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Do bonding and bridging social capital affect self-rated health, depressive mood and cognitive decline in older Japanese? A prospective cohort study

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ABSTRACT

Little is known regarding the longitudinal effects of bonding and bridging social capital on health. This study examined the longitudinal associations of bonding and bridging social capital with self-rated health, depressive mood, and cognitive decline in community-dwelling older Japanese. Data analyzed in this study were from the 2010 (baseline) and 2012 (follow-up) Hatoyama Cohort Study. Bonding social capital was assessed by individual perception of homogeneity of the neighborhood (the level of homogeneity among neighbors) and of networks (the amount of homogeneous personal networks) in relation to age, gender, and socioeconomic status. Bridging social capital was assessed by individual perception of heterogeneity of networks (the amount of heterogeneous personal networks) in relation to age, gender, and socioeconomic status. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to evaluate the effects of baseline social capital on poor health outcome at follow-up by logistic regression analysis. In total, 681 people completed baseline and follow-up surveys. The mean age of participants was 71.8 ± 5.1 years, and 57.9% were male. After adjusting for sociodemographics, lifestyle factors, comorbidity, functional capacity, baseline score of each outcome, and other bonding/bridging social capital, stronger perceived neighborhood homogeneity was inversely associated with poor self-rated health (OR = 0.55, 95% CI = 0.30–1.00) and depressive mood assessed by the Geriatric Depression Scale (OR = 0.58, 95% CI = 0.34–0.99). When participants who reported a depressive mood at baseline were excluded, stronger perceived heterogeneous network was inversely associated with depressive mood (OR = 0.40, 95% CI = 0.19–0.87). Neither bonding nor bridging social capital was significantly associated with cognitive decline assessed by the Mini-Mental State Examination. In conclusion, bonding and bridging social capital affect health in different ways, but they both have beneficial effects on the health of older Japanese. Our findings suggest that intervention focusing on bonding and bridging social capital may improve various health outcomes in old age.

Introduction

Social capital is used to explain health disparities and promote health (Baum & Ziersch, 2003; Kawachi & Berkman, 2000; Lindström, 2008). According to Putnam (1993), social capital refers to "features of social organization, such as trust, norms and networks that can improve the efficacy of society by facilitating coordinated actions (p. 167)". Because social capital is an umbrella concept, subclassification of social capital into some aspects and dimensions is useful for clarifying its effect on health (e.g., Murayama, Wakui, Arami, Sugawara, & Yoshie, 2012). This could be helpful for developing an intervention program to foster social capital. To date, several classification systems for social capital have been suggested (Harpham, Grant, & Thomas, 2002; Putnam, 1993; Szreter & Woolcock, 2004) of which the concept of bonding and bridging social capital has credence. According to Szreter and

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Woolcock (2004), bonding social capital refers to aspects of "inward-looking" social networks that reinforce exclusive identities and homogeneous groups. Therefore, there are strong ties between members of a network who are similar in terms of sociodemographic or social characteristics (e.g., age, ethnicity, and social class). Bridging social capital refers to "outward-looking" social networks across different social and ethnic groups that do not necessarily share similar identities. Although the importance of distinguishing between these types of social capital is understood, few empirical studies have investigated their individual effects on health.

The first empirical study to examine the association of bonding and bridging social capital with health was reported by Mitchell and LaGory (2002). They showed that higher bridging social capital on an individual level (strength of trust and ties with others of different race and education from the respondent) was associated with less mental distress, whereas bonding social capital had the opposite association in an impoverished community. Following this study, further reports on the association of bonding and bridging social capital with health emerged. Kim, Subramanian, and Kawachi (2006) reported that bonding social capital at the individual (definition based on race/ethnicity, gender, and education) and community (aggregated based on individual responses) levels was associated with better self-rated health, but there was no such association with bridging social capital at both levels among U.S. adults. Beaudoin (2009) studied the two health outcomes of self-rated health and stress, and defined bonding and bridging social capital based on the relationships of an individual with people of (dis)similar race/ethnicity. He found that bonding and bridging social capital on an individual level were associated with better self-rated health, and that bonding social capital was associated with less stress among U.S. adults. Iwase et al. (2012) reported that in Japan, individual-level bridging social capital, which was defined by the number of heterogeneous groups that each respondent participated in, was associated with better self-rated health, particularly among women.

