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Article

Do age, psychosocial, and health characteristics alter the weak and strong tie composition of network diversity and core network size in urban adults?

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ABSTRACT

Social capital and social support are two key constructs in the study of social networks and health. Despite their importance, little research has sought to examine the characteristics of those social ties by which individuals access social capital and support resources. Network diversity – a key structural feature in accessing social capital – refers to a person's broad but generally weak and heterogeneous social ties; core network size – a key structural feature in accessing social support – refers to the close, strong ties in personal networks. Our study examines whether the tie strength composing network diversity and core network size varies according to age-, psychosocial-, or health-related characteristics. Data came from the Montreal Neighbourhood Networks and Healthy Aging (MoNNET-HA) study, a representative sample of 2707 Montreal, Canada adults. Position and name generators were used to collect data on network diversity and core networks, and whether access to social resources was through kin, friends, or acquaintances. Multilevel negative binomial regression was used to account for the counts of different tie strengths nested within individuals and tracts. Network diversity and core network size both declined with older age groups, with those declines being more noticeable in not having ties at all or fewer ties with friends. Psychosocial and health factors altered the relative contribution of kin, friends and acquaintances to network diversity and core network size in similar patterns. Understanding the tie composition of network diversity and core network size can contribute to our knowledge of the social mechanisms linking social capital and support to health outcomes.

1. Introduction

Research on social capital and social support both highlight the importance of social ties and the resources accessible through those ties for health and wellbeing. Social capital refers to the resources accessible to individuals and potentially groups through their social networks (Bourdieu, 1986; Lin 2001). These resources tend to emerge through a person's extensive social contacts (Eagle, Macy, & Claxton, 2010), with weak ties being key to accessing more heterogeneous social resources (Granovetter, 1973; Erickson, 2003; Lin, 2001). Having diverse networks may provide better access to all kinds of social resources since they include a wider variety of network members, each with different sets of resource collections (van der Gaag, Snijders, & Flap, 2008). Social support refers to specific types of coping resources, and is often defined in terms of the functions performed by significant others (Thoits, 1995). Social support can be distinguished into different functional types, including expressive, instrumental, appraisal, and informational support (Berkman, Glass, Brissette & Seeman, 2000). Having strong, core networks are essential in the provisioning of social support, particularly expressive support. Research has documented the importance of both network capital and social support for a range of mental and physical health outcomes and conditions (Thoits, 2011; Uchino, 2006; Barefoot, Grønbaek, Jensen, Schnohr & Prescott, 2005; Haines, Beggs, & Hurlbert, 2011; Moore et al., 2011; Verhaeghe, Pattyn, Bracke, Verhaeghe, & Van De Putte, 2012).

Social capital and social support have often been distinguished according to the ecological level in which these social influences are viewed to operate. Social capital has conventionally been seen as a property of groups or places, with social support more often conceptualized as an individual-level property (Leal, Pereira, Lamarca, & Vettore, 2011). With increased research on individual or interpersonal network capital, the ecological distinction between

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social capital and support can result in some confusion. There are, however, a few distinctions that may be useful. First, theoretically, research on social support and social capital emerge from different intellectual traditions, with network approaches to social capital arising from conflict and inequality perspectives (Lin, 2001) and social support from cohesion and attachment theories (Berkman et al., 2000). These differences are important but beyond the scope of the present essay. Second, social capital may be viewed as the broader, more heterogeneous set of resources that tend to support instrumental actions and informational gains, such as knowledge about new opportunities (Lin, 2001). Social support, on the other hand, may be seen as a subset of network capital resources that contribute to expressive actions, such as emotional support and sharing of sentiments. Finally, the network sources of social capital and social support may tend to differ, with social capital emerging more from a person's weak ties and social support from their strong ties (Lin, 2001).

The following study aims to contribute to our understanding of the distinction between social capital and social support. We test a series of working hypotheses related to the composition of the ties by which individuals access these social resources. Our study examines whether individual age, psychosocial, and health characteristics alter the strength of the ties through which individuals access social capital and social support. To date, research examining such patterns has focused mainly on a person's close, core ties. For example, Cornwell (2009) showed that older adults with poor functional health have networks heavily composed of strong ties. Few studies have compared the tie composition of network diversity and core networks across a range of individual social and health characteristics. Our study contributes to the understanding of network diversity and the ties contributing to its makeup, and also furthers our knowledge of social support by comparing the composition of network diversity to core network size. Identifying whether there are common tie patterns by which social resources are accessed may provide further insight into the mechanisms through which social capital and social support provides health and social benefits.

1.1. Comparing the tie composition of network diversity and core network size

Tie strength can be defined as a function of the emotional intensity, intimacy, reciprocity, and temporal duration (Granovetter, 1973). Tie strength is important since it indicates the types of resources that may be accessed and the likelihood that those resources might be mobilized. Strong ties may be more easily mobilized than weak ties, but they often reflect homogeneous, insular social relationships that can limit access to social and economic prospects, information, and resources that lie beyond one's close social circle (Smith & Christakis, 2008). Weak ties, in contrast, are indispensable for bridging social groups, transmitting information across greater social distances, and provide the basis for social integration (Granovetter, 1973). Direct measures of tie strength, such as contact frequency, are preferable but not always available. In such cases, relationship type, such as kin, friend, or acquaintance, might be used as a proxy indicator of tie strength. Research has suggested that the general assumption that non-kin ties are weaker than kin ties is accurate, although there may be variations in tie strength among kin or non-kin (Marsden, 1984). Brashears (2014) has also shown an association between social role and the availability of social resources. For this study, relationship type – kin, friends, and acquaintances - will be used to indicate tie strength, with kin and friends considered to reflect stronger ties and acquaintances reflecting weaker ties.

