"Hidden" Social Networks in Behavior Change Interventions

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We investigated whether "hidden" (or unobserved) social networks were evident in a 2011 physical activity behavior change intervention in Belfast, Northern Ireland. Results showed evidence of unobserved social networks in the intervention and illustrated how the network evolved over short periods and affected behavior. Behavior change interventions should account for the interaction among participants (i.e., social networks) and how such interactions affect intervention outcome. (*Am J Public Health.* 2015;105:513–516. doi:10.2105/AJPH.2014.302399)

Complex behavior change interventions have unintentional and unobserved consequences and effects that must be captured to help us fully understand mechanisms of behavior change.[1] For example, many interventions do not account for the interaction among participants (i.e., social networks) and how such interactions affect intervention outcome.[2]

Berkman[3] illustrates how social networks affect health through social interactions at the microlevel affecting behavior at the meso- and macrolevels, and previous research has helped us understand the effect of social networks on a range of health behaviors.[4–13]

We argue that "hidden" (or unobserved) social networks are inherent in behavior change interventions, particularly in cluster trials, and hypothesize that such networks affect the outcome of behavior change interventions. We investigated (1) whether social networks were evident in a physical activity behavior change intervention, and (2) if evident, what the characteristics and evolution of the network structure were over time.

METHODS

We collected objective social network and physical activity data concurrently over a 12-week period from a quasi-experimental trial of a financial incentive intervention (in Belfast, Northern Ireland, 2011).[14] We placed sensors (near field communication readers) along footpaths and in the gym in a workplace environment. Employees scanned a card containing a radio frequency identification tag at sensors when undertaking physical activity, such as walking, which created a timestamp (date, time in seconds, and location) that logged their activity.

The timestamp data facilitated our identification of participants' social networks. We derived the criteria for inferring participants' social networks from timestamps (1) on the same day; (2) at the same sensor (at 3 or more co-occurrences); and (3) within 30 seconds (which signified co-occurrences of physical activity behavior and enabled us to capture the social interactions of more than 2 people; data available as a supplement to the online version of this article at http://www.ajph.org).[15,16] We calculated the minutes of physical activity by aggregating the minutes between the timestamp data at each scanned sensor.

We calculated the network density (proportion of ties in the network), degree centrality (number of ties in a node), triadic census (structure involving 3 people), total number of social ties (number of co-occurrences of card swipes between at least 2 participants), and the Jaccard index, a measure of network stability (proportion of stable ties to ties at each time point) to describe the network structure[17] using UCINet 6[18] and Netdraw.[19]

RESULTS

Of the 406 participants, 225 engaged in physical activity involving social interactions with at least 1 other participant (as opposed to those doing physical activity alone or not at all). We inferred 5578 social interactions over the 12-week intervention, with 282 distinct pairings of participants, demonstrating clear evidence of hidden social networks within the intervention.

