

Social support for physical activity—role of Facebook with and without structured intervention

David N. Cavallo, Ph.D.,^{1,4} Deborah F. Tate, Ph.D.,² Dianne S. Ward, Ed.D.,¹ Robert F. DeVellis, Ph.D.,³ Linden M. Thayer,¹ Alice S. Ammerman, Dr.PH.

¹Department of Nutrition, University of North Carolina, Gillings School of Global Public Health, Chapel Hill, NC, USA

²Departments of Nutrition and Health Behavior, University of North Carolina, Gillings School of Global Public Health, Chapel Hill, NC, USA

³Department of Health Behavior, University of North Carolina, Gillings School of Global Public Health, Chapel Hill, NC, USA

⁴Center for Cancer Prevention and Control Research, University of California Los Angeles, 650 Charles Young Drive South, Room A2-125CHS Box 956900, Los Angeles, CA 90095-6900, USA

Correspondence to: D Cavallo
dncavallo@ucla.edu

Cite this as: *TBM* 2014;4:346–354
doi: 10.1007/s13142-014-0269-9

Abstract

Despite their widespread use and extensive technical features, little is known about how to use online social networking sites to increase physical activity. This study aims to examine Facebook engagement among participants in the online social networking arm of a randomized controlled physical activity promotion trial ($n=67$). Facebook communications were double coded and analyzed using ATLAS.ti. Regression procedures were used to determine predictors of Facebook use and associations between types of use and changes in perceived social support and physical activity. Changes in perceived social support and physical activity were more strongly associated with participants' individual Facebook use than use of the Facebook intervention group. The way social media sites are used in intervention design could have an impact on their effects. Including existing friends in interventions and using applications that incorporate intervention activities into a more naturalistic use of Facebook may improve the efficacy of future interventions.

Keywords

Social support, Exercise, Online social networking, Intervention studies

INTRODUCTION

The reach of and technical features possessed by social networking sites (SNSs), such as Facebook™ and Twitter™, have led to a growing number of recommendations in the literature for their use in web-based interventions for improving diet- and physical activity (PA)-related behaviors [1, 2]. Social networking sites are used by two thirds of adult Internet users in the USA, providing a potentially cost-effective means of delivering behavioral interventions that are part of participants' customary internet use [3]. These sites also give participants the ability to digitally articulate social connections; easily communicate with these connections in groups and individually; and record, aggregate, and share behavioral data as well as content with their connections [4]. This provides the potential for participants to not only receive information but to actively contribute to intervention content and delivery. For example, existing commercial applications

Implications

Practice: Establishing groups within online social networks to promote social support for physical activity may be less effective than instructing participants to enlist their existing connections.

Policy: Although social networking sites may provide an easily disseminated means of delivering physical activity interventions, large-scale programs should be delayed until more is known about the principles underlying their use.

Research: Research is needed to establish underlying principles of effectiveness in the use of social networking sites to promote physical activity.

within social networking sites allow participants to automatically track and share goal setting and achievement data related to weight loss, which could serve as a catalyst for support from other participants or provide behavioral modeling. If successful, this approach could lead to “user generated” interventions with lower development costs that are easily scalable.

There are few studies in the literature using online social networks to deliver physical activity- and nutrition-related interventions. Among published interventions that use online social networks, rigorous, randomized designs have yet to demonstrate their efficacy [5]. Existing studies addressing weight loss and physical activity have reported no significant differences in weight loss, physical activity, or social support when compared to controls [6–8]. These studies represent a productive first step in understanding how social networking sites can be used to improve nutrition and physical activity, but these studies were all limited by small sample sizes, did not fully capitalize on participant engagement strategies available through social networking sites, and in some cases, did not isolate the effects of social networking intervention components.

Observational evidence suggests that social network site interventions including the exchange of social influence could be successful in changing dietary and physical activity behavior. Social support has

been positively associated with increased physical activity, healthy eating, and weight loss and there is increasing evidence that dietary and physical activity behaviors may be spread through social networks [9–12]. Studies examining commercially available online weight loss social networking sites have shown that high-quality social support is frequently exchanged and that social networking site use is associated with greater levels of social support [13, 14]. Other researchers have found that the number of social ties in social media-based interventions is associated with intervention engagement, which has been linked to intervention efficacy in web-based studies [15–17].

