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Temporal heterogeneity of the association between social capital and health: an age-period-cohort analysis in China

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ABSTRACT

Objectives: The temporal heterogeneity of the association between social capital and health has not been fully discussed yet, so this study aimed to examine whether and how the association between social capital and health varied with age, period, and cohort.

Study design: Data were taken from the Chinese General Social Survey of 2005 and 2015, with 15,488 samples being collected.

Methods: An ordinary least square model with interaction terms was used to examine the age, period, and cohort variations in the association between bonding/bridging social capital and self-rated health/depression from the perspective of urban-rural comparison.

Results: In urban China, the association between bonding social capital and self-rated health varied with age, the association between bonding social capital and depression varied with age and cohort, the association between bridging social capital and self-rated health varied with period, and the association between bridging social capital and depression varied with period and cohort. By contrast, in rural China, only the association between bonding social capital and self-rated health varied with period and the association between bridging social capital and depression varied with cohort.

Conclusions: This study extends the traditional perspective of social capital and health study, and the results indicate that we should not only examine the association between social capital and health from the perspective of urban-rural comparison but also consider the impacts of life course and social development on this association. In this sense, specific interventions should be taken to improve social capital and health.

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Introduction

The association between social capital and health has been widely discussed over the past several decades,[1,2] and most studies, mainly from developed countries, indicate that social capital is positively related to health.[1,3,4] As social capital is substantially a kind of social connection in our daily life[5] and only exists in human relations,[6] cultures that shape the pattern of social behaviors and values matter in the connotation of social capital. However, the cultural tradition and structures are substantially different between China and the US or European countries.[7] For example, Chinese people are deeply influenced by Confucianism and have their unique patterns of social contact, and strong ties are stressed more in their daily life;[8] by contrast, Puritanism has stronger influence, and weak ties have more advantages in most English-speaking countries.[9] Thus, social capital may have distinct connotations across China and those English-speaking countries, which may modify the association between social capital and health.[10] Therefore, the association between social capital and health in unique Chinese contexts is deserved to be discussed.

When investigators want to examine the association between social capital and health in China, three questions, at least, should be replied: first is the application of social capital concept or definition in Chinese contexts; second, whether there are population disparities in the association between social capital and health, for example, the patterns of social contact and culture are different between urban and rural China, which may matter; and third, in the context of social transition, whether there is a temporal heterogeneity in the association between social capital and health. Although studies on social capital and health in China have gradually increased in recent years, no study has examined the temporal heterogeneity of the association between social capital and health in unique Chinese settings yet. China has witnessed several huge transitions over the past century: from the war era (before 1949) to peaceful era (after 1949), from a semi-colonial and semi-feudal society (before 1949) to a socialist society (after 1949), and from the small-scale peasant economy and bureaucrat capitalism (before 1949) to planned economy (1949–1977) and then to market-oriented economy (after 1977). In addition, the household registration system established in 1958 has gradually produced various social differentiations nowadays.[11] Social capital is nested in individuals' social network, develops in individuals' daily life,[12] and is influenced by the dynamic social contexts in China. Therefore, examining how the association between social capital and health varies with age, period, and cohort has huge academic values and policy implications.

Literature review

Although social capital is considered as a kind of social connection in our daily life,[5,12] its conception and measures are on debate. In the area of epidemiology, the perspective of communitarian proposed by Putnam[13] has a far-reaching influence on the operationalization of social capital.[14] Based on the perspective of integration, Putnam[13] proposed that social capital consists of cognitive and structural elements, and it should be measured at the collective level. By contrast, Bourdieu[15] and Lin[12] stressed the network perspective, and they treated social capital as a kind of resources nested in social network. In this context, multiple measures of social capital have been proposed, where the typology of bonding and bridging, proposed by Putnam,[13] is most widely recognized and used.[16,17] Bonding social capital refers to a kind of inward social relation or network among individuals within homogeneous groups, while bridging social capital refers to a kind of outward social relation or network among members across heterogeneous groups.[18–20]