Position and name generators are two instruments commonly used to capture different personal network dimensions. Position generator instruments ask individuals about their ties to persons who hold various occupations in society. Persons holding these occupations are considered to control more or less valued resources depending on the prestige associated with that occupation. The instrument often consists of a representative list of occupations across a range of socioeconomic positions. Different indicators of personal network capital can thus be calculated. These include upper reachability (i.e., the highest prestige occupation accessed), range (i.e., the difference between highest and lowest occupation accessed), and diversity (i.e., the number of different occupations accessed). Among those, network diversity may be the most comprehensive measure in that it reflects access to persons controlling various resource collections, and thus captures network size across socioeconomic positions (Lin, 2009; Song and Lin, 2009).

To measure a person's core networks, researchers have often relied on name generators. Name generators ask respondents to nominate significant others, or alters, who belong to a specific content field, e.g., confidants with whom they may discuss important matters. Name interpreter questions often follow the name generator and are used to gather information about those network contacts, e.g., their age or whether they are kin, friends, or acquaintances. Name generators on discussant ties tend to capture a person's strong, core social networks (Marsden, 1987; McPherson, Smith-Lovin, & Brashears, 2006). Alters occupying a person's core network tend to be more homophilic than those in one's extensive networks, and thus less socioeconomically diverse compared to the ego respondent.

1.2. Network diversity across age groups

Research on social networks and aging has tended to highlight the decline in social connectedness that often comes with age. Recently, researchers have suggested a mixed picture of social connectedness in older age in which certain forms of connectedness (e.g., network size) decrease while other forms (e.g., volunteering) increase (Cornwell, Laumann, & Schumm, 2008). Despite this more nuanced understanding of social networks and aging, there remain significant gaps in our knowledge of the social networks of older adults. Research has tended to focus on the strong, core ties of older adults and their access to social support, and given less attention to the importance of bridging ties and network heterogeneity in the aging process (Cornwell, 2011).

Little is known about differences in network diversity across age groups and the relative contribution of kin, friends, or acquaintances to diversity in different age groups. Most research on social networks and aging has examined the core networks and strong ties of older adults and the importance of network size, density, and social support to health. Research has shown, for example, that network size tends to shrink with age (Cornwell et al., 2008; McPherson et al., 2006) with an increased contribution of kin to older adult networks (Cornwell, Schumm, Laumann, & Graber, 2009; McPherson et al., 2006; Shaw, Krause, Liang, & Bennett, 2007). Decreased network size may also have health implications. Network size has been associated with reduced mortality (Berkman and Syme, 1979) and access to social support (Munch, McPherson, & Smith-Lovin, 1997). Along with reduced network size, the social networks of older adults might become denser as family members become more important.

Research on network diversity over the life course suggests a decline in the weak ties of older age groups with acquaintances becoming less a feature of personal networks. Transitions involving events such as retirement can represent key moments in the social networks of older adults leading to decreased network size, increased social insularity, and the decay of weak ties as a key dimension of personal networks (van Tilburg, 1998; Shaw et al.,

2007; Burt, 2002; Moore et al., 2013). Findings on the composition of network diversity and core network size across the life course and different age groups suggest the following hypothesis:

Hypothesis 1: Acquaintances and friends compared to kin tend to contribute less to network diversity (or core network size) in older compared to younger age groups.

1.3. Social and psychosocial correlates of network diversity

Social capital has been measured using a diverse set of indicators ranging from social participation, trust, social cohesion, and network capital. Recent studies have sought to examine the degree to which these different indicators of social capital are correlated with one another and thus measuring similar social processes (Moore, Daniel, Gauvin, & Dubé, 2009; Carpiano & Hystad, 2011; Carpiano & Fitterer, 2014). Yet, few studies have sought to examine whether these factors might alter the strength of the ties by which individuals access social resources. There is theoretical reason, however, to suspect that these social and psychosocial indicators may enhance the importance of certain types of ties (e.g., weak ties) to a person's social network. For example, according to Granovetter (1973), a person's weak ties enable access to a more extensive, heterogeneous set of resources than those that are accessible through their strong, core ties.

The following study examines four common social and psychosocial indicators or correlates of social capital: (1) social participation, (2) generalized trust, (3) perceived cohesion, and (4) perceived control. Social participation, which refers to a person's level of engagement and activity in formal organizations and associations, (Gilmour, 2012; Nummela, Sulander, Rahkonen, Karisto, & Uutela, 2008) tends to increase the size and diversity of personal networks. Less known is whether social participation alters the tie composition of a person's network. Generalized trust refers to an individual's trust in people in general rather than their trust in specific people or groups (Abbott & Freeth, 2008). Generalized trust is often taken to represent a cognitive dimension of social capital (Hurtado et al., 2011; Carpiano & Fitterer, 2014). Recent research has suggested however that generalized trust is not directly associated with certain network characteristics, such as having core or neighborhood ties (Moore et al., 2009), and may thus be an inadequate proxy for personal social network elements (Carpiano & Hystad, 2011; Carpiano & Fitterer, 2014). Yet, it remains unclear as to whether generalized trust may in fact be indirectly associated with network diversity or core network size by moderating the degree to which kin, friend, or acquaintance ties contribute to its formation. Social cohesion may be considered to operate as both a contextual- and individual-level variable. As a contextual variable, social cohesion refers to a range of characteristics including the possession of common values, social solidarity, social capital, sense of belonging and social equity (Forrest & Kearns, 2001). As an individual-level variable, perceived social cohesion may be seen as related to the degree to which individuals perceive themselves to be embedded in places where they feel that they belong, have social connections and others with whom they share certain values. Perceived social cohesion may thus capture inter-individual variability in the way that people experience local social environments. Perceived control refers to the degree to which individuals believe that they have personal mastery over and can effectively manage their social environment, thereby helping people to cope with problematic encounters and stressful experiences (Ensel & Lin, 1991; Mirowsky, 2013; Mirowsky & Ross, 1991). Based on the idea that these four social and psychosocial indicators of social capital may be related to the greater contribution of weaker versus stronger ties to a person's network diversity, we hypothesize the following:

Hypothesis 2: Social participation (generalized trust, perceived social cohesion, perceived control) is associated with the greater contribution of acquaintances and friends compared to kin to network diversity (and core network size).

