The influence of social networking sites on health behavior change: a systematic review and meta-analysis

RECEIVED 27 March 2014
REVISED 4 June 2014
ACCEPTED 24 June 2014
PUBLISHED ONLINE FIRST 8 July 2014

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ABSTRACT

Objective Our aim was to evaluate the use and effectiveness of interventions using social networking sites (SNSs) to change health behaviors.

Materials and methods Five databases were scanned using a predefined search strategy. Studies were included if they focused on patients/consumers, involved an SNS intervention, had an outcome related to health behavior change, and were prospective. Studies were screened by independent investigators, and assessed using Cochrane's 'risk of bias' tool. Randomized controlled trials were pooled in a meta-analysis.

Results The database search retrieved 4656 citations; 12 studies (7411 participants) met the inclusion criteria. Facebook was the most utilized SNS, followed by health-specific SNSs, and Twitter. Eight randomized controlled trials were combined in a meta-analysis. A positive effect of SNS interventions on health behavior outcomes was found (Hedges' g 0.24; 95% CI 0.04 to 0.43). There was considerable heterogeneity ($I^2 = 84.0\%$; $T^2 = 0.058$) and no evidence of publication bias.

Discussion To the best of our knowledge, this is the first meta-analysis evaluating the effectiveness of SNS interventions in changing health-related behaviors. Most studies evaluated multi-component interventions, posing problems in isolating the specific effect of the SNS. Health behavior change theories were seldom mentioned in the included articles, but two particularly innovative studies used 'network alteration', showing a positive effect. Overall, SNS interventions appeared to be effective in promoting changes in health-related behaviors, and further research regarding the application of these promising tools is warranted.

Conclusions Our study showed a positive effect of SNS interventions on health behavior-related outcomes, but there was considerable heterogeneity.

Protocol registration The protocol for this systematic review is registered at http://www.crd.york.ac.uk/PROSPERO with the number CRD42013004140.

Key words: Social Networking Site, Social Network, Social Media, Consumer Health, Behavior Change

REVIEW

BACKGROUND AND SIGNIFICANCE

Social networking sites (SNSs) have become a global phenomenon. They are generally defined as web-based platforms that allow individuals to create their own personal profile and build a network of connections with other users.[1] As of September 2013, 73% of online adults were using an SNS of some kind and 42% were using more than one.[2,3] Facebook is the most popular platform (with more than 1.19 billion monthly active users[4]), followed by Twitter (500 million users worldwide[5]).

In parallel to general purpose SNSs like Facebook and Twitter, health-specific SNSs are also emerging.[6] Some are oriented towards patients with a specific chronic condition (eg, TuDiabetes), others are more general and open to patients with any chronic condition (eg, PatientsLikeMe), and a few others target people wanting to change a particular health-risk behavior (eg, smoking cessation[7]) or other health-related lifestyle factors.

The application of SNSs in the health domain shows tremendous potential.[8] At the population level, they are currently being used for public health surveillance,[9] both for communicable[9,10] and non-communicable diseases.[11,12] At the individual level, they are able to facilitate access to health-related information[13–16] and social support,[7,17] promoting better-informed treatment decisions.[18,19] Given that lifestyle behaviors are

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nowadays responsible for the global burden of non-communicable diseases,[20] increasing attention is being given to using SNSs to fight this trend.[21,22] Interestingly, studies of offline social networks have demonstrated the actual role of social influence in spreading certain risk behaviors, such alcohol consumption,[23] smoking,[24] and obesity.[25] Researchers are now focusing on how to leverage social influence to promote healthy behaviors. The fact that SNSs are widely accessible across geographical barriers, and that they are increasingly being used by people on a daily basis (namely through mobile phones), turn them into especially interesting loci for public health interventions in the behavioral domain.

The aim of this study was to systematically review the literature regarding the use and effectiveness of SNSs in health behavior change.

MATERIALS AND METHODS

Search strategy

A systematic search of the literature from the last 10 years was performed in March 2013, on PubMed, Embase, CINAHL, ACM Digital, and PsycINFO, using several search terms regarding social media, SNSs, and health behavior change (the complete search strategy is available in online supplement 1). The reference lists of relevant articles were also screened. To capture gray literature, we reviewed the proceedings (last 5 years) of several related conferences (AMIA, MedInfo, MIE, Medicine 2.0, Medicine X) and tweets from key opinion leaders regarding possible additional studies that met the inclusion criteria.

Study selection criteria and risk of bias assessment

Studies were included in this review if they[26]: (1) focused on patients/consumers; (2) involved an SNS,[3] either isolated or as part of a multi-component intervention; (3) included any type of comparison (eg, with a control group, with another intervention, or pre–post); (4) had an outcome related to health behavior change or presumed to be a consequence of it (eg, weight loss in a fitness or dieting intervention); and (5) had a prospective study design.

