

Original Research Article

# From a Bird's Eye View: Whole Social Networks in Adult Day Care Centers and Continuing Care Retirement Communities

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## Abstract

**Background and Objectives:** The present study describes whole social networks in 4 adult day care centers (ADCCs) and 4 continuing care retirement communities (CCRCs) in Israel.

**Method:** Each respondent received a list of names of all individuals receiving services in the respective ADCC or CCRC and was asked to indicate whom he/she knows from the list. We derived whole social network properties and used hierarchical cluster analysis to group network settings. We further examined the ability of the social network data to classify respondents as members of either an ADCC or a CCRC.

**Results:** Many social network properties were more favorable in CCRCs than in ADCCs. A striking finding of the present study is that one can classify with a relatively high degree of accuracy a respondent as belonging to an ADCC or a CCRC, simply based on his or her social properties (specifically, number of people who know the participant and are known by the participant).

**Implications:** Despite some similarities between CCRCs and ADCCs, CCRCs likely allow for more inclusive and active social relations. This information should be valuable to administrators and care providers.

**Translational Significance:** Both adult day care centers (ADCCs) and continuing care retirement communities (CCRCs) aim to ease loneliness while allowing older adults to age in place, but participants in ADCCs report fewer ties with other participants than members of CCRCs. ADCCs should consider incorporating social interventions that increase ties between participants.

**Keywords:** Egocentric, Long-term care, Social network analysis, Sociocentric

The socioemotional selectivity theory is one of the most popular theories in the field of gerontology (Carstensen, Fung, & Charles, 2003). The theory predicts that as older adults age and realize that their time is limited, their motivations change as well (English & Carstensen, 2016). Older adults become less motivated to acquire knowledge and

new information and more motivated to maintain intimate emotionally gratifying relationships. This change in motivation also results in changes in older adults' social networks (English & Carstensen, 2014). With age, older adults invest more in their intimate relationships at the expense of discarding superficial contacts (Carstensen et al., 2003).

In support of this theory, past research has shown that older adults' social networks shrink with age (Wrzus, Hänel, Wagner, & Neyer, 2013). Whereas the number of intimate ties remains relatively constant, there is a decline in the overall number of relationships mainly due to shrinkage in the peripheral network (B. Cornwell, Schumm, Laumann, Kim, & Kim, 2014). Within this framework of the socioemotional selectivity theory, one can use the differentiation between primary and secondary groups. A primary group is considered a small social group, whose members share strong concerns for one another and have similar background and interests (Litwak & Szelenyi, 1969). A secondary group on the other hand, consists of a large number of individuals who share only superficial ties with each other (McIntosh & Alston, 1982).

Using the socioemotional selectivity theory as a framework, one would expect older adults to be more tuned toward primary groups than toward secondary ones. Yet, the social lives of many older adults evolve around secondary groups, as in the case of formal long-term care services provided through adult day care centers (ADCCs) and continuing care retirement communities (CCRCs; Ayalon & Green, 2013; Iecovich & Biderman, 2012a).

Both ADCCs and CCRCs can be characterized as representing secondary groups. This means that they consist of a relatively large group of individuals gathered for a common purpose, such as, social interaction, recreational time, and possibly the protection from the outside world. Moreover, both settings target loneliness and social isolation among older adults and offer a variety of social services and activities to facilitate social interactions among older adults (Ayalon & Green, 2013; Iecovich & Biderman, 2012a).

The present article describes the social networks of older adults in four ADCCs and four CCRCs. In addition to the shared purpose of alleviating loneliness and providing social stimulation to older adults, both types of settings can be characterized as age-segregated. As both types of settings explicitly admit individuals over a certain age. This means that the two types of settings are specifically designed to allow older adults with ample opportunities for social interactions with "like-minded" people of a similar age (Ayalon & Green, 2013; Iecovich & Biderman, 2012a). Given the relatively large size of these groups and the limited previous common history, background, or purpose, individuals are likely to develop only limited personal relationships of temporary nature in such settings. Within these secondary groups, though, it is possible that smaller groups characterized by greater intimacy and personal relationships will be formed. These groups can be defined as primary groups (Litwak & Szelenyi, 1969).

In addition to age, another common criterion upon which older adults are selected into these facilities is their ability to carry out activities of daily living (Ayalon, 2016a; Iecovich & Biderman, 2012b; Shippee, 2009). However, whereas in ADCCs, being physically impaired is an eligibility criterion for entrance, in CCRCs, older adults are

expected to be physically independent at least upon entering the CCRC. Nevertheless, research has shown that often-times, the entrance to a CCRC is motivated by concerns about future physical decline (Bekhet, Zauszniewski, & Nakhla, 2009).

Another common characteristic of the two types of settings is the fact that they have well-defined geographic boundaries (Campbell, 2015). One either belongs or does not belong to a CCRC or an ADCC and this membership is formal (as clearly documented by the list of service users in each of the settings). Membership is defined by clear spatial boundaries, with members of a particular setting also being physically present in that setting for at least some of the time.

Despite these similarities, there are notable differences between the settings. ADCCs represent a care alternative for older adults who suffer from functional impairments (Baumgarten, Lebel, Laprise, Leclerc, & Quinn, 2002). This care alternative is currently funded in Israel through the Long-Term Care Insurance Law. The law which was enacted in the late 80s of the previous century aims to keep older adults in the community. According to the law, older adults who are impaired in activities of daily living or require supervision due to dementia are eligible to receive governmental support in the form of services or cash. Currently, the law supports almost 17% of the population of older adults in the country. Of these, 7.4% participate in ADCCs (National Insurance Institute of Israel, 2015).