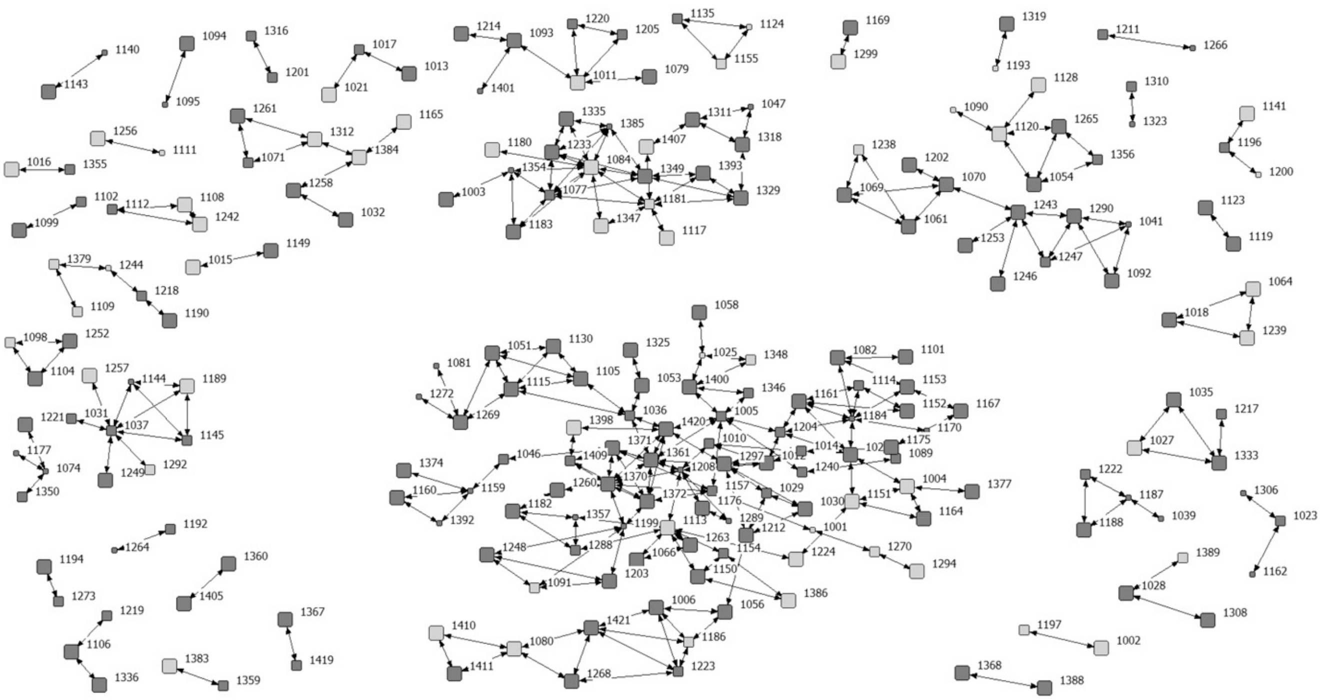
The network graph (Figure 1) illustrates that certain participants formed clear physical activity clusters, including cliques of dyadic (19 groups of 2 people) and triadic (9 groups of 3 people) structures. On average, participants engaged in physical activity with 1.4 (SD = 1.8) others (mean degree of centrality).

Figure 2 demonstrates the evolution of the social network structure over time. Dyadic and triadic structures are evident at each time point, illustrating a sustained pattern of participants walking with the same participants. The Jaccard index showed an increase in stability from a range of 8%–11% in weeks 1 and 2 to a range of 36%–45% in the last 4 weeks of the intervention, suggesting that walking "buddies," once established, remained stable. Results suggest that those engaged in physical activity with others maintained higher activity levels (i.e., 150 min/wk) throughout the intervention, which is reflected by the larger node size.

DISCUSSION

Results provide evidence of hidden social networks in a complex behavior change intervention and illustrate how the network evolved over short periods and affected behavior. Findings demonstrate that those who exercised in pairs or a group maintained higher levels of physical activity than do those who did not. Therefore, harnessing and using such networks could help promote and maintain behavior change. This may involve changing the structure or functioning of existing networks or the purposeful development of new social networks. Further, analyses of interventions that take explicit account of previously unobserved hidden social networks might better uncover mediators and pathways of initiation and maintenance of behavior change.

Social networks have been identified as an important modifiable mediator of physical activity behavior change[20]; however, we know very little about how to use and exploit such networks in behavior change interventions.[21] To our knowledge, this is the first study to provide explicit evidence of social networks inherent in behavior change interventions. We argue that these hidden social networks have typically been overlooked, unobserved, and subsequently underused in behavior change interventions. However, our analyses were limited to the influence of those who were enrolled in the physical activity intervention, and we did not attempt to model the broader social networks that exist outside the workplace.



Note. Node size indicates physical activity level: small nodes indicate no physical activity (0 minutes/week), medium nodes indicate some physical activity (1–149 minutes/week), and large nodes indicate sufficient physical activity (≥ 150 minutes/week). Light grey nodes indicate men; dark grey nodes indicate women. The mean degree centrality is 1.4 (SD = 1.8) and ranges from 0 to a maximum of 10, meaning that the average participant (from all 406 participants) engaged in physical activity with 1.4 others.

FIGURE 1—Network graph showing the derived social networks aggregated over the 12-week intervention period and their relation to achieved level of within-trial physical activity: Belfast, Northern Ireland, 2011.

The collection of such data is relatively straightforward and could (and should) be incorporated into future behavior change interventions for a range of behaviors, including physical activity, diet, alcohol, and smoking. Further, emerging technologies and social media enable unobserved social interactions in behavior change interventions to (1) be objectively measured, (2) capture social interactions directly related to the health behavior under investigation, (3) be measured longitudinally, and (4) be monitored, manipulated (if appropriate), and analyzed in real time and help us better understand the effect of inherent social networks within behavior change interventions.