Studies were excluded if they: (1) had an intervention based on non-SNS types of social media (eg, online forum, message board, chat group, mailing list); (2) described the use of SNSs for other purposes (eg, recruitment, data collection); (3) focused on healthcare providers instead of patients; (4) focused on behaviors unrelated to health; (5) were centered on psychology aspects or on the eSociology phenomenon (eg, cyberbullying); or (6) were duplicates or were not in English.

The screening form was piloted before the beginning of the screening process. Initial screening of studies was based on the information contained in their titles and abstracts and was conducted by four teams, each consisting of two independent investigators. When a decision on inclusion or exclusion could not be reached based on the title and abstract, the full text was retrieved. If doubts persisted, a third person was asked to make a decision.

The initial screening was purposely broad in order to retrieve articles that could inform the background and discussion, and to avoid missing any important studies. In the full-paper screening, completed by two independent investigators, the inclusion and exclusion criteria described above were applied more strictly, and any disagreements were resolved by a third person. The kappa statistic was used to measure inter-coder agreement in the screening phase as a whole (including the initial screening and the full-paper screening).

All eligible studies were reviewed by two researchers in order to appraise their risk of bias according to the Cochrane Collaboration's 'risk of bias' tool.[26] Disagreements were resolved by a third person.

Data extraction strategy and synthesis procedures

One reviewer abstracted information from the included studies into a standardized computer-based form. Another investigator reviewed the completed abstraction form for consistency. Disagreements were referred to a third person.

The following information was collected: first author, year, health domain, type of SNS used in the intervention, study type, number of participants, population characteristics, study duration, intervention characteristics, health behavior theories or models underlying the intervention, and retention rates. Data from one outcome measure in each study were extracted. When more than one measure was present, a decision was made based on the following: (1) primary outcomes were used whenever possible; (2) if several health behavior-related outcomes were available (none of which was the primary outcome), the decision was based on clinical importance. Additional criteria for data extraction included: (1) use of intention-to-treat analysis whenever possible; (2) in repeated-measures studies, selection of the baseline and longest follow-up; and (3) where more than one intervention was present, selection of that for which the primary outcome was determined. In the event data were missing, we contacted the study authors.

Data synthesis and meta-analysis

The main characteristics of each study were synthesized.

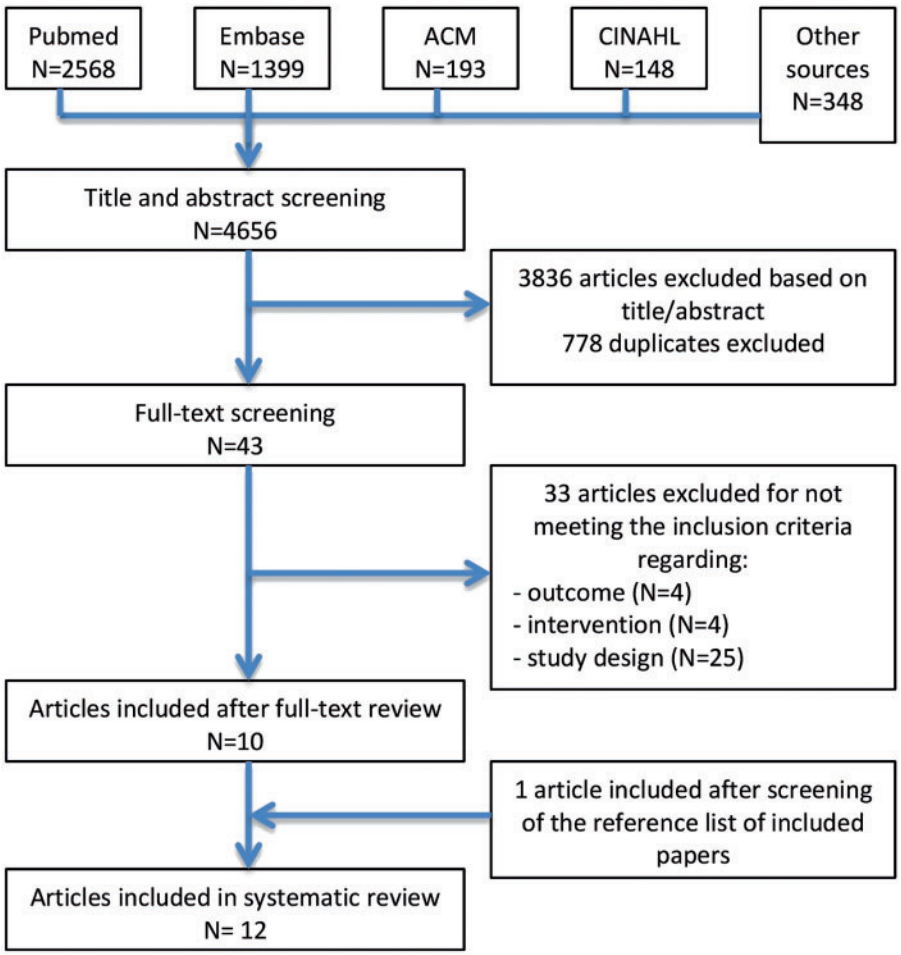
As suggested in the literature, we did not use the argument of heterogeneity to avoid conducting a meta-analysis.[27–29] The studies included in our review were deemed comparable in relevant ways, as well as measuring the same outcome, and were therefore pooled together for a summary effect.