ADCCs in Israel are open 5 or 6 days per week and provide services for 6–7 hr per day. ADCCs offer recreational and social activities, transportation, and nutritional meals. They also provide physiotherapy, occupational therapy, nursing care, and dietary supervision. Additional services, such as showering, shaving, or pedicure can be purchased at extra fees (Iecovich & Biderman, 2012b).

In contrast to ADCCs, CCRCs represent a care alternative which aims to replace community dwelling by creating age-segregated communities. CCRCs are available to older adults who are independent upon transition (Shippee, 2009). Similar to ADCCs, CCRCs provide social services, such as the opportunity to participate in various classes of arts and crafts, sports, and recreation. Residents can choose whether or not they wish to participate in social activities, eat their meals or obtain health and social services in the setting (Ayalon, 2016a). CCRCs represent an alternative for older adults who have substantial means as there is no governmental funding to support this living arrangement. Although there is a growing interest in this living arrangement, the majority of older Israelis still live in the community and fewer than 4% live in institutions (Brotsky, Shnoor, & Be'er, 2012).

## The Present Study

A substantial amount of research in the field of gerontology has addressed the social world of older adults (Antonucci &

Akiyama, 1987; Dickens, Richards, Greaves, & Campbell, 2011). However, it has been done primarily from the ego-perspective (Ayalon, & Levkovich, 2018). This means that data are collected from the perspective of focal persons (egos) concerning their ties with alters (individuals in the ego's network environment), but alters are not directly queried about their relationships with the ego or with each other. Relying on such a design, networks are analyzed as if they are being independent of each other. Although informative, this type of research ignores the fact that relationships are bidirectional and have a strong subjective component (Casciaro, 1998; Valtorta, Kanaan, Gilbody, & Hanratty, 2016). It also does not allow to examine the entire (i.e., whole) social network structure within a particular setting.

Examining an entire social network, as a whole, rather than the individuals who make up the network is important. Such an analysis points to the social whole that oftentimes is greater than the sum of its parts (Burt, 2001). By doing so, it is possible to examine the social characteristics of a particular setting, for example, an ADCC or a CCRC, rather than exclusively focus on the characteristics of the individuals who make up the setting. This can point to opportunities and barriers potentially put forth by the setting. For instance, past research has shown that certain characteristics of the social network, such as density or size, can foster innovation (Baer, Evans, Oldham, & Boasso, 2015), whereas other characteristics, such as homophily, that is, similarity between the people who make up the network, hinder innovation (Granovetter, 1983). This type of information is important because it suggests that it is not only the people who make up the network who are important, but also the ties between them and the overall composition of these ties. Moreover, familiarity with the social network as a whole can assist policy stakeholders and administrators in the introduction of interventions at the network level, such as fostering ties among network members or capitalizing on a brokerage position of key members (Valente, 2017).

The focus of the present study was on the network ties formed through social familiarity. Familiarity (e.g., whether or not one knows others in the network) represents a basic property of a social network, as it is impossible to develop any further relationships, such as likes or dislikes, without at least knowing others in the network (Baldassare, Rosenfield, & Rook, 1984). As both ADCCs and CCRCs likely offer older adults more opportunities for the formation of secondary groups than primary, intimate groups, we would expect participants in these settings to at least know one another. Not knowing others in the setting, means that even the most basic tie is left unfulfilled.

To characterize each of the networks as a whole, we selected several network properties:

**Component**—a component is a portion of the network (a subset of the nodes [individual] and edges [ties between them]) that includes a path between each pair of individuals. A network may include one or multiple components,

which are disconnected from each other. Multiple components indicate a more segmented network, whereas a single component represents a more cohesive structure. This property was examined given the expectation for both settings to be composed of a giant component, in which all individuals are eventually connected to form a large secondary group.

**Isolates** represent the number of individuals who have no outgoing or ingoing ties with anyone in the network. Settings characterized by a larger number of isolates are probably doing a poorer job in integrating network members and making them part of the social fabric of the setting. These settings can be problematic, given the negative implications of social isolation on the lives of older adults (Cornwell & Waite, 2009).

**Overall density** of the network is defined as the portion of the potential connections in a network that are actual connections. The number of potential ties in a *directed network* is  $N \times (N - 1)$ , because every member may have ties with all other members. Density can range between 0% and 100%, with a higher percentage representing a denser network. A denser network indicates stronger ties and sense of community among community members (Girvan & Newman, 2002; Granovetter, 1983; Rademacher & Wang, 2014). Past research had shown that a strong sense of community is associated with beneficial outcomes (Zhang, Zhang, Zhou, & Yu, 2018) and therefore, should be encouraged.

**Degree**—The node *degree* represents the number of connections an individual has with other individuals in the network. We examined: the number of outgoing ties (*out-degree*; e.g., A knows B) and the number of ingoing ties (*in-degree*; e.g., A is known by B). The degree measure is calculated for each node in the network. The in-degree represents one's popularity in the network, whereas the out-degree measure represents one's level of social activity in the network (Snijders, 2001). Given past research, which has shown associations between in-/out-degree, quality of life, and cognitive functioning, these properties are of potential significance (Ayalon & Levkowitz, 2018).

High degree *correlation* between the node in-degree and the node out-degree in a network suggests that the more "popular" older adults who are well-known by everyone also know more people and vice versa: the wallflowers are not well-known by others and also know very few people in the particular setting (Snijders, 2001). We would expect social settings to be characterized by a high degree correlation.