The use of social networking site features within intervention studies has also been positively associated with physical activity and nutrition behavior. A recent study examining the exchange of Twitter messages between participants in a weight loss program found a positive association between participation and weight loss [18]. In a small within-subjects evaluation of a physical activity Facebook application, participants reported greater step counts when using social comparison features than stand-alone self-monitoring [19]. In addition, interventions employing SNS features have generated greater communication between participants than traditional online social support mechanisms such as online support groups [7, 15, 18, 20, 21]. Participant evaluations of SNS-based interventions also indicate that these platforms are well received by participants [6, 7].

Although these early findings hold promise, additional research needs to be done to determine optimal design principles for interventions using online social networks such as the mode of delivery (e.g., groups vs. applications) and how to leverage their social features (e.g., establishing new network connections vs. using existing connections) [22]. In this study, we examine these questions by analyzing participant use of the online social network component of the Internet Support for Healthy Associations Promoting Exercise (INSHAPE) randomized controlled trial [7]. The INSHAPE trial compared changes in perceived social support for physical activity and physical activity between a study arm receiving access to a physical activity-themed Facebook group, online self-monitoring tools, and web-based physical activity education (online social network arm) and a study arm receiving web-based physical activity education alone (education-only arm). In order to better understand the lack of significant differences in social support and physical activity between study arms over time observed in the INSHAPE trial and inform future online social network intervention designs, this secondary data analysis describes the frequency, modality, and types of physical activity-related Facebook engagement among online social network arm participants. We also examine baseline predictors of Facebook engagement and the association between Facebook engagement and changes in physical activity and social support for physical activity.

METHODS

Study population

We performed secondary data analysis using data from online social network arm participants only ($n=67$). Recruitment procedures for the study are described in detail elsewhere [7]. In brief, participants were recruited through flyers, university listserv e-mails, social media, and advertisements in the college newspaper. Interested participants completed an online screener to determine their eligibility. Participants were deemed eligible if they were currently enrolled female undergraduates at the university under the age of 25 years, reported less than 30 min of daily physical activity, and more than 30 min of daily use of Facebook. Participants were excluded if they answered yes to two or more questions on the SCOFF disordered eating questionnaire [23]. To identify participants with contraindications to an unstructured exercise program, participants were required to submit physician approval if they answered yes to one or more questions on the Physical Activity Readiness Questionnaire [24]. All participants provided informed consent and the IRB at the participating university approved this study. This study is registered at clinicaltrials.gov NCT01421758.

Intervention and control conditions

Intervention participants had access to the INSHAPE website, which included educational materials related to physical activity and a self-monitoring tool. They were also invited to join the INSHAPE Facebook group, whose purpose was to provide participants with a mechanism to exchange social support for physical activity. The INSHAPE Facebook group allowed participants to post comments to a common area (e.g., the group wall); respond to others' posts; create and post to discussion boards; and post web links, photographs, and videos. To encourage participation, participants received a maximum of one entry per week into a biweekly drawing for a US\$40 gift card for any number of posts made to the INSHAPE Facebook group in a given week. Participants were also asked upon joining the INSHAPE Facebook group to answer ice-breaker questions on a discussion board including the types of exercise they were interested in and when and where they preferred to exercise. Based on their answers, discussion boards were created for individual exercises and participants were encouraged to use them to coordinate exercise activity. In addition to using the PA-themed INSHAPE Facebook group, participants were encouraged via text on the study website and e-mails from the study administrator to share information related to their exercise efforts with their own Facebook connections. A doctoral student in Public Health served as the group's moderator, who posted discussion questions, articles, aggregate participant exercise totals, and answered technical questions about the study. The moderator responded to exercise-related questions from participants posted to the INSHAPE Facebook group or received through e-

Table 1 | Facebook interaction coding definitions

Code	Definition
Companionship social support	Partnership assistance that suggests “we participate together”
Esteem social support	Esteem information provision that suggests “you are good”
Informational social support	Knowledge assistance that suggests “you should know”
Encouragement social support	Encouragement information that suggests “you should start or continue exercise activities”
Modeling	Descriptions of performed exercise
Exercise support request	Requests for exercise-related support
Exercise endorsement	Endorsement of specific exercise types
Exercise barriers	Information about barriers to participating in exercise
Exercise facilitators	Information about facilitators to participating in exercise
Positive exercise consequences	Descriptions of the positive consequences of exercise
Negative exercise consequences	Descriptions of the negative consequences of exercise
Exercise failure	Descriptions of failing to exercise
Exercise success	Descriptions of successfully exercising
Exercise motivation	Descriptions of motivations to exercise
Sedentary relapse	Descriptions of starting exercise after a period of inactivity

mail, but did not provide direct social support to individual participants. Education-only arm participants were provided access to a limited version of the INSHAPE website, which included only the educational materials.

