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# **THEORETICAL APPROACHES OF ONLINE SOCIAL NETWORK INTERVENTIONS AND IMPLICATIONS FOR BEHAVIORAL CHANGE: A SYSTEMATIC REVIEW**

Running Title: ONLINE SOCIAL NETWORK AND BEHAVIORAL CHANGE

Amaël ARGUEL<sup>1,2,3</sup>; Oscar PEREZ-CONCHA<sup>1</sup>; Simon Y.W. LI<sup>4</sup>; Annie Y.S. LAU<sup>1</sup>

1. Centre for Health Informatics, Australian Institute of Health Innovation, Macquarie University, Sydney, Australia
2. ARC-SRI Science of Learning Research Centre
3. Department of Educational Studies, Macquarie University, Sydney, Australia
4. Department of Applied Psychology, Lingnan University, Tuen Mun, NT, Hong Kong

## **Corresponding author:**

Amaël Arguel  
Department of Educational Studies  
4 First Walk 931  
Macquarie University, NSW 2109, Australia  
amael.arguel@mq.edu.au  
+61 2 9850 8664

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Online social network; health intervention; social media; behavioral change; health psychology ; Social Cognitive Theory

**ABSTRACT**

The aim of this review was to identify general theoretical frameworks used in online social network interventions for behavioral change. To address this research question, a PRISMA-compliant systematic review was conducted. A systematic review (PROSPERO registration number CRD42014007555) was carried out using three electronic databases (PsycINFO, Pubmed, and Embase). Four reviewers screened 1,788 abstracts; 15 studies were selected according to the eligibility criteria. Randomized controlled trials (RCTs) and controlled studies were assessed using Cochrane Collaboration's "Risk of Bias" tool, and narrative synthesis. Five eligible articles used the Social Cognitive Theory (SCT) as a framework to develop interventions targeting behavioral change. Other theoretical frameworks were related to the dynamics of social networks, intention models, and community engagement theories. Only one of the studies selected in the review mentioned a well-known theory from the field of health psychology. Conclusions were that guidelines are lacking in the design of online social network interventions for behavioral change. Existing theories and models from health psychology that are traditionally used for in-situ behavioral change should be considered when designing online social network interventions in a healthcare setting.

## **INTRODUCTION**

Online social networks seem to be an effective mean to influence health-related behaviors for consumers and patients (1-3). Some diseases such as obesity, depression, or diabetes proved to be sensitive to social media and social network interventions (2-5). With the spread of consumer digital devices, online social media are expected to play an increasing role in the prevention and management of diseases (6). Although there is increasing empirical evidence on how social networks influence our health behaviors (1), there is still a lack of clarity on the inner mechanisms of how this is done (7). Social and health psychology provide several theoretical frameworks that explain behavioral changes induced by social influence (8, 9). Numerous studies have also pointed out the importance of incorporating theory in the design of an intervention to effectively induce behavior change (2, 10, 11). Yet, are theories being used at all when designing social network interventions? What is the state of the art of theoretical approaches in the healthcare domain? The aim of this review is to identify theoretical components that have been used in online social network interventions to influence behavioral change. The review also aims to identify possible theoretical frameworks that could be used for designing online interventions addressing quantifiable behavioral changes, and which would present a certain degree of consensus for studies from different fields.

## **MATERIAL AND METHODS**

A PRISMA-compliant systematic review was conducted (12), with a focus on experimental studies. The review targeted online or computer-based studies in which theory-based interventions using social media were designed to produce certain behavioral changes.

### **Registration**

The protocol of this systematic review was registered and is openly available in PROSPERO (international prospective register of systematic reviews) database (registration number CRD42014007555) (13).

### **Eligibility criteria and search strategy**

The literature search was systematically performed on 3 electronic databases on July 27<sup>th</sup> 2016: PsycINFO (via OvidSP), PubMed, and Embase (via OvidSP). The complete search strategy is available in Appendix 1. The selection of search terms was analogous to some previous systematic reviews on similar topic (1, 2, 10, 14). Several pilot searches were conducted to adjust the terms and the filters, and the electronic databases chosen for the search. This iterative protocol led to the following search terms: *social network, social media, social web, social influence, study, intervention, randomized controlled trial, trial, experiment, experimental, behavior, behavioral change, decision, online, internet, Facebook, Twitter, and web*. Terminology of search terms was controlled using MeSH keywords when available and different spellings were used to address studies written in American English or British English. We set up the following filters in the electronic databases: (1) articles in English, (2) published within the last 12 years (2003 to 2015), and (3) where the abstracts are available. The search was limited to articles describing experiments on adult participants.