1.4. Health-related correlates of network diversity

Research on social networks and health has often recognized the potential recursive effects by which health may affect a person's willingness and ability to be socially active or create and maintain social ties (Cornwell, 2009). Poor functional health has been described as a barrier to the social participation of older adults (Li & Ferraro, 2005). Nevertheless, limited research has examined the importance of health for the structure or composition of a person's social networks (Cornwell, 2009). In a sample composed exclusively of older Americans and using name generator instruments alone, Cornwell (2009) showed that older adults with poor functional health had social networks consisting more heavily of strong, kin-based ties (Cornwell, 2009). Wilby (2011) reported however that depressed elderly adults were more likely to report contact with their friends rather than kin. In a longitudinal study of mental health patients, Perry and Pescosolido (2012) showed that patients' networks decreased in size over a three-year period when compared to the population at large, with the decrease due more to the loss of less supportive, weaker ties over time. Health conditions seem therefore to impact the degree to which kin, friends, or acquaintances compose a person's core network, particularly in older and clinical populations. Less known is whether physical and mental health conditions are associated with variations in the network composition among the general adult population. We examine this topic using mental and physical health indicators of poor health, including self-reported health (SRH), depressive symptoms, chronic conditions, and social activity limitations. Although previous findings are limited and mixed, we hypothesize that poor health conditions would be associated with the greater contribution of strong ties to a person's access to social resources:

Hypothesis 3: Poor health (mental or physical) is associated with the greater contribution of kin compared to friends and acquaintances to network diversity (and core network size).

2. Methods

2.1. Sample

Data came from the 2008 Montreal Neighborhood Networks and Healthy Aging Study (MoNNET-HA). MoNNET-HA study used a two-stage stratified cluster sampling design to collect social network data on 2707 adults nested within 300 census tracts across the Montreal Metropolitan Area in the summer 2008. Details on the MoNNET-HA sampling design can be found in additional publications (Legh-Jones & Moore, 2012; Moore et al., 2011). To be selected, individuals had to 1) be non-institutionalized, 2) have resided at their current address for at least one year, and 3) able to complete the questionnaire in French or English. Random digit dialing of listed telephone numbers was used to select households and a computer assisted telephone interviewing system guided questionnaire administration. The MoNNET-HA response rate was 38.7%. Chi-square analyses comparing the MoNNET sample to a range of 2006 Canada census variables showed that the sample overrepresented older adults (by design), females, households with an income less than 50,000 per year, persons who lived in their current residence for more than five years, and those with more than a high school degree.

2.2. Measures

2.2.1. Network outcomes: network diversity and core network size

Network diversity was assessed using a position generator. To create the MoNNET-HA position generator, a list of 90 occupations ranked from high to low occupational prestige was divided into octiles (Goyder, Guppy & Thompson, 2003). From each octile, one occupation was randomly selected; two additional occupations (i.e., physician and musician/artist) were selected for a total of ten occupations. These ten occupations were randomly listed in the position generator. For each occupation, participants were asked if they knew someone on a first name basis with that occupation, and, if so, were they kin, friend, or an acquaintance. If a respondent reported knowing more than one person with a particular occupation in the position generator, they were asked to answer the question keeping in mind the person who was emotionally closest to them. Table 2 lists the ten occupations along with their prestige values found in the study's position generator.

To measure core network size, we used a "discuss important matters" name generator question. The name generator/interpreter questions asked participants to name up to three alters with whom they had discussed important matters in the last six months, and whether they were kin, friend, or an acquaintance. If participants reported that they had not discussed important matters with anyone in the last six months, interviewers confirmed whether they had or had not spoken with anyone or preferred not to answer the question. Participants who said that they preferred not to answer this question were dropped from analyses (n=72).

2.2.2. Relationship type

For each alter named in the position and name generator, the participant was asked if they considered them to be kin, friend, or acquaintance. Kin was used as the referent category in the analyses.

2.2.3. Age group

Participants' ages were grouped into six categories: (1) 25–34, (2) 35–44, (3) 45–54, (4) 55–64, (5) 65–74, and (6) 75 years or older, with the youngest age group used as the reference.