Although numerous studies have examined the association between bonding or bridging social capital and health, inconsistent or ambiguous results are observed. Most studies observe that elevated bonding social capital is related to better self-rated health (SRH)[3,4,21] and a reduced level of depression.[22] Some studies, however, show that the association between bonding social capital and health is not statistically significant or negative.[2] Similarly, the association between bridging social capital and health is also uncertain. While some evidence demonstrates that bridging social capital is not associated with SRH or physical health,[3,10,21] other evidence suggests that bridging social capital is a key factor to improve SRH[4] and psychological health.[10,23] In the perspective of urban-rural comparison, some studies indicate that bonding social capital is positively related to SRH in both urban and rural areas, while bridging social capital is only positively associated with the SRH of urban residents.[24] However, other evidence indicates that bonding social capital is positively related to SRH in urban China only, bridging social capital is not associated with SRH in both urban and rural China, and no urban-rural disparity is observed in the association between social capital and mental health.[10]

Because social capital is substantially a kind of social connection,[5] the way it comes into being and its structure are influenced not only by individual factors but also by social development and social structure. Therefore, the stock and connotation of social capital may be inconstant in different life cycles (age), life courses (cohort), and social stages (period). Age, period, and cohort are three distinct temporal conceptions, but there is an exact linear dependence among them: age+cohort = period, which is called the identification conundrum of the age-period-cohort (APC) model.[25] The APC conundrum has been discussed over the past several decades.[25,26] Although some studies have demonstrated that both social capital[27,28] and health[29–31] have significant variations in age, period, and cohort, limited studies, usually in developed countries, have discussed the age, period, and cohort variations in the association between social capital and health. For example, evidence from the US suggests that formal social participation is negatively associated with depression in males, and this negative association enlarges with age because formal social participation usually has a stronger inhibiting effect on depressive symptoms in older male adults.[32]

Nevertheless, some evidence about similar temporal heterogeneity can still be observed in the comparison between different studies. For example, for age effects, evidence from

Chinese older adults indicates that bonding social capital is positively related to both the physical and mental health of urban residents, and no association is observed between bridging social capital and older adults' health in both urban and rural China.[33] In another study conducted in adults aged 18 years and older using the same database,[24] the positive association between bonding/bridging social capital and health is observed to be larger. Does the association between social capital and health really decline with age? Furthermore, evidence from European older adults suggests that both bonding and bridging social capital are positively associated with the SRH of older adults.[34] Thus, these inconsistent results make us unable to well understand the age variation in the association between social capital and health. Similar results can also be found when it comes to period and cohort variations. Because there are some differences in target population, region, culture, and history in studies conducted in different periods and cohorts, the effect of age, period, and cohort on the association between social capital and health in different studies is difficult to directly compare, so it is necessary to examine these effects in a unified framework.

To sum up, the temporal heterogeneity of the association between social capital and health has been less discussed, and we do not clearly know whether the effect of social capital on health varies with age, period, and cohort. In contemporary China, with a huge social transition, both social capital and health vary with age, period, and cohortis;[27,30] thus, the temporal heterogeneity of the association between social capital and health is worthy of discussion. Accordingly, the present study aimed to examine the temporal heterogeneity of the association between bonding/bridging social capital and health in China.

Methods

Data source

Data for this study were obtained from the Chinese General Social Survey (CGSS) of 2005 and 2015. The CGSS is the first comprehensive and large-scale investigation project organized by the National Survey Research Center (NSRC) founded by the Renmin University of China and the Hong Kong University of Science and Technology. Social capital and health outcomes in urban and rural China were first investigated in CGSS2005. In CGSS2015, some constant indicators were remeasured in the module of *Ten Years Review*, including social capital and health outcomes. A stratified multistage random sampling design with unequal probabilities was applied in both CGSS2005 and CGSS2015.Thirty province-level administrative regions were covered, and 10372 questionnaires were collected in CGSS2005; 28 province-level administrative regions were covered, and 10968 questionnaires were collected in CGSS2015. In this study, missing data in social capital, health, *hukou*, age and period variables were omitted by a listwise deletion strategy, and 15488 samples were finally used, where 7324 samples were from CGSS2005 and 8164 samples were from CGSS2015, or 7867 samples were collected in urban China and 7621 samples were collected in rural China.