**Reciprocity** is a measure of the likelihood of actors (i.e., nodes) in a directed network to be mutually linked (e.g., A knows B and A is also known by B). The measure of reciprocity defines the proportion of mutual connections, in a directed graph. It is most commonly defined as the probability that the opposite counterpart of a directed tie (edge) is also included in the network. A reciprocal tie may indicate a stronger tie between two actors (Hammer, 1985;

Wasserman & Faust, 1994). Reciprocal ties among friends are thought to be more satisfactory (Rook, 1987) and thus, a social setting should strive to have an overall higher level of reciprocity among its members.

We also report the *degree distribution* which represents the probability distribution of the *in-degree* and *out-degree* in the whole network. This provides information regarding the fraction of nodes with a specific in-degree/out-degree in the network. A common degree distribution is the scale-free distribution (Barabási & Bonabeau, 2003). In such a network, most individuals have very few ties, and a small minority has a large number of ties. This type of distribution represents a tendency of those “rich” in social ties to get even richer and to attract a larger number of connections than would be expected by chance alone. This distribution can be contrasted with another well-known distribution, called the random distribution, in which individuals have a random chance of connecting to each other.

The present analysis, “from a bird’s eye view,” is one of the first studies in the field of gerontology to use quantitative social network analysis (SNA) to describe the structure of different long-term care settings (Ayalon, 2018). This allows for an appreciation of the unique characteristics of each of the settings as a whole. Instead of examining the individual actors who make up the network and their unique characteristics, we focus on the relations between actors to describe the social structure in each of the settings. Both actors and possible ties are confined based on a predefined boundary which delineates the borders of the network (Scott, 2017). In the present study, the entire social network of older adults in four ADCCs and four CCRCs is described. In doing so, we capitalize on the natural geographic- and membership-boundaries imposed by these long term care settings. Information obtained in this study can guide the design of social settings for older adults and point to potentially meaningful social characteristics at the network level.

Given the limited availability of prior research in the field of gerontology, our primary aim is to describe the networks and their properties. We expect both settings to be characterized by giant components, in which most actors are connected to each other, as is typical for secondary groups (Litwak & Szelenyi, 1969). We also expect a relatively low level of network density (e.g., the proportion of actual ties out of all possible ties), consistent with past research, which has found low levels of density in an Australian nursing home (Casey, Low, Jeon, & Brodaty, 2016). Finally, we explore whether certain settings share similar network properties which make them more similar to one another and differentiate them from other settings (e.g., whether one can distinguish between ADCCs and CCRCs based on their network properties).

## Method

### The Settings

The selection of settings was fueled by past research (Ayalon & Green, 2015; Ayalon, 2016b), which has stressed the

importance of the CCRC’s features in shaping older residents’ social lives. In selecting the settings, we specifically aimed for geographic diversity (center, south, Jerusalem) as well as for variations in size (40–299), socioeconomic status and cultural background. This potentially allows for the generalization of the findings beyond the individual characteristics of a particular setting (Patton, 2005). The social workers in the respective sites provided background information about each of the settings as detailed below:

Three of the ADCCs were located in the Center of the country and one in the South. *BH* is a 135-person setting. It is adjacent to *BM*, which is a 130-person setting. However, the two settings are very different as *BH* has gone through a complete re-organization and currently consists of a mixture of participants who come from two different neighborhoods of different socioeconomic backgrounds. *BM*, on the other hand, caters to a more homogenous cliental in terms of geographic residence. *KS* is considered a unique setting as it offers services to older adults who are impaired in activities of daily living as well as to independent older adults, who attend a social club in the same facility. In this study, only the older adults who had functional impairments and attended the ADCC, rather than the club, were interviewed. Finally, *BG* is located in a Kibbutz in the remote South corner of the country and has 74 participants. It caters to people from different rural settlements in the area. Some of the participants represent child survivors of the Holocaust and collaboratively attend additional activities as a result of this status. This group has known each other all its life and has a proud identity of survivorship. Participants in *BG* have a mixed-level of dependence, with some being completely independent, viewing themselves as volunteers in the arts and crafts workshop and others being physically dependent.

Of the four CCRCs, two CCRCs were located in the center of the country and two in Jerusalem. CCRCs ranged in size, with *MF* having 299 residents and *AG* having 40 residents. *MF* is right in the center of the country. It serves affluent older adults of high socioeconomic status. Independent and dependent older adults live in the same setting. *AG* is a small CCRC, located right in the center of Jerusalem. Many of the people there chose the CCRC for its location, rather than for the social activities it offers. *BY* is a 162-resident CCRC, which serves Holocaust survivors who receive special funds to support their stay in this particular CCRC. The majority of residents originated from a single Central European country and many of the services are given in their mother tongue rather than in Hebrew. Some of the residents arrived to the CCRC in old age directly from Europe to age and eventually die in Israel. *MJ* has 89 residents. It serves a very heterogeneous group of older adults, who come from diverse cultural backgrounds, speak 14 different languages as their mother tongue, and have diverse socioeconomic statuses, with some being highly educated and others being illiterate. There is a mixture of people with and without disability, who live together in the same setting. It is located in Jerusalem. See Table 1



for further details regarding the settings, based on information provided by respondents. Of interest is the fact that there were no differences in activities of daily living (range 0–6, higher score indicates greater impairment) between older adults in CCRCs and ADCCs ( $M [SD] = 0.84 [1.80]$  vs  $M [SD] = 0.90 [1.33]$ ,  $t [df] = -.40 [450]$ ,  $p = .69$ ) or in age of respondents ( $M [SD] = 82.43 [19.14]$  vs  $M [SD] = 82.86 [9.80]$ ,  $t [df] = -.30 [447]$ ,  $p = .77$ ). However, as expected, CCRC residents had more years of education ( $M [SD] = 12.86 [4.40]$  vs  $M [SD] = 8.40 [4.70]$ ,  $t [df] = 10.31 [441]$ ,  $p < .001$ ) and higher levels of subjective financial status (range 1–4, a higher score indicates better subjective financial status;  $M [SD] = 2.60 [0.71]$  vs  $M [SD] = 2.18 [0.78]$ ,  $t [df] = 5.88 [450]$ ,  $p < .01$ ).

