)	-2.70 (-6.06, .65)	1.70	-.03
Baseline Weight	.97 (.92, 1.01)	.02	.96***
More than 1 reply (ref = 0-1 replies)	.51 (-1.59, 2.61)	1.06	.01
Note. † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient			

3.6 Self-Efficacy

3.6.1 Association between self-efficacy and weight outcomes

We found no significant association between total self-efficacy and weight loss, after adjusting for baseline weight and race (Table 14).

Table 14. Association Between Total Self-Efficacy and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	2.30 (-4.55, 9.15)	3.46	
Race: Black (ref = White)	1.47 (-1.92, 4.85)	1.71	0.02
Race: Other (ref = White)	-2.77 (-6.12, .57)	1.69	-0.03
Baseline Weight	0.96 (.92, 1.00)	0.02	.96***
Total Self-Efficacy	-0.02 (-.05, .02)	0.02	-0.02

Note. † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$; *B* = unstandardized regression coefficient; *SE_B* = standard error of the coefficient; β = standardized coefficient

We found a significant association between availability self-efficacy and weight loss, after adjusting for race and baseline weight. Specifically, each 1-unit increase in availability self-efficacy was associated with a 0.14 kg. decrease in weight at follow-up ($p < .05$).

We found no significant association between negative emotions self-efficacy and weight loss, after adjusting for race, gender, and baseline weight. We also found no

significant association between social pressure self-efficacy and weight loss, after adjusting for race and baseline weight. Finally, we found no significant association between physical discomfort self-efficacy and weight loss, after adjusting for race and baseline weight. Regression coefficients and standard errors can be found in Tables 15 and 16.

Table 15. Associations Between Self-Efficacy Subscales and Weight Loss, Part 1

Negative Emotions				Availability			
Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	-1.71	3.47		Intercept	3.45	2.84	
	(-8.57, 5.15)				(-2.17, 9.06)		
Race: Black (ref = White)	1.78	1.67	0.02	Race: Black (ref = White)	1.22	1.63	0.02
	(-1.52, 5.09)				(-2.00, 4.45)		
Race: Other (ref = White)	-2.57	1.77	-0.03	Race: Other (ref = White)	-2.67	1.66	-0.03
	(-6.07, .93)				(-5.95, .61)		
Gender (ref = female)	0.91	1.54	0.01				
	(-2.15, 3.96)						
Baseline Weight	0.97	1.54	0.01***	Baseline Weight	0.96	0.02	0.96***
	(.93, 1.01)				(.92, 1.00)		
Negative Emotions	0.01	0.06	0.00	Availability	-0.14	0.06	-0.04*
	(-.11, .13)				(-.27, -.01)		
<p><i>Note.</i> †$p < .10$, *$p < .05$, **$p < .005$, ***$p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient</p>							

Table 16. Associations Between Self-Efficacy Subscales and Weight Loss, Part 2

Social Pressure				Physical Discomfort			
Variable	<i>B</i>	<i>SE_B</i>	β	Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	1.02	2.88		Intercept	2.37	3.16	
	(-4.67, 6.71)				(-3.90, 8.63)		
Race: Black (ref = White)	1.89	1.75	0.02	Race: Black (ref = White)	2.01	1.71	0.02
	(-1.58, 5.35)				(-1.37, 5.39)		
Race: Other (ref = White)	-2.77	1.70	-0.03	Race: Other (ref = White)	-2.91	1.72	-0.03†
	(-6.13, .60)				(-6.32, .50)		
Baseline Weight	0.96	0.02	0.96***	Baseline Weight	0.96	0.02	0.96***
	(.92, 1.00)				(.91, .99)		
Social Pressure	-0.06	0.07	-0.02	Physical Discomfort	-0.04	0.07	-0.01
	(-.19, .07)				(-.18, .10)		

Note. † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$; *B* = unstandardized regression coefficient; *SE_B* = standard error of the coefficient; β = standardized coefficient

3.7 Outcome Expectations

3.7.1 Association between outcome expectations and weight loss

We found a significant association between follow-up weight and percent weight that participants expected to lose at baseline (Table 17), after adjusting for race and baseline weight. Specifically, each 1-unit increase in percent weight that participants expected to lose was associated with a 0.27 kg. decrease in follow-up weight ($p < .05$).

Table 17. Association Between Outcome Expectations and Weight Loss

Variable	<i>B</i>	<i>SE_B</i>	β
Intercept	2.81 (-2.22, 7.83)	2.54	
Race: Black (ref = White)	2.60 (-.66, 5.86)	1.65	0.03
Race: Other (ref = White)	-1.61 (-4.92, 1.71)	1.67	-0.02
Baseline Weight	0.96 (.92, 1.00)	0.02	.96***
Percent Weight Expected to Lose	-0.27 (-.48, -.07)	0.10	-.05*
<p>Note. †$p < .10$, *$p < .05$, **$p < .005$, ***$p < .0005$; <i>B</i> = unstandardized regression coefficient; <i>SE_B</i> = standard error of the coefficient; β = standardized coefficient</p>			

3.8 Weight Control Behaviors

Results of our mediation analyses can be found in Tables 18-20. We found no significant indirect effect of total number of posts on weight loss through weight control behaviors, $b = .021$, BC_a CI [-1.170, 1.232]. Additionally, we found no significant indirect effect of number of non-introductory posts on weight loss through weight control behaviors, $b = .06$, BC_a CI [-.1.55, 1.84].

We also found no significant indirect effect of number of high contact roles ($b = -.054$, BC_a CI [-.2971, .2044]), size of social network ($b = -.003$, BC_a CI [-.062, .055]), or number of embedded networks ($b = .015$, BC_a CI [-.3492, .3996]) on weight loss through weight control behaviors.

We found a significant indirect effect of esteem support on weight loss through weight control behaviors (Figure 3). Participants who perceived greater esteem support were more likely to engage in weight control behaviors than those who perceived lower esteem support ($a = .039$), and participants who engaged in greater weight control behaviors had lower follow-up weight ($b = -3.26$). A bias-corrected confidence interval for the indirect effect ($ab = -.128$) was entirely below zero (-.268, -.012). There was no evidence that esteem support influenced follow-up weight independent of its effect on weight control behaviors ($c' = -.171$, $p = .173$).

We also found a significant indirect effect of emotional support on weight loss through weight control behaviors (Figure 4). Participants who perceived greater

emotional support were more likely to engage in weight control behaviors than those who perceived lower emotional support ($a = .036$), and participants who engaged in greater weight control behaviors had lower follow-up weight ($b = -3.42$). A bias-corrected confidence interval for the indirect effect ($ab = -.123$) was entirely below zero ($-.2637, -.0101$) There was no evidence that emotional support influenced follow-up weight independent of its effect on weight control behaviors ($c' = -.048, p = .68$).