Due to a high risk of bias, quasi-experimental studies were not included in the meta-analysis. Furthermore, to avoid unit of analysis issues, a cluster-randomized trial was also excluded from the meta-analysis. For these studies, a narrative synthesis was elaborated.

In the meta-analysis, continuous and dichotomous outcomes were pooled together.[28] We transformed all effect sizes to a common metric comparable across studies—the bias-corrected standardized difference in means (Hedges' g)—and classified it as positive when in favor of the intervention and negative when in favor of the control.

We used the random effects model to combine the results in a more conservative way, and used the method of moments to estimate the between-studies variance (T^2). I^2 was used to

Figure 1: Flow diagram of included studies.



assess the presence of heterogeneity.[28,29] A subgroup analysis was performed to assess the effect of two particularly different studies[30,31] on heterogeneity. The presence of publication bias was evaluated by use of a funnel plot and the Duval and Tweedie's trim and fill method. Comprehensive Meta-Analysis V.2.2 was used for all computations.

The study protocol was registered with PROSPERO (International prospective register of systematic reviews)[32] and the PRISMA statement was followed in writing this report.[33]

RESULTS

The database search retrieved 4656 citations (figure 1). Their titles and abstracts were screened and 778 duplicates were excluded, as well as 3836 articles that did not meet the inclusion criteria. After the full-text of the remaining articles was reviewed, an additional 33 were excluded (a list of excluded articles is available in online supplement 2). Screening of the reference lists of the remaining 11 papers revealed an extra study that met our pre-defined criteria. The kappa statistic measuring inter-coder agreement was 0.41 (fair agreement).[26]

Description of included studies

The 12 included studies involved a total of 7411 participants (table 1). One study was conducted in Australia[34] and another in the UK[35]; the remaining were from the USA. The health domains covered were: fitness,[31,34–39] sexual health,[40,41] food safety,[42] smoking,[43] and health promotion.[30] All the studies were experimental in nature: three were quasi-experimental and the remaining were randomized controlled trials (RCTs). Publication year ranged from 2010 to 2013 and study duration varied from 21 days to 18 months. Participants were diverse in age; three studies recruited students[37,38,42] and two studies involved young adults. Unfortunately, not all studies reported age data, and socioeconomic and ethnicity data were seldom mentioned, so a complete characterization of the population in this meta-analysis was not possible.

Recruitment strategies were diverse and often included offline and online approaches; SNSs were used in four studies.[37,39–41] Two studies used respondent-driven sampling to identify further contacts from participants' networks.[40,41]

Table 1: Characteristics of included studies

Study author, year	Health domain	SNS	Study type	N total* (I;C)	Participants	Study duration	Intervention	Outcomes†
Brindal *et al*, 2012[34]	Fitness (weight loss)	Health-specific SNS	RCT	435 (213;16)	Overweight and obese adults	12 weeks	Participants were randomized to one of *three arms*‡. (I) Access to website (Total Wellbeing Diet portal) with diet and exercise information + interactive meal planner + compliance feedback + diet and weight self-monitoring + SNS; or (C) access to information-only website.	Weight loss (%)§
Bull *et al*, 2012[40]	Sexual health	Facebook	Cluster RCT	1578 (942;636)	Young adults	6 months	Participants were randomized to either: (I) exposure to Just/Us—Facebook page regarding 8 sexual health topics; or (C) exposure to content on 18–24 News—Facebook page with news and events.	Condom use at last sex and proportion of sex acts protected by condom§
Cavallo *et al*, 2012[38]	Fitness (physical activity)	Facebook	RCT	134 (67;67)	Female undergraduate students	12 weeks	Participants were randomized to: (I) Facebook group + INSHAPE website for education, goal setting, and self-monitoring; or (C) INSHAPE website providing education only.	Physical activity (kcal; measured by a questionnaire)¶
Centola, 2010[30]	Health promotion	Health-specific SNS	RCT (6 trials)	1528 (764;764)	Visitors of health-specific internet sites	3 weeks (each trial)	Participants were randomized into two different situations in an online social network: (I) clustered network (with more redundant ties between individuals); or (C) random network.	Registration in an internet-based health forum§
Centola, 2011[31]	Fitness (diet diary)	Health-specific SNS	RCT (5 trials)	710 (355;355)	Participants in an online fitness program	7 weeks (each trial)	Participants were randomized into two different situations in an online social network: (I) homophilous network, where individual traits (gender, age, and body mass index) were aggregated; or (C) unstructured population, where participants were mixed at random regardless of their individual characteristics.	Adoption of an internet-based diet diary§
Foster *et al*, 2010[35]	Fitness (physical activity)	Facebook	Quasi-experimental	10 (5;5)	Nurses	21 days	Participants were assigned to: (I) exposure to Step Matron—Facebook application to view and comment on each other's step data; or (C) access to their own personal step data only.	Number of steps§
Mayer *et al*, 2012[42]	Food safety	Facebook	Quasi-experimental	710 (101;83)	College students	4 weeks	Participants were divided into *eight groups*‡. (I) Exposure to a food safety lecture and access to the 'Safe Eats' Facebook page for 15 min or more each week; or (C) no exposure to food safety education.	Food safety practice score (scale of 1–5)**