### The Sample and Procedure

For the purpose of this study, all users of four ADCCs and four CCRCs were approached. Older adults were eligible to participate, provided they spoke Hebrew or English and did not suffer from dementia as indicated in their medical records. We received lists of names of all service users from the respective ADCCs and CCRCs. Potential respondents received written announcements as well as oral presentations about the study. Respondents were able to opt out of the study at any time and there were no sanctions associated with lack of participation. Interviews were conducted in a face-to-face format, by trained research assistants. Most interviews occurred in a special room designated for this purpose or in the respondent’s room in the CCRC. Interviews took place between November, 2016 and October, 2017; in each of the settings, interviews occurred for about 3–4 months.

The study was approved by the ethics committee of the PI’s university. All participants signed an informed consent. Overall nonresponse rate ranged between 27% in BG and 41% in BY. For details concerning reasons for nonresponse, please see [Supplementary Table 1](#). For five out of eight settings, the in-degree of respondents was the highest and that of nonrespondents due to dementia, illness, or language barriers was the lowest. This suggests that results are not missing at random and may not be generalized.

*Demographic information*, including age, gender, years of education, subjective financial status (range 1–4, a higher score indicates better financial status), and number of impairments in activities of daily living (0–6, a higher score indicates greater impairment) were gathered to characterize the participants in each of the settings. Given the nature of the present study, demographic information is used to characterize each of the settings, rather than the individuals who make up the settings.

### Constructing the Social Networks

Each respondent received a list of names of all individuals receiving services in the respective ADCC or CCRC. All names appeared on the list, unrelated to whether or not these individuals participated in the present study. The following question was used in order to construct the social network: “Please indicate whether you know the following person [NAME OF ALL ADCC USERS/CCRC RESIDENTS].” Respondents, who indicated whether or not they know another person, reported on directed ties, because person A may know person B, but person B may not be familiar with person A or may opt not to respond.

**Table 1.** Sample Characteristics of the Continuing Care Retirement Communities (CCRCs) and the Adult Day Care Centers (ADCCs)

Sample characteristics <sup>a</sup>	CCRCs				ADCCs			
	AG (N = 23)	MF (N = 115)	BY (N = 55)	MJ (N = 36)	BG (N = 46)	BM (N = 66)	KS (N = 71)	BH (N = 44)
Geographic location	Jerusalem	Center	Center	Jerusalem	South	Center	Center	Center
Overall size	40	299	162	89	74	130	121	135
Age ( $M [SD]$ )	82.8 (6.9)	79.7 (25.8)	86.7 (5.7)	84.3 (9.3)	82 (7.7)	85 (6.2)	80.6 (14.4)	84 (5.0)
Women (N, %)	18 (78%)	97 (84%)	42 (76%)	25 (69%)	28 (61%)	43 (65%)	52 (73.2%)	34 (78%)
Education in years ( $M [SD]$ )	15.4 (4.7)	13.6 (4.2)	12.7 (3.3)	9.9 (5.6)	10.7 (3.6)	9.2 (4.0)	7.1 (5.6)	7.0 (4.0)
Financial status (1–4; $M [SD]$ )	2.4 (0.7)	2.6 (0.7)	2.8 (0.8)	2.4 (0.6)	2.8 (0.6)	2.2 (0.7)	1.8 (0.8)	2.1 (0.8)
Activities of daily living (0–6; $M [SD]$ )	1.0 (2.1)	0.9 (1.8)	0.8 (1.8)	0.6 (1.4)	0.4 (1.1)	1.0 (1.3)	1.4 (1.6)	0.5 (0.7)
Number of years in the ADCC/CCRC ( $M [SD]$ )	7.4 (5.5)	6.4 (7.0)	7.0 (7.7)	3.4 (2.8)	6.5 (5.2)	3.4 (1.3)	5.0 (6.9)	4.7 (3.7)

Note:  $M [SD]$  = mean [standard deviation]; N = frequency.

<sup>a</sup>Financial status ranges between 1 and 4, with a higher score indicates better financial status; activities of daily living range between 0 and 6, with a higher score indicating greater impairment.

N- number of people who participated in the study.

## Analysis

The current study uses SNA methodology, grounded in the premise that social life is created by relationships and the patterns formed by these relations. Social networks are formally defined as a set of nodes (representing network members) connected by one or several types of relations (i.e., edges; Wasserman & Faust, 1994). Because network analysts view networks as the primary building blocks of the social world, they collect unique types of data and begin their analyses from a fundamentally different perspective from the approach used by attribute-based social scientists.

Analysis was conducted using R (R Core Team, 2013) and the *igraph* package (Csardi & Nepusz, 2006). We examined the entire set of reported ties, which takes into account the direction of the tie (e.g., when A knows B the direction of the tie is different from a situation in which B knows A), hence forming a *directed network*. Such an analysis allows examining tie reciprocity among individuals. Those who did not provide information on the network were excluded from further analysis.