For gray literature, an additional search was undertaken in consumer search engines (Google, Yahoo, and Bing); however no other references were retrieved.

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***Insert Table 1 here***

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A comprehensive list of inclusion and exclusion criteria is presented in Table 1 as well as a description of the population, intervention, comparator, outcomes, and study design (PICOS) (see Table 2).

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***Insert Table 2 here***

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The search strategy targeted articles covering four overlapping dimensions:

- 1) Social media in the intervention (e.g. social network, forum, discussion group, etc.),
- 2) Online interventions (e.g. computer-mediated interactions),
- 3) Primary outcome comprises a behavioral change (e.g. adoption of a new behavior or intention to adopt), and
- 4) Experimental methodology (e.g. involving at least one comparison group).

A study was eligible for inclusion if all the four criteria were satisfied.

The search produced a total of 1,788 responses which were exported into EndNote X4 (15). The duplicates were then removed from the resultant list and subsequently, titles, authors, year of publication, and abstract of articles were extracted and exported. Articles were randomly distributed into two subsets in order to be screened by two independent teams. Each team consisted of two of the co-authors (AA and OP were assigned to Team 1; AL and SYWL to Team 2) who independently screened article abstracts. Each article was coded as either accepted or rejected or 'uncertain'. Cohen's Kappa inter-coder agreement coefficients for team 1 and team 2 were  $\kappa = .40$  and  $\kappa = .47$  respectively, which are considered to be of *fair* and *moderate* agreement strengths (16).

Within each team, all articles accepted by both investigators were selected for further investigation. In case of disagreement, a third party moderator decided about the paper's inclusion or exclusion. Disagreements were defined as articles accepted by one investigator and rejected (or labeled as 'uncertain') by the other; or articles labeled as 'uncertain' by both investigators. AL and AA were moderators for disagreement cases that had arisen from team 1 (a total of 39 disagreements) and team 2 (34 disagreements) respectively. After moderation, 35 articles in total were identified for full-text assessment. The same eligibility criteria used for abstract screening was used to screen the 35 articles; 20 were rejected and 15 were selected for full analysis in this review (see Figure 1). The features of the selected articles are summarized in Appendix 2.

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*Insert Figure 1 here*

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## **RESULTS**

### **Description of included articles**

In total, 15 experimental studies were identified. The domains covered by these studies were diverse and were not limited to health-related interventions. Within the studies which were health-related, the topics varied from physical activity and healthy lifestyle (17-21), to hip fracture prevention (22), uptake of vaccination (23), coronary heart disease prevention (24), sexual transmissible infection prevention (25), and smoking cessation (26). Within the studies which were not health-related interventions, four papers dealt with online shopping or brand community (27-30) and one paper addressed the topic of activism engagement (31). The countries of origin of participants were United States of America for 9 studies (17-22, 27, 28, 31), with the remaining in Hong Kong (27), Brazil (29), Germany (23), United Kingdom (24), Taiwan (25), and New Zealand (26).

The methodologies used in these studies involved random allocation to either an intervention or a control group, with an exception of one study (25), which used a quasi-experimental design with a control website as a comparison group. All the other studies involved randomized controlled trials (17-22, 24, 26) and controlled laboratory experiments (23, 27-31).

In all these studies, the outcomes were associated with behavioral changes, either as an adoption of a new behavior (e.g. physical activity, smoking cessation, registration on a website, etc.) (17-22, 24-26) or the intention of new behaviors (e.g. intention to get vaccinated, purchase intention, intention of engaging in a community, or of joining an activist group) (23, 27-31).

The participants were either university students (27-31), or they were recruited according to their specific medical condition, or their assumed risk to develop a specific condition. These conditions

included: sedentary lifestyle (18, 20, 21), risks of coronary heart disease (24), HIV and STI (25), smoking (26), and relapsing-remitting multiple sclerosis (19). The rest of the studies involved healthy participants, who were mainly recruited online (17, 22, 23, 31).