2.2.4. Social and psychosocial characteristics

Five social and psychosocial characteristics were assessed: social participation, marital status, generalized trust, perceived cohesion, and perceived control. Social participation was based on whether participants reported being active in any community, professional, or other voluntary associations over the past year. Marital status was a categorical variable based on participants' reports on being (1) married or common law status (reference), (2) separated, (3) divorced, (4) widowed, or (5) single. Three psychosocial characteristics were assessed: generalized trust, perceived neighborhood cohesion, and perceived control. Generalized trust was assessed using the question: "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?" Participants who replied "most people can be trusted" were considered to have high trust; those who replied with you can't be too careful, depends, most people cannot be trusted, or don't know were considered to have low trust. Perceived cohesion was assessed using the items: (1) "you have trouble with your neighbors," (2) "people in your neighborhood can be trusted," (3) "people in your neighborhood are willing to help each other," (4) "most people in your neighborhood know you," (5) "you have someone in your neighborhood who you can really talk to," (6) "you have someone in your neighborhood who could help you out with things, like give you a ride," and (7) "your neighborhood is clean." Responses were on a five-point Likert scale from strongly agree to strongly disagree with "don't know" responses kept as the neutral category. Responses were reverse coded with the exception of item one, and centered on the neutral category so that higher numbers indicated greater perceived cohesion. Principal components analysis was used to construct a perceived cohesion score. Items six (0.29), three (0.28), and two (0.27) loaded the highest on the cohesion score. Perceived control was measured using four items from Mirowsky's and Ross' control scale (Mirowsky & Ross, 1991). These items were (1) "I am responsible for my on successes;" (2) "the really good things that happen to me are mostly luck;" (3) "I can do just about anything I set my mind to;" and, (4) "there's no sense planning a lot - if something good is going to happen it will." Responses were on a five-point Likert scale from strongly agree to strongly disagree with "don't know" responses used as the neutral category. Items one and were reverse coded. Higher values indicated greater perceived internal control. The control scale had a reliability of 0.36. Despite its low reliability, the scale has high validity since it was developed specifically to cancel agreement bias (Mirowsky & Ross, 1991).

2.2.5. Health characteristics

Four health characteristics were assessed: (1) self-rated health (SRH), (2) social activity limitations (SAL), (3) chronic conditions, and (4) depressed symptoms. For SRH, participants were asked if they, generally speaking, would say that their current health was excellent, very good, good, fair, or poor. For these analyses, SRH was kept an ordinal variable. SAL was based on participant responses to the question: "During the past 4 weeks, how much of the time have your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?" Responses were on five point Likert scale from "all of the time" to "none of the time." The presence of chronic conditions was a count of whether participants reported having diabetes, hypertension, high cholesterol, cardiac problems, osteoporosis, and arthritis. Depressive symptoms were measured with the Center for Epidemiologic Studies 10-item Depression Scale (CES-D Scale). Based on the CES-D recommended cutoff for the 10-item scale, respondents who reported experiencing four or more items were classified as having depressive symptoms (Irwin, Haydari Artin, & Oxman,1999). The MoNNET-HA depression scale had a Cronbach's alpha of 0.72.

2.2.6. Confounding variables

Confounding variables included gender, socioeconomic status (SES), and marital status. Previous research has shown that a person's level of social resources tends to increase with socioeconomic status with the social networks of higher SES groups tending to consist more of weak, bridging ties than those of lower SES groups (Campbell, Marsden, and Hurlbert, 1986; Lin, 2009). Given the strength of these findings, SES was treated as a confounding variable that might moderate the association between relationship type and either network diversity or core network size. The SES measure was constructed using principal components analysis and based on educational attainment, employment status, and participants' household income. Educational attainment was grouped into four categories: (1) no high school degree, (2) a high school diploma, (3) a college certificate, or (4) a bachelor's degree or higher. Participants reported whether they were currently employed or not. Income was categorized into five groups: (1) less than $28,000, (2) $28,000–$49,000, (3) $50,000–$74,000, (4) $75,000–$100,000, and (5) more than $100,000. Single imputation was used to impute income for 20% of the respondents using ordinal regression and data (1) on education, age, and employment status and (2) Canada census data on median household income, population density, average eduction for the

census tract in which they resided. The SES scoring coefficients consisted of 0.32, 0.24, and 0.49, respectively.

2.3. Statistical analyses

Two main statistical analyses were conducted. First, ANOVA with pairwise comparisons were used to compare the proportion of kin, friend, and acquaintance ties composing network diversity and core network size for each age group. Second, multilevel negative binomial response models were used to account for the multilevel structure of the data, the counts of ties for different response items, and overdispersion. The level-one outcome consisted of a set of response items nested within individuals, i.e., repeated measures within individuals of the counts of each relationship type (kin, friend, or acquaintance). The only independent variable modeled at level one was the relationship type (kin, friend, or acquaintance), which represented a fixed effect estimate of the average for each relationship type. Level two consisted of the individual attributes and characteristics, which are nested within level-three census tracts from which respondents were recruited. No census-level variables were used. The third level was meant to account for the clustered sampling design of the MoNNET study. Duncan, Jones and Moon (1998) refer to this multilevel model approach as the "mixed, multivariate multilevel response" model. There are a number of advantages to this approach, including the fact that the model enables the simultaneous examination of (1) whether or not 'something' occurs (e.g., does a person report having a tie or not) and, (2) if it does occur, to what degree or quantity does it occur (i.e., how many ties). To test our hypotheses, the following modeling steps were undertaken. First, we assessed the bivariate association between relationship type and diversity (or core network size). Second, we introduced age category, and the sets of social/psychosocial and health variables to the models in a two-step process: (1) we first estimated the direct association of the variables with network diversity (or core size); (2) we then tested, using interaction terms, whether those variables moderated the association between relationship type and the network outcome. If a variable did not moderate the association between relationship type and network diversity or core network size, the interaction term was not reported nor included in the next model step. Confounding variables were also included. Regression tables thus report those estimates that were directly or indirectly associated with the network outcomes. Negative binomial model coefficients (*NBE*), their standard errors (*SE*), and significance levels are reported. The between-person and between-census tract variances in relationship type were null for both network diversity and core network size. These are reported in the Supplementary Tables. We considered non-hierarchical modeling approaches but elected to keep the multilevel approach since it remained applicable to the structure of our data and provided greater flexibility in testing our hypotheses. Analyses were performed with Stata, version 14.