Variables

In this study, social capital was measured by trust, for, on the one hand, this strategy is widely used and recognized as an acceptable way to measure social capital in many other studies,[21,35] and, on the other hand, only trust indicators are available in both 2005 and 2015 and thus can meet our analytical needs. In both surveys, respondents were required to answer the question: 'Without economic interests being considered, to what extent do you trust the following kinds of people in your daily life?' Response options included the following: '1 = very distrust, 2 = relatively distrust, 3 = neutrality, 4 = relatively trust, 5 = very trust.' In urban China, trust in close neighbors, common neighbors, relatives, colleagues, and old classmates was used as bonding social capital, and the Cronbach's α was 0.811; trust in common friends/acquaintances, hometown fellows, fellows who participated in recreational/physical/leisure activities together, fellows who participated in social/volunteer activities together, and strangers was used as bridging social capital, and the Cronbach's α was 0.796. In rural China, by contrast, trust in close neighbors, residents in the same village, residents in the same village with the same surname, residents in the same village with different surnames, and relatives was used as bonding social capital, and the Cronbach's α was 0.865; trust in common friends/acquaintances, hometown fellows, and strangers was used as bridging social capital, and the Cronbach's α was 0.605. Then, the scores of bonding and bridging social capital were calculated through exploratory factor analysis (EFA) (Appendices A1 and A2) and were translated into hundred-mark scores by maximum difference normalization method. The use of hundred-mark score can make us understand the level of specific variables easily and make them more comparable because people usually understand or evaluate a continuous variable easier when it is expressed as a hundred-mark score.

The SRH and self-reported depression were used as two outcome variables. For SRH, in CGSS2005, respondents were asked to answer the following question: 'Generally speaking, what do you think of your health status in last month?' Response options included the following: '1 = beyond compare, 2 = very good, 3 = good, 4 = fair, 5 = poor, 6 = very poor.' But in CGSS2015, respondents were asked to answer the following question: 'What is your current health status in your own mind?' Response options included the following: '1 = very unhealthy, 2 = relatively unhealthy, 3 = fair, 4 = relatively healthy, 5 = very healthy.' To unify the measurement scale of SRH, we recoded '5 = poor, 6 = very poor' in CGSS2005 and '1 = very unhealthy, 2 = relatively unhealthy' in CGSS2015 into '1 = unhealthy,' recoded '4 = fair' in CGSS2005 and '3 = fair' in CGSS2015 into '2 = fair,' and recoded '1 = beyond compare, 2 = very good, 3 = good' in CGSS2005 and '4 = relatively healthy, 5 = very healthy' in CGSS2015 into '3 = healthy.' For depression in both surveys, respondents were asked to answer the following question: 'In the last four weeks, how often do you feel depressed?' A reverse recoding was operated, and then options included the following: '1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = always.' Finally, both SRH and depression were also translated into

Table 1 – Descriptive information of variables.