Measures

Participants completed self-report study measures by online survey at baseline and at the conclusion of the 12-week intervention period. Perceived social support for PA was measured using an adapted version of the positive subscales (informational, esteem, and companionship) from Chogahara’s Social Influence on Physical Activity questionnaire modified to explicitly include support experienced through online forms of communication [25, 26]. PA was measured using a version of the Paffenbarger activity questionnaire adapted for online use [27]. The Facebook Intensity Scale was used at baseline to measure participants’ overall engagement in Facebook [28]. This instrument produces a standardized sum of items assessing participants’ overall Facebook use and a series of Likert-type questions assessing their attitudes toward Facebook (e.g., “I am proud to tell people that I am on Facebook”). We assessed the frequency of participants’ visiting the INSHAPE Facebook group with a single item; “During this study, how many times do you remember visiting the INSHAPE group on Facebook” with seven-answer choices ranging from “never” to “daily.” Use of the INSHAPE website was measured objectively via server data, which captured unique participant logins.

Facebook interactions

The study moderator recorded Facebook interactions manually on a daily basis during the intervention including all comments and web links, discussion board posts, and instances where participants hit the “like” button in response to content. In addition to message

content, source, receiver, originating message, and message type (e.g., wall post, picture) were recorded for each interaction. Prior to data collection, a codebook was developed with definitions and examples of physical activity-related communications. As an example, one code was defined as “Communications that are not related to a specific physical activity but discuss the topic of exercise including information about exercise, exercise programs, and the exercise behavior of the participant or others or responses to those communications” with the following examples: “This new exercise program is over the top,” “How are things going with your fitness group?” “Does anyone know where I can get some cheap kicks for running?” “I really struggle with exercising when I’m traveling.” This codebook was tested on a sample of Facebook posts by two undergraduate research interns and demonstrated adequate inter-rater agreement ($\kappa=0.94$). At enrollment, all participants were asked to “friend” a dedicated moderator Facebook account, which was established specifically for the study. This allowed the moderator to record Facebook interactions related to physical activity found on the individual Facebook walls (non-INSHAPE Facebook group interactions) of intervention participants. Non-INSHAPE Facebook group interactions were collected for intervention participants who accepted the Facebook friend invitation from the study moderator and INSHAPE Facebook group interactions were collected for all INSHAPE Facebook group members.

We performed qualitative analysis using a grounded theory approach [29, 30]. Two doctoral students in Public Health coded Facebook interactions, with the exception of hitting the “like” button, to identify instances of social support. A draft codebook was developed using deductive codes based on three a priori social support dimensions used in previous studies: companionship support, informational support, and esteem support; [25, 26] and inductive codes based on themes discovered through an initial review of Facebook interactions (see Table 1 for a description

Table 2 | Baseline demographic data for online social network group participants

Number	67
Age (years) (mean±SD)	20.35 (±1.32)
Race [n (%)]	
Non-white	21 (31.3)
White	46 (68.7)
Ethnicity [n (%)]	
Hispanic	5 (7.5)
Non-Hispanic	62 (92.5)
Parent education [n (%)]	
No college	13 (19.4)
College	54 (80.6)
BMI (kg/m ²) (mean±SD)	24.32 (±5.1)
Overweight (BMI 25–29.9) [n (%)]	15 (22.4)
Obese (BMI ≥ 30) [n (%)]	10 (14.9)

of codes). A trained second coder reviewed the Facebook interactions and draft codebook. The two coders met to discuss and modify the codebook by clarifying definitions. This codebook was then used to code a small sample of Facebook interactions by both coders, who subsequently met to discuss and make appropriate changes to the codebook based on this sample. The remaining Facebook interactions were double coded iteratively with periodic meetings between coders to reconcile coding. Disagreements in coding were resolved by discussion and mutual agreement. All coding and analysis was performed using ATLAS.ti version 6.2.