3. Results

After dropping observations with missing information, there were 2495 cases available for analysis. Table 1 provides the demographic, socioeconomic, psychosocial, and health characteristics of this study sample. The average diversity was 4.3 and average core network size was 2.3 ties. Table 2 provides further information on responses to the position generator. Accountants were the most (65.3%) and taxi drivers (18.6%) the least accessed occupation. Both were accessed primarily through acquaintance ties. When accessed, welders and registered nurses were the only occupation reached by a higher percentage of kin ties. Table 3 provides information on the tie composition of the sample overall and by age group. Roughly 6% of the respondents reported no diverse ties, whereas 11% reported no core network ties. Acquaintances contributed 40% and friends 28% to the network diversity of participants, whereas acquaintances contributed 9% and friends 44% to core network size.

Table 1
Characteristics of Montreal Neighborhood Networks and Healthy Aging Study (MoNNETs-HA), Weak Ties and Aging, 2008, n=2495.

Variables	Mean (Std. dev.)
Network Extensity (0-10)	4.33 (2.36)
Kin ties	1.11 (1.20)
Friend ties	1.35 (1.47)
Acquaintance ties	1.85 (1.65)
Network Size (0-3)	2.34 (1.05)
Relative ties	1.18 (1.09)
Friend ties	1.55 (1.11)
Acquaintance ties	0.26 (0.66)
	Percentage (%)
(Std. Err.)	
Age Group	
25 to 34 years old	15.2% (0.01)
35 to 44 years old	18.2% (0.01)
45 to 54 years old	20.7% (0.01)
55 to 64 years old	16.2% (0.01)
65 to 74 years	20.5% (0.01)
or 75 years and more	9.2%(0.01)
Female	64.7% (0.01)
Employed	56.1% (0.01)
Income	
Less than $28,000	19.4% (0.01)
$28,000-$49,000	28.4% (0.01)
$50,000-$74,000	27.1% (0.01)
$75,000-$100,000	13.1% (0.01)
More than $100,000	12.0% (0.01)
Education	
Less than a high school degree	11.1% (0.01)
High school degree or trade certificate	29.2% (0.01)
College certificate	21.0% (0.01)
Bachelors degree and higher	38.7% (0.01)
Marital status	
Married/Common-law relationship	55.3% (0.01)
Single	20.4% (0.01)
Divorced/Separated	14.7% (0.01)
Widowed	9.6% (0.01)
Social and Psychosocial Characteristics	
Social participation	36.5% (0.01)
Social isolation	10.8% (0.01)
High Generalized trust	43.3% (0.01)
Perceived control (0-4)	0.78
Health Conditions	
High self-rated health	56.2% (0.01)
Depressive symptoms diagnosis	17.2% (0.01)
Social activity limitations (1-5) **[***mean***]**	1.94 (1.05)
Chronic conditions (0-6) **[***mean***]**	0.93

Hypothesis 1. Table 3 presents the ANOVA pairwise comparison tests with Bonferroni adjustments examining differences between age groups. Results showed that overall network diversity tended to be lower in older age groups, with the oldest age groups having a greater proportion of adults reporting no diversity. Tests also revealed differences in the tie composition of network diversity across age groups. The average proportion of acquaintance ties composing network diversity ($F(5,2489)=8.96$, $p<0.001$) differed between the older and middle-age groups with the youngest group having the lowest proportion of acquaintances composing their network diversity. Inversely, friends contributed most to the network diversity of the younger compared to older age groups. Kin ties contributed similar proportions to network diversity across age groups. Negative binomial results are shown in Table 4 and Supplementary Tables 1 and 2 supported the ANOVA

Table 2
Position generator occupations and the type of relationship through which the occupation was accessed, in decreasing order based on occupational prestige value, MoNNET-HA – Social Ties Sample, n = 2495.

No.	Occupation	Prestige value	Do you know someone on a first name basis?		Type of Relationship		
			% No	% Yes	% Kin	% Friend	% Acquaintance
1	Physician	93	41.5	58.5	20.6^	28.4	51.0^
2	Registered nurse	77	49.3	50.7	34.5^	34.4	31.1^
3	High school teacher	68	55.3	44.7	31.8	36.7^	31.5
4	Accountant	67	34.7	65.3	24.9	31.1	44.0
5	Musician/Artist	60	49.1	50.9	32.9^	41.0^	26.1^
6	Welder	55	75.5	24.5	39.0^	27.3	33.7
7	Carpenter	52	56.9	43.1	29.7	30.4	39.9
8	Receptionist	40	56.9	43.1	15.0	27.3	57.7^
9	Taxi driver	35	81.4	18.6	15.1	31.4	53.5^
10	Janitor	34	67.7	32.3	8.9	19.2	71.9^

^ indicates significant difference in percentage values of at least $p < 0.05$.

Table 3
Analysis of Variance (ANOVA) pairwise comparisons between age groups by network diversity and core network size outcomes.