Variables	Urban (N = 7867)		Rural (N = 7621)	
	2005	2015	2005	2015
Gender (n/%)				
Male	1804/48.4	1973/47.7	1815/50.5	1954/48.5
Female	1924/51.6	2166/52.3	1780/49.5	2071/51.5
Age in years (M/SD)	44.12/15.23	47.52/17.31	44.27/13.66	51.78/16.11
Education (n/%)				
Illiteracy	158/4.2	226/5.5	616/17.2	876/21.8
Primary school	500/13.4	559/13.5	1463/40.7	1374/34.2
Junior high school	1045/28.1	1088/26.4	1152/32.1	1224/30.5
Senior high school	1269/34.1	1020/24.7	334/9.3	393/9.8
College or above	752/20.2	1234/29.9	26/0.7	150/3.7
Personal income (M/SD)	17228/19860	48760/249389	5541/7377	18051/165394
Family income (M/SD)	40345/67519	99748/312371	13235/14414	44491/245798
Social capital				
Bonding (M/SD)	68.77/13.40	65.32/13.55	74.02/14.54	68.49/15.43
Bridging (M/SD)	47.00/15.52	49.92/15.95	44.70/16.02	44.79/15.72
Health outcomes				
SRH (M/SD)	77.19/33.66	77.02/34.78	71.25/39.14	66.29/41.71
Depression (M/SD)	22.95/24.27	26.00/21.99	26.15/25.80	32.16/23.10

Note: Two income variables were standardized, and inflation rate (2005–2015, 132.6%) was used to adjust the income level in 2005; the unit of income was CNY/year.
M, mean; SD, standard deviation; SRH, self-rated health.

hundred-mark scores by maximum difference normalization method.

In addition, gender, education, personal income, and family income were used as controlling variables to reasonably adjust the effects of social capital on health and the temporal heterogeneity of the association between social capital and health. More details can be seen in Table 1.

Analytic strategy

The APC analysis and its theoretical basis, the life course theory, have been remarkably developed since the 1970s.[25] Based on a comprehensive review of APC analytic strategies, the ordinary least square (OLS) model was used as the basic model in the present study, where cohort effects were reflected by the interaction between age and period (period effects within different ages).[36] This strategy was confirmed to be useful in examining cohort effects.[37] In addition, the interactions between age/period/cohort and bonding/bridging social capital were further used to examine the temporal heterogeneity of the association between bonding/bridging social capital and SRH/depression. Accordingly, the model specification was as follows:

$$\begin{aligned} Health_i = {} & \beta_0 + \beta_1 * age_i + \beta_2 * age_i^2 + \beta_3 * period_i + \beta_4 * age_i * period_i \\ & + \beta_5 * bonding_i + \beta_6 * bridging_i + \beta_7 * age_i * bonding_i \\ & + \beta_8 * age_i * bridging_i + \beta_9 * period_i * bonding_i \\ & + \beta_{10} * period_i * bridging_i + \beta_{11} * age_i * period_i * bonding_i \\ & + \beta_{12} * age_i * period_i * bridging_i + \sum_{13}^{16} (\beta_k * x_i) + \varepsilon_i \end{aligned}$$

where $Health_i$ was the SRH or depression of individual i; β_0 was the intercept; β_1~β_{12} were the coefficients of age, period, cohort, bonding social capital, bridging social capital, and the interactions between age/period/cohort and bonding/bridging social capital in order; $\sum_{13}^{16}(\beta_k * x_i)$ denoted four controlling variables, including gender, education, personal income, and family income; ε_i was the error. In this study, IBM SPSS, version 21.0, statistical software was used to perform descriptive analysis and OLS model, and $\alpha = 0.1$ was set as the statistical significance level.[a]

Results

Description of the temporal variation of social capital in urban and rural China

Period-cohort–specific social capital scores are presented in Figs. 1 and 2, where the horizontal axis represents the birth cohort[b] and the ordinate represents the score of social capital. The dashed line denoted the social capital in 2005, and the full line denoted the social capital in 2015.

Figs. 1 and 2 show that the stock of social capital did not increase or decline with cohort significantly in urban China, but it seemed to slightly decline with cohort in rural China. The comparison of bonding/bridging social capital between two periods reflected the period variation in social capital. Based on Figs. 1 and 2 and Table 1, bonding social capital in urban China was observed to decline from 2005 to 2015, but bridging social capital in urban China increased with period;

[a] In many studies from social science, P = 0.1 is commonly used as the significance level[32] because when the P-value is between 0.05 and 0.1, it is usually considered as marginal significant statistically, and it usually provides some non-negligible information.