Despite the growing literature on evidence for an association between bonding/bridging social capital and health, this association remains inconclusive, and some issues need to be addressed. First, almost all of the previous studies used cross-sectional designs that failed to identify causality. Longitudinal studies are required to understand the effect of social capital on health. Poulsen et al. (2012) reported the only longitudinal study to date examining the effects of bonding and bridging social capital on mortality; however, they failed to find any significant link between these factors. Second, the health outcomes included by previous studies were limited. Most previous studies used either self-rated or mental health (e.g., stress) as their outcome. Exploring the effects of bonding and bridging social capital on various types of health outcomes could lead to a broader understanding of their importance, possibly leading to interventions and health policies. Third, most studies considering bonding and bridging social capital and health were conducted in Western countries. Only three studies based in Asia have been reported, including two Japanese studies (Iwase et al., 2012; Norstrand & Xu, 2012; Ueshima et al., 2010). In Japan, which has a relatively collectivist society with intense group ties, people feel comfortable under systems of mutual assurance and monitoring among residents within a community (Nakane, 1970; Yamagishi, Cook, & Watabe, 1998; Yamagishi & Yamagishi, 1994). Therefore, considering the difference in cultural and historical backgrounds between Japan and Western countries, it is important to explore the association between bonding and bridging social capital and health in Japan.

In this study, data were analyzed from a cohort study of community-dwelling older Japanese. Three types of health outcomes were used: self-rated health (as an indicator of general health), depressive mood (as a measure of psychological health), and cognitive decline (as a measure of cognitive health). These three factors are known to effect functional decline in old age (Stuck et al., 1999). In Japan, measures of depression and cognitive decline are considered good indicators for developing policies for long-term care prevention (Ministry of Health, Labour and Welfare, 2012). The purpose of this study was to examine the longitudinal association of bonding and bridging social capital with self-rated health, depressive mood, and cognitive decline in older Japanese.

Methods

Study population

The Hatoyama Cohort Study consisted of randomly sampled community-dwelling individuals aged 65 years or older, living in the town of Hatoyama in Saitama, Japan. Hatoyama is a suburban area located 50 km northwest of central Tokyo. To recruit the study participants, we used stratified random sampling of four groups classified by age (65–74 and 75–84 years) and residential area of the town (traditional areas and newly developed areas). People with long-term care certification (levels 1–5) and those admitted to hospitals or residing in nursing homes were excluded. In addition to the random sampling recruitment, we recruited study participants using the Hatoyama town bulletin, to permit broader recruitment. Further information on sampling and the participants is described by Murayama, Nishi, et al. (2012).

After using these two methods, 751 people agreed to participate in the Hatoyama Cohort Study. Immediately before the baseline survey, we directly informed participants of the study purpose, method, survey items, and merits of participation, after which nine declined to participate in the study. As a result, a total of 742 people participated in the baseline survey in 2010. Comprehensive information was collected at face-to-face interviews. In 2012, a follow-up survey of the participants in the baseline survey was conducted. Of 742 participants, eight had died, 27 had dropped out between baseline and follow-up surveys (e.g., moved away and health-related exclusion), and 26 were unable to attend the follow-up survey (e.g., health-related reasons and schedule conflicts). In the follow-up survey, a mailed questionnaire option was offered to participants unable to attend the face-to-face interviews. As a result, 681 (91.8%) participants completed both baseline and follow-up surveys (571 attended a face-to-face interview and 110 self-completed the questionnaire at the follow-up survey).

The study protocol was reviewed and approved by the Ethical Committee of the Tokyo Metropolitan Institute of Gerontology, Japan. All subjects gave written consent to participate in this study.

Measurements

Bonding and bridging social capital

There is no standard measure of bonding and bridging social capital. Based on previous studies (Harpham et al., 2002; Kawachi, Subramanian, & Kim, 2008; Poortinga, 2012; Szreter & Woolcock, 2004), a system of assessing bonding social capital using two factors and bridging social capital by a single factor was developed in the baseline study. Previous studies from Western countries have defined bonding and bridging social capital based on relationships with racially or ethnically (dis)similar people (Beaudoin, 2009; Kim et al., 2006; Poortinga, 2012). However, because Japan has little racial and ethnic diversity, we considered that this definition was inappropriate for this study. Therefore, we focused on the (dis) similarity of relationships with regard to age, gender, and socioeconomic status (SES).

