Social Networks and Physical Activity in Senior Housing: A Pilot Feasibility Study

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Objective: Only 16% of people aged >65 years engage in recommended levels of physical activity, putting a vast majority at risk for multiple chronic conditions including heart disease. Physical activity is even lower among older adults with fewer economic resources. Research is needed to develop context-specific approaches to pair with physical activity interventions to increase effectiveness. In this pilot study, we examine social ties and physical activity levels of older adults living in a US Department of Housing and Urban Development subsidized senior housing community to test feasibility of a social network-based approach to physical activity interventions. This study is grounded in Social Contagion Theory and the Convoy Model of Social Relations, which argue health and health-related behaviors are facilitated through network ties.

Methods: Data were collected through face-to-face interviews conducted over the course of three months (September-November 2018) with 46 residents living in a low-income senior housing community in southeast Michigan. Residents were asked about physical activity, people they know in the community, and their close social network composition.

Results: Residents reported knowing, on average, six other residents and approximately 28% of those in their close networks were also residents. Sociocentric network analysis identified two socially engaged (known by seven or more other residents) physically active residents, whereas egocentric analysis identified four (60% or more of their network comprised residents).

Conclusions: This study demonstrates potential feasibility of a strategic partnership that involves pairing social resources with physical activity interventions in afford-

Introduction

Regular physical activity is one of the most important predictors of healthy independent living among older adults. Physical activity reduces risk of multiple diseases and falls, improves bone and muscle strength, and enhances mental and functional health.[1] Despite these benefits, only 16% of people aged >65 years engage in recommended levels (2.5 hours) of moderate intensity activity per week.[2-3] Prevalence of physical activity remains low despite availability of evidence-based resources (eg, the National Institute on Aging's Go-4Life campaign[4]) and interventions.[5] This indicates a clear need to develop and test approaches to pair with existing resources and interventions in order to increase their effectiveness.

Physical activity is especially low among lower income older adults. This is due in part to socioeconomically driven disparities in access to physical activity-related resources such as knowledge about benefits and effective regimens, equipment, and areas to exercise.[6-8] In contexts with fewer economic resources, social networks have powerful effects on older adults' health and health-related behaviors.[9,10] This suggests pairing a social network-based approach with existing physical activity resources and interventions in this context may be particularly helpful in increasing effectiveness. Residential communities such as affordable (ie, subsidized by the US Department of Housing and Urban Development) senior housing are well-suited for a social network-

able senior housing. Multiple approaches, which need to be evaluated, exist to identify socially engaged residents.

based approach to intervention since these apartment-style buildings are home to large numbers of older adults who live in close proximity. Furthermore, residents may have few options to participate in physical activity outside the community due to limited transportation resources.

Previous work has conceptualized how networks can be incorporated into behavior change interventions.[11] Few studies, though, have conducted the necessary translational research (ie, research that fosters the multidirectional integration of basic re-

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search, patient-oriented research, and population-based research, with the long-term aim of improving the health of the public')[12] to evaluate the effectiveness of these approaches. An exception is a randomized controlled trial conducted by Kim and colleagues,[13] which found enhanced dissemination of a public health intervention through network ties in Honduras. Valente argues the design of network-based interventions needs to be guided by the characteristics of the network, behavior, and social

context in which the intervention will take place.[11] To our knowledge, no research has been conducted that translates network science into a social network-based physical activity intervention in the context of affordable senior housing. In this study, we examine social ties and physical activity levels of older adults in an affordable senior housing community to evaluate the feasibility of pairing a social network-based approach with physical activity interventions in this context. We also compare the effectiveness of two theoretically grounded measurement approaches for identifying socially engaged residents. If feasible, this approach could lead to a strategic partnership between residents and staff working in affordable senior housing communities to collaboratively disseminate and implement interventions.