(continued)

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Table 1: Continued

Study author, year	Health domain	SNS	Study type	N total* (I;C)	Participants	Study duration	Intervention	Outcomes†
Graham *et al*, 2011[43]	Smoking cessation	Health-specific SNS	RCT	2005 (675;679)	Smokers	18 months	Participants were randomized to one of *three arms*‡. (I) Access to the QuitNet website (includes SNS feature) + telephone and email counseling; or (C) access to a static, information-only website composed of the content on QuitNet.com.	Smoking abstinence at 18 months§
Napolitano *et al*, 2012[37]	Fitness (weight loss)	Facebook	RCT	52 (18;17)	College students	8 weeks	Participants were randomized to one of *three arms*‡. (I) Facebook Plus—Facebook group + text messaging for personalized feedback + self-monitoring + education + health buddy; or (C) waiting list.	Weight loss (kg)§
Turner-McGrievy *et al*, 2011[36]	Fitness (weight loss)	Twitter	RCT	96 (47;49)	Overweight adults	6 months	Participants were randomized to: (I) podcast + mobile—access to podcasts + mobile app for diet and physical activity monitoring + interaction with study counselors and other participants on Twitter; or (C) podcast only .	Weight loss (%)§
Valle *et al*, 2012[39]	Fitness (physical activity)	Facebook	RCT	86 (45;41)	Young adult cancer survivors	12 weeks	Participants were randomized to either: (I) Facebook FITNET intervention (pedometer + website + enhanced Facebook group); or (C) Facebook self-help comparison (pedometer + Facebook group without moderator, reminders, or behavioral lessons and strategies)	Moderate-to-vigorous physical activity (min)§
Young *et al*, 2013[41]	Sexual health	Facebook	Quasi-experimental	57†† (57;–)	Men who have sex with men	12 weeks	Participants were exposed to a 'secret' group on Facebook where trained peer leaders posted HIV-related content.	Request of an HIV test§

Studies included in the meta-analysis are indicated in bold.

*'N total' indicates the total number of participants per study, followed by the numbers in the I and C groups (the sum of the participants in the I and C groups might not correspond to the total N in studies with more than two groups).

†Only health behavior-related outcomes were considered.

‡In studies with more than two arms, only the most complex intervention and the control were considered.

§Study's main/primary outcome.

¶Four behavioral outcomes were measured—heavy, moderate, light and total physical activity—the last was chosen.

**The outcomes measured were attitudes, knowledge, and practices regarding food safety—the last was the only behavior outcome and was therefore chosen.

††The comparison group was not included by the authors in the analysis—only results for the intervention group were presented.

App, application; C, control group; I, intervention group; kcal, kilocalories; RCT, randomized controlled trial; SNS, social networking site.

In two studies it was not possible to assess whether there was enough power to detect a statistically significant difference in the primary outcome.[34,43]

Interventions and adherence

Facebook was the most utilized SNS (seven studies), either isolated[40] or as part of a more complex intervention with other components.[35,37–39,41,42] Twitter was used in one study[36] and health-specific SNSs in four.[30,31,34,43] Table 2 presents a detailed characterization of the various interventions, as well as their respective retention rates.

The SNS component of each intervention was primarily used as a means of providing education and social support. Only one study used the SNS in the intervention for data sharing, with the goal of promoting accountability and social competition.[35] Intervention components other than the SNS were primarily used for educational and self-monitoring purposes and were most often web-based.

Only five studies mentioned a health behavior theory or model underlying the intervention.[30,31,36,39,42] Retention rates were above 80% in four studies,[35–38] and between 65% and 75% in two others.[39,43] Four studies did not report retention rates.[30,31,41,42]

Usage data were seldom and inconsistently reported. Data concerning Facebook use were provided in three studies.[37,39,40] Two studies reported usage data regarding website access.[34,38] Finally, one study reported podcast downloads, mean days per week of self-monitoring activity, and number of tweets.[36] Four studies reported having conducted dose–response analysis.[34,36,38,39] The four studies that evaluated engagement variation throughout the study duration reported its decline, both in the intervention and in control groups.[34,36,38,39]

Comparisons and outcomes

The comparisons in seven studies were active controls: (1) access to a Facebook page/group with a different content than in the intervention[39,40]; (2) access to an information or education-only website[34,38,43]; (3) access to personal step information[35]; and (4) podcasts only.[36] In two studies, the comparisons were 'life-as-usual', involving no action from the investigators.[37,42] One study did not consider the comparison group in its analysis and only presented results for the intervention group.[41] Finally, two studies[30,31] were particularly different in their design: the network structure in each group was purposely manipulated so that random and unstructured networks (controls) were compared with clustered and homophilous ones.