For bonding social capital, the perception of homogeneity of neighborhood and personal networks (network homogeneity) was examined. Perceived neighborhood homogeneity was regarded as the level of homogeneity among local residents in their neighborhood in terms of social characteristics. This concept was investigated by asking the participants: "Do you agree that many residents in your neighborhood have similar social characteristics (age, gender, and SES) to yourself?" (1 = agree, 2 = slightly agree, 3 = slightly disagree, and 4 = disagree). The response of "agree" meant that participants thought that there were many residents with similar social characteristics to them, and "disagree" meant that they thought that there were not many residents with such social characteristics. Perceived network homogeneity was regarded as the amount of personal networks with others who have similar social characteristics. This concept was examined with the statement: "Do you agree that you have some networks with people who have similar social characteristics to yourself in your daily life?" (1 = agree, 2 = slightly agree, 3 = slightly disagree, and 4 = disagree). The response of "agree" meant that participants thought that they have some networks with people who have similar social characteristics to them, and "disagree" meant that they thought that they have few such networks.

Bridging social capital was assessed by perception of the heterogeneity of participants' networks (network heterogeneity). Network heterogeneity was regarded as the amount of personal networks with others who have dissimilar social characteristics, and this was addressed with the statement: "Do you agree that you have some networks with people who have dissimilar social characteristics to yourself in your daily life?" (1 = agree, 2 = slightly agree, 3 = slightly disagree, and 4 = disagree). The response of "agree" meant that participants agreed that they have some networks with people who have dissimilar social characteristics to themselves, and "disagree" meant that they thought that they have few such networks. Responses for the three questions were classified into two categories: stronger (responses 1 and 2) and weaker (responses 3 and 4).

We assumed that homogeneous and heterogeneous networks were not opposite concepts to each other because these were defined as the amount of networks that the respondents had. Therefore, some people would have homogeneous and heterogeneous networks, while some would have neither of these networks.

Individual-level social capital was the focus of this study. Although the precise definition and measurement of social capital are controversial (Baum & Ziersch, 2003; Kawachi et al., 2008), it remains important to determine the association between individual social capital and health. This is because individual social capital indices are components of aggregated measurements of community social capital (Harpham, 2008). Moreover, individuals are one of the essential units of health intervention. Therefore, investigating the effect of individual-level social capital on health could contribute to developing interventions that target individual perceptions and behavior.

Health outcomes

Self-rated health, depressive mood, and cognitive decline were measured in baseline and follow-up surveys. Self-rated health was assessed by the question "How would you rate your current overall health?" Respondents answered on a four-point Likert scale (1 = good, 2 = slightly good, 3 = slightly poor, and 4 = poor). Responses were dichotomized into "good" (1 and 2) and "poor" (3 and 4). Depressive mood was assessed using the Geriatric Depression Scale (GDS) short-form (Burke, Roccaforte, & Wengel, 1991; Schreiner, Hayakawa, Morimoto, & Kakuma, 2003). Respondents answered dichotomized questions, and the answers were summed (range of scores: 0–15). Cronbach's alpha at baseline was 0.77. A cutoff point of 5/6 was adopted, and a score of $\geq$6 indicated depressive mood (Schreiner et al., 2003).

Cognitive decline was assessed with the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975; Tombaugh & McIntyre, 1992), which was administered by trained personnel. The MMSE is widely used as a brief screening test for dementia and is a measure of global cognitive ability. The MMSE consists of 11 questions, and the score ranges from 0 to 30, with a lower score indicating poorer global cognitive ability. In this study, a cutoff point of 26/27 was adopted, and a score of $\leq$26 indicated cognitive decline (Kukull et al., 1994). At the follow-up survey, the MMSE was only administered to participants who were interviewed face-to-face.

Covariates

Baseline data on age, gender, marital status, SES, lifestyle factors, comorbidity, and functional capacity were used as covariates in the analysis of this study. Marital status was categorized as "married" or "not married" (unmarried, divorced, and widowed). SES included educational attainment and long-term occupation. Lifestyle factors included smoking status and body mass index (BMI). BMI was calculated from measured height and weight (kg/m^2). Information on comorbidity was assessed in a medical interview by a doctor or registered nurse and included the following five diseases: hypertension, cardiovascular disease, cerebrovascular diseases, hyperlipidemia, and diabetes mellitus.

Functional capacity included basic activities of daily living (BADL) and instrumental activities of daily living (IADL). BADL was measured using five actions: walking, eating, bathing, dressing, and toileting. IADL was measured by five actions: the ability of the participant to use public transport (bus or train), shop for daily necessities, prepare meals, pay bills, and handle banking. The ability of an individual to perform each action was assessed by 1 = yes or 0 = no. The actions were summed to give a score between 0 and 5. A higher score indicated greater independence, with a score of 5 indicating complete independence.