Additionally, we found a significant indirect effect of tangible support on weight loss through weight control behaviors (Figure 5). Participants who perceived greater tangible support were more likely to engage in weight control behaviors than those who perceived lower tangible support ($a = .044$), and participants who engaged in greater weight control behaviors had lower follow-up weight ($b = -3.344$). A bias-corrected confidence interval for the indirect effect ($ab = -.145$) was entirely below zero ($-.299, -.023$) There was no evidence that tangible support influenced follow-up weight independent of its effect on weight control behaviors ($c' = -.280, p = .051$).

We found no significant indirect effect of appraisal support on weight loss through weight control behaviors, $b = -.075$, BC_a CI $[-.238, .022]$. We also found no significant indirect effect of supportive replies ($b = -0.31$, BC_a CI $[-1.35, 0.58]$) or total number of replies ($b = -0.28$, BC_a CI $[-1.39, 0.65]$) on weight loss through weight control behaviors.

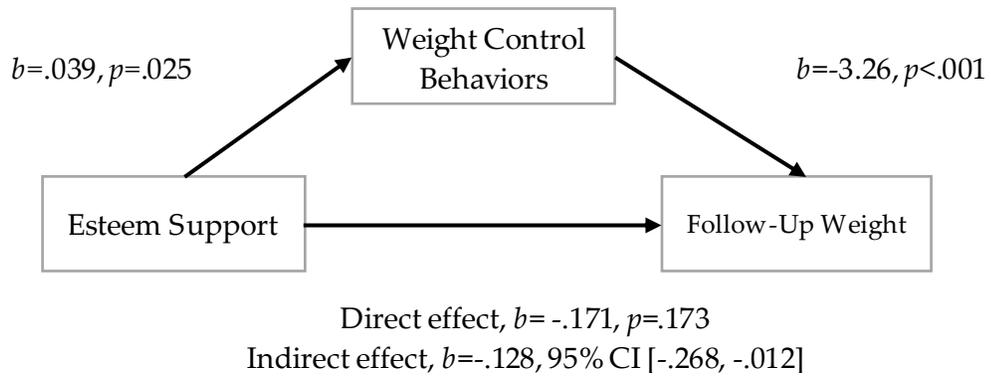


Figure 3. Esteem Support on Weight Loss Through Weight Control Behaviors

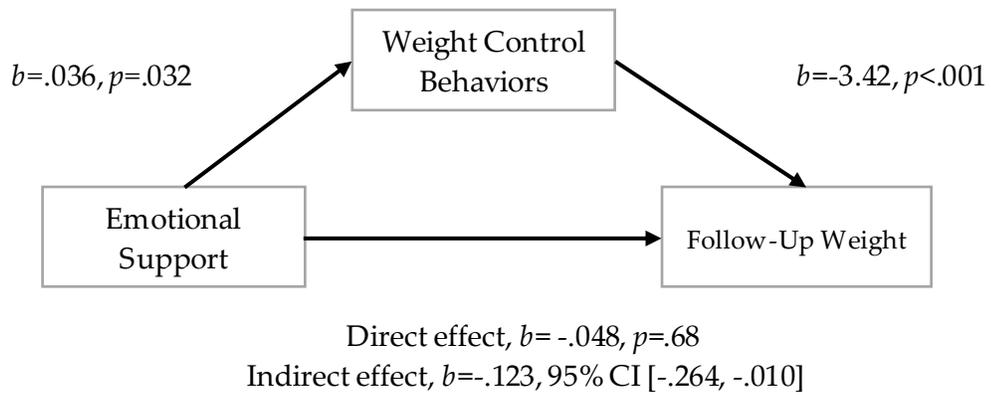
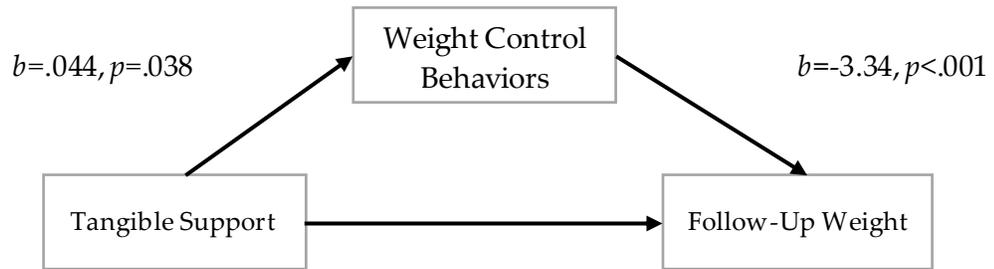


Figure 4. Emotional Support on Weight Loss Through Weight Control Behaviors



Direct effect, $b = -.280, p = .051$
Indirect effect, $b = -.145, 95\% \text{ CI } [-.299, -.023]$

Figure 5. Tangible Support on Weight Loss through Weight Control Behaviors

We found a significant indirect effect of each of our self-efficacy subscales (including our total self-efficacy score) on weight loss through weight control behaviors. Total Score: $b = -.026$, BC_a CI [-.044, -.012] (Figure 6); Availability: $b = -.076$, BC_a CI [-.143, -.025] (Figure 7); Negative Emotions: $b = -.072$, BC_a CI [-.139, -.014] (Figure 8); Social Pressure: $b = -.076$, BC_a CI [-.141, -.024] (Figure 9); Positive Emotions: $b = -.073$, BC_a CI [-.163, -.007] (Figure 10); Physical Discomfort: $b = -.090$, BC_a CI [-.1740, -.031] (Figure 11). Specifically, across all measures of self-efficacy, participants who reported greater self-efficacy at baseline engaged in greater weight control behaviors than those who reported lower self-efficacy at baseline, and participants who engaged in greater weight control behaviors had lower follow-up weight. All bias-corrected confidence intervals for indirect effects were entirely below zero, and there was no evidence that any of the self-efficacy subscales influenced follow-up weight independent of their effect on weight control behaviors.