Theoretical Perspectives

This study is grounded in Social Contagion Theory,[14] which argues behaviors are contagious, spreading through networks via multiple mechanisms including: 1) induction - when one person's behavior induces change in others because of their influence in the network; 2) proximity effects or shared environmental factors; and 3) homophily - when people associate with others similar to themselves. Recent studies have successfully applied Social Contagion Theory to negative health behaviors such as obesity[15] and smoking.[16] Testing of social contagion mechanisms typically requires sociocentric network measurement approaches, which attempt to understand the web of ties within a

group of people. This study is also based on the Convoy Model of Social Relations, which argues networks influence health and behavior through network structure (eg, size and composition) and supportive ties.[17-18] Measurement and testing of the Convoy Model typically involves use of ego-centric network measurement approaches in which a person is asked to nominate close relationships. These data are then aggregated to summarize the ego network. Despite the prevalence of both theories in the literature, little research has translated them and their related measurement approaches into interventions. This study draws from both to maximize potential network influences on behavior change.

In this study, we examine two research questions: 1) Can we identify a group of affordable senior housing residents who are socially engaged (ie, have social ties to a large number of other residents) and are physically active? We hypothesize a small group of socially engaged residents who engage in some physical activity will be identified. 2) Do measurement approaches grounded in Social Contagion Theory (socio-centric) and the Convoy Model of Social Relations (ego-centric) identify similar or different socially engaged residents? We hypothesize socio- and ego-centric measurement approaches will identify some, but not all the same residents.

METHODS

Participants

Face-to-face interviews lasting approximately one hour were conduct-

ed by trained interviewers over the course of three months (September – November 2018) with 46 residents living in an affordable senior housing community in southeast Michigan. The community is a multi-story residential apartment building with approximately 250 residents meeting low-income criteria for the area (ie, <$20,400/year for 1 person; <$23,300/year for 2 persons). The sample of residents had a mean age of 73 (SD=11.7; range: 30-93), 78% were female, and 26% were racial/ethnic minorities (9% were Black, 13% Asian, and 4% reported 'other' as their race/ethnicity); 11% were married; and 76% had completed some college or more education (Table 1). This study was approved by the University of Michigan's Institutional Review Board and all procedures followed were in accordance with the IRB and the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants included in the study.

Measures

Social Networks

We adapted socio- and ego-centric network measures used previously with older adults.[19-21] For the socio-centric measure, residents were asked to list people in the community they know, ie, 'if they passed by us, would you be able to tell me their name?' For the egocentric measure, we used an adapted version of the Hierarchical Mapping Technique to measure close social networks.[21] We asked respondents to list people who were close and important in their life based on varying levels of close-

Table 1. Sample characteristics and descriptive statistics

	Mean (SD)
Age (30-93)	73.4 (11.7)
Sex, % female	77.8
Race/ethnicity, %	
Black	8.7
Asian	13.0
White	73.9
Other	4.4
Marital status, % married	10.9
Educational attainment, % some college or more	76.1
Physical activity	
Frequency/wk at least moderate intensity physical activity, times (0-28)	5.3 (6.7)
Engage in at least moderate intensity physical activity one time during typical week in past month, %	65.2
Socio-centric network ties (within community)	
Reported known ties, (0-20)	6.3 (5.3)
Reported known ties - restricted, (0-12)[a]	3.2 (2.9)
Listed as known by others (0-18)	3.2 (3.7)
Ego-centric – close social network	
Network size (0-29)	12.5 (6.5)
Number of network members in community (0-17)	3.2 (4.0)
Percentage of network comprised residents (0-100)	27.7 (31.2)

a. Reported known ties restricted to known ties only among other participating residents.

ness. After each person was named, respondents were asked whether that person lived in the community.

Physical Activity

The Community Health Activities Model Program for senior's physical activity self-report questionnaire was administered during the face-to-face interivew.[22] Two of the 41 items (heavy work around house, eg, cleaning gutters and heavy gardening) were not included because residents lacked the opportunity to engage in these activities in an apartment building context. Residents were first asked if they did each activity in a typical week during the past month, and if yes, how many times. A summary of the frequency/week engaging in at least moderate intensity physical activity measure was created following