Statistical analysis

First, intercorrelation between bonding and bridging social capital was assessed by Cramér's V. Logistic regression analyses were then used to examine the associations of bonding and bridging social capital with health outcomes. In Model 1, we regressed each outcome variable at follow-up into each social capital indicator at baseline, adjusting for age, gender, marital status, SES, and each baseline outcome variable (i.e., when self-rated health was used as the outcome, self-rated health at baseline was adjusted for). In Model 2, we also controlled for lifestyle factors and comorbidity, and functional capacity in Model 3. In Model 4a, we added two other bonding/bridging social capital indicators simultaneously. Finally, to check the robustness of the effects of bonding and bridging social capital on health outcomes, additional analysis was performed excluding the participants who reported poor health for each health outcome at baseline in Model 4b. Odds ratios (ORs) and 95% confidence intervals (CIs) for poor health were calculated. A p-value of <0.05 was considered statistically significant (two-sided test). All analyses were conducted with IBM SPSS Statistics 20.

Results

Table 1 shows the characteristics of the participants. All participants scored full points on the BADL, indicating that all had BADL independency. Therefore, BADL was not used as a variable in the logistic regression models. Responses to questions on social

Table 1
Characteristics of participants ($n = 681$).

		No. of respondents	Mean ± SD or n (%)[a]
Baseline (2010)			
Age		681	71.8 ± 5.1
Gender	Male	681	394 (57.9)
Marital status	Not married	679	111 (16.3)
Socioeconomic status			
Education attainment	12 years or less	681	444 (65.2)
Long-term occupation		680	
	White-collar job		361 (53.1)
	Blue-collar job		168 (24.7)
	Unemployed/ housewife		151 (22.2)
Lifestyle factors			
Smoking status	Current smoker	680	75 (11.0)
Body mass index (kg/m^2)		679	23.5 ± 3.0
Comorbidity		681	
	0		171 (25.1)
	1		249 (36.6)
	≥2		261 (38.3)
Functional capacity			
Basic activities of daily living	Dependent (score of 0–4)	680	0 (0.0)
Instrumental activities of daily living	Dependent (score of 0–4)	680	26 (3.8)
Bonding social capital			
Perceived neighborhood homogeneity	Stronger	679	506 (74.5)
Perceived homogeneous network	Stronger	680	449 (66.0)
Bridging social capital			
Perceived heterogeneous network	Stronger	677	207 (30.6)
Self-rated health	Poor	681	94 (13.8)
GDS	≥6	680	81 (11.9)
MMSE	≤26	675	64 (9.5)
Follow-up (2012)			
Self-rated health	Poor	673	106 (15.8)
GDS	≥6	656	104 (15.9)
MMSE	≤26	569	59 (10.4)

GDS: Geriatric Depression Scale; MMSE: Mini-Mental State Examination.
[a] Mean, SD, and percentage were calculated based on the number of respondents for each variable.

capital showed that 75% of respondents felt that their neighborhood was homogeneous. A total of 66% of respondents felt that they had a stronger homogeneous network, while 31% felt that they had a stronger heterogeneous network. The interrelationships between bonding and bridging social capital were 0.13 ($p = 0.001$) between perceived neighborhood homogeneity and perceived homogeneous network, 0.02 ($p = 0.589$) between perceived neighborhood homogeneity and perceived heterogeneous network, and 0.10 ($p = 0.007$) between perceived homogeneous network and perceived heterogeneous network.

Table 2 shows the adjusted ORs and 95% CIs for outcomes according to levels of bonding and bridging social capital assessed at baseline. For self-rated health, stronger perceived neighborhood homogeneity was negatively associated with poor self-rated health (OR = 0.55, 95% CI = 0.30–1.00) and a score of ≥6 on the GDS (OR = 0.58, 95% CI = 0.34–0.99) in Model 4a. Neither bonding nor bridging social capital was associated with cognitive decline, as measured on the MMSE. However, when we used the original four response categories of bonding and bridging social capital in the analysis, although not significant, we found a possible association of perceived heterogeneous networks with cognitive decline (OR = 0.43, 95% CI = 0.12–1.56 in the category of "strong" [1 = agree] compared with that of "weak" [4 = disagree] in Model 4a) (see Supplementary data).

To further check the robustness of our analyses, they were repeated after excluding participants who reported poor health outcomes at baseline. In Model 4b, the association between perceived neighborhood homogeneity and self-rated health was attenuated (OR = 0.66, 95% CI = 0.32–1.38). However, the association between perceived neighborhood homogeneity and the GDS remained significant and strengthened (OR = 0.39, 95% CI = 0.21–0.73), and that between perceived heterogeneous networks and the GDS became significant (OR = 0.40, 95% CI = 0.19–0.87).