The outcomes were self-reported in seven studies[34–40,42,43] and directly measured by the outcome assessor in three studies: registration in a health forum[30]; adoption of a diet diary[31]; and request for an HIV test.[41] For all the outcomes, the intervention group was compared with the control group, except in the study by Young and Jaganath.[41]

Risk of bias assessment

Authors of the included studies seldom detailed two aspects of the experiments: random sequence allocation and allocation concealment (table 3). Additionally, trial protocol registration was only mentioned in four studies,[38–40,43] which made the 'selective reporting' domain difficult to assess. The quasi-experimental studies[35,41,42] had, in general, a high risk of bias. Most RCTs lacked sufficient information for risk assessment in several domains. However, two RCTs[30,31] stood out as having the lowest risk of bias according to the Cochrane Collaboration's 'risk of bias' tool.

Studies not included in the meta-analysis—narrative synthesis

The three quasi-experimental studies excluded from the meta-analysis due to a high risk of bias showed statistically significant results.[35,41,42] The remaining cluster randomized trial did not find a statistically significant difference between intervention and control groups.[40]

Meta-analysis

Eight studies (3943 participants) were included in the meta-analysis: four with a continuous outcome[36–39] and three with a dichotomous outcome.[30,31,43]

We found a slight positive effect of SNSs on health behavior-related outcomes (Hedges' g 0.24; 95% CI 0.04 to 0.43) (figure 2). Heterogeneity was high ($I^2 = 84.0\%$; $T^2 = 0.058$). A subgroup analysis showed a decrease of I^2 to 9.5% when the two studies by Centola[30,31] were removed from the analysis, with the summary effect dropping to 0.05 (not statistically significant).

The funnel plot of SE by Hedges' g appears symmetric, indicating a similar proportion of studies in each direction of the effect size (see online supplement 3). Based on Duval and Tweedie's trim and fill method, no studies needed to be imputed for symmetry to be increased, suggesting that papers with negative results were published in approximately the same proportion as those with positive results, both being adequately represented in our review. Therefore, no evidence of publication bias was detected.

DISCUSSION

To the best of our knowledge, this is the first meta-analysis evaluating the effectiveness of SNS interventions in changing health-related behaviors. Our study identified a slight positive effect of SNS interventions on health behavior change.

Similar literature

A recently published study concluded that interventions incorporating SNSs showed modest evidence of effectiveness in health behavior change.[44] Despite appearing to address the same research question, this systematic review differed from ours in several important ways. First, the authors considered health behaviors and associated cognitions (eg, dietary awareness) as outcomes, whereas in our study the focus was primarily on health behaviors and their consequences, in order to enable the computation of a summary effect. Second, we reasoned that only prospective studies would be adequate to answer our research question, while Maher *et al* also included

Table 2: Characteristics of the interventions and retention rates

Study author, year	SNS type	SNS component of the intervention		Other components of the intervention (non-SNS)		Health behavior theories or models underlying the intervention	Retention rates, intervention (control) %
		Characteristics	Functions	Components	Functions		
Bull *et al*, 2012[40]	Facebook page	Discussions, Q&A with youth facilitators, videos, quizzes, games	▶ Education ▶ Social support	N/A		None mentioned	45 (59)
Mayer *et al*, 2012[42]		Discussions, Q&A, images, videos, games, polls	▶ Education ▶ Social support	Lectures	Education	Social cognitive and social constructivism	N/R
Cavallo *et al*, 2012[38]	Facebook group	Discussions, Q&A with a moderator	▶ Education ▶ Social support	Website	▶ Education ▶ Physical activity self-monitoring ▶ Goal setting	None mentioned	84 (96)
Napolitano *et al*, 2012[37]		Leaflets, podcasts, polls, invitations to fitness events, links to weekly report of tracked data	▶ Education ▶ Social support ▶ Physical activity promotion ▶ Self-monitoring	Book + text messaging + digital scale + pedometer + food measuring utensils	▶ Education ▶ Diet and physical activity self-monitoring ▶ Personalized goal setting and feedback ▶ Social support with a buddy	None mentioned	89 (100)
Valle *et al*, 2012[39]		Discussions, Q&A with moderator, videos, news, links, information, and tips regarding physical activity, reminders, behavioral lessons, and strategies	▶ Education ▶ Social support ▶ Physical activity promotion ▶ Self-efficacy promotion	Pedometer + website	▶ Physical activity self-monitoring ▶ Goal setting and feedback ▶ Reminders	Social cognitive	71 (83)
Young *et al*, 2013[41]		Discussions, Q&A with trained peer leaders	▶ Education ▶ Social support	N/A	None mentioned	None mentioned	N/R
Foster *et al*, 2010[35]	Facebook app	Data sharing (number of steps)	▶ Social support ▶ Social influence	Pedometer	▶ Physical activity self-monitoring	None mentioned	100 (100)
Turner-McGrievy *et al*, 2011[36]	Twitter	Health and fitness messages, Q&A	▶ Education ▶ Social support	Podcasts + smartphone app	▶ Education ▶ Diet and physical activity self-monitoring	Social cognitive	89 (90)
Brindal *et al*, 2012[34]		(SNS is part of a website) Discussions, Q&A	▶ Education ▶ Social support	Website	▶ Education ▶ Diet and weight self-monitoring ▶ Interactive meal planner + compliance feedback	None mentioned	5.2 (8.7)