[b] Using birth cohort as the horizontal axis can make the changing trends of the same social capital form in two periods more consistent.

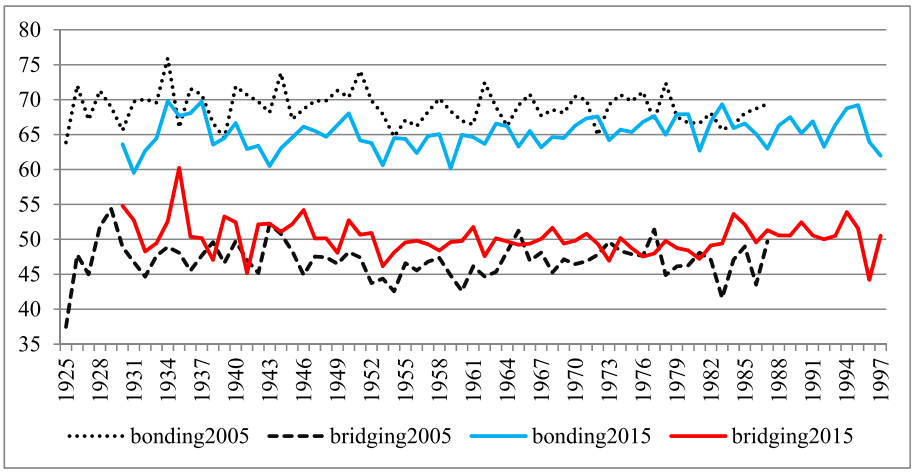

Fig. 1 – Period-cohort–specific bonding and bridging social capital scores in urban China.

in rural China, by contrast, bonding social capital declined with period, and bridging social capital did not increase or decrease with period. Actually, the age, period, and cohort effects were mixed, and the net effects of them could not be displayed in Figs. 1 and 2, let alone the temporal heterogeneity of the association between social capital and health. Thus, this study further examined whether and how the association between bonding/bridging social capital and SRH/depression varied with age, period, and cohort.

Social capital and SRH

In Table 2, with gender, education, personal income and family income controlled for, both bonding and bridging social capital were positively associated with the SRH of urban residents: every additional unit of bonding social capital increased 0.233 of SRH ($P < 0.001$), and every additional unit of bridging social capital increased 0.079 of SRH ($P < 0.01$). However, in rural China, only bonding social capital was positively associated with SRH: every additional unit of bonding social capital increased 0.145 of SRH ($P < 0.001$). The temporal heterogeneity analysis indicated that, in urban China, the positive association between bonding social capital and SRH significantly varied with age, and the positive association between bridging social capital and SRH significantly varied with period: every additional unit of age increased 0.008 of the positive association between bonding social capital and SRH ($P < 0.001$); compared with 2005, the positive association between bridging social capital and SRH decreased by 0.133 ($P < 0.05$) in 2015. By contrast, in rural China, the positive association between bonding social capital and SRH significantly varied with period only: compared with 2005, the positive association between bonding social capital and SRH decreased by 0.114 ($P < 0.1$) in 2015. The cohort effects of SRH increased gradually in urban China, that is to say, the score of SRH was higher in more recent cohorts, and the difference in SRH between the earliest cohort and the most recent cohort was 0.128 ($P < 0.05$). However, the association between bonding/bridging social capital and SRH did not vary with cohort in both urban and rural China.