Discussion

The present study attempted to distinguish between bonding and bridging social capital. We examined their different effects on three health outcomes after 2 years using cohort data of older Japanese. Overall, bonding social capital was associated with self-rated health and depressive mood, and bridging social capital was associated with depressive mood after adjusting for sociodemographics, lifestyle factors, comorbidity, functional capacity, baseline score of each outcome, and other bonding/bridging social capital. This study is the first attempt to examine the longitudinal association of bonding and bridging social capital with various health outcomes. Our results should stimulate further research and discussion on the link between bonding/bridging social capital and health, and also provide guidelines for health promotion policies for both current and future aging societies.

In our study, perceived neighborhood homogeneity, measured as an aspect of bonding social capital, was negatively associated with poor self-rated health and depressive mood. This result is consistent with previous studies, which found that individual bonding social capital is inversely associated with poor self-rated health (Beaudoin, 2009; Kim et al., 2006; Poortinga, 2012) and mental health (Beaudoin, 2009). Similarity among local residents is of greater benefit than dissimilarity. This is because shared personal characteristics elicit perceptions of trust and social resemblance, which may foster the development of a social support system and enhance the flow of information and knowledge in a community (Kawachi & Berkman, 2000). Moreover, residents of cohesive neighborhoods are more likely to form social organizations (Coleman, 1990). Greater need for a service or amenity would develop by gathering people with similar sociodemographics in one community. In such a community, healthcare services or amenities to meet this need are likely to be allocated and maintained (Kawachi & Berkman, 2000). Such services or amenities would in turn have a positive influence on the perception of the health and psychological health of the residents.

Perceived homogeneous networks were not associated with health outcomes in our study, even though this was considered as another aspect of bonding social capital. Hatoyama was developed as a typical commuter town for Tokyo at the end of a period of high economic growth from the mid-1950s through to the mid-1970s. Many young adults and middle-aged people who worked in Tokyo at that time moved to live in Hatoyama with their families, and many stayed as they aged. In Hatoyama in 2010, the proportion of people aged 65 years and older was 26.1% and that of people aged 55 years and older was 48.0%. This proportion substantially exceeds the national average and suggests that Hatoyama has demographic homogeneity. At baseline, three-quarters of participants answered that perceived neighborhood homogeneity was strong where they lived (Table 1). In such a homogeneous society, people could easily find others nearby with a similar background to themselves. Therefore, accessibility to homogeneous networks may be relatively less valuable than access to heterogeneous networks. Moreover, people tend to receive less novel information and ideas or tend to receive these less easily through strong ties (e.g., networks with similar persons, such as family members and close friends) than weak ties (e.g., networks with acquaintances), because strong

Table 2
Individual effects of bonding and bridging social capital on self-rated health, depressive mood, and cognitive decline in older Japanese.

		All participants					Excluding participants who reported poor health for each outcome at baseline	
		% poor health at follow-up	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4a OR (95% CI)	% poor health at follow-up	Model 4b OR (95% CI)
Poor self-rated health								
Bonding social capital								
Perceived neighborhood homogeneity	Weaker	24.6	1	1	1	1	11.5	1
	Stronger	12.8	0.50 (0.29–0.87)	0.50 (0.28–0.91)	0.55 (0.30–1.00)	0.55 (0.30–1.00)	6.6	0.66 (0.32–1.38)
Perceived homogeneous network	Weaker	17.0	1	1	1	1	7.8	1
	Stronger	14.9	1.00 (0.58–1.71)	0.79 (0.44–1.41)	0.79 (0.44–1.42)	0.85 (0.46–1.54)	7.7	0.83 (0.40–1.73)
Bridging social capital								
Perceived heterogeneous network	Weaker	16.2	1	1	1	1	7.6	1
	Stronger	15.1	1.14 (0.66–1.98)	1.02 (0.55–1.89)	1.04 (0.56–1.93)	1.01 (0.54–1.88)	8.3	1.07 (0.51–2.26)
GDS ≥6								
Bonding social capital								
Perceived neighborhood homogeneity	Weaker	24.0	1	1	1	1	18.1	1
	Stronger	13.0	0.61 (0.37–0.99)	0.58 (0.34–0.97)	0.61 (0.36–1.02)	0.58 (0.34–0.99)	7.8	0.39 (0.21–0.73)
Perceived homogeneous network	Weaker	21.1	1	1	1	1	10.4	1
	Stronger	13.0	0.74 (0.45–1.20)	0.80 (0.48–1.33)	0.79 (0.47–1.32)	0.82 (0.48–1.39)	10.0	1.10 (0.58–2.09)
Bridging social capital								
Perceived heterogeneous network	Weaker	17.7	1	1	1	1	12.3	1
	Stronger	12.1	0.59 (0.34–1.02)	0.60 (0.34–1.02)	0.61 (0.34–1.09)	0.59 (0.33–1.06)	5.7	0.40 (0.19–0.87)
MMSE ≤26								
Bonding social capital								
Perceived neighborhood homogeneity	Weaker	14.4	1	1	1	1	6.6	1
	Stronger	9.1	0.82 (0.42–1.60)	1.08 (0.55–2.12)	1.06 (0.52–2.18)	1.06 (0.51–2.18)	7.0	1.64 (0.67–4.01)
Perceived homogeneous network	Weaker	12.0	1	1	1	1	7.2	1
	Stronger	9.6	0.93 (0.49–1.77)	0.99 (0.50–1.93)	0.96 (0.49–1.91)	0.96 (0.48–1.91)	6.7	0.83 (0.38–1.82)
Bridging social capital								
Perceived heterogeneous network	Weaker	9.9	1	1	1	1	7.2	1
	Stronger	11.6	1.04 (0.54–1.99)	1.08 (0.55–2.12)	1.11 (0.56–2.20)	1.10 (0.55–2.19)	6.1	0.95 (0.43–2.10)