### **Risk of bias evaluation**

We used the 'Cochrane Collaboration' risk of bias tool to assess the quality of randomized controlled trials (32). The results of that evaluation are available in Table 3.

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*Insert Table 3 here*

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Overall, risks of bias were considered relatively high due to the lack of reported information in the methodology. In the majority of cases, the provided information did not allow the assessment for the presence or absence of a defined risk of bias since these cases did not report the concealment of allocation of experimental and control groups. In general, studies from fields other than medicine and health management received more 'high risk of bias' notations. However, since the risk of bias tool has been primarily designed for RCTs and medical and pharmacological studies, this tool may not be well suited for studies from other domains, such as marketing. The lack of consistency in reporting risks of bias in study designs among non-medical disciplines suggests the need for setting standards in bias reporting in these disciplines.

### **Theoretical frameworks**

Various theoretical frameworks were used in the 15 studies reported: Social Cognitive Theory (SCT) was cited as a basis for social network interventions in five articles (18, 19, 21, 22, 26); electronic Word of Mouth (eWOM) effects in two articles (28, 29). Other theoretical models that were reported in at least one article were: (a) Technology acceptance model (TAM) (27), (b) the Theory of Planned Behavior (TPB) (20), (c) "strength of weak ties" theory (17), (d) perceived risk influence (23), (e) learning from peer-facilitated interactions (24), (f) Internet popular opinion leader (i-POL) model



(25), (g) a model of the degrees of *personalness* of networks (31), and (h) a model of online brand community (30).

### Social Cognitive Theory

SCT was the most commonly used theoretical model reported in these studies (18, 19, 21, 22, 26).

The SCT model is based on social learning theory that describes human behavior with three major factors: personal factors (e.g. knowledge, expectations, affects), behavioral factors (e.g. skills, self-efficacy), and environmental factors (e.g. reinforcements, social norms, influence). SCT is well adapted to interventions that target health-related behavioral changes, notably because it states that social learning from observation and imitation of others can influence decision-making (33, 34).

Certain components of SCT attempted to engage participants in online social network interventions.

For example, the *self-efficacy principle in the SCT theory* was cited in all five studies (18, 19, 21, 22, 26), and measured with scales in four of them (18, 19, 21, 22). Other SCT constructs were also addressed in these interventions. For example, a common strategy was the use of role models allowing for social influence and/or observational learning. This is achieved via the use of video-clips, discussion forums, and Questions & Answers with experts in all of the four studies. Other interventional features focused on promoting self-belief in achieving goals, such as via educational material in the written form.

### Theories based on the structure of networks

The rest of the articles did not involve SCT, but instead they used various models or some components borrowed from other theoretical models. The common approach of most studies was to consider the structure and characteristics of the adopted online social networks and test for their effects on the new behaviors. The different theoretical components used are as follow:

- Electronic Word of Mouth (eWOM):

Two studies (28, 29) used eWOM, which could be considered as an approach more than a proper theory; it explores social influence of consumers regarding commercial products (28,

29). These studies considered network structure (i.e. density, tie strength, position in the network), and the influence of positive and negative comments in order to explain the effect of eWOM on online purchase intentions. The valence (i.e. positive or negative) of opinion concerning a product was interpreted in regard to the Prospect Theory, which was developed to describe decision processes in the domain of behavioral economics (35).

- Network structure (clustered-lattice vs. random network structure):

A study by Centola (17) tested the effect of network structure (i.e. clustered-lattice vs. random network structure) on the spread of health behaviors. Clustered-lattice networks are defined as networks in which ties link each node with others in their neighborhood but without links to distant nodes. In random networks, links between nodes are evenly distributed among nodes, whatever their location in the network. In his study, Centola showed that behavior adoption spread faster and farther in clustered-lattice networks than in random networks.

- Internet Popular Opinion Leader (I-POL) model:

One study (25) investigated the effect of Internet popular opinion leaders with i-POL model, which is an adaptation of the popular opinion leader (POL) model (25, 36). The POL model was itself based on the diffusion of innovation theory, which considers social network structure and its influence on behavioral changes (37).