Statistical analyses

Three types of Facebook engagement were analyzed: the number of INSHAPE Facebook group and non-INSHAPE Facebook group interactions and the self-reported frequency of visiting the INSHAPE Facebook group. For each measure of engagement, participants were dichotomized into two groups representing an approximate midpoint of the sample based on the following criteria: (1) participants who contributed to the INSHAPE Facebook group once or less and those who contributed more than once; (2) participants who never contributed to the non-INSHAPE Facebook group vs. those who did; and (3) participants who self-reported visiting the INSHAPE Facebook group at least once per week vs. those who visited less than once per week. Participants who did not join the INSHAPE Facebook group were included in the once or less group for analysis. We assessed baseline predictors of engagement (age, race, parent education, BMI, and Facebook intensity) using binary logistic regression. Race and parent education were dichotomized into white vs. other and college degree vs. no college degree. We used repeated measures ANCOVA models to assess the association between engagement and changes in study outcomes controlling for age, race, parent education, BMI, Facebook intensity scores, and participant logins to the INSHAPE web site. Models included terms for engagement group, time, and covariates as well as engagement

group and covariate x time interactions. Descriptive statistics for interactions were also calculated. Overall differences between the types of interactions were assessed using a likelihood ratio Chi-square test. We performed follow-up logistic regressions to assess the probability that specific interaction types were different between the INSHAPE Facebook group and non-INSHAPE Facebook group. Participants ($n=12$) who did not friend the study administrator, did not report age data at baseline, or did not provide self-report data of INSHAPE Facebook group use were excluded from binary logistic regression and mixed model analyses. We used an alpha level of 0.05 for all statistical tests. We performed all quantitative data analyses using SPSS version 21 for Windows.

RESULTS

Participant characteristics at baseline are detailed in Table 2. Participants were predominately white, non-Hispanic, whose parents had a greater than high school education. Among those randomized to the online social network group ($n=67$), 65 (97.0 %) accepted the Facebook friend request from the study and 64 (95.5 %) joined the Facebook group.

Description of Facebook interactions

Excluding moderator contributions, 503 physical activity-related Facebook interactions were recorded over a 12-week period (259 INSHAPE Facebook group, 244 non-INSHAPE Facebook group). The most popular communication types for INSHAPE Facebook group interactions were responses to discussion board posts (30.5 %), posting to the group wall (27.8 %), responding to group posts (23.2 %), and hitting the “like” button (16.2 %). Participants rarely posted links to information (0.4 %) and none posted photographs. The majority of discussion board posts (64.2 %) were responses to an icebreaker question posted by the study moderator at the beginning of the intervention. The most popular non-INSHAPE Facebook group interactions included hitting the like button (39.8 %), posts to another user’s wall (18.0 %), responses to status posts (14.3 %), and status posts (11.1 %).

Results from the qualitative analysis of Facebook interactions including frequencies, proportions, and examples of the most common types of social influence-related interactions are included in Table 3. Among these interactions, modeling was the most common followed by companionship support. Participants posted more companionship support than informational support to their own Facebook network. In contrast, participants offered less companionship support than information support within the INSHAPE Facebook group. Overall differences in the composition of interactions between the INSHAPE Facebook group and non-INSHAPE Facebook groups were significant, $\chi^2(4, n=205)=31.11, p<0.001$. Follow-up tests indicated that there were significant differences in the number of

Table 3 | Description of intervention participant Facebook communications

Type	INSHAPE Facebook group		Non-INSHAPE Facebook group		Total		Example
	#	%	#	%	#	%	
23	21.9	37	37.0	60	29.3		Companionship support “Sounds great guys, let’s meet up for Zumba next Tuesday a little before 5 outside the SRC?”
Esteem support	4	3.8	8	8.0	12	5.9	“woman! you’re like on a fitness steroid or something...”
Informational support	36	34.3	8	8.0	44	21.5	“You should try something less intense, as [Name] suggested. Try taking a yoga class, or pick up a yoga dvd to use in your room. I found one at Target for less than \$10!”
4	3.8	15	15.0	19	9.3	“have fun	Encouragement walking in this amazing weather”
Modeling	38	36.2	32	32.0	70	34.1	“I went for a walk with my mom and sister on Sunday. We ended up walking almost 5 miles! It was so fun and we didn’t even realize we had walked that much!”
Total	105		100		205		