CI: confidence interval; GDS: Geriatric Depression Scale; MMSE: Mini-Mental State Examination; OR: odds ratio.
Model 1: age, gender, marital status, educational attainment, long-term occupation, each outcome variable at baseline, and neighborhood homogeneity/homogeneous network/heterogeneous network.
Model 2: Model 1 + smoking status, body mass index and comorbidity.
Model 3: Model 2 + instrumental activities of daily living.
Model 4a: Model 3 + other two social capital variables.
Model 4b: each outcome variable at baseline was excluded from Model 4a.

ties have some redundancy (Granovetter, 1973). Therefore, the possession of homogeneous networks might not have affected health outcomes in this study.

We found that people with stronger perceived heterogeneous networks, which were measured as an indicator of bridging social capital, were unlikely to be depressed. This result supports findings from previous studies (Erickson, 2003; Mitchell & LaGory, 2002). Our study was based on a prospective longitudinal design. Therefore, our study provides dynamic evidence for the relationship between bridging social capital and depression. Bridging ties involving dissimilar persons is important for obtaining outside information and assistance from diverse resources to address challenges (Putnam, 2000; Wellman & Wortley, 1990). Particularly later in life, people experience changes in various factors, such as social function (e.g., retirement), social relations (e.g., death of a spouse and friends), and physical condition (e.g., chronic disease and disability) (Müller-Spahn & Hock, 1994; Rowe & Kahn, 1997). In fact, symptom scale-based studies of depression show an increasing rate of depression with age (Luppa et al., 2012; Stordal et al., 2001). In such a period of change, people with richer perceived heterogeneous networks are able to access a wider variety of resources than those with weaker ones, which is beneficial for their mental condition.

The present study also found that a strong perceived heterogeneous network was possibly associated with less cognitive decline compared with a weak heterogeneous network. Previous studies have reported that rich social networks help to prevent cognitive decline in old age (Crooks, Lubben, Petitti, Little, & Chiu, 2008; Holtzman et al., 2004; Zunzunegui, Alvarado, Del Ser, & Otero, 2003). This study confirms the importance of heterogeneous social networks as in these previous studies. Granovetter (1973) argued that weak ties with acquaintances who sometimes have different values, styles, and social standing can provide novel information and inspiring ideas. The association between a heterogeneous network and cognitive decline did not reach statistical significance in the present study. However, our results suggest that such information and ideas obtained through heterogeneous networks might stimulate cognitive function and protect against cognitive decline. Further examination of this issue using a larger sample size and longer follow-up period is necessary.

Excluding participants who reported a depressive mood at baseline strengthened the effects of bonding and bridging social capital on lessening depression (Model 4b). We conclude that both types of social capital may prevent the onset of depressive mood. In contrast, excluding those with poor self-rated health possibly reduced our ability to detect a statistically significant association between perceived neighborhood homogeneity and self-rated health, resulting in an imprecise risk estimate. An alternative interpretation is that neighborhood homogeneity helps people with poor self-rated health at baseline to recognize their own health better during the follow-up period.