	Age Group	Network Diversity					Core network size				
		Ties (avg.)	Kin (%)	Friends (%)	Acquaintances (%)	No Ties (%)	Ties (avg.)	Kin (%)	Friends (%)	Acquaintances (%)	No Ties (%)
	All ages	4.33	25.75	27.95	39.56	5.96	2.34	36.95	43.60	8.52	10.84
1	25–34 years	$4.42^{5,6}$	24.90	$40.15^{3,4,5,6}$	$31.27^{3,4,5,6}$	$3.43^{5,6}$	$2.65^{3,4,5,6}$	40.72^{5}	$52.46^{4,5,6}$	$3.39^{3,4,5,6}$	$3.43^{4,5,6}$
2	35–44 years	$4.69^{5,6}$	23.38	$34.80^{3,4,5,6}$	37.63^{4}	$3.94^{5,6}$	$2.60^{4,5,6}$	39.42	$49.38^{5,6}$	7.91	$3.28^{4,5,6}$
3	45–54 years	$4.62^{5,6}$	24.34	$28.3^{1,2,4,5,6}$	43.39^{1}	$3.47^{5,6}$	$2.41^{1,5,6}$	36.16	$47.20^{5,6}$	8.33^{1}	$8.30^{5,6}$
4	55–64 years	$4.66^{5,6}$	27.28	$22.24^{1,2,3}$	$44.24^{1,2}$	5.93	$2.32^{1,2,6}$	38.35	$42.55^{1,6}$	9.22^{1}	$9.63^{1,2,5,6}$
5	65–74 years	$3.87^{1,2,3,4}$	27.12	$22.33^{1,2,3,6}$	39.18^{1}	$10.16^{1,2,3}$	$2.12^{1,2,3,6}$	32.26^{1}	$38.80^{1,2,3,6}$	11.36^{1}	$17.58^{1,2,3,4,6}$
6	75 years +	$3.34^{1,2,3,4}$	29.32	$15.83^{1,2,3,5}$	41.04^{1}	$10.53^{1,2,3}$	$1.63^{1,2,3,4,5}$	35.53	$21.78^{1,2,3,4,5}$	11.11^{1}	$31.14^{1,2,3,4,5}$
	df	5, 2489	5, 2489	5, 2489	5, 2489		5, 2489	5, 2489	5, 2489	5, 2489	
	F statistic	17.87***	2.16	36.78***	8.96***	37.92***	41.41***	2.73*	22.21***	6.01***	173.82***

**p < 0.01.
*p < 0.05.
***p < 0.001.

estimates. Bivariate analyses showed that reporting acquaintances and friends compared to kin was associated with higher network diversity (shown in Supplementary Table 1 A – Model 1). Results showed that age moderated the association between relationship type and network diversity such that reporting acquaintances was associated with higher network diversity in the older and middle-aged groups compared to the youngest age group; nominating friends was associated with lower network diversity in older and middle-aged groups.

The tie composition of core networks revealed a slightly different picture than that found with network diversity. Bivariate analyses showed that reporting acquaintances compared to kin was associated with a smaller core network size (shown in Supplementary Table 2 A – Model 1). The percentage of respondents reporting no core ties increased across age groups, with 31% of those adults 75 years and older reporting no core tie. The percentage of acquaintance ties contributing to core network size rose modestly in older age groups, whereas the percentage of friends declined with increasing age group. The percentage of kin ties remained consistent across age groups at roughly 37%. Age also moderated the association between relationship type and core network size such that nominating acquaintances was associated with a larger core network size in age groups older than the 25-34 years group. Reporting friends was associated with a smaller core network size only in adults 75 years and older compared to the youngest age group.

Hypothesis 2. In the case of network diversity, social participation moderated the association between relationship type and diversity, such that participation was associated with the greater contribution of friends compared to kin to network diversity (*NBE*: 0.15 (*SE*: 0.04), $p < 0.001$). Generalized trust was neither directly nor indirectly associated with diversity. Perceived cohesion was associated with network diversity but, in contrast to Hypothesis 2c, we found that the contribution of acquaintances compared to kin was less (−0.08 (0.04); $p < 0.05$) in those with higher perceived cohesion. Adults with higher perceived control had more diverse networks (0.12 (0.02), $p < 0.001$), but control did not moderate the association between relationship type and diversity.

In terms of core network size, social participation moderated the association between relationship type and core network size, such that participation was associated with the greater contribution of friends compared to kin to core network size (*NBE*: 0.17 (*SE*: 0.06, $p < 0.01$). Generalized trust was also shown to moderate the association between relationship type and core network size such that those with high trust had fewer acquaintance compared to kin ties (−0.32 (0.11), $p < 0.01$) in their core networks. Perceived cohesion also moderated the association between relationship type and core network size such that those with higher perceived cohesion had more acquaintances (−0.17 (0.16), $p < 0.01$) compared to kin in their core networks. Finally, perceived control was associated with larger overall core network size (0.08 (0.03), $p < 0.01$), but control did not moderate the association between relationship type and core network size.

Hypothesis 3. For network diversity, results showed that having depressive symptoms or chronic conditions moderated the association between relationship type and network diversity, but in opposite directions. Those having chronic conditions had a lower contribution of acquaintances (−0.07 (0.03), $p < 0.05$) or friends (−0.11 (0.03), $p < 0.001$) to their network diversity, whereas those having depressive symptoms had more acquaintances (0.15 (0.08);

Table 4
Negative binomial model estimates and standard errors from regressing network diversity on study correlates, Final Models, MoNNET-HA sample, $n_{ct}=300$; $n_i=2495$.