(continued)

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Table 2: Continued

Study author, year	SNS type	SNS component of the intervention		Other components of the intervention (non-SNS)		Health behavior theories or models underlying the intervention	Retention rates, intervention (control) %
		Characteristics	Functions	Components	Functions		
Centola, 2010[30]	Health-specific SNS	Clustered network; notification when a health buddy adopts a health behavior (registration in an internet-based health forum)	▶ Social influence	N/A		Social network	N/R
Centola, 2011[31]		Homophilous network; notification when a health buddy adopts a health behavior (registration in an internet-based diet diary)	▶ Social influence	N/A		Social network	N/R
Graham *et al*, 2011[43]		(SNS is part of a website) Discussions	▶ Social support	Website + telephone + email	▶ Education ▶ Assistance in setting a quit date + tailored help and guidance	None mentioned*	67 (69)

*Authors mention 'theory-driven hypothesis' and 'evidence-based cessation treatment', but specific theories or models are not reported.
App, application; N/A, not applicable; N/R, not reported; Q&A, questions and answers; SNS, social networking site.

Table 3: Assessment of the risk of bias for the included studies

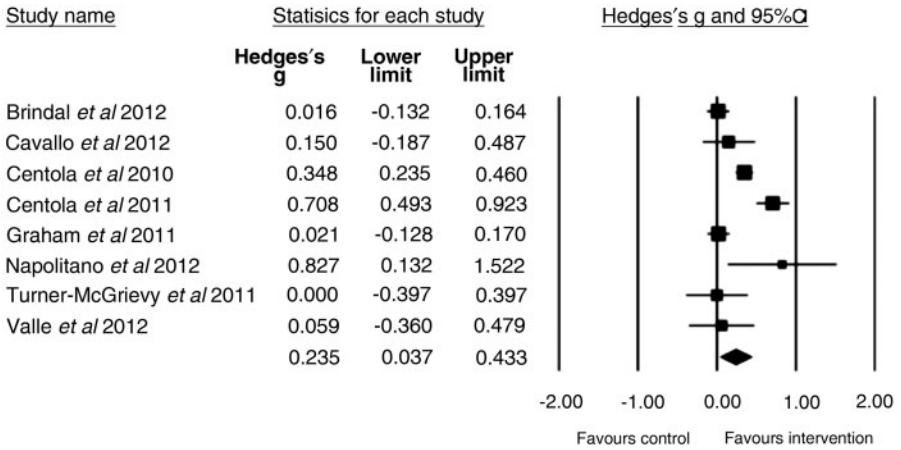
Study author(s), year	Random sequence allocation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Brindal *et al*, 2012[34]	+	?	−	−	−	?
Bull *et al*, 2012[40]	?	?	−	−	+	+
Cavallo *et al*, 2012[38]	?	?	−	−	+	+
Centola, 2010[30]	?	?	+	+	+	?
Centola, 2011[31]	?	?	+	+	+	?
Foster *et al*, 2010[35]	−	−	−	−	+	?
Graham *et al*, 2011[43]	+	?	−	−	+	+
Mayer *et al*, 2012[42]	−	−	−	−	+	?
Napolitano *et al*, 2012[37]	?	?	−	?	+	?
Turner-McGrievy *et al*, 2011[36]	+	+	−	?	+	?
Valle *et al*, 2012[39]	+	−	−	−	+	+
Young *et al*, 2013[41]	−	−	−	+	−	−*

Outcome-related domains were assessed considering the outcomes mentioned in table 1.

*Outcome of interest reported for only 20 participants (those who posted about HIV prevention/testing). No information on the outcome for 37 participants.

+, Low risk of bias; −, high risk of bias; ?, unclear risk of bias.