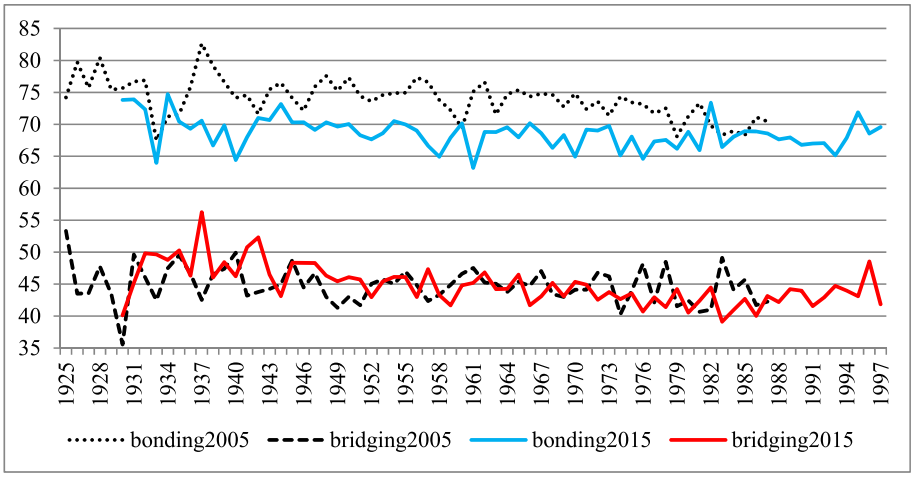

Fig. 2 – Period-cohort–specific bonding and bridging social capital scores in rural China.

Table 2 – Temporal heterogeneity of social capital affecting SRH (weighted).

Variables	Model 1 (urban)		Model 2 (rural)	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	56.222 ***	3.393	29.275 ***	3.527
Age	−0.694***	0.029	−0.627***	0.036
Age-squared	−0.001	0.001	0.009***	0.002
Period (ref: 2005)	2.349**	0.852	−3.246**	1.000
Age*Period	0.128*	0.052	0.066	0.068
Bonding	0.223***	0.030	0.145***	0.032
Bridging	0.079**	0.026	0.051	0.031
Age*Bonding	0.008***	0.002	0.001	0.002
Age*Bridging	0.002	0.002	0.002	0.002
Period*Bonding	−0.090	0.061	−0.114ˆ	0.063
Period*Bridging	−0.133*	0.052	−0.004	0.061
Age*Period*Bonding	−0.001	0.004	−0.001	0.004
Age*Period*Bridging	0.003	0.003	0.007	0.004
Gender (ref: male)	−4.322***	0.803	−3.317**	0.949
Education	1.048**	0.395	4.214***	0.538
Personal income (ln)	0.304ˆ	0.157	0.886***	0.191
Family income (ln)	1.966***	0.317	2.715***	0.328
F	76.020***		69.594***	
R^2_{adj}	0.153		0.129	

Note: ***P < 0.001, **P < 0.01, *P < 0.05, ˆP < 0.1.
Period variable was recoded as 0–1 form: '0 = 2005, 1 = 2015,' and it had been centralized around its mean value.
SRH, self-rated health.

Social capital and depression

In Table 3, with gender, education, personal income and family income controlled for, both bonding and bridging social capital were negatively associated with depression in urban China: every additional unit of bonding social capital reduced 0.175 of depression ($P < 0.001$), and every additional unit of bridging social capital decreased 0.032 of depression ($P < 0.1$). However, in rural China, only bonding social capital was negatively associated with depression: every additional unit of bonding social capital decreased 0.123 of depression ($P < 0.001$). The temporal heterogeneity analysis indicated that, in urban China, the negative association between bonding social capital and depression significantly varied with age and period and the negative association between bridging social capital and depression significantly varied with period and cohort: every additional unit of age increased 0.003 of the negative association between bonding social capital and

Table 3 – Temporal heterogeneity of social capital affecting depression (weighted).