the procedure described by Stewart and colleagues.[22-23] The number of times residents reported engaging in each of the 17 moderate-to-vigorous intensity physical activities (eg, dancing, jogging) in a typical week was summed. Residents reporting that they did not do a specific activity received a score of zero and all residents received a score of zero for the two dropped items. Next, residents were categorized into two groups based on whether they reported engaging in at least moderate intensity physical activity one or more times during a typical week in the past month (0=not physically active; 1=physically active). It is likely that not all of the residents identified as physically active were meeting current activity recommendations (eg, 150 minutes of moderate intensity physical activ-
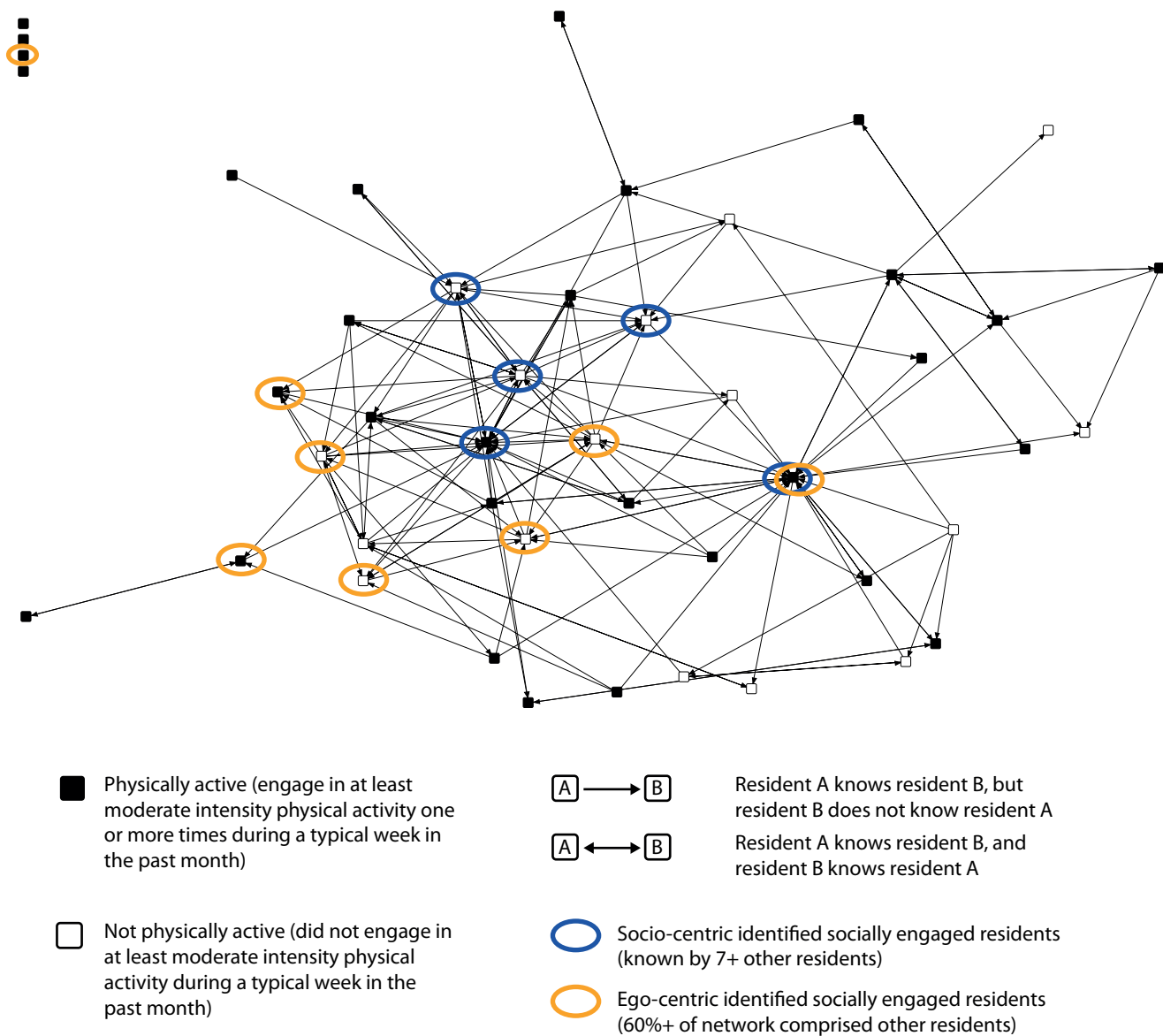
Physically active (engage in at least moderate intensity physical activity one or more times during a typical week in the past month)