Variable	Network diversity	Core network size
Relationship type (RT)		
Acquaintance	0.23** (0.08)	−2.49*** (0.27)
Friend	0.44*** (0.08)	−0.30* (0.15)
Kin	REF	REF
AGE		
Age Category		
74 years +	0.01 (0.11)	−0.28** (0.11)
65-74 yrs. old	−0.02 (0.08)	−0.33*** (0.08)
55–64 yrs. old	0.12 (0.08)	−0.15 (0.08)
45–54 yrs. old	−.02 (0.07)	−0.18* (0.07)
35–44 yrs. old	−0.03 (0.08)	−0.09 (0.15)
25–34 yrs. old	REF	REF
***Age category*RT**		
74 years + *Acquaintance	0.32* (0.14)	1.56*** (0.24)
65–74 yrs. old *Acquaintance	0.33** (0.11)	1.47*** (0.21)
55–64 yrs. old *Acquaintance	0.30** (0.10)	1.09*** (0.21)
45–54 yrs. old *Acquaintance	0.35*** (0.10)	0.95*** (0.21)
35–44 yrs. old *Acquaintance	0.23* (0.10)	0.88*** (0.21)
25–34 yrs. old *Acquaintance	REF	REF
74 years + *Friends	−0.66*** (0.15)	−0.50** (0.15)
65–74 yrs. old * Friends	−0.38** (0.11)	0.14 (0.10)
55–64 yrs. old * Friends	−0.49*** (0.10)	−0.07 (0.10)
45–54 yrs. old * Friends	−0.26** (0.10)	0.05 (0.09)
35–44 yrs. old * Friends	−0.09 (0.10)	0.01 (0.10)
25–34 yrs. old * Friends	REF	REF
SOCIAL & PSYCHOSOCIAL		
Social Participation	0.09** (0.03)	−0.03 (0.03)
Generalized Trust	0.00 (0.02)	0.02 (0.05)
Perceived cohesion	0.14*** (0.03)	0.10*** (0.03)
Perceived control	0.12*** (0.02)	0.08** (0.03)
Marital Status		
Single	0.01 (0.03)	0.04 (0.04)
Separated	−0.04 (0.06)	0.08 (0.07)
Divorced	0.07 (0.04)	0.05 (0.05)
Widowed	−0.01 (0.05)	0.04 (0.06)
Married/Common-law	REF	REF
Social Participation * RT		
Participation * Acquaintance	0.06 (0.04)	0.03 (0.07)
Participation * Friend	0.15*** (0.04)	0.17**** (0.04)
Participation * Kin	REF	REF
Perceived Cohesion * RT		
Cohesion * Acquaintance	−0.08* (0.04)	−0.17** (0.06)
Cohesion * Friend	0.01 (0.04)	−0.01 (0.04)
Cohesion * Kin	REF	REF
Generalized Trust * RT	N/A	
Trust * Acquaintance		−0.32** (0.11)
Trust * Friend		0.09 (0.06)
Trust * Kin		REF
HEALTH		
Self-rated health (SRH)	0.02 (0.01)	0.00 (0.02)
Social activity limitations	−0.03* (0.01)	−0.07** (0. 02)
Depressed	−0.05 (0.06)	−0.18** (0.07)
Chronic conditions	0.08 (0.02)	0.00 (0.02)
Depressed * RT		
Depressed * Acquaintances	0.15* (0.08)	0.41** (0.13)
Depressed * Friends	0.05 (0.08)	0.32*** (0.09)
Depressed * Kin	REF	REF
Chronic conditions * RT		**N/A**
Chronic * Acquaintances	−0.07* (0.03)	
Chronic * Friends	−0.11*** (0.03)	
Chronic * Kin	REF	
SAL * RT	N/A	
SAL* Acquaintances		0.01 (0.05)
SAL * Friends		0.08* (0.03)
SAL* Kin		REF
CONFOUNDERS		
Gender		
Female	−0.02 (0.02)	0.01 (0.03)
Male	REF	REF
SES	0.09** (0.03)	0.03 (0.03)
SES*RT		
SES * Acquaintance	0.15** (0.04)	0.12 (0.07)
SES * Friends	0.09 (0.04)	0.13** (0.04)
SES * Kin	REF	REF
Constant	−0.07 (0.09)	0.32 (0.12)*

* $p<0.05$.
** $p<0.01$.
*** $p<0.001$.

$p<0.05$) compared to kin in their diverse networks. For core network size, those having depressive symptoms also had a higher contribution of acquaintances (0.41 (0.13), $p<0.01$) compared to kin. More SAL was associated with lower network diversity (−0.03 (0.01), $p<0.05$); SAL was shown to moderate the association between relationship type and core network size, such that those adults with more social activity limitations had more friends compared to kin in their core networks. SRH was neither directly nor indirectly associated with network diversity or core size.

3.1. Confounding associations

SES was shown to moderate the association between relationship type and network diversity such that among higher SES individuals, acquaintances and friends compared to kin contributed more to diversity. In terms of core network size, higher SES persons tended to have a greater contribution of friends compared to kin to their core networks. Gender was not associated with diversity or core network size. Likelihood ratio tests examining the significance of the nested model building process showed in all instances a significant improvement from one model to the next. See Supplementary Tables for this information.

4. Discussion

This study tested three sets of hypotheses related to the age-, social, and health-related correlates of network diversity – a key structural feature in accessing social capital – and the degree to which these correlates might alter the tie composition of network diversity. One premise of the study was that alterations in the tie strengths by which individuals access these network resources could indicate differences in the mechanisms linking social capital to various social and health outcomes. We compared the results of our hypothesis tests for network diversity with those for core network size – a key structural feature in accessing social support – to assess whether age-, psychosocial-, and health correlates operated similarly across both network dimensions.