encouragement (Wald 95 % CI for the percentage of encouragement support interactions in the INSHAPE Facebook group=0.08–0.45) and informational support (Wald 95 % CI for the percentage of informational support interactions in the INSHAPE Facebook group=0.68–0.91) interactions between groups. The difference in companionship support interactions between groups approached significance (Wald 95 % CI for the percentage of companionship support interactions in the INSHAPE Facebook group=0.27–0.51). Other Facebook interaction themes included exercise support requests ($n=45$); exercise endorsements ($n=49$); barriers to ($n=41$) and facilitators of ($n=28$) exercise; positive ($n=29$) and negative ($n=16$) consequences of exercise; exercise failures ($n=29$) and successes ($n=12$); motivations to exercise ($n=12$); and starting exercise after a period of inactivity ($n=12$).

Predictors of Facebook engagement, social support, and physical activity

Binary logistic regression models were used to test the relationship between baseline characteristics (age, race, parent education, Facebook intensity scores, and BMI) and INSHAPE Facebook group contributions, non-INSHAPE Facebook group contributions, and visiting the INSHAPE Facebook group. Older age was significantly associated with fewer contributions to the INSHAPE Facebook group ($\beta=-0.48$, $p=0.04$, Nagelkerke $R^2=0.10$), fewer non-INSHAPE Facebook group contributions ($\beta=-0.53$, $p=0.03$, Nagelkerke $R^2=0.12$), and lower frequency of self-report visits to the INSHAPE Facebook group ($\beta=-$

-0.54 , $p=0.03$, Nagelkerke $R^2=0.13$). Greater BMI was also associated with greater non-INSHAPE Facebook group contributions ($\beta=0.15$, $p=0.04$, Nagelkerke $R^2=0.13$). No other baseline characteristics were significantly associated with engagement. The associations between engagement and changes in companionship, esteem, and informational social support and physical activity controlling for age are reported in Table 4. Non-INSHAPE Facebook group contributions related to physical activity were significantly associated with changes in physical activity and companionship, esteem, and informational support. Frequency of visiting the INSHAPE group was significantly associated with changes in physical activity. There was no significant association between INSHAPE Facebook group contributions and changes in social support outcomes or physical activity.

DISCUSSION

Among intervention group participants in a online social network-based 12-week physical activity study, we found an individual’s communications about physical activity with their existing Facebook friends was more strongly associated with changes in social support and physical activity than communications with study participants in a dedicated PA-themed Facebook group. To our knowledge, this study is the first to compare the association between use of and changes in psychosocial and behavioral outcomes between these types of online social network use. Other intervention studies examining the association between online social network use and behavioral outcomes have

Table 4 | Estimated marginal means and associations between engagement and changes in social support and physical activity

	INSHAPE Facebook group contributions		Non-INSHAPE Facebook group contributions		Frequency of visiting the INSHAPE Facebook group	
	≤1 (n=27)	>1 (n=28)	None (n=24)	Any (n=31)	<1 x per week (n=34)	≥1 x per week (n=21)
Physical activity (total Kcal)						
Baseline M (SE)	1,839.12 (211.74)	1,415.85 (207.00)	1,729.04 (215.28)	1,542.04 (186.01)	1,791.72 (178.56)	1,351.50 (238.34)
Post study M (SE)	2,326.50 (342.43)	2,424.95 (334.77)	1,806.13 (327.42)	2,818.29 (282.90)	2,047.90 (281.10)	2,908.84 (375.20)
Companionship support						
Baseline M (SE)	1.99 (0.22)	2.58 (0.21)	2.30 (0.22)	2.29 (0.19)	2.07 (0.18)	2.65 (0.24)
Post study M (SE)	2.11 (0.22)	2.76 (0.22)	2.02 (0.22)	2.77 (0.19)	2.12 (0.18)	2.96 (0.24)
Esteem support						
Baseline M (SE)	1.76 (0.19)	1.98 (0.19)	2.03 (0.19)	1.75 (0.16)	1.68 (0.16)	2.18 (0.21)
Post study M (SE)	2.10 (0.21)	2.24 (0.21)	1.84 (0.20)	2.43 (0.18)	1.90 (0.17)	2.61 (0.23)
Informational support						
Baseline M (SE)	1.77 (0.19)	1.67 (0.19)	2.00 (0.18)	1.50 (0.16)	1.65 (0.16)	1.83 (0.21)
Post study M (SE)	1.85 (0.19)	1.99 (0.19)	1.75 (0.19)	2.06 (0.17)	1.68 (0.16)	2.32 (0.21)

Covariates include race, parent education, age, Facebook intensity score, INSHAPE web logins

reported similar findings, including increased weight loss and step counts [18, 19].