Figure 2: Forest plot of effect sizes and 95% CIs representing the effect of interventions with social networking sites on health behavior-related outcomes (random effects model).



cross-sectional and retrospective studies. Third, we specifically searched for gray literature, and did not limit our interest to particular health domains. Fourth, we used the Cochrane 'risk of bias' tool[26] to identify the studies with a higher risk, not pooling them together with the others, and cautioning readers in the interpretation of their results. Finally, we found a greater number of studies meeting inclusion criteria, and we were able to combine the effect sizes of eight RCTs in a meta-analysis.[27–29]

Our results are in line with findings for interactive health communication applications (IHCAs), where a positive effect on behavioral outcomes was found in a Cochrane meta-analysis.[45] IHCAs are computer-based (usually web-based) systems that combine health information with social support, decision

support, or behavior change support. In contrast, SNSs can be defined as web-based services that allow individuals to create a personal profile and build a list of connections to other users, originating innumerous interconnected and dynamic personal networks.[1] Although the two concepts are indeed different, many of the SNS interventions included in our review were in fact comparable to IHCAs, in that they generally provided education, social support, self-management, and tailoring. The combination of these functions has also been previously described as being commonly used in other social media interventions.[46]

Finally, a modest number of systematic reviews have been published evaluating the effect of social media in health behavior change,[46] health promotion,[47] and health communication,[48] showing feasibility but no definitive conclusions regarding effectiveness. Nevertheless, one must bear in mind that social media is much broader than the concept of SNSs, and also includes blogs, discussion boards, and wikis, among others.

Health domains and participants

The predominant health domain among the included studies was fitness related (eg, weight loss and physical activity), which reflects the growing interest of the medical informatics field in wellness and obesity.[49,50] In the future, as more patients with chronic illnesses become social media users,[14,51] it is expected that SNS research will increasingly focus on chronic disease self-management.

Finally, among the participants of the 12 included studies, there appeared to be a preponderance of young adults, which is in line with previous characterizations of SNSs' common users.[3]

Intervention components and underlying theories

The majority of interventions in our review consisted of other components in addition to the SNS, most often in the form of a website. The scarcity of single-component interventions has been previously reported regarding social media and other web-based interventions,[49–52] posing problems in determining the effectiveness of a particular component. It is unclear whether the observed effects in studies with multi-component interventions are attributable either to the SNS or the non-SNS component, or to a synergistic effect of both. Furthermore, the majority of studies did not address the effects of individual features of an intervention (eg, education, feedback, tailoring, goal setting, self-monitoring) on effectiveness, engagement, or user satisfaction.

Only five studies mentioned a specific health behavior theory or model underlying the intervention,[30,31,36,39,42] and the most frequently used theories were those regarding interpersonal health behavior, such as 'social network' and 'social cognitive' theories. The two studies that were based on 'social network' theory[30,31] were among the three that showed a statistically significant positive effect on the behavioral outcome. There is now sufficient evidence showing that interventions grounded in theory lead to more powerful effects,[53,54] and several models have already been proposed to explain behavior change in internet interventions.[55–57] However, few authors seem to take these theories and models into consideration when designing interventions, as was observed in our review. A possible consequence is that studies may be technology driven instead of user centered, and resources may be wasted in non-optimized and non-evidence-based interventions that are likely to be ineffective.

Social networking sites

The type of SNS used was health-specific in four studies: two provided the SNS as part of a comprehensive website[34,43] and the other two studies used a purposely designed SNS.[30,31] The remaining eight studies used a general SNS: Facebook[35,37–42] and Twitter.[36]

General SNSs present several advantages for the implementation of health interventions, compared to health-specific SNSs.[58,59] They have enormous reach—millions of regular users worldwide[2,4]—potentially minimizing problems of retention and lack of adherence to interventions. Also, they can be efficient ways of disseminating interventions and recruiting participants,[37,39–41] and they can take advantage of participants' existing social networks[60,61] instead of asking them to form new connections (which has been termed 'the stranger phenomenon'[49]). Finally, as general SNSs are nowadays a part of people's daily lives, and not focused only on health, they have huge potential to improve engagement. This way, interventions can be incorporated in people's routines and habits, instead of being an extra burden on their already busy lives.[62] Indeed, retention rates of general SNS studies included in this review are very promising at around 80%, and they shed new light on the 'law of attrition' of online interventions.[46,63]

Network interventions

Two of the studies showing a positive effect size were particularly different in their design,[30,31] involving 'network alteration'.[64] In those studies, the interventions were based on two aspects of offline social networks: the tendency of people to associate with those who resemble them—homophily[65]; and the tendency for people's friends to be connected to each other through redundant ties—clustering.[65,66] The author hypothesized that people were more likely to adopt a behavior if they knew someone similar to them, or some of their friends' friends, had done it before.[67] By modifying participants' networks in an SNS it was indeed demonstrated that homophily and clustering contribute to the social diffusion of 'easy' behaviors (eg, adoption of a diet diary). Nonetheless, it remains to be demonstrated that the same mechanism applies to more complicated health behaviors (eg, dieting, exercising, smoking cessation).[68] Indeed, it is known that the need for social reinforcement increases when the adoption of a given behavior is difficult, costly, or unfamiliar.[67]

Strengths and limitations

This study has several strengths. First, we followed a rigorous and pre-defined protocol, openly available.[32] Second, we did an extensive search of the literature with the help of an academic librarian, to ensure sensitivity and specificity. Third,

study selection was based on strict criteria, in order to avoid selection bias. Fourth, we used a pre-tested and piloted screening form, as well as four teams of two independent investigators, so that an acceptable level of reliability could be reached. Fifth, we followed the Cochrane Collaboration's 'risk of bias' tool to appraise the included studies, so that results could be interpreted in the context of their quality. Sixth, we took a conservative approach and conducted a meta-analysis of the studies with the least risk of bias (the three non-included quasi-experimental studies were indeed statistically significant).