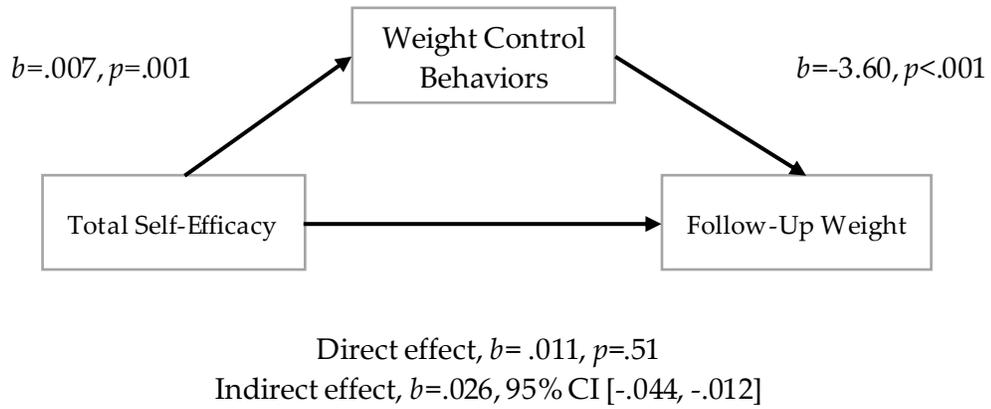


Figure 6. Total Self-Efficacy on Weight Loss Through Weight Control Behaviors

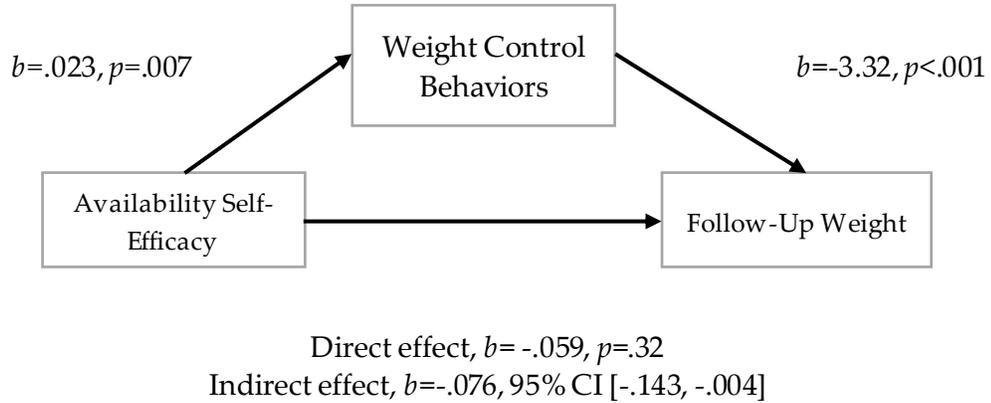
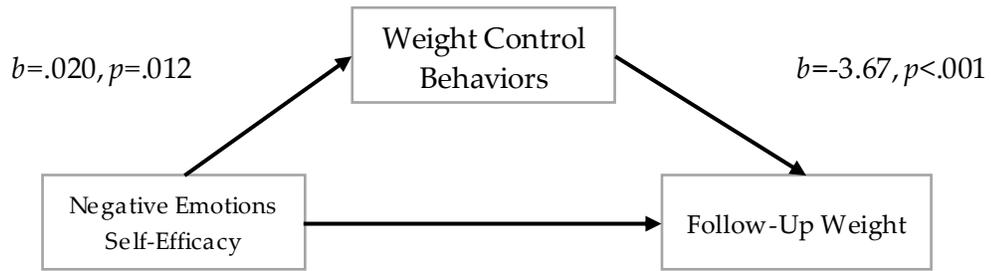
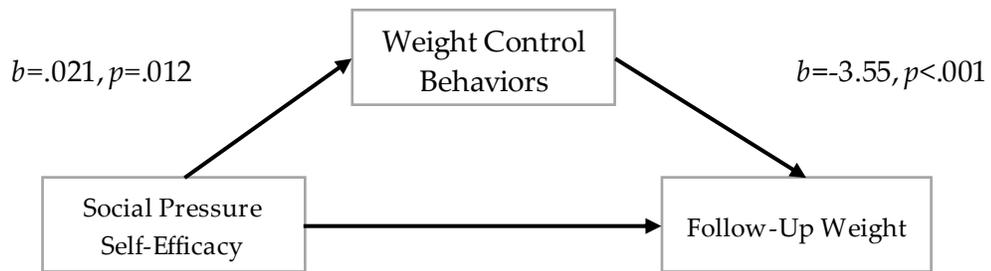


Figure 7. Availability Self-Efficacy on Weight Loss through Weight Control Behaviors



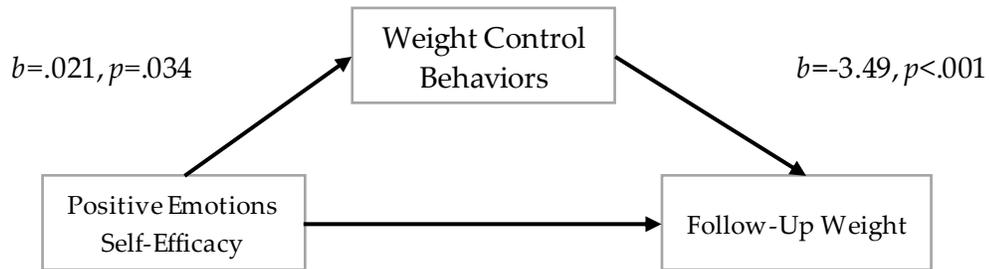
Direct effect, $b= .081, p=.145$
 Indirect effect, $b=-.072, 95\% \text{ CI } [-.139, -.014]$

Figure 8. Negative Emotions Self-Efficacy on Weight Loss through Weight Control Behaviors



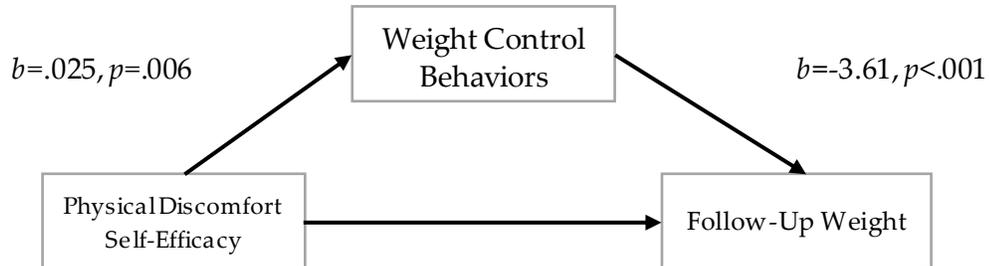
Direct effect, $b=.025, p=.432$
 Indirect effect, $b=-.076, 95\% \text{ CI } [-.141, -.024]$

Figure 9. Social Pressure Self-Efficacy on Weight Loss Through Weight Control Behaviors



Direct effect, $b = -.004, p = .961$
 Indirect effect, $b = -.073, 95\% \text{ CI } [-.163, -.007]$

Figure 10. Positive Emotions Self-Efficacy on Weight Loss through Weight Control Behaviors



Direct effect, $b = -.070, p = .291$
 Indirect effect, $b = -.090, 95\% \text{ CI } [-.174, -.031]$

Figure 11. Physical Discomfort Self-Efficacy on Weight Loss through Weight Control Behaviors

We found no significant indirect effect of expected weight loss on weight loss through weight control behaviors, $b = -.073$, BC_a CI [-.200, .011].