A potential explanation for the contrast between the effect of INSHAPE Facebook group and non-INSHAPE Facebook group contributions in the current study is the importance of friendship strength in the exchange and impact of social support. Even though greater average physical activity-related Facebook contributions per participant occurred in the INSHAPE Facebook group, participants' lack of familiarity prior to the intervention may have limited the effects of these interactions. This is consistent with findings from social support research that more intimate forms of social support are transmitted through stronger ties [31]. Evidence from experimental and intervention studies related to political participation and sexual health also support the importance of the strength of existing Facebook relationships in changing behavior [32, 33]. This suggests that the optimal use of social networking sites in health promotion should incorporate existing social ties.

Another possible explanation for differences between INSHAPE Facebook group and non-INSHAPE Facebook group associations are the incentives that were provided to participants for contributions to the INSHAPE Facebook group. If the motivation for participation came primarily from the incentives, contributions may have been less authentic or perceived as such by other participants, a concern that was mentioned by one participant in process interviews. Incentivizing participation may need to take a different form to be effective in the context of social networking sites. Strategies such as providing participants with the ability to incentivize each other for participation could be attempted in future studies. This could take the form of basing incentives on participant ratings of comments on dimensions such as helpfulness or allowing participants to provide each other with digital non-monetary gifts. These are commonly used strategies in commercial social media applications.

Greater frequency of visiting the INSHAPE Facebook group was significantly associated with an increase in physical activity but not an increase in social support. The measure of visiting the INSHAPE Facebook group was intended to capture overall use including individuals who view the group but do not contribute. It is possible that this level of engagement was sufficient for influencing physical activity (perhaps through modeling) but not enough to increase perceptions of social support. This is important in that "lurking" behavior comprises a significant portion of activity in online support forums [34].

The only significant predictors of engagement in the current study were age and BMI, where being older was associated with less frequent participation and greater BMI with more frequent participation. Younger students may be less socially engaged offline than older students and more likely to engage in an online social network intervention. Older students may also be more reluctant to seek out advice from younger students. Differences in engagement by race, ethnicity, and parent education were not significant. This may be

a result of the relatively homogenous population recruited for this study, but this lack of difference is also concordant with previous research that among individuals with internet access, traditional disparities are not apparent for online social network use [35]. A lack of association between Facebook intensity and participation is most likely a result of the near ubiquitous use of Facebook in this population and requiring participants to have a minimal amount of Facebook use [3].

The level of engagement reported in other health promotion social media interventions has varied considerably. Our average number of contributions was considerably less than that reported in a Twitter-based study but similar to or exceeding other Facebook-based interventions [6, 18, 33]. Social media interventions, however, do appear to generate more engagement than previous online weight loss social support mechanisms such as e-mail exchange and bulletin boards [15, 20, 21]. In the current study, moderator activities were limited to those that could be automated in the future in order to increase the cost effectiveness and dissemination potential of the intervention. Future interventions will need to balance these characteristics with the need for creating a critical mass of communication, especially at the outset. This may require more robust moderator communications with participants until the group reaches a self-sustaining level of engagement.

There has also been inconsistency in the types of social support recorded in the natural use of social media and within social media intervention studies. Analysis of Twitter messages in a weight loss intervention found that informational support was far more common than other types of support, similar to group interactions in the current study [18]. Other researchers have found in observational research that encouragement and motivation was more commonly reported than information [14]. This suggests that there may be fundamental differences between the ways individuals use social media within intervention groups vs. more natural use.