Not physically active (did not engage in at least moderate intensity physical activity during a typical week in the past month)

A ⟶ B   Resident A knows resident B, but resident B does not know resident A

A ⟷ B   Resident A knows resident B, and resident B knows resident A

Socio-centric identified socially engaged residents (known by 7+ other residents)

Ego-centric identified socially engaged residents (60%+ of network comprised other residents)

Figure 1. Sociogram of known resident ties in an affordable senior housing community

ity/week).[24] However, this measure and categorization aligned with the goals of the pilot feasibility study to identify residents engaging in some moderate/vigorous physical activity who could work with community staff to implement an intervention aimed at increasing their own as well as other residents' activity levels.

Analysis

Social network analysis was conducted to identify socially engaged residents.

Socio-centric

UCINET[25] was used to calculate in-degree centrality, ie, number of times each respondent was indicated

as being known by another resident. NETDRAW[25] was used to create a sociogram of the ties (see Figure 1) with labels indicating whether residents engaged in moderate/vigorous physical activity. This analysis and depiction of within community ties was restricted to only ties between residents who participated

in the interview. The ties between participating and non-participating residents were not included due to the lack of physical activity data on non-participating residents.

Ego-centric

We calculated a summary measure for each resident to indicate the percentage of their close social network composed of other residents (total number of people nominated in their network living in the community divided by total number of people nominated).

To identify socially engaged physically active residents, we identified residents 1+ standard deviation above the mean for in-degree centrality and network percentage in community. We then evaluated whether the identified residents were physically active. Lastly, we compared residents identified from both approaches.

Results

Physical Activity

Residents reported engaging in at least moderate intensity physical activity on average 5.3 times during a typical week in the past month (SD=6.7; range: 0-28 times). Almost two-thirds (65%; N=30 of 46) of the respondents reported engaging in moderate/vigorous activity at least one time during a typical week in the past month.

Socio-Centric Networks

Respondents reported knowing on average 6.3 (SD=5.3; range: 0-20) other residents who could be linked back with certainty to a resident in

the community. When restricted to other participating residents, respondents knew on average 3.2 residents (SD=2.9; range 0-12). Respondents were listed as being known (ie, in-degree centrality) on average 3.2 times (SD=3.7; range: 0-18).

Ego-Centric Networks

Respondents nominated an overall average of 12.5 (SD=6.5; range: 0-29) people in their close social networks. Approximately 3.2 were residents (SD=4.0; range: 0-17), resulting in an average network percentage of community residents of 28% (SD=31%; range: 0-100).

Research Question #1

In support of our hypothesis, socially engaged, physically active, affordable senior housing residents were identified using theoretically driven socio- and ego-centric measures (Figure 1). Socio-centric: Five residents were 1+ standard deviation above the mean on in-degree centrality, ie, seven or more residents knew them. Among these seven, two were physically active. These are indicated by the blue circles in Figure 1. Ego-centric: Eight residents were 1+ standard deviation above the mean on network percentage in community (60% or more). Among these eight, four were physically active. These are indicated by the orange circles in Figure 1.

Research Question #2

We found partial support for our hypothesis that the socio- and ego-centric approaches would identify similar residents. As indicated in Figure 1, the blue circles indicate

residents identified using the socio-centric approach while the orange circles indicate residents identified with the ego-centric. Although, the socio-centric method identified two socially engaged and physically active residents and the ego-centric method identified four. Interestingly, only one resident was identified by both approaches as being socially engaged and physically active (in-degree centrality = 16; network percentage in community = 91%).

We examined whether there were race and ethnicity differences in the residents identified by the two approaches. Interestingly, there were similarities in the racial/ethnic diversity of the residents identified. First, of the five residents identified as socially engaged by the socio-centric approach, one was Black, one reported as 'other' race/ethnicity, and three were White. Of the two socially engaged and physically active residents, one was Black and one was 'other' race/ethnicity. Of the eight socially engaged residents identified by the ego-centric approach, one was Black, one was Asian, and six were White. Among the four identified as socially engaged and physically active, one was Black, one was Asian, and two were White. Finally, the one resident identified by both approaches was Black.