The current study has several limitations. First, measurements for bonding and bridging social capital were developed in this study. Further examination of the validity and reliability of these

measurements would be useful. We cannot rule out the possibility that these items are double-barreled. In the example of perceived homogeneous network, we intended to ask the respondents about the amount of networks with people who have similar social characteristics to themselves in their daily life. However, some respondents might misunderstand the phrase "the amount of networks with people who have similar social characteristics", where the emphasis is on the similarity of social characteristics. Therefore, the response of "disagree" might indicate that participants have some networks with people who have dissimilar social characteristics to them. We thought that the respondents correctly understood our intention because the correlation between homogeneous network and heterogeneous network was weak (Cramér's V was 0.10). However, the findings of this study should be carefully interpreted, and more robust items about bonding and bridging social capital should be developed. Second, data for this study came from a single suburban area of Tokyo. Therefore, the generality of these findings should be examined by conducting further studies in various settings. Third, the possibility of an effect of healthy volunteers must be considered. Our study participants tended to be healthy and wealthy compared with the Japanese average (Murayama, Nishi, et al., 2012), and perhaps people with depression or cognitive impairment tended not to participate. In particular, in the analysis using the MMSE as outcome, we used the data of participants who performed a face-to-face MMSE at baseline and follow-up surveys. This might have caused selection bias. In fact, for participants who had a questionnaire mailed for the follow-up survey, there was a higher proportion of people with an MMSE $\leq$26 at baseline than that among participants who had a face-to-face interview at the follow-up survey ($p < 0.001$, data not shown). This suggests that the association between social capital and health outcomes was underestimated.

In conclusion, the present longitudinal study provides evidence that bonding and bridging social capital have different effects on health outcomes, but all of these effects are beneficial to the health of older Japanese. Therefore, intervention focusing on bonding and bridging social capital may improve various health outcomes in old age.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2013.09.026.