This study has several limitations. Within group analyses of the relationship between Facebook engagement and changes in outcomes does not indicate a causal relationship. Changes in social support and behavior may have given participants greater motivation to contribute. Although we have included INSHAPE website use as a covariate in our models in order to better isolate the effects of Facebook engagement, changes related to Facebook engagement could simply be representing greater overall engagement in the intervention. It is also possible that participants who were more active in their non-INSHAPE Facebook group use were also more likely to receive face to face social support. We also did not code instances of hitting the "like" button in response to content as it was deemed too difficult to assess the intention of those interactions consistently. Future research should attempt to better assess this commonly used feature of online social networks.

Because we did not have access to server data, visiting the Facebook group could only be assessed by self-report. We also used a self-report measure of physical activity, which is subject to bias and considered less desirable than more objective measures such as accelerometers. The ability to examine the relationship between specific types of social support interactions and changes in their respective measures was also limited by the data collected in the current study. It was not possible to examine the effects of receiving versus providing support because many Facebook communications are directed at the group level and could not be assigned to individual participants. Future studies should attempt to obtain more comprehensive network level use data in order to examine this relationship.

The sample used was limited in terms of range in age, parent education, ethnicity, and gender. Participants also self-selected into a health promotion intervention to increase their physical activity. As a result, their levels of motivation to exchange social support for physical activity may be greater than the general population they represent. Even though we attempted through screening to exclude already active individuals from our sample, baseline reports of physical activity indicate that many participants did not meet that criterion.

Given the focus of this paper, this study only compares the most common social influence interactions found in our qualitative analysis. A more comprehensive description of interactions that includes other common themes found in physical activity-related online social network interactions should be pursued in future research.

Given their reach and technical capabilities, social networking sites have significant potential to promote health. Results from this study suggest that the way social media sites are used in intervention design could have an impact on their effects. Including existing friends in interventions, using applications that incorporate intervention activities into more naturalistic use of Facebook, and trying more innovative socially determined incentives may improve the efficacy of future interventions.

Acknowledgments: This research was supported by the Lineberger Comprehensive Cancer Center Control Education Program, Predoctoral Fellowship, UNC (SR25-CA057726) and by a grant from NIH (DK056350) to the University of North Carolina Nutrition Obesity Research Center.

Conflict of interest: All authors of this manuscript declare that they have no conflicts to report.

Ethical standards and informed consent: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

1. Buis LR. The potential for web-based social network sites and self-reporting for health promotion. *Am J Health Promot.* 2011; 26(2): 73-76.
2. Bennett GG, Glasgow RE. The delivery of public health interventions via the internet: actualizing their potential. *Annu Rev Public Health.* 2009; 30: 273-292.
3. Duggan M, Brenner J. *The demographics of social media users—2012.* Washington, DC: Pew Research Center; 2013.