Discussion

This pilot study demonstrated feasibility of pairing a social network-based approach with physical activity interventions in an affordable senior housing setting. Feasibility was

demonstrated through identification of socially engaged physically active community residents who could potentially serve as influential agents of change. These findings contribute to the developing knowledge base regarding best approaches to translate social network literature into behavioral and context-specific interventions.

This study also demonstrated differences across theoretical perspectives and related measurement approaches in identifying socially engaged resi-

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dents within a community. Each approach was effective, and each approach has pros and cons. For example, a socio-centric approach is time and labor intensive to collect and analyze. It also requires very high response rates to obtain a complete view of a community. However, this approach addresses potential reporting bias by obtaining multiple perspectives on the same tie. The ego-centric approach, while less time intensive to collect and analyze, may be less effective in driving behavior change given subjectivity

bias inherent in reporting social ties, ie, a person may think they are close to someone, but the relationship may not be reciprocated.[26] Another strength of this approach compared with others is that it can more efficiently collect information on ties outside a defined (ie, senior housing) community. Both approaches identified a racially and ethnically diverse group of residents, which highlights the potential of both approaches when paired with interventions in affordable senior housing to impact not only socio-economic disparities in health behaviors but also racial and ethnic disparities.

Research is needed to understand which approaches identify residents who are most effective at facilitating and sustaining behavior change among other residents. It may be that a combination of both approaches is needed to identify the most influential residents. We argue this for two reasons. First, it is likely that the structure of a within-community social network is influenced by the broader set of social ties residents have that may include people outside the community. Second, an approach to identifying socially engaged residents within a community that incorporates multiple measurement approaches can help minimize limitations associated with each. The approaches examined in this study are only two of many possible approaches.[11,13]

LIMITATIONS AND FUTURE DIRECTIONS

This pilot study was intended as a first step to demonstrate the potential of pairing social resources with

physical activity interventions in senior housing. There were multiple limitations that should be considered. First, in this study associations between social ties and physical activity were not evaluated. Additional research is needed to understand how specific aspects of social networks are associated with physical activity in affordable senior housing. For example, are residents who report knowing another resident who engages in physical activity more likely to engage in physical activity themselves if the tie is reciprocated, the other resident is more respected by the person, lives closer to them, is more similar to them, reports being in more frequent contact, and/or feels more comfortable confiding in them? This information will help to further refine development of a social network-based physical activity intervention for affordable senior housing. Second, this study was limited in that the data are from one affordable senior housing community and may not be generalizable to other communities. Additional studies with larger samples including more communities are needed.

Third, this study was limited in that only 46 (18%) of 250 residents participated. As a result, no physical activity data were available for many residents known by participating residents. This likely resulted in an underestimate of the number of socially engaged physically active residents in the community identified via the socio-centric measure. To address this limitation, future studies should ask participating residents to list the names of residents with whom they engage in physical activity. Despite

these limitations, the current pilot study was successful in demonstrating the feasibility of this approach.

Conclusions

A focus on social networks and interpersonal ties as a resource to help disseminate and implement interventions may help make them more effective. This pilot study is an initial step in demonstrating the potential of developing a strategic partnership between affordable senior housing residents and staff to promote sustainable behavior change among older adults. This partnership would involve staff first identifying and then working with socially engaged residents in the community to disseminate and implement health interventions. Health researchers can help facilitate this partnership by conducting studies to identify the most effective types of social ties in this context to pair with interventions. Furthermore, researchers can provide senior housing staff with guidance on how to identify socially engaged residents within the community in a scientifically rigorous, but low-burden and cost-effective manner. If effective, this partnership can help reduce socio-economically linked disparities in health behavior by leveraging naturally occurring social resources.

Conflict of Interest
No conflicts of interest to report.

Author Contributions
Research concept and design: Webster, Antonucci, Alexander; Acquisition of data: Webster; Data analysis and interpretation: Webster, Antonucci, Alexander; Manuscript draft: Webster, Antonucci, Alexander; Statistical expertise: Webster; Acquisition of funding: Webster, Antonucci, Alexander; Administrative: Webster; Supervision: Webster

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