Table 18. Mediation Results, Part 1

	Independent Variable (X)	Mediating Variable (M)	Dependent Variable (Y)	Effect of X on M (a)	Effect of M on Y (b)	Direct Effect (c')	Indirect Effect (ab)	95% CI of Indirect Effect	Total Effect (c)
Engagement	Total number of posts	Weight Control Behaviors	Follow-up weight	-0.01	-3.69***	-0.23	0.02	(-1.17, 1.23)	-0.21
	Number of non-introductory posts (0 vs. > 0)	Weight Control Behaviors	Follow-up weight	-0.02	-3.67***	-0.65	0.06	(-1.55, 1.84)	-0.59
Social Integration	Number of high contact roles	Weight Control Behaviors	Follow-up weight	0.02	-3.37***	0.02	-0.05	(-.30, .20)	-0.03
	Number of social networks	Weight Control Behaviors	Follow-up weight	0.00	-3.40***	-0.01	-0.00	(-.06, .06)	-0.01
	Number of embedded networks	Weight Control Behaviors	Follow-up weight	-0.00	-3.40***	-0.2	0.02	(-.35, .40)	-0.18
Social Support	Emotional Support	Weight Control Behaviors	Follow-up weight	0.04*	-3.42***	-0.05	-0.12*	(-.26, -.01)	-0.17
	Esteem Support	Weight Control Behaviors	Follow-up weight	0.04*	-3.36***	-0.17	-0.13*	(-.27, -.01)	-0.3*

Note. tp < .10, *p < .05, **p < .005, ***p < .0005

Table 19. Mediation Results, Part 2

	Independent Variable (X)	Mediating Variable (M)	Dependent Variable (Y)	Effect of X on M (a)	Effect of M on Y (b)	Direct Effect (c)	Indirect Effect (ab)	95% CI of Indirect Effect	Total Effect (c)
Social Support	Tangible Support	Weight Control Behaviors	Follow-up weight	0.04*	-3.32***	-0.28†	-0.15*	(-.30, -.02)	-.42*
	Appraisal Support	Weight Control Behaviors	Follow-up weight	0.03	-3.42***	-0.08	-0.1	(-.24, .02)	-0.17
	Total number of replies (0-1 vs. >1)	Weight Control Behaviors	Follow-up weight	0.08	-3.68***	0.55	-0.28	(-1.39, .65)	0.27
	Number of supportive replies (0 vs. >0)	Weight Control Behaviors	Follow-up weight	0.09	-3.52***	1.06	-0.31	(-1.35, 0.58)	0.75
Self-Efficacy	Total Self-Efficacy	Weight Control Behaviors	Follow-up weight	.01**	-3.60***	0.01	-0.03*	(-.04, -.01)	-0.02
	Availability	Weight Control Behaviors	Follow-up weight	.03*	-3.32***	-0.06	-.08*	(-.14, -.02)	-0.13*

Note. †p < .10, *p < .05, **p < .005, ***p < .0005

Table 20. Mediation Results, Part 3

	Independent Variable (X)	Mediating Variable (M)	Dependent Variable (Y)	Effect of X on M (a)	Effect of M on Y (b)	Direct Effect (c')	Indirect Effect (ab)	95% CI of Indirect Effect	Total Effect (c)
Self-Efficacy	Negative Emotions	Weight Control Behaviors	Follow-up weight	.02*	-3.67***	0.08	-0.07*	(-14, -.01)	0.01
	Social Pressure	Weight Control Behaviors	Follow-up weight	.02*	-3.55***	0.02	-0.08*	(-14, -.02)	-0.05
	Positive Emotions	Weight Control Behaviors	Follow-up weight	0.02*	-3.49***	-0.00	-0.07*	(-16, -.01)	-0.08
	Physical Activity	Weight Control Behaviors	Follow-up weight	0.02*	-3.61***	0.07	-0.09*	(-17, -.03)	-0.02
Outcome Expectations	Percent Weight Loss Expected	Weight Control Behaviors	Follow-up weight	0.02*	-3.18***	-0.18†	-0.07	(-.20, .01)	-0.25*

Note. † $p < .10$, * $p < .05$, ** $p < .005$, *** $p < .0005$

4. Discussion

Overall, results from our prospective observational study of MyFitnessPal users suggest that participants within this online community lost weight after three months of participation ($M = 4.55 \text{ kg.} \pm 8.06$). On average, participants who completed the study reported losing 4.27% of their initial weight (± 7.23) over the three-month study period. This magnitude of weight change is consistent with recent clinical guidelines suggesting that a 3% change in weight can significantly improve health outcomes (Jensen et al., 2013). Ultimately, weight change results from this study are consistent with findings from our 2013 systematic review, further suggesting that online communities can be an effective treatment for weight management.

Using a number of different metrics (i.e., total number of posts, number of non-intro posts), we found that engagement in the online community was not associated with weight loss. These results are surprising, given that a number of studies have demonstrated a strong positive association between amount of engagement in eHealth interventions and weight loss across a range of different engagement metrics (Bennett & Glasgow, 2009; Hales, Davidson, & Turner-McGrievy, 2014; M. Neve et al., 2010). While engagement is often defined as number of posts to the community, it has also been operationalized as number of log-ins to the website (Tate, Wing, & Winett, 2001; Trial, Tate, Jackvony, & Wing, 2003), number of “likes” the participant makes on posts within

the community (Hales et al., 2014), and/or frequency of participation in poll voting within the community (Hales et al., 2014). Regardless of the metric used, researchers have consistently demonstrated a strong positive association between level of engagement and weight loss. These findings are consistent with those seen in standard in-person contexts. For example, Baker and Kirschenbaum (1993) found that high engagement with keeping a food log within the context of a weight management intervention was highly predictive of weight outcomes, regardless of the actual content of the food log.

Given the existing literature on engagement and weight loss, there are a number of potential interpretations and implications of our current findings. First, while number of posts is often used as a primary measure of engagement in eHealth interventions, this measurement may not fully capture the extent of engagement within the specific context of an online community, especially in light of the fact that we found very infrequent posting behavior among our participants. There are likely many other potential measures of engagement (i.e., number and/or content of private messages, number of log-ins to the online community, amount of time spent “lurking” in the community) which may more fully assess the nature of engagement within online communities. Additionally, due to the infrequent posting behaviors of our participants, we were unable to assess *content* of posts with a high level of granularity, which is another limitation of our study. As described above, however, a wealth of data from both online

and online weight loss studies demonstrates that the mere dose of engagement is predictive of weight loss outcomes, regardless of the actual content or quality of engagement.