- The degrees of *personalness* of social networks:

Nekmat et al. (31) explored the effects of online social networks in engaging participants in activist collective actions. In a controlled laboratory-based experiment the so-called *personalness* of fictional social networks were tested. Depending of the condition, participants were told that the source of a message was from a close network (e.g. “someone to whom you are very close”), from more distant network (e.g. “someone who is a friend of someone you know”) or from an organizational source such as a student

association. The study provided evidence that the degree of *personalness* can influence the participation of novice individuals in some collective actions.

### Other theoretical basis

The remaining studies (20, 23, 24, 27, 30) used different theoretical approaches to test and explain behavioral changes in social network interventions.

- Cavallo et al. (20) used the Theory of Planned Behavior (TPB) in order to design an online intervention aiming at increasing physical activity. The intervention specifically addressed some TPB variables related to physical activity, such as perceived behavioral control, intention, and attitude. Although traditional TPB variables were able to explain only small to medium impacts on the outcomes, the authors developed an extended version of the TPB that could explain 27% of the variance observed in physical activity and 59% for intention.
- A study on online heart disease support groups (24) used a theory of “weak ties” networks (38) to test effects of peer-to-peer interactions and types of moderation in virtual discussion rooms in a randomized controlled trial.
- Another study described an intervention designed to increase vaccination rate (23). Using a simulated online patient social network similar to the website *patientslikeme.com*, the authors manipulated the perception of a risk of adverse events related to vaccination. Across different conditions, information from the website was manipulated, mainly the frequency of vaccine adverse events, the type of information (narrative vs. summary statistics), and the presence or not of a bias awareness disclaimer. That theoretical approach was similar to some early cognitive theories in health psychology such as Health Belief Model (HBM), which states that the perception of a threat, and the belief one can have about measures to reduce that threat, can together have an influence on the likelihood of engaging in some behavioral changes (39).

- In the field of online shopping, a study cited the technology acceptance model (TAM) as a theoretical basis for designing an ad hoc research model (27), which explains consumer's purchase decisions on an experimental website used in a controlled laboratory study. The website pretended to sell cinema tickets and included an online discussion forum. The theoretical model used in this study integrated the components from an early version of TAM (*perceived usefulness* and *perceived ease of use*), and an additional component corresponding to positive informational social influence (27, 40).
- Another ad hoc model was presented in the field of online consumer engagement: the "online brand community engagement behavior" model (30). The model was based on both attribution theory and social identity theory (41, 42). Attribution theory was used in this case to describe when online brand community could be perceived as result of extrinsic motives (e.g. profit of a company) or intrinsic motives (e.g. altruism of consumers) (43). Social identity theory was defined as an individual self-concept linked to knowledge of a membership of a social group that involves an emotional significance (44). The online brand community engagement behavior model suggested that the types of online brand community (i.e. marketer-created vs. consumer-created) had an influence on the quality of community engagement behaviors.

## **DISCUSSION**

The first finding of this review suggests that the most common theory in health-related studies designed for online social network interventions was SCT. Originally, SCT was not specifically constructed for designing online social network interventions, but some authors have adapted that theory to online interventions. Other studies reported in the review cited various models and theories as rationales for their experiments. Two of them mentioned the eWOM, and others cited: the theory of the "strength of weak ties", an adapted version of the TAM, the perceived risk influence, and an ad-hoc model of online brand community engagement.

The second finding suggests that none of the studies selected in this review has mentioned any well-known theories or models from the field of health psychology, with the exception of (20). This finding is somewhat surprising given some of the identified studies were about health interventions in particular. Examples of well-known health psychological theories include the HBM, which is widely used in health education programs when engagement of new behaviors is sought. Similarly, the TPB and the Transtheoretical Model of Behavioral Change were surprisingly virtually absent from the studies in our review but one (20), despite being widely used in other health-related interventions (45, 46). Numerous reviews have emphasized the importance of incorporating a theoretical approach when designing interventions for behavioral change, especially for health (2, 3, 10, 14, 47).