Whether such networks could be harnessed to support a successful public health intervention depends on a range of practical and theoretical issues that have yet to be studied.[22–24] For example, which psychosocial and behavior change theories plausibly underpin the intervention design and how social networks can be optimally designed to generate, accelerate, and maintain behavior change? ■

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Contributors

R.F. Hunter conceptualized the study, collected the data, and drafted the article. R.F. Hunter, M. Davis, and F. Kee contributed to the study design. R.F. Hunter, H. McAneney, M. Davis, and T.W. Valente analyzed and interpreted the data. All authors read and approved the final draft.

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Human Participant Protection

The study was approved by the Research Ethics Committee of the School of Medicine, Dentistry and Biomedical Sciences, Queen's University Belfast, Northern Ireland. All participants provided informed written consent before participation.

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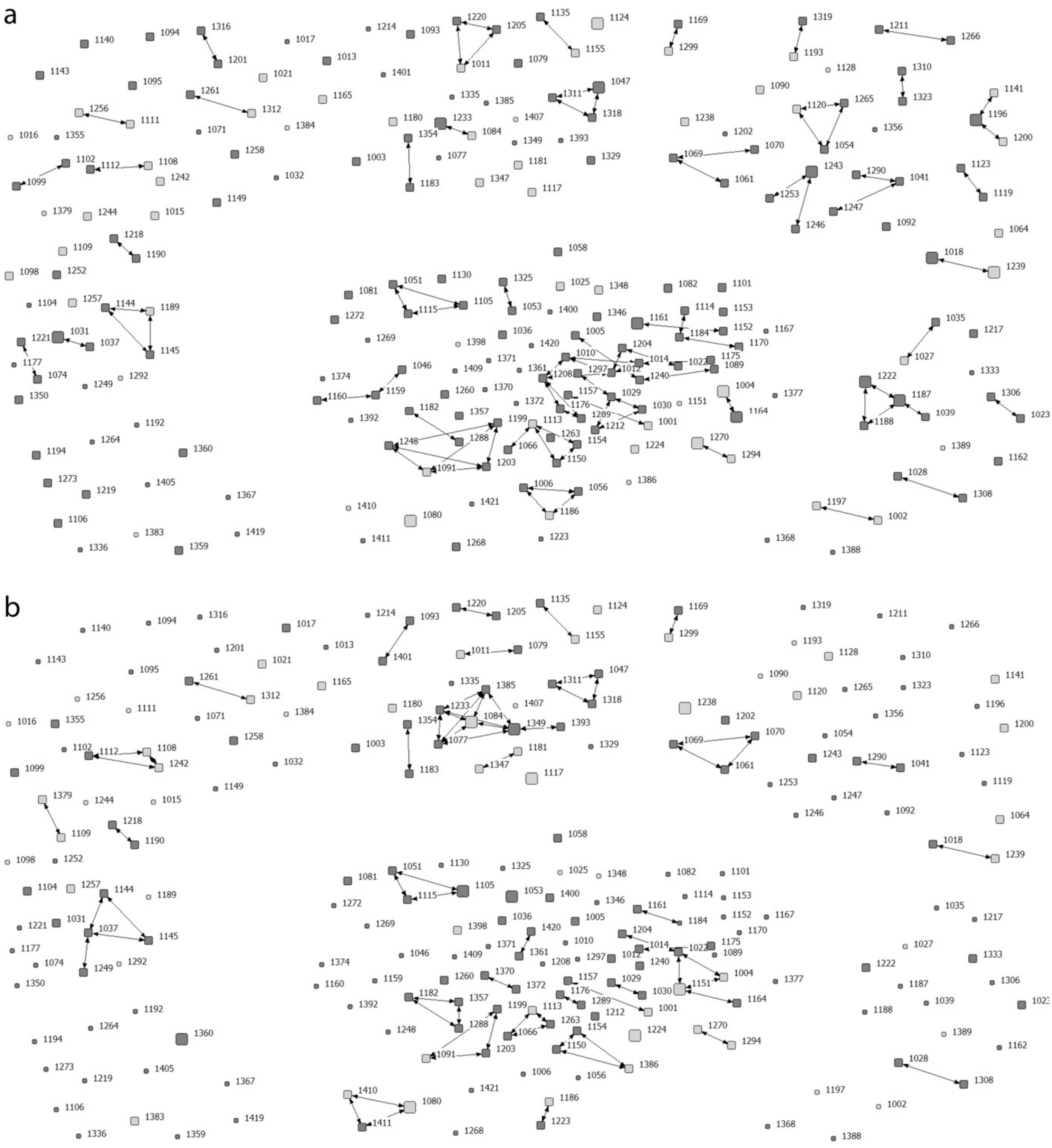