Our findings about the low frequency of posting behaviors run counter to other eHealth interventions that demonstrated more frequent posting behaviors amongst participants (Cussler et al., 2008; Hales et al., 2014; Turner-McGrievy & Tate, 2013). However, there are a number of differences between our study and prior studies in which eHealth engagement has been studied. First, our study was observational in nature, meaning that participants were not provided with any recommendations as to the frequency of posting behavior. It is possible that participants' posting behavior is dramatically different when they are explicitly instructed to post within the context of a weight loss intervention. Additionally, the MyFitnessPal online community likely differs from other online communities for weight loss in some meaningful ways. For example, the MyFitnessPal online community is not a standalone community; rather, it exists within the context of the larger MyFitnessPal application. Frequency of posting behaviors may differ between those who participate in standalone online communities and those who post within communities that serve as one component of a multi-component weight management application. Additionally, many of the prior studies of engagement in online communities have taken place within the context of popular social networking platforms, such as Twitter or Facebook (Hales et al., 2014; Turner-McGrievy

& Tate, 2013). Since many individuals are already frequent users of these modalities, this may have elicited more frequent posting behaviors than would an online community that is explicitly focused on weight loss. Ultimately, our engagement findings may suggest that frequent posting behavior within an online community is not essential in order for one to successfully lose weight while engaging in that community. However, further research is necessary in order to determine the optimal type/level of engagement in online communities and whether this differs by modality (i.e., message board, Facebook, standalone vs. in-app integration, etc.).

We hypothesized that those who were less integrated in their offline lives would have higher motivation to participate in the online community, and would thus lose more weight than those who were more socially integrated. We based this hypothesis on research demonstrating that people who perceive inadequate social support in their offline networks may perceive online communities as a favorable alternative for receiving health information and/or support (Chung et al., 2013; Kevin & Wright, 2016). We found, however, that social integration outside of the online community was not associated with weight loss. To our knowledge, this is the first study to examine the association between offline social integration and weight outcomes for participants in an online community. While our findings regarding social integration were counter to our initial hypotheses, they are consistent with the literature surrounding the increasing ubiquity of online communities. Given that participation in online communities has

become quite normative, it stands to reason that one's social integration (or lack thereof) would not substantially affect one's motivation to participate in an online community (thereby affecting weight outcomes). These findings suggest that individuals can potentially have successful weight loss experiences within online communities regardless of their level of social integration outside of the online community. One limitation of our methodology for this aim is that our measure did not directly assess one's perceived level of *support* within his or her offline social network, nor did it assess perceived *stigma* from offline contacts. It is possible that one could be highly integrated within one's offline community, while perceiving stigma from others and/or not being highly satisfied with the quality of support received from others. Thus, a more direct investigation of the association between perceived support and/or stigma in offline relationships and one's weight loss outcomes within an online community is an area that warrants further research.

Consistent with our hypotheses, we found that those who perceived higher esteem support, emotional support, and/or tangible support in the MyFitnessPal community were more likely to engage in weight control behaviors than those with lower support in each of those domains, and those who were engaged in more weight control behaviors were significantly more likely to lose more weight than those who engaged in fewer weight control behaviors. These findings are consistent with a wealth of research demonstrating the role of social support in facilitating weight control

behaviors and/or weight outcomes in both offline (Verheijden, Bakx, van Weel, Koelen, & van Staveren, 2005; Wing & Jeffery, 1999) and online (Eysenbach et al., 2004; Kevin O Hwang et al., 2010; Mo & Coulson, 2008) contexts. Of note, the role of social support in facilitating weight change is somewhat nuanced and complex. Kumanyika and colleagues (2009) found, for example, that social support from friends and family during an in-person weight loss intervention only facilitated weight change when support people were also losing weight and were highly engaged in treatment. These findings suggest that social support is most salient when support people also have goals of weight change. Results of Kumanyika et al.'s paper are consistent with our social support findings. Namely, in our study, social support was associated with weight change within the context of the online community (i.e., an environment where individuals likely perceived shared weight loss goals). However, general social integration outside of the online community (i.e., an environment in which others may not share in one's weight loss goals) had no effect on weight change. Ultimately, our findings provide evidence that the shared goals inherent in an online community may serve to bolster perceived support, thereby affecting weight control behaviors and weight loss outcomes.

Surprisingly, appraisal support was the only type of support for which we found no association with weight control behaviors and/or weight outcomes. Items for the appraisal support subscale generally assessed whether participants anticipated that

others in the community would provide a comfortable environment in which to discuss highly sensitive issues related to weight and/or health. In some ways, this can be viewed as the most intimate or personal type of perceived support that we assessed. Thus, our findings may suggest that the perception of a more intimate level of support is not necessary (or helpful) in order to achieve weight loss success while participating in an online community. It is also possible that participants rarely felt the need or desire to share more sensitive issues within the online community. This is consistent with standard in-person interventions for weight management, which typically strive to provide a supportive environment, yet do not promote discussion of highly sensitive content. Overall, our findings suggest the utility of ensuring a supportive environment within online communities for weight loss, as such environments would bolster weight control efforts, thereby increasing weight loss.

Counter to our social support hypotheses, we found no association between replies received by participants (both quantity and type) and weight outcomes. While these findings are somewhat surprising, they are also largely consistent with our engagement findings. Given that we did find associations between perceived social support (assessed by the self-report) and weight outcomes, as mediated by weight control behaviors, our findings again suggest that there may be other unmeasured behaviors within the online community that can lead to a sense of feeling supported (i.e., reading others' posts, sending/receiving private messages, etc.).

Of note, participants' perceptions of support within the online community were likely bolstered by the fact that MyFitnessPal moderators routinely screen out offensive content. Thus, we hypothesize that moderation of online communities may be an important component of participants' perceptions of support (and ultimate weight loss success) within online communities for weight management. In other words, it is possible that participants may have perceived a lesser amount of support had they been exposed to content that was offensive, unhelpful, and/or unsupportive in nature. Ultimately, the association between community moderation and weight outcomes is an area that warrants further investigation.

We also found that across all subscales, those with higher baseline self-efficacy were significantly more likely to engage in weight control behaviors, and those with more weight control behaviors were significant more likely to lose more weight. These findings are highly consistent with those found in standard in-person interventions for weight management (Linde et al., 2006; Shin et al., 2011; Teixeira et al., 2010). For example, in an 8-week behavioral intervention for weight loss, Linde and colleagues (2006) found that weight control behaviors mediated the effect of self-efficacy on weight change. Our findings suggest the potential utility of assessing individuals' baseline self-efficacy upon their initial entry into an online community, and potentially implementing brief interventions to bolster self-efficacy when necessary (i.e., when individuals present with lower baseline self-efficacy). These recommendations are consistent with those

made by Shin and colleagues (2011), who found strong associations between self-efficacy and weight outcomes in post-menopausal women participating in a behavioral weight loss intervention. There are a number of different forms that a brief self-efficacy intervention could take, but such an intervention could include brief motivational enhancement strategies, such as presenting statistics about typical behaviors of online community participants, asking participants to imagine how they would behave in different scenarios, and/or asking participants to describe their motivation for joining the online community.