Our hypothesis is that there might be two reasons behind the absence of use of health psychology theories in the articles of our review. Firstly, health psychology theories are not technology-oriented, and might appear inadequate for online interventions at the first instance to researchers unfamiliar with them (48). Health psychology theories can typically be categorized into two groups: (1) the continuum models, which consider linear predictions of likelihood behaviors (e.g. SCT), and (2) the stage models, which examine the chance of progression of individuals in several discrete stages (e.g. Transtheoretical Model)(11, 49). When selecting a theoretical framework, it is possible that researchers prefer to use a continuum approach rather than stage models, which are more complex as they require the implementation of staging algorithms (11, 49). That could partially explain why SCT was found to be the most used theory for health-related interventions in our review. Secondly, each discipline or field seems to have its own “favorite” theories. For example, health-related interventions mostly use a limited set of theories from health psychology (50), while eWOM is widely used for marketing research (51) and TAM for information system research (52). Hence, each discipline would tend to adopt the theory based on its common disciplinary practice rather than the appropriateness of the theory.

All selected studies were experimental and involved comparison groups to test the effect of social media, such as online discussion forums, presence of opinion leaders, type of feedback from other users, and different characteristics of the networks (structure, density, size, type of moderation). The domains covered in the studies were diverse and did not focus only in the field of healthcare. In addition, there was a large variation in the duration of the interventions, ranging from 10 minutes to 9 months. Four studies in the review were targeting online shopping or online consumer communities. We chose not to restrict the review to medical publications because we believed that the cognitive mechanisms underlying behavioral change from online social network interventions would be independent of the nature of the domain (i.e. health-related or not). However, we observed that the most eligible studies from different fields of research did not share a similar theoretical background according to the field of the research (e.g. health interventions vs. product selling). All in all, it seemed that there was not a consensus in the approaches used to explain online social network effects on behavioral changes. Instead, the studies seemed to reuse traditional approaches in their own field and try to adapt them to online social media.

The review illustrated the diversity of theoretical approaches that were used in social network intervention studies. There is currently a lack of consensus on what theories should be used in social network interventions. Although the choice of an appropriate theory can be dependent on many factors (10) and we have also suggested a number of possible reasons to explain this, researchers can refer to previous research that was conducted to guide choice of theory for online interventions in general (2, 10, 11). These resources provide guidance on ways to choose an appropriate theory depending on parameters such as: the consideration of a continuum/stage model (49), the type of component thought to be important to the behavior sought (11), whether the behavioral change is expected to be maintained at short-term or long-term (53), the mode of delivery, the technological platform, the demographics, and the associated behavior techniques involved (2, 10, 11). We believe that these parameters would provide a good starting point to base the choice of theory for

investigation and overcome problems of unfamiliarity of theories from other disciplines or adopting theories based on common disciplinary practice.

### **Strengths and limitations**

The main strength of this review is the inclusion of experimental studies coming from any field of application, each of them with different scientific methodologies. This wide-inclusion decision ensures that we have covered all relevant articles on the subject of online social network interventions. However, the strategy also brings a mixed collection of different scientific standards making analysis more difficult.

Although there were only 15 studies, the review proceeded according to the PRISMA-compliant protocol with no changes introduced during the process. Our search methodology is based on peer-reviewed systematic reviews in the area (for example, the choice of search terms, data base selection, and article selection criteria). In fact, the number of included articles is in line with a few of recent systematic reviews on social network interventions (1, 2, 10, 54). The criteria of using theory and a quantifiable behavioral measure may have limited the number of eligible articles. However, these criteria are essential as they provide answers to how we can design interventional studies that involve social networks and produce quantifiable changes. In addition, the small number of eligible studies is an indication of the scarcity of publications in this area. The field of using social networks to change behaviors is relatively new. Despite its rapid growth, the number of theory-based studies is still limited in social network interventions, highlighting the need for further research in this area. The first step in the article selection process was focused on titles and abstracts as suggested by PRISMA guidelines (12); there might be a slight probability that some articles were erroneously rejected from the review. In addition, the review targeted only articles in English. This limitation might have resulted in the exclusion of some relevant articles written in other languages than English.