The results of this study need to be interpreted in the context of some limitations. There was fair agreement resulting from the screening phase, which can be attributed to a strategy that was intentionally used to increase sensitivity: screeners were instructed to classify papers in three different ways ('include,' 'exclude,' or 'uncertain'), and some researchers were more 'risk averse' than others, leading to discrepancies in classification.

Additionally, there was a moderate risk of bias in included studies. However, it is important to remember that aspects like random sequence allocation and allocation concealment are frequently under-reported, not necessarily meaning that adequate procedures were not followed.[69,70] Additionally, blinding is seldom possible in web-based interventions.

The small number of included studies reflects the current scarcity of experiments in this emerging and rapidly evolving field, and made it impossible to conduct analyses according to type of intervention/outcome/health domain. Instead, all RCTs were grouped together, and their diverse nature contributed to the high heterogeneity observed.

Implications for research

Interventions for health-behavior change involving general and health-specific SNSs are feasible and show promise. However, more experimental studies are needed in order to increase meta-analytical power and determine their effectiveness more precisely. Future research should focus on identifying the features that increase the engagement and retention of the target audience, as well as the specific characteristics that promote long-term behavior change and improve cost-effectiveness.

Intervention design

In designing interventions, theoretical models for behavior change should always be considered. Researchers are urged to evaluate existing literature on diffusion of innovations, social networks and health behavior change theories, so that they can leverage their interventions with the most up-to-date evidence. Future studies should also try to use the RE-AIM framework (Reach, Effectiveness, Adoption, Implementation, Maintenance)[59] to better plan and evaluate their interventions, aiming at the future translation of research into practice.

Study design

Single-component interventions, factorial design methods, and adaptive designs should be considered more often, so that the effectiveness of SNS components can be clearly evaluated.[71] Additionally, the type of comparison group should be considered carefully: on the one hand, standard of care, waiting list, or 'true' controls (ie, no-intervention comparators) may exacerbate the Hawthorne effect in non-blinded studies; on the other hand, active controls may inappropriately give non-significant results. Study duration should also be thoughtfully planned, so that engagement and retention are optimized and enough time is allowed for the specific type of behavior change to occur. Finally, the accuracy of outcome measures should be optimized and, when possible, self-reporting bias should be avoided (eg, data upload from digital sources).

Reporting recommendations

When reporting interventions, two aspects are particularly important: consistent engagement metrics should be used, so that future reviewers are able to provide recommendations for optimal intervention 'doses'; and effect sizes should be interpreted in terms of their potential clinical relevance, whenever possible.

Finally, authors are urged to follow the CONSORT and TREND[72] statements when reporting RCTs and non-randomized trials, so that a correct evaluation of the studies' risk of bias can be performed.

Public health impact

SNSs are becoming ubiquitous in people's everyday life, making them especially appealing in the public health domain. On the one hand, they present a low-cost opportunity to virally spread health information, possibly improving the cost-effectiveness of health interventions. On the other hand, they can promote social support and social influence, facilitating health behavior change. In particular, network interventions that increase clustering and homophily appear promising, warranting further investigation regarding their effectiveness in influencing long-term health behavior change.

An interesting hypothesis—that remains untested—is that SNSs may be used in a synergistic way with personal health records and mobile devices,[73,74] allowing consumers to continuously benefit from the daily knowledge, accountability, support, and influence that their social connections can provide.

CONCLUSION

The use of SNSs in health-related research has been rising as they become more popular and ubiquitous. Our study is the first meta-analysis evaluating the effectiveness of SNSs in changing health behavior-related outcomes. We found a statistically significant positive effect of SNS interventions on behavior change, boosting encouragement for future research in this area.

ACKNOWLEDGEMENTS

The authors would like to thank Andrew Georgiou and Armando Brito de Sá for their insights in the design and implementation of this study.

CONTRIBUTORS

All the authors contributed substantially to the design of the study and the acquisition, analysis and/or interpretation of data. The paper was drafted by the first author and critically reviewed by all the remaining authors. All the authors approved the final version to be published.

FUNDING

This work was supported by a Junior Clinical Research award from the Harvard Medical School-Portugal program (HMSP-ICJ/0005/2010; Fundação para a Ciência e Tecnologia) awarded to the first author. AL and AA were supported by the National Health and Medical Research Council (NHMRC) Centre of Research Excellence in Informatics and E-Health (1032664). ALN was supported by the Portuguese Foundation for Science and Technology (SFRH / BD / 52036 / 2012).

COMPETING INTERESTS

None.

PROVENANCE AND PEER REVIEW

Not commissioned; externally peer reviewed.

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