We found that the more weight participants expected to lose at baseline, the more weight they lost after three months. Findings are broadly consistent with both social cognitive theory and with the existing research on outcome expectations and weight loss (Bandura, 1989; Finch et al., 2005). It is worth noting, however, that opinions on this topic are somewhat mixed. Some have argued, for example, that unrealistically high expectations of weight loss could be associated with poor clinical outcomes (i.e., Foster, Wadden, Vogt, & Brewer, 1997), and that practitioners should thus counsel patients to have more modest weight loss expectations. However, the work of Linde and colleagues (2004) suggests that while individuals often have unrealistic expectations for the amount of weight they will lose, such expectations do not have a detrimental effect on weight outcomes. Ultimately, our findings suggest the potential utility of brief interventions to enhance weight loss expectations at the outset of joining an online community. Such

interventions could take the form of presenting data on average percentage of weight loss within the community or asking participants to report the amount of weight that they expect to lose.

There were a number of limitations of our study that are important to address. As described in our methods section, our recruitment methodology required participants to complete several steps before accessing the survey, resulting in an initial recruitment rate of 11.75%. Our recruitment rate was somewhat lower than recruitment rates typically seen in surveys delivered by telephone or web-based modalities (Manfreda, Bosnjak, Berzelak, Hass, & Vehovar, 2008), which is again likely reflective of the extra steps required in order to complete our survey. Given these barriers, it is possible that individuals who completed our survey were more motivated than the average MyFitnessPal user, and thus not fully representative of a typical user of the online community.

Our lower recruitment rates exist in stark contrast to our overall retention rate of 61.21%, which is consistent with (or better than) retention rates often demonstrated in eHealth interventions (Bennett & Glasgow, 2009; Eysenbach, 2005; M. J. Neve, Collins, & Morgan, 2010). However, our inability to gain follow-up data for over one-third of our participants is another limitation of our study, and somewhat limited our statistical power. In conducting our analyses, we found no sociodemographic differences between completers and non-completers of our study, with the exception of those with higher

educational status being slightly more likely to complete our study. While baseline weight did not significantly differ between completers and non-completers, it is possible that some non-completers did not complete the follow-up survey because they were dissatisfied with their follow-up weight, which could have biased our results. It is worth noting, however, that of those who completed the follow-up survey, 32 participants (24.43%) reported a weight gain, thus suggesting that our follow-up data were not only representative of those who had lost weight over the 3-month period. Ultimately, given that attrition continues to be a common phenomenon in eHealth interventions, future explorations of online communities for weight management should continue to focus on effective methods of participant retention.

Baseline BMI and weight of our participants was higher than what is often seen in standard weight management interventions (Appel et al., 2011; Espeland, 2007; Sacks et al., 2001). While it is possible that online community participants present with more significant weight concerns than those who participate in in-person interventions, it is also possible that those with higher baseline weight were more motivated to complete our survey, thus also limiting the generalizability of our results. Additional research would be helpful in elucidating potential weight differences between those who participate in online communities and those who participate in in-person interventions for weight management. Additionally, there was also limited diversity in our sample in terms of gender and race, which limits the generalizability of our results.

One limitation of our recruitment methodology was that our sample only included those who posted an introduction within the online community. While such methodology ensured that we recruited new members of the community, it also led to the exclusion of those with other online community behaviors (i.e., “lurkers” who did not post, active community members who did not post an introduction, etc.). This represents another limitation in the generalizability of our results. In the future, it would be useful to study the psychosocial characteristics of “lurkers” within online communities for weight loss.

There are also a number of unique characteristics of our sample of MyFitnessPal users that may differ from characteristics of those who participate in other online communities for weight loss. As previously described, MyFitnessPal differs from traditional social networking sites like Twitter or Facebook in that it consists of a community of individuals with the shared goal of weight loss. Characteristics of our study participants may differ from characteristics of those who, for example, post weight-related content within the context of a broader community on Reddit or Facebook, where they may be exposed to individuals who do not share their goals. Additionally, there may be a level of baseline motivation inherent in users of a weight-loss focused online community (i.e., the motivation required to download the weight loss app, post in the community, etc.) that may differ from baseline motivation of those who participate in online communities that are not explicitly focus on weight loss. Given

these potential differences, future exploration of our research questions is warranted within the context of other online communities.

While our study was observational in nature, it is possible that our some of our baseline measures had an intervention effect. For example, asking participants to report the amount of weight they expected to lose after three months may have served as a priming effect that could have bolstered outcome expectations, self-efficacy, and/or other motivational processes. While this possibility represents a limitation of our study, it also suggests the utility of offering brief motivational interventions when individuals join an online community, as described above.

Finally, our primary outcome measure (follow-up weight) was collected via self-report, which is less accurate than an objective measure of body weight (Dhaliwal, Howat, Bejoy, & Welborn, 2010; Kovalchik, 2009). We attempted to combat this limitation in several ways. First, at baseline, we excluded participants who indicated that they did not own a home scale, as this would likely preclude their ability to weigh themselves on the days of survey completion. We also provided specific instructions for self-weighing (i.e., wear light clothing, shoes off, place the scale on a level surface, etc.) to help facilitate an accurate weight measurement. Finally, in our post-hoc analyses, we calculated self-reported weight adjustments that were developed based on a study of NHANES adult weight data (Mozumdar & Liguori, 2016). We conducted our multiple regression and mediation analyses a second time using these adjusted weights and then

compared the slopes of our coefficient of interest in both sets of analyses. In all cases, we found that regression slopes did not significantly differ from those for unadjusted weights, thus suggesting that our collection of self-reported weight data did not significantly impact our results and conclusions.

Ultimately, our study provides further evidence of the utility of online communities for weight management and suggests a number of individual-level characteristics that may be predictive of weight control behaviors and/or outcomes. The recent ubiquity of electronic technologies presents an important opportunity to develop and implement evidence-based, cost-effective weight management interventions that can reach large and diverse groups of individuals; thus, it is crucial to continue to investigate the factors that lead to weight loss success within these electronic domains.