4. Boyd DM, Ellison NB. Social network sites: definition, history, and scholarship. *J Comput Mediat Commun.* 2007; 13(1): 210-230.
5. Chou WY, Hunt YM, Beckjord EB, Moser RP, Hesse BW. Social media use in the United States: implications for health communication. *J Med Internet Res.* 2009; 11(4): e48.
6. Napolitano MA, Hayes S, Bennett GG, Ives A, Foster GD. Using Facebook and text messaging to deliver a weight loss program to college students. *Obesity (Silver Spring).* 2013; 21: 25-31.
7. Cavallo DN, Tate DF, Ries AV, Brown JD, Devellis RF, Ammerman AS. A social media-based physical activity intervention: a randomized controlled trial. *Am J Prev Med.* 2012; 43(5): 527-532.
8. Turner-McGrievy G, Tate D. Tweets, apps, and pods: results of the 6-month mobile pounds off digitally (mobile POD) randomized weight-loss intervention among adults. *J Med Internet Res.* 2011; 13(4): e120.
9. Cunningham SA, Vaquera E, Maturo CC, Narayan KM. Is there evidence that friends influence body weight? A systematic review of empirical research. *Soc Sci Med.* 2012; 75(7): 1175-1183.
10. Greaves CJ, Sheppard KE, Abraham C, et al. Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health.* 2011; 11: 119.
11. Kelsey K, Earp JL, Kirkley BG. Is social support beneficial for dietary change? A review of the literature. *Fam Community Health.* 1997; 20(3): 70-82.
12. Van Der Horst K, Paw MJ, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc.* 2007; 39(8): 1241-1250.
13. Hwang KO, Etchegaray JM, Sciamanna CN, Bernstam EV, Thomas EJ. Structural social support predicts functional social support in an online weight loss programme. *Health Expect.* 2012; 17(3): 345-352.
14. Hwang KO, Ottenbacher AJ, Green AP, et al. Social support in an internet weight loss community. *Int J Med Inform.* 2010; 79(1): 5-13.
15. McKay HG, King D, Eakin EG, Seeley JR, Glasgow RE. The diabetes network Internet-based physical activity intervention—a randomized pilot study. *Diabetes Care.* 2001; 24(8): 1328-1334.
16. Poirier J, Cobb NK. Social influence as a driver of engagement in a web-based health intervention. *J Med Internet Res.* 2012; 14(1): e36.
17. Tate DF, Wing RR, Winnett RA. Using internet technology to deliver a behavioral weight loss program. *JAMA.* 2001; 285(9): 1172-1177.
18. Turner-McGrievy G, Tate D. Weight loss social support in 140 characters or less: use of an online social network in a remotely delivered weight loss intervention. *Transl Behav Med.* 2013; e.1-8.
19. Foster D, Linehan, C., Kirman, B., Lawson, S., & James, G. Motivating physical activity at work: using persuasive social media for competitive step counting. Paper presented at: Proceedings of the 14th International Academic MindTrek Conference on Envisioning Future Media Environments MindTrek 10 (2010)2010; Tampere Finland.
20. Kim C, Draska M, Hess ML, Wilson EJ, Richardson CR. A web-based pedometer programme in women with a recent history of gestational diabetes. *Diabet Med.* 2012; 29(2): 278-283.
21. Kosma M, Cardinal BJ, McCubbin JA. A pilot study of a web-based physical activity motivational program for adults with physical disabilities. *Disabil Rehabil.* 2005; 27(23): 1435-1442.
22. Cobb NK, Graham AL. Health behavior interventions in the age of Facebook. *Am J Prev Med.* 2012; 43(5): 571-572.
23. Perry L, Morgan J, Reid F, et al. Screening for symptoms of eating disorders: reliability of the SCOFF screening tool with written compared to oral delivery. *Int J Eat Disord.* 2002; 32(4): 466-472.
24. Thomas S, Reading J, Shephard RJ. Revision of the physical activity readiness questionnaire (PAR-Q). *Can J Sport Sci.* 1992; 17(4): 338-345.
25. Chogahara M. A multidimensional scale for assessing positive and negative social influences on physical activity in older adults. *J Gerontol B Psychol Sci Soc Sci.* 1999; 54(6): S356-S367.
26. Okun MA, Ruehlman L, Karoly P, Lutz R, Fairholme C, Schaub R. Social support and social norms: do both contribute to predicting leisure-time exercise? *Am J Health Behav.* 2003; 27(5): 493-507.
27. Pereira MA, FitzerGerald SJ, Gregg EW, et al. A collection of Physical Activity Questionnaires for health-related research. *Med Sci Sports Exerc.* 1997; 29(6 Suppl): S1-S205.
28. Ellison NB, Steinfield C, Lampe C. The benefits of Facebook "friends": Social capital and college students' use of online social network sites. *J Comput Mediat Commun.* 2007; 12(4): 1143-1168.
29. Strauss A, Corbin J. *Basics of qualitative research: grounded theory procedures and techniques.* Newbury Park: Sage Publications; 1990.
30. Miles M, Huberman A. *Qualitative data analysis.* 2nd ed. Thousand Oaks (CA): Sage; 1994.
31. Berkman LF, Glass T, Brissette I, Seeman TE. From social integration to health: Durkheim in the new millennium. *Soc Sci Med.* 2000; 51(6): 843-857.

32. Bond RM, Fariss CJ, Jones JJ, et al. A 61-million-person experiment in social influence and political mobilization. *Nature*. 2012; 489(7415): 295-298.
33. Bull SS, Levine DK, Black SR, Schmiede SJ, Santelli J. Social media-delivered sexual health intervention: a cluster randomized controlled trial. *Am J Prev Med*. 2012; 43(5): 467-474.
34. Nonnecke B, Preece J. Lurker demographics: counting the silent. 2000.
35. Kontos EZ, Emmons KM, Puleo E, Viswanath K. Communication inequalities and public health implications of adult social networking site use in the United States. *J Health Commun*. 2010; 15(S3): 216-235.