As a *macro-level exploratory analysis*, we used the network properties (e.g., number of components, number of isolates, mean in- and out-degree, degree correlation, density, and reciprocity) to group the eight networks into clusters, using *hierarchical cluster analysis*. Grouping begins with each of the eight settings as a separate cluster. At each stage, the two clusters that are most similar are joined into a single new cluster. The number of clusters is not determined a priori, but instead emerges from the data.

As a *micro-level exploratory analysis*, we utilized classification tree capabilities to classify respondent into an ADCC or a CCRC based on their social properties, namely in- and out-degrees. Classification trees associate responders with a probability of belonging to a predefined class (we randomly chose CCRC as the initial class) given their social properties (in-degree, out-degree; Hothorn, Hornik, & Zeileis, 2006).

## Results

### Descriptive Analysis

#### Components and isolates

All settings, but KS and BG (both ADCCs), are characterized as having a single giant component in which everyone is connected. KS and BG are the only settings that have more than a single component and several isolates. See Figure 1 and Table 2.

#### Overall density

Based on Figure 1, two of the networks stand out. They appear to be less dense: BG and BH. Both settings are ADCCs. Table 2 presents the network characteristics. These characteristics confirm the observation that the two ADCCs: BG and BH have the lowest density. In contrast, two settings have a particularly high density: AG, BY. Both

settings are CCRCs. Of the three other settings with a density greater than .1, two are CCRCs. Hence, all four CCRCs appear to have a high density compared with ADCCs.

#### In-degree and out-degree

BG and BH (both ADCCs) have the lowest in-degree and out-degree. In contrast, the in- and the out-degree of three of the CCRCs are the highest: BY, AG, and MF. Between these two extremes, lie three settings, with MJ (a CCRC) and BM (an ADCC) being quite similar to one another, even though they each represent a different type of setting.

#### Correlation between in-degree and out-degree

The four CCRCs and one ADCC (BM) had the highest correlation between in-degree and out-degree. A high correlation suggests that those individuals who are more “popular” and well-known by others, also are more likely to know others and vice versa. This social characteristic appears to be more common in CCRCs than in ADCCs.

#### Reciprocity

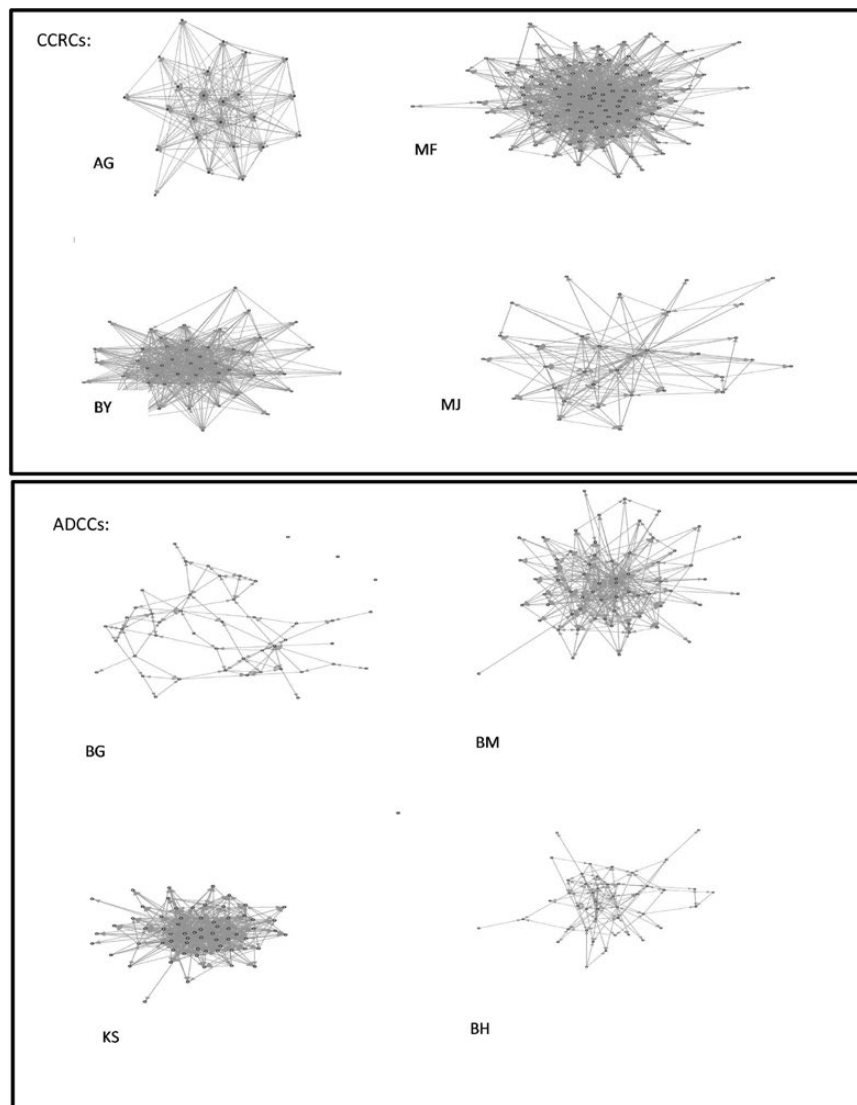
AG was notable for its high reciprocity ratio. This suggests that in this particular setting, if A knows B, B is also likely to know A. Second to AG were BY, MF, and MJ. All represent CCRCs. In contrast, the lowest reciprocity ratio was at BH and KS, both representing ADCCs.