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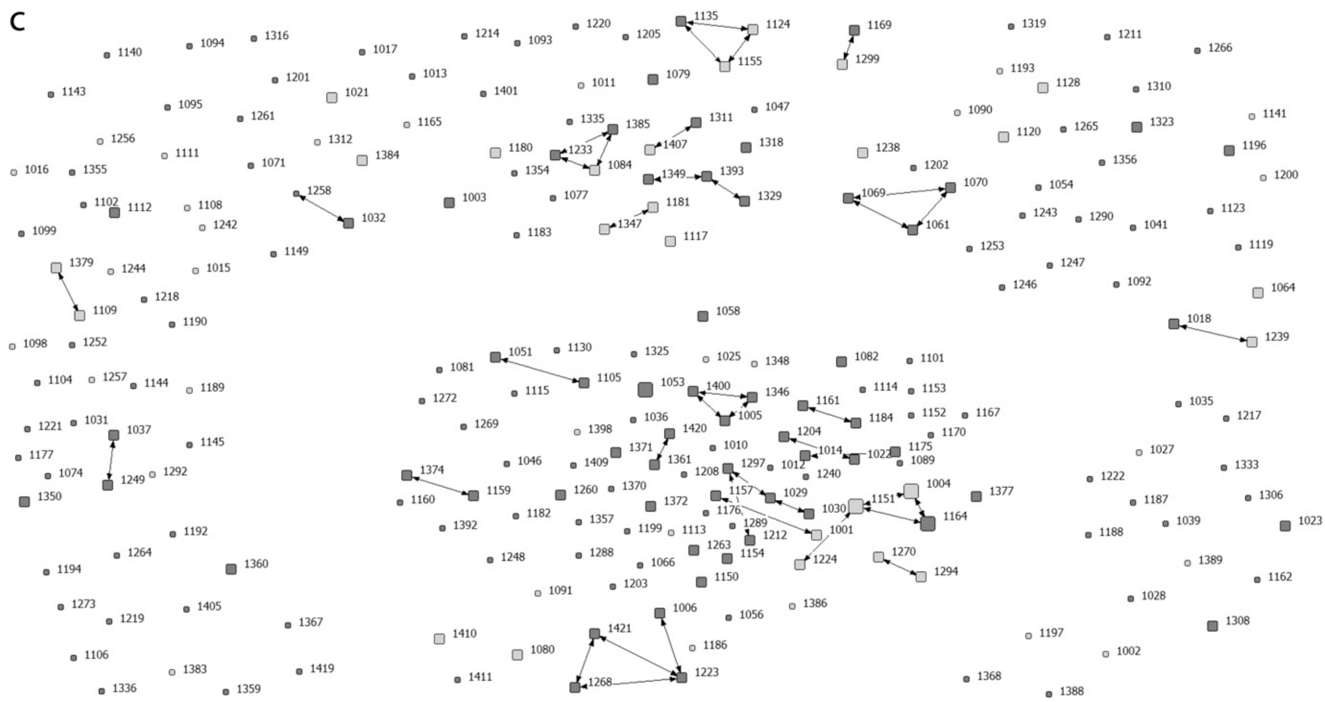

Note. Node size indicates physical activity level: small nodes indicate no physical activity (0 minutes/week), medium nodes indicate some physical activity (1–149 minutes/week), and large nodes indicate sufficient physical activity (≥ 150 minutes/week). Light grey nodes indicate men; dark grey nodes indicate women. Social ties were determined by the number of co-occurrences of card swipes between at least 2 participants during physical activity. The Jaccard Index is the proportion of stable ties to ties that exist.

FIGURE 2—Snapshots of network graphs illustrating the evolving dynamic nature of social networks and their relation to achieved level of within-trial physical activity occurring at (a) week 1 of the intervention, (b) week 6 of the intervention, and (c) week 12 of the intervention: Belfast, Northern Ireland, 2011.

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