Appendix A

Demographic and Historical Information

1. What is your gender?
 - a. Male
 - b. Female
 - c. Other _____

2. What is your ethnicity?
 - a. Hispanic or Latino/a
 - b. Not Hispanic or Latino/a

3. What is your race?
 - a. American Indian or Alaska Native
 - b. Asian
 - c. Black or African American
 - d. Native Hawaiian or Other Pacific Islander
 - e. White
 - f. Other _____

4. What is your age?
_____ years old

5. What is the highest degree or level of education you have completed?
 - a. Less than high school
 - b. High school graduate (includes GED)
 - c. Some college
 - d. Associate's degree
 - e. Bachelor's degree
 - f. Graduate or professional degree

6. What is your current employment status?
 - a. Employed for wages
 - b. Self-employed
 - c. Out of work and looking for work
 - d. Out of work but not currently looking for work
 - e. A homemaker
 - f. A student
 - g. Military
 - h. Retired
 - i. Unable to work

7. Have you ever received a diagnosis of Anorexia Nervosa or Bulimia Nervosa?
 - a. Yes
 - b. No

8. Are you currently receiving treatment for a serious medical condition, such as cancer?
 - a. Yes
 - b. No

9. Are you currently pregnant or nursing?
 - a. Yes
 - b. No
 - c. N/A

10. Do you currently have home access to a scale that measures your body weight?
 - a. Yes
 - b. No

11. What is your e-mail address? _____

Weight History

1. What has been your highest weight after age 18? ____ lbs. or ____ kg. ____ yrs. old

Weight Loss Goals and Expectations

1. How much weight do you **expect** to lose after your first three months of participating in the MyFitnessPal online community? _____ lbs. or _____ kg.
2. What is your **dream weight**? This is a weight that you would choose if you could weigh whatever you wanted. _____ lbs. or _____ kg.
3. What is your **happy weight**? This weight is not as ideal as the first one. It is a weight, however, that you would be happy with. _____ lbs. or _____ kg.
4. What is your **acceptable weight**? This is a weight that you would not be particularly happy with, but one you could accept. _____ lbs. or _____ kg.
5. What is your **disappointed weight**? This is a weight you would not find satisfactory in any way. _____ lbs. or _____ kg.

I can resist eating even when I have a headache.	
I can resist eating when I am reading.	
I can resist eating when I am angry (or irritable).	
I can resist eating even when I am at a party.	
I can resist eating even when others are pressuring me to eat.	
I can resist eating when I am in pain.	
I can resist eating just before going to bed.	
I can resist eating when I have experienced failure.	
I can resist eating even when high-calorie foods are available.	
I can resist eating even when I think others will be upset if I don't eat.	
I can resist eating when I feel uncomfortable.	
I can resist eating when I am happy.	

Social Network Index

Instructions: This questionnaire is concerned with how many people you see or talk to on a regular basis including family, friends, workmates, neighbors, etc. Please read and answer each question carefully. Answer follow-up questions where appropriate.

1. Which of the following best describes your marital status?

____ (1) currently married & living together, or living with someone in marital-like relationship

____ (2) never married & never lived with someone in a marital-like relationship

____ (3) separated

____ (4) divorced or formerly lived with someone in a marital-like relationship

____ (5) widowed

2. How many children do you have? (If you don't have any children, check '0' and skip to question 3.)

____0 ____1 ____2 ____3 ____4 ____5 ____6 ____7 or more

2a. How many of your children do you see or talk to on the phone at least once every 2 weeks?

____0 ____1 ____2 ____3 ____4 ____5 ____6 ____7 or more

3. Are either of your parents living? (If neither is living, check '0' and skip to question 4.)

____ (0) neither ____ (1) mother only ____ (2) father only ____ (3) both

3a. Do you see or talk on the phone to either of your parents at least once every 2 weeks?

____ (0) neither ____ (1) mother only ____ (2) father only ____ (3) both

4. Are either of your in-laws (or partner's parents) living? (If you have none, check the appropriate space and skip to question 5.)

____ (0) neither ____ (1) mother only ____ (2) father only ____ (3) both ____ (4) not applicable

4a. Do you see or talk on the phone to either of your partner's parents at least once every 2 weeks?

____ (0) neither ____ (1) mother only ____ (2) father only ____ (3) both

5. How many other relatives (other than your spouse, parents & children) do you feel close to? (If '0', check that space and skip to question 6.)

____0 ____1 ____2 ____3 ____4 ____5 ____6 ____7 or more

5a. How many of these relatives do you see or talk to on the phone at least once every 2 weeks?

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

6. How many close friends do you have? (meaning people that you feel at ease with, can talk to about private matters, and can call on for help)

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

6a. How many of these friends do you see or talk to at least once every 2 weeks?

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

7. Do you belong to a church, temple, or other religious group? (If not, check 'no' and skip to question 8.)

___ no ___ yes

7a. How many members of your church or religious group do you talk to at least once every 2 weeks? (This includes at group meetings and services.)

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

8. Do you attend any classes (school, university, technical training, or adult education) on a regular basis? (If not, check 'no' and skip to question 9.)

___ no ___ yes

8a. How many fellow students or teachers do you talk to at least once every 2 weeks? (This includes at class meetings.)

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

9. Are you currently employed either full or part-time? (If not, check 'no' and skip to question 10.)

___ (0) no ___ (1) yes, self-employed ___ (2) yes, employed by others

9a. How many people do you supervise?

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

9b. How many people at work (other than those you supervise) do you talk to at least once every 2 weeks?

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

10. How many of your neighbors do you visit or talk to at least once every 2 weeks?

___0 ___1 ___2 ___3 ___4 ___5 ___6 ___7 or more

11. Are you currently involved in regular volunteer work? (If not, check 'no' and skip to question 12.)

_____ no _____ yes

11a. How many people involved in this volunteer work do you talk to about volunteering-related issues at least once every 2 weeks?

_____0 ____1 ____2 ____3 ____4 ____5 ____6 ____7 or more

12. Do you belong to any groups in which you talk to one or more members of the group about group-related issues at least once every 2 weeks? Examples include social clubs, recreational groups, trade unions, commercial groups, professional organizations, groups concerned with children like the PTA or Boy Scouts, groups concerned with community service, etc. (If you don't belong to any such groups, check 'no' and skip the section below.)

_____ no _____ yes

Consider those groups in which you talk to a fellow group member at least once every 2 weeks. Please provide the following information for each such group: the name or type of group and the total number of members in that group that you talk to at least once every 2 weeks.

Type of Group	# of group members you talks to at least once every 2 weeks
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-
- 1.
 - 2.
 - 3.
 - 4.
 - 5.
 - 6.

Appendix B

Weight Outcomes

Please weigh yourself on your home scale. Your scale should be on a level surface (e.g., a hard floor), you shoes should be off, and you should be wearing very light clothing.