Based on our findings, we discuss three points. First, network diversity like core network size declined in older age groups. Adults older than 65 years had higher proportion of participants reporting no contacts in the position generator and name generator. The decline in network diversity among the oldest age group represents a significant change in a person's social connections and access to resources. In addition, the pattern by which acquaintances, friends, and kin contributed to network diversity and core network size differed across age groups. Acquaintances contributed the greatest proportion to network diversity, whereas kin contributed the greatest proportion to core network size. Among the oldest age groups, friends contributed the least to network diversity and acquaintances the least to core network

size. As suggested in previous research, a shift toward kin-based relationships can represent a loss in the bridging capital or social integration of older adults (Cornwell, 2009). Our findings on network diversity and core network size do not suggest a shift toward kin-based relationships in older age groups, as much as the overall loss of network diversity and core network size through the decline in reporting friend ties. Future research examining social capital and aging should consider the network changes that happen around retirement age, potentially examining not only whether older adults can access social capital but also the types of ties by which they might access social capital.

Second, our research examined the role that social and psychosocial characteristics might play in the breadth and tie composition of network diversity. Recent research on social capital and health has examined the degree to which different measures of social capital (e.g., trust) are valid indicators of network social capital (Moore et al., 2009; Carpiano & Hystad, 2011; Carpiano & Fitterer, 2014). For example, Carpiano and Fitterer (2014) showed that measures of generalized and particularized trust were associated with general and mental health outcomes, after adjusting for network capital measures, concluding that trust is conceptually distinct from and an inadequate proxy for network ties. This study reframed the question slightly to ask whether trust, participation, and perceived cohesion might alter the types of ties composing a person's network capital. Based on the proposition that weaker ties contribute to greater network heterogeneity and bridging capital (Granovetter, 1973; Granovetter, 1983), our study showed that those with higher participation had more friends compared to kin in their diverse and core networks. Social participation may thus reflect greater network heterogeneity and bridging capital in a person's social networks. Generalized trust, on the other hand, was not associated with network diversity, suggesting that generalized trust is a distinct construct from that of network social capital (Carpiano & Fitterer, 2014). However, our study did show that those persons with higher generalized trust tended to have less heterogeneous core networks (i.e., more acquaintances and friends compared to kin). Perceived cohesion altered the tie composition of network diversity and core network size in similar directions. Those with higher perceived cohesion had fewer acquaintances compared to kin in their network diversity and core networks. Finally, higher perceived control was directly associated with greater network diversity and core network size, but did not alter their tie composition, suggesting that persons with greater perceived control may maintain more diverse and larger core networks regardless of the type of relationships composing them. Further research is required to understand better the role of psychosocial factors in the tie composition of personal social networks, and whether variations in composition can help to explain specific types of social or health outcomes. Nevertheless, our findings suggest that participation, often considered a structural measure of social capital, introduces a greater number of friends compared to kin into one's networks. Generalized trust and perceived cohesion, often considered cognitive measures of social capital, reduces the number of acquaintances compared to kin. Future research might examine whether network compositional differences between structural and cognitive measures have additional implications for health outcomes.

Thirdly, recent research on the relationship between health conditions and social networks has highlighted the role that poor health conditions may play in shaping network structure and composition. Poor health conditions may tax the ability of individuals to maintain weak ties leading to more insular, kin-based social networks (Cornwell, 2009). Previous research in this field has tended to focus exclusively on the effects that health conditions may have on the core social networks of older adults (Cornwell, 2009). Our study examined this question across a broader set of age groups and in relation to network diversity. Findings showed that chronic conditions and depressive symptoms moderated the association between relationship type and network diversity and core network size in different ways. Adults with chronic conditions tended to have a lower contribution of acquaintances and friends compared to kin to their network diversity, supporting the idea that poor physical conditions may lead to more insular, kin-based networks. In contrast, adults with depressive symptoms had more acquaintance ties composing their network diversity and had more acquaintances and friends compared to kin composing their core networks. Our data do not allow us to assess whether having more acquaintances and friends compared to kin in one's network predated depressive status. As a result, we are unable to conclude if having weaker ties in one's networks might lead to depressive status or having weaker ties may be a strategy for coping with depressive status. Together, however, our results suggest that physical and mental health conditions may alter personal networks and their composition in different ways.

4.1. Limitations

A number of limitations are worth noting. First, the study is cross sectional in design, thereby precluding the analysis of causal relationships. Further longitudinal research is needed to assess potential recursive effects among social networks, psychosocial resources, and social and health conditions. Second, our definition and measurement of strong versus weak ties was based on the relationship type relationship characterizing the social connection. Such a definition may not fully capture tie strength. For example, there may be situations in which friends represent a stronger tie than family, or kin may be much weaker than presumed. Relatedly, if a respondent knew more than one person holding an occupation, we asked them to answer the follow up questions with the person whom they considered closest to them in mind. This may have introduced an overestimation of the strong ties present in respondent's access to network capital., Third, the MoNNET-HA name generator capped the number of core network members that could be nominated to three. Although this was to reduce potential recall errors (Bell, Belli-McQueen, & Haider, 2007) and questionnaire administration time, it may have affected the pattern of strong and weak tie contributions. Presumably, if the cap were increased, there may be a higher number of acquaintances or friends nominated. However, even when respondents have been allowed to name up to five or not been given a limit, previous research has shown average core size to be approximately two (McPherson et al., 2006). Finally, although the perceived control scale was designed to reduce agreement bias and enhance overall validity, its reliability was low. We retained the variable for our study given its general importance as a psychosocial construct, but we caution against drawing firm conclusions.

Despite these limitations, this study is unique in the representative nature of its urban adult sample and its use of both position and name generators in measuring social networks. Adjusting for age and a rich set of variables, our study identified important age-, psychosocial-, and health-related variations in the tie patterns by which individuals access network capital and social support resources. Future research on social capital, social support and health might consider the importance of tie strength in understanding how these social network mechanisms might operate to influence health outcomes.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.ssmph.2016.08.009.

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