#### In-degree and out-degree distributions

Figure 2 presents the degree distributions in each of the settings. With the exception of two CCRCs (BY, AG), the shapes of all distributions are positively skewed. This indicates that most individuals in these settings have very few in-going and very few out-going ties (e.g., scale-free distributions). The two exceptions are BY and AG, in which the out-degree distribution is flat and the in-degree distribution has a normal shape. In these two settings, although there is variability in the number of people the residents are familiar with, this variability is quite evenly spread. In contrast, there is a relatively large percentage of “popular” residents who are well-known by a relatively large number of people.

### Exploratory Analysis

Using network properties, we conducted hierarchical cluster analysis to group the eight settings into clusters (Figure 3). The cluster analysis shows a clear separation between three of the CCRCs (AG, BY, MF) and all of the ADCCs. According to the cluster analysis, MJ resembles an ADCC. BG can be seen as part of the ADCC cluster, yet it stands out as a unique center, with slightly different properties compared with the remaining cluster. The result is robust to clustering algorithm selection (e.g., agglomerative methods as single and complete linkage, and Ward’s variance increase algorithm).



**Figure 1.** The social network map in each of the continuing care retirement communities (CCRCs) and adult day care centers (ADCCs). *Note:* Dots represent an individual person, lines represent ties between individuals, and arrows represent the direction of the ties.

Employing a micro-perspective, using respondents' social properties (e.g., in-degree, out-degree), a tree classifier classified random respondents as members of either an ADCC or a CCRC at the accuracy level of 71.2%. As is customary in the classification process (Hothorn et al., 2006; Shmueli, Patel, & Bruce, 2016), the tree classifier was trained on 60% of randomly selected respondents, and evaluated on the remaining 40% of respondents. In the training stage, we fitted the parameters (in-degree, out-degree) into the classification tree, whereas in the second validation stage, we used the same predictions obtained in the training stage to examine model fit in the remaining 40% of the sample. Splitting the analysis into two stages allows for the validation of the model predictions made in the training phase during the evaluation stage to obtain unbiased estimates of model fit.

## Discussion

This is one of very few studies to describe the social structures of ADCCs and CCRCs, using a full social network perspective. Both types of settings specifically aim to ease loneliness among older adults and both allow older adults to age in place. Moreover, both are age-segregated and provide services to individuals who are selected based on their physical functioning (Ayalon & Green, 2013; Iecovich & Biderman, 2012a). A striking finding of the present study is that one can classify with a relatively high degree of accuracy a setting as an ADCC or a CCRC, simply based on its in-degree and out-degree properties. Hence, our findings suggest that ADCCs and CCRCs likely offer quite different social opportunities for their users.

In general, CCRC residents are more likely to know other residents and to be known by other residents.

**Table 2.** Directed Network Properties of the Adult Day Care Centers (ADCCs) and Continuing Care Retirement Communities (CCRCs)

Setting type	Setting	Size	No. of nonresponse	Mean in-degree <sup>a</sup>	Mean out-degree <sup>b</sup>	Degree correlation <sup>c</sup>	Density <sup>d</sup>	Reciprocity <sup>e</sup>	No. of components <sup>f</sup>	No. of isolates <sup>g</sup>
CCRCs	AG	40	16	12.25	12.25	0.66	0.53	0.73	1	0
	MF	299	184	14.09	14.09	0.56	0.12	0.38	1	0
	BY	162	112	17.06	17.06	0.54	0.35	0.52	1	0
	MJ	89	57	5.62	5.62	0.32	0.18	0.38	1	0
ADCCs	BG	74	28	2.26	2.26	0.16	0.05	0.35	4	3
	BM	130	66	6.20	6.20	0.45	0.10	0.32	1	0
	KS	121	54	9.37	9.37	0.21	0.14	0.26	2	1
	BH	135	91	3.20	3.20	0.13	0.07	0.27	1	0

<sup>a</sup>In-degree: number of people who know the respondent.

<sup>b</sup>Out-degree: number of people known by the respondent.

<sup>c</sup>Degree correlation: the correlation between in-degree and out-degree; higher values indicate those who are well known also know more people.

<sup>d</sup>Density: number of actual ties out of all possible ties.

<sup>e</sup>Reciprocity: the likelihood of actors (i.e., nodes) in a directed network to be mutually linked (e.g., A knows B and A is also known by B).

<sup>f</sup>Components: a proportion of the network that includes a path between each pair of individuals.

<sup>g</sup>Isolates: number of individuals who have no outgoing or ingoing ties in the network.

Moreover, whereas in CCRCs, knowing also means being known, in general (i.e., high correlation between in-degree and out-degree) as well as by the exact same persons one knows (i.e., reciprocity), this is not necessarily the case in ADCCs. In many ways, CCRCs represent a more enabling social environment, which facilitates greater familiarity among members. In such an environment, there are consequences to one's social behavior: people who are more likely to know others and thus, to be socially active, also are more likely to be known by others. Moreover, when relationships are formed, they are more likely to be mutual. Under such circumstances, it is expected that friendships are more likely to be formed and intimate relations flourish (Vaquera & Kao, 2008). Given the significance that intimate relationships play in older adults' lives (Carstensen et al., 2003), it appears that CCRCs are better capable of moving older adults from large secondary groups, to more intimate primary groups (Olk & Gibbons, 2010; Perion & Steiner, 2017). This finding is consistent with a recent study which has found higher levels of loneliness among ADCCs' users compared with CCRC residents (Ayalon, 2018). Hence, it appears that compared with ADCCs, CCRCs are better at facilitating more intimate social interactions between older adults. Although knowing people is not synonymous with liking or frequently interacting with others (Rafnsson, Shankar, & Steptoe, 2015), it is certainly a necessary step, which appears to be more probable in CCRCs.