12. What is your current weight? _____ lb. or _____ kg.
13. Please indicate which of the below statements most accurately describes your weight loss over the past three months.
 - a. I lost more weight than I expected to lose
 - b. I did not lose as much as I expected to and/or I gained weight
 - c. I lost the exact amount that I expected to lose
14. On a scale from 1 (strongly disagree) to 7 (strongly agree), please indicate your agreement with the following statement: my participation in the MyFitnessPal online community helped me lose weight. _____

Online Community Activity

Think about a typical week. Over the past three months, how often did you:

8. Read the MyFitnessPal message boards:
 - a. More than once per day
 - b. About once per day
 - c. 4-6 days per week
 - d. 1-3 days per week
 - e. Less than once per week
9. Post something on the MyFitnessPal message boards:
 - a. More than once per day
 - b. About once per day
 - c. 4-6 days per week
 - d. 1-3 days per week
 - e. Less than once per week
10. Access the MyFitnessPal message boards on a mobile device (e.g., cell phone, iPad):
 - a. More than once per day
 - b. About once per day

- c. 4-6 days per week
 - d. 1-3 days per week
 - e. Less than once per week
11. Access the MyFitnessPal message boards on your computer:
- a. More than once per day
 - b. About once per day
 - c. 4-6 days per week
 - d. 1-3 days per week
 - e. Less than once per week
12. What was the primary location from which you accessed the MyFitnessPal message boards?
- a. Home
 - b. Work
 - c. Library
 - d. Other _____
13. Did you participate in other online communities for weight loss over the past three months (e.g., Weight Watchers message boards, LoseIt subreddit, etc.)?
- a. Yes
 - b. No
14. Which other online communities for weight loss have you participated in over the past three months? Please check all that apply.
- a. LoseIt subreddit
 - b. SparkPeople
 - c. 3 Fat Chicks
 - d. Weight Watchers Message Boards
 - e. Other (please specify) _____
15. Over the past three months, what was the primary online community for weight loss in which you participated? In other words, in which community did you spend the most time?
- a. MyFitnessPal
 - b. LoseIt subreddit
 - c. SparkPeople
 - d. 3 Fat Chicks
 - e. Weight Watchers Message Boards
 - f. Other (please specify)_____

Weight Control Strategies

Please indicate how often you used the following strategies to try to control your weight over the past three months.

	Never or Hardl y ever	Some of the time	About half of the time	Much of the time	Always or almost always
1. I had servings of fruits and/or vegetables each day.	....1	....2	....3	....4	....5
2. I kept high calorie, high fat foods (e.g., chips, cookies, cakes) out of sight so they would not tempt me.	....1	....2	....3	....4	....5
3. I avoided fried foods.	....1	....2	....3	....4	....5
4. I kept low-calorie foods (e.g., fruit, raw vegetables, unbuttered popcorn) accessible for a healthy snack.	....1	....2	....3	....4	....5
5. I limited my intake of regular soda.	....1	....2	....3	....4	....5
6. I ate lower-fat meats (e.g., chicken, turkey, fish) or meat substitutes (e.g., lentils).	....1	....2	....3	....4	....5
7. When eating dairy products (e.g., milk, yogurt, cheese), I chose reduced fat or fat free options.	....1	....2	....3	....4	....5
8. I ate meats, fish or vegetables that were baked, broiled, or grilled.	....1	....2	....3	....4	....5
9. I chose low-calorie and/or low-fat foods to eat instead of higher calorie options.	....1	....2	....3	....4	....5
10. I ate high-fiber foods (e.g., whole grain breads or cereals, fruit, vegetables).	....1	....2	....3	....4	....5
11. I set a daily calorie goal for myself.	....1	....2	....3	....4	....5

12. I kept a record of the type and amount of food I ate.	1	2	3	4	5
13. I weighed and/or measured the foods I ate.	1	2	3	4	5
14. I kept a record of the calories and fat in the foods I ate.	1	2	3	4	5
15. I kept a record of my minutes of exercise.	1	2	3	4	5
16. I weighed myself daily.	1	2	3	4	5
17. I kept a graph of my weight.	1	2	3	4	5
18. I set exercise goals for myself.	1	2	3	4	5
19. I had a plan for getting my exercise in if the weather was bad and I couldn't exercise outside.	1	2	3	4	5
20. I engaged in moderate-intensity exercise like brisk walking or something similar to brisk walking for at least 30 minutes a day.	1	2	3	4	5
21. If I missed exercising on one day, I made up for it by exercising longer another day.	1	2	3	4	5
22. I scheduled exercise into my day.	1	2	3	4	5
23. I kept my exercise clothes or shoes where I could see them as a reminder to exercise.	1	2	3	4	5
24. If I overate, I thought about what led up to my overeating.	1	2	3	4	5
25. If I overate on one day, I made up for it by eating less the next day.	1	2	3	4	5
26. When I reached my calorie goal for the day but still felt hungry, I tried a pleasant activity to take my mind off of the hunger.	1	2	3	4	5
27. If I got off track with my eating or exercise, I encouraged myself by thinking positively.	1	2	3	4	5

28. When I met a goal related to my eating, exercise, or weight loss, I rewarded myself with something special that did not involve food.	1	2	3	4	5
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Biography

Ilana Beth Lane (née Schriftman) was born in Philadelphia, PA on August 11, 1986. She attended the Schreyer Honors College at Pennsylvania State University in State College, PA and received a Bachelor of Arts degree in Psychology in May 2008. Following her undergraduate studies, she worked as a Clinical Research Coordinator at the University of Pennsylvania Center for Weight and Eating Disorders under the supervision of Thomas A. Wadden, Ph.D. Her work in that laboratory resulted in co-authorship on the following publication: "Relationship between sexual function and quality of life in obese persons seeking weight reduction" (Obesity, 2012). In 2010, she began her graduate studies in Clinical Psychology at Duke University in Durham, NC, under the mentorship of Gary G. Bennett, Ph.D. She will receive her Doctor of Philosophy degree in Clinical Psychology in August 2016, following completion of her clinical internship at the Durham VA Medical Center.

Ilana's work at Duke has resulted in co-authorship on the following publications: "Availability of and Ease of Access to Calorie Information on Restaurant Websites" (PLoS One, 2013), "Electronic health (eHealth) interventions for weight management among racial/ethnic minority adults: a systematic review" (Obesity Reviews, 2014), "Adherence to self-monitoring via interactive voice response technology in an eHealth intervention targeting weight gain prevention among Black women"

(Journal of Medical Internet Research, 2014), and “Engagement with eHealth self-monitoring in a primary care-based weight management intervention” (PLoS One, 2015). She was a recipient of The Obesity Society’s First Annual Poster Award for Excellence in Science with a Focus on eHealth and mHealth (2012). She has also been a recipient of the Vertical Integration Program Summer Fellowship (2012) and the Duke University Summer Research Fellowship (2013). Following completion of her doctoral training, she will pursue a postdoctoral fellowship in Psychosocial Rehabilitation at the Durham VA Medical Center.