References

Baum, F. E., & Ziersch, A. M. (2003). Social capital. *Journal of Epidemiology & Community Health, 57*, 320–323.
Beaudoin, C. E. (2009). Bonding and bridging neighborliness: an individual-level study in the context of health. *Social Science & Medicine, 68*, 2129–2136.
Burke, W. J., Roccaforte, W. H., & Wengel, S. P. (1991). The short form of the Geriatric Depression Scale: a comparison with the 30-item form. *Journal of Geriatric Psychiatry and Neurology, 4*, 173–178.
Coleman, J. S. (1990). *Foundations of social theory*. Cambridge, MA: Harvard University Press.
Crooks, V. C., Lubben, J., Petitti, D. B., Little, D., & Chiu, V. (2008). Social network, cognitive function, and dementia incidence among elderly women. *American Journal of Public Health, 98*, 1221–1227.
Erickson, B. (2003). Social networks: the value of variety. *Contexts, 2*, 25–31.
Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state": a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*, 189–198.
Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology, 78*, 1360–1380.
Harpham, T. (2008). The measurement of community social capital through surveys. In I. Kawachi, S. V. Subramanian, & D. Kim (Eds.), *Social capital and health* (pp. 51–62). New York: Springer.
Harpham, T., Grant, E., & Thomas, E. (2002). Measuring social capital within health surveys: key issues. *Health Policy and Planning, 17*, 106–111.
Holtzman, R. E., Rebok, G. W., Saczynski, J. S., Kouzis, A. C., Wilcox Doyle, K., & Eaton, W. W. (2004). Social network characteristics and cognition in middle-aged and older adults. *Journal of Gerontology Series B: Psychological Sciences & Social Sciences, 59*, 278–284.
Iwase, T., Suzuki, E., Fujiwara, T., Takao, S., Doi, H., & Kawachi, I. (2012). Do bonding and bridging social capital have differential effects on self-rated health? A community based study in Japan. *Journal of Epidemiology & Community Health, 66*, 557–562.
Kawachi, I., & Berkman, L. F. (2000). Social cohesion, social capital, and health. In L. F. Berkman, & I. Kawachi (Eds.), *Social epidemiology* (pp. 174–190). New York: Oxford University Press.
Kawachi, I., Subramanian, S. V., & Kim, D. (2008). Social capital and health: a decade of progress and beyond. In I. Kawachi, S. V. Subramanian, & D. Kim (Eds.), *Social capital and health* (pp. 1–26). New York: Springer.
Kim, D., Subramanian, S. V., & Kawachi, I. (2006). Bonding versus bridging social capital and their associations with self rated health: a multilevel analysis of 40 US communities. *Journal of Epidemiology & Community Health, 60*, 116–122.
Kukull, W. A., Larson, E. B., Teri, L., Bowen, J., McCormick, W., & Pfanschmidt, M. L. (1994). The Mini-Mental State Examination score and the clinical diagnosis of dementia. *Journal of Clinical Epidemiology, 47*, 1061–1067.
Lindström, M. (2008). Social capital and health-related behaviors. In I. Kawachi, S. V. Subramanian, & D. Kim (Eds.), *Social capital and health* (pp. 215–238). New York: Springer.
Luppa, M., Sikorski, C., Luck, T., Ehreke, L., Konnopka, A., Wiese, B., et al. (2012). Age- and gender-specific prevalence of depression in latest-life: systematic review and meta-analysis. *Journal of Affective Disorders, 136*, 212–221.
Ministry of Health, Labour and Welfare. (2012). *Manual for care prevention*. Tokyo: Ministry of Health, Labour and Welfare.
Mitchell, C. U., & LaGory, M. (2002). Social capital and mental distress in an impoverished community. *City & Community, 1*, 199–222.
Müller-Spahn, F., & Hock, C. (1994). Clinical presentation of depression in the elderly. *Gerontology, 40*, 10–14.
Murayama, H., Nishi, M., Shimizu, Y., Kim, M. J., Yoshida, H., Amano, H., et al. (2012). The Hatoyama Cohort Study: design and profile of participants at baseline. *Journal of Epidemiology, 22*, 551–558.
Murayama, H., Wakui, T., Arami, R., Sugawara, I., & Yoshie, S. (2012). Contextual effect of different components of social capital on health in a suburban city of the greater Tokyo area: a multilevel analysis. *Social Science & Medicine, 75*, 2472–2480.
Nakane, C. (1970). *Japanese society*. Los Angeles: University of California Press.
Norstrand, J. A., & Xu, Q. W. (2012). Social capital and health outcomes among older adults in China: the urban–rural dimension. *Gerontologist, 52*, 325–334.
Poortinga, W. (2012). Community resilience and health: the role of bonding, bridging, and linking aspects of social capital. *Health & Place, 18*, 286–295.
Poulsen, T., Siersma, V. D., Lund, R., Christensen, U., Vass, M., & Avlund, K. (2012). Impact of social capital on 8-year mortality among older people in 34 Danish municipalities. *Journal of Aging and Health, 24*, 1203–1222.
Putnam, R. D. (1993). *Making democracy work: Civic traditions in modern Italy*. New Jersey: Princeton University Press.
Putnam, R. D. (2000). *Bowling alone: The collapse and revival of American community*. New York: Simon & Schuster.
Rowe, J. W., & Kahn, R. L. (1997). Successful aging. *Gerontologist, 37*, 433–440.
Schreiner, A. S., Hayakawa, H., Morimoto, T., & Kakuma, T. (2003). Screening for late life depression: cut-off scores for the Geriatric Depression Scale and the Cornell Scale for Depression in Dementia among Japanese subjects. *International Journal of Geriatric Psychiatry, 18*, 498–505.
Stordal, E., Kruger, M. B., Dahl, N. H., Kruger, O., Mykletun, A., & Dahl, A. A. (2001). Depression in relation to age and gender in the general population: the Nord-Trondelag Health Study (HUNT). *Acta Psychiatrica Scandinavica, 104*, 210–216.
Stuck, A. E., Walthert, J. M., Nikolaus, T., Bula, C. J., Hohmann, C., & Beck, J. C. (1999). Risk factors for functional status decline in community-living elderly people: a systematic literature review. *Social Science & Medicine, 48*, 445–469.
Szreter, S., & Woolcock, M. (2004). Health by association? Social capital, social theory, and the political economy of public health. *International Journal of Epidemiology, 33*, 650–667.
Tombaugh, T. N., & McIntyre, N. J. (1992). The mini-mental state examination: a comprehensive review. *Journal of American Geriatric Society, 40*, 922–935.
Ueshima, K., Fujiwara, T., Takao, S., Suzuki, E., Iwase, T., Doi, H., et al. (2010). Does social capital promote physical activity? A population-based study in Japan. *PLoS ONE, 5*.
Wellman, B., & Wortley, S. (1990). Different strokes from different folks: community ties and social support. *American Journal of Sociology, 96*, 558–588.
Yamagishi, T., Cook, K. S., & Watabe, M. (1998). Uncertainty, trust, and commitment formation in the United States and Japan. *American Journal of Sociology, 104*, 165–194.
Yamagishi, T., & Yamagishi, M. (1994). Trust and commitment in the United States and Japan. *Motivation and Emotion, 18*, 129–166.
Zunzunegui, M. V., Alvarado, B. E., Del Ser, T., & Otero, A. (2003). Social networks, social integration, and social engagement determine cognitive decline in community-dwelling Spanish older adults. *Journal of Gerontology Series B: Psychological Sciences & Social Sciences, 58*, S93–S100.