Density was higher in all four CCRCs and one of the ADCCs. Research concerning the effects of network density is mixed. On the one hand, highly dense networks might result in high levels of satisfaction among members of the network and in greater homogeneity between network members (Stokes, 1983; Zou, Ingram, & Higgins, 2015). On the other hand, highly dense networks might inhibit innovation and the spread of new information or ideas in

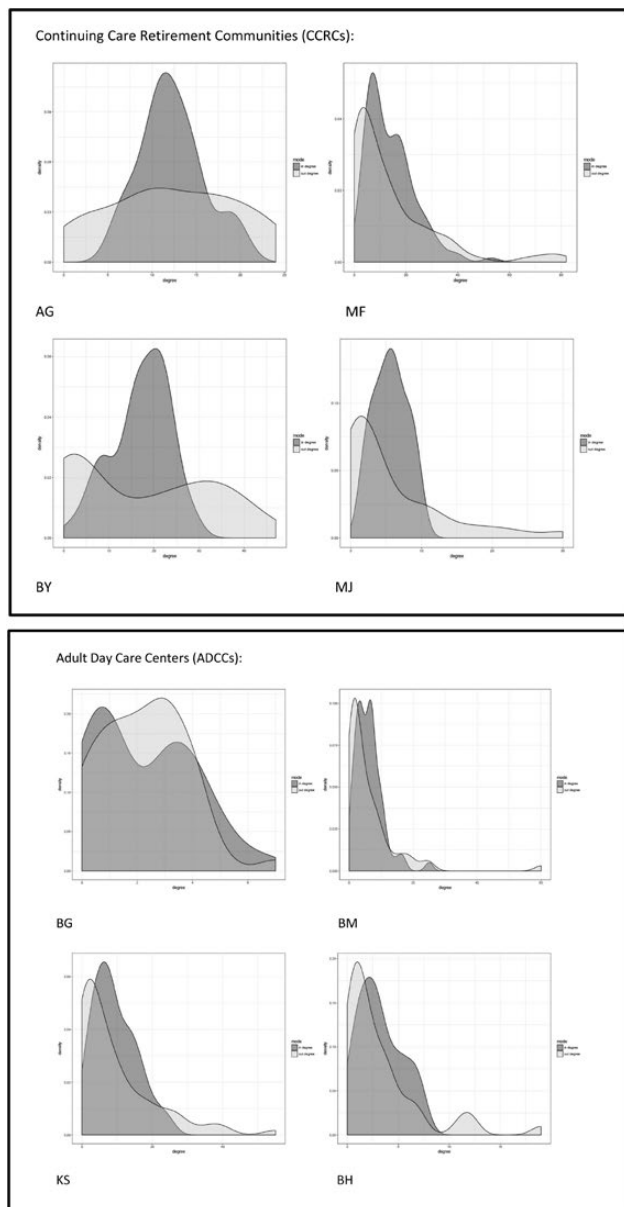
the network and constrain individuals' behaviors (Baer et al., 2015; Fritsch & Kauffeld-Monz, 2010). In the case of older adults in ADCCs and CCRCs, one would expect that greater network density is desired as this likely facilitates familiarity among network members.

Research, to date, has focused primarily on the individual characteristics (i.e., attributes) that make a person more or less capable of establishing intimate ties with others (Felmlee & Muraco, 2009; Olk & Gibbons, 2010). Consistently, the socioemotional selectivity theory stresses individual processes as being responsible for older adults' social interactions and social preferences (Carstensen et al., 2003). Moreover, to date, those researchers who have studied whole social networks have stressed older adults' health status (i.e., an individual attribute) as a determinant of their social standing (Schafer, 2011, 2013). Much less attention has been given to the setting as enabling or disabling the establishment of social ties (Ayalon & Levkovich, 2018). This study adds by demonstrating that CCRCs and ADCCs likely provide different social opportunities to their users.

The findings could be explained by the fact that CCRCs provide residential care and thus, usually operate over a wider period of the day. ADCCs, on the other hand, provide social engagement opportunities for a limited amount of time per day, up to 6 days per week. However, in contrast to CCRCs, where people can choose whether or not they wish to participate in a social event (Ayalon, 2016a), all participants in ADCCs attend at least some of the social activities offered by the ADCC as this is the main purpose of these settings (Iecovich & Biderman, 2012a).

It also is informative to note some of the deviant settings that can be seen as potential outliers in the present study. BG, an ADCC, had a relatively large number of components and isolates. It also was classified as a single cluster, somewhat dissimilar from other ADCCs. This setting