Several studies in the review (18-21, 24, 25, 27, 28, 31) did not provide enough information in their material and methods sections. Modest scores in the risk of bias assessment illustrated that lack of information. This was particularly obvious for studies from the field of marketing (27, 28), which did not seem to follow scientific protocols as rigorous as for studies from the field of health.

Finally, this review follows a rigorous methodology: the review was conducted to be strictly compliant with a protocol designed and openly available prior to the search of selected articles. During the selection process, two assessors reviewed independently each abstract and a third party mediated in case of disagreement.

## **CONCLUSION**

The main lesson learnt from our review was that we observed a lack of consensus when applying theoretical frameworks in the design of online social network interventions to induce behavioral change. In order to ensure the effectiveness of interventions and to be able to reuse this knowledge in the long run, a theoretical approach is necessary. Through this review, we suggest that existing theories and models from health psychology that are traditionally used for in-situ behavioral change should be considered when designing online social network interventions for healthcare. However, research on behavioral change produced by online social network is still in its infancy, like were health psychology theories twenty years ago (49). These theories were derived from other psychological disciplines and now, they constitute an independent branch of knowledge. Similarly, it is plausible that in the future, online social interventions will be based on new theories, integrating theories from health psychology and theories from other domains.

## **Abbreviations**

eWOM: Electronic Word of Mouth

HBM: Health Belief Model

i-POL: Internet Popular Opinion Leader

PICOS: Population, intervention, comparator, outcomes, and study design



POL: Popular Opinion Leader

SCT: Social Cognitive Theory

TAM: Technology Acceptance Model

TPB: Theory of Planned Behavior

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### **Author Disclosure Statement**

No competing financial interests exist.

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**Table 1: Eligibility criteria at different stages of study selection**

Abstract eligibility criteria:	<ul style="list-style-type: none"> <li>• Published within the last 12 years</li> <li>• English language</li> <li>• Abstract available</li> </ul>
Study eligibility criteria	<ul style="list-style-type: none"> <li>• Intervention is about social networking</li> <li>• Intervention is online (virtual communities)</li> <li>• Intervention targets adult customers/patients</li> <li>• Theoretical basis used in the study (e.g. theories from the fields of Social/Health Psychology, explanation in terms of cognitive mechanisms, etc.)</li> <li>• Outcomes are quantitative behavioral changes (including decision making)</li> </ul>
Exclusion criteria	<ul style="list-style-type: none"> <li>• Non-experimental study (e.g. editorial, case-study, qualitative study, review, one-group design, etc.)</li> <li>• Breaching any of filter restrictions (date, language, abstract), eligibility criteria (offline, not about networking, children, without any hypothesis/experimental methodology...)</li> <li>• Fail to comply with peer-reviewed published full paper criterion (e.g. website, blog, conference abstract, book, etc.)</li> </ul>

**Table 2: PICOS criteria for the studies included in the review**

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<b>Population</b>	Humans, consumers or patients, adults
<b>Intervention</b>	Social networks interventions (online)
<b>Comparator</b>	Control group with no access to social features (social network, social media), i.e. usual care or altered social intervention
<b>Outcomes</b>	Quantitative behavioral change, including decision making
<b>Study design</b>	Randomized control trials / controlled laboratory experiments

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Table 3: Risk of bias assessment for randomised controlled studies

Study	Random sequence allocation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Lee, Shi, 2011	?	?	✗	?	✓	?
Sohn, 2009	✓	✓	?	✗	✓	?
Sendes, 2013	✓	✓	?	?	✓	?
Carr, 2013	?	?	✗	?	✗	?
Centola, 2010	?	?	✓	✓	✓	?
Nahm, 2010	✓	✓	?	?	✓	?
Betsch, 2013	?	?	?	?	✓	?
Lindsey, 2009	?	?	✗	?	✓	?
Ko, 2013	✗	✗	✗	?	✓	?
Whittaker, 2011	✓	✓	?	?	?	?
Motl, 2011	✓	✓	✗	✗	✓	?
Lee, Kim, 2011	✓	✓	?	?	?	?
Joseph, 2015	?	✗	✗	✗	✓	?
Cavallo, 2014	?	?	?	?	✓	?
Nekmat, 2015	?	✓	?	?	✓	?

✓: Low risk of bias; ✗: High risk of bias; ?: Unclear risk of bias