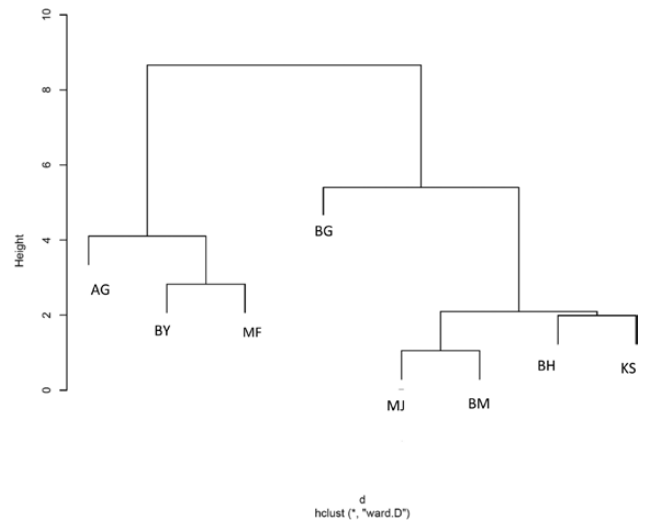




**Figure 2.** In- and out-degree distributions of each of the site. *Note:* The Y-axis represents the probability density; the X-axis represents the degree distribution. Dark represents the in-degree distribution; light represents the out-degree distribution.

incorporates people of mixed-levels of dependence, who come from different, though highly cohesive living arrangements (e.g., participants from different kibbutzim come together for the purpose of this ADCC). In addition, a segment of the participants in that setting are identified by their mutual past identity (e.g., Holocaust child survivors). Possibly, this is why this setting appeared to be segmented as people who attend the setting come from several different, yet, cohesive groups.

Another outlier is MJ, a CCRC with similar properties as BM, an ADCC. The relatively heterogeneous nature of the residents in MJ, who come from multiple cultural groups, compared with the homogenous nature of the participants in BM (e.g., similar geographic and cultural background)



**Figure 3.** Results of cluster analysis to classify sites by network properties. *Note:* Network properties used to classify the settings: in-degree—number of people who know the respondent, out-degree—number of people known by the respondent, degree correlation—the correlation between in-degree and out-degree; higher values indicate those who are well known also know more people, density—number of actual ties out of all possible ties, reciprocity—the likelihood of actors (i.e., nodes) in a directed network to be mutually linked (e.g., A knows B and A is also known by B), components—a proportion of the network that includes a path between each pair of individuals, isolates—number of individuals who have no outgoing or ingoing ties in the network; continuing care retirement communities: AG, MF, BY, MJ; adult day care centers: BG, BM, KS, BH.

could potentially account for the similarity between them. As one setting (MJ) represents a favorable place for interactions (a CCRC), under unfavorable conditions (heterogeneity), whereas the other setting (BM) represents a less favorable setting for social interactions (an ADCC), under favorable conditions (homogeneity among members).

Two other unique outliers that stand out for their high density and reciprocity are AG and BY. AG is a small, thus potentially more cohesive CCRC, whereas BY is characterized by the common cultural background of its residents, the majority of whom are of a central European descent, receiving financial compensation as Holocaust survivors. These were the only two settings in which the in-degree and out-degree distributions had nonpositively skewed shapes. Common to both CCRCs is the fact that there are quite a few highly “popular” residents who are known to a relatively large number of people. Knowing others, on the other hand, is equally spread in the network. This is contrasted with all other settings, in which the in-degree and out-degree distributions were positively skewed, with most people knowing only a few people and being known by only a few people (e.g., scale-free).

### Implications

This study examines the entire social structure of ADCCs and CCRCs, “from a bird’s eye view.” Although the study has multiple strengths and a great potential to introduce

the field of social network to gerontology researchers and administrators, results should be viewed in light of the study's limitations. First, the study relied on four ADCCs and four CCRCs. Although this represents a substantial number of different settings, given the very limited research on the topic conducted thus far (Ayalon, 2018), to fully explore the network structure as a whole and draw firm conclusions about it, a larger number of settings is desired. The nonresponse rate in our study was similar to the nonresponse rate reported in several other studies with difficulty to reach populations (Casey, Low, Jeon, & Brodaty, 2016; Locker, 1993), yet, it certainly limits the information one can infer about the social network (Kossinets, 2006). This is particularly true given the fact that our data are not missing at random. It is the more physically and cognitively impaired individuals who did not participate in our study. These people also are less socially noticeable. Finally, the study cannot differentiate between cause and effect. It is impossible to conclude based on the findings that one type of setting is necessarily preferable to another. Moreover, the analyses presented in this study do not take into consideration the attributes of the older people who make up the network. This is despite past research which has shown that older adults' health status, for instance, is associated with their position in the social network (Schafer, 2016). It also is important to note that simply knowing others is a necessary, though an insufficient condition for having quality relationships. Future research will benefit from examining other types of relationships, which could potentially be more meaningful for older adults. Moreover, when constructing the network, we focused solely on service users and failed to query older adults about staff members or family members, who potentially play an important role in their lives (Ayalon, 2016a; Shinan-Altman & Ayalon, 2018).

Nevertheless, our choice to present the entire social network rather than focus on the ego network, was led by the realization that the sum is greater than its parts and that in order to more fully understand the social opportunities offered by ADCCs and CCRCs, one has to explore them first, as wholes. Our findings suggest that despite similarities between CCRCs and ADCCs, CCRCs likely allow for more active and reciprocal social relations. This information should be valuable to administrators and care providers in these settings who might wish to utilize social network interventions to change the social structure of the setting (Valente, 2017). For instance, administrators can use information about high levels of fragmentation and low levels of density as indicative of a need for social interventions that facilitate familiarity between participants. Moreover, given the fact that these unfavorable network properties are more likely to characterize ADCCs, a rethinking about these settings as a viable source for social interactions is justified. This finding is further support by the fact that loneliness levels are as high in ADCCs as in the community (Iecovich & Biderman, 2012a).

## Supplementary Material

Supplementary data are available at *Innovation in Aging* online.

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## Conflict of Interest

None to declare.

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