Variables	Model 3 (urban)		Model 4 (rural)	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	44.413 ***	2.386	54.251***	2.209
Age	0.138***	0.020	0.170***	0.022
Age-squared	0.000	0.001	−0.005***	0.001
Period (ref: 2005)	2.341***	0.599	6.649***	0.627
Age*Period	−0.264***	0.037	−0.207***	0.042
Bonding	−0.175***	0.021	−0.123***	0.020
Bridging	−0.032ˆ	0.018	0.008	0.019
Age*Bonding	−0.003*	0.001	−0.001	0.001
Age*Bridging	0.001	0.001	0.001	0.001
Period*Bonding	0.083ˆ	0.043	0.047	0.040
Period*Bridging	0.168***	0.036	0.055	0.038
Age*Period*Bonding	−0.001	0.003	0.002	0.003
Age*Period*Bridging	−0.006*	0.002	−0.007**	0.002
Gender (ref: male)	1.354*	0.565	2.307***	0.594
Education	−2.107***	0.278	−2.179***	0.337
Personal income (ln)	−0.143	0.111	−0.207ˆ	0.120
Family income (ln)	−1.179***	0.223	−2.117***	0.205
F	28.354***		45.588***	
R^2_{adj}	0.062		0.088	

Note: ***P < 0.001, **P < 0.01, *P < 0.05, ˆP < 0.1.
Period variable was recoded as 0-1 form: '0 = 2005, 1 = 2015,' and it had been centralized around its mean value.

depression ($P < 0.05$); compared with 2005, the negative association between bonding social capital and depression decreased by 0.083 ($P < 0.1$) in 2015 and the negative association between bridging social capital and depression decreased by 0.168 ($P < 0.001$) in 2015. The negative cohort effects of depression increased gradually, that is to say, the level of depression was lower in more recent cohorts, and the difference in depression between the earliest cohort and the most recent cohort was 0.264 in urban China ($P < 0.001$) and 0.207 in rural China ($P < 0.001$). In addition, a significant temporal heterogeneity of the association between bridging social capital and depression was observed in both urban and rural China. The negative association between bridging social capital and depression increased with cohort: the negative association between bridging social capital and depression increased by at most 0.006 across cohort in urban China ($P < 0.05$) and at most 0.007 across cohort in rural China ($P < 0.01$).

Discussion

China has witnessed a rapid development in urbanization and social economy over the past decades. In this unique setting, the pattern of residents' social contact and behaviors has also changed a lot in China.[38] As mentioned earlier, because social capital is a kind of social resource nested in social relations,[12] the development in the pattern of social contact and behaviors may change the connotation of social capital and the way that people obtain health resources; thus, this development may also influence the association between social capital and health in China. On this background, this study tried to examine temporal heterogeneity of the association between social capital and health across China from a dynamic perspective.

The health effect of social capital and its urban-rural disparities have been examined in numerous studies,[10,21,24,39] and most results in this study are in line with previous evidence. Generally speaking, bonding social capital was positively related to both SRH and psychological health across China, but bridging social capital was positively associated with SRH and psychological health in urban China only. According to previous studies, the urban-rural disparities in social capital in China are mostly determined by the level and structure of socio-economy and culture.[40] Rural China is an acquaintance society with high stock of bonding social capital, while the rapid marketization increases the stock of bridging social capital in urban China.[40] On the other hand, the unique social environment in urban China makes it easier to translate social capital, especially bridging social capital, into health returns. For example, individuals in urban China can build social networks with people across different social classes and access more healthcare resources and high-quality education resources, from which they benefit a lot.[10] Thus, bridging social capital is more likely to be positively related to health in urban China. By contrast, bonding social capital is closely related to kinship and other strong ties that all individuals own, so both urban and rural residents benefit a lot from it. However, although the stock of bonding social capital is less in urban China (Table 1), more sufficient material resources that urban residents easily access make the association between bonding social capital and health stronger and more robust in urban China.

Examining the association between social capital and health from the perspective of APC analysis is the biggest innovation of this study, which extends the field of social capital and health studies. The association between bonding/bridging social capital and health has significant urban-rural disparities in China, and similar disparities are also observed in the analysis of temporal heterogeneity. Subjective health is usually observed to have a U-shaped association with age in previous studies,[29,41] but this U-shaped association is not observed in urban China in the present study. Why do subjective health outcomes, including SRH and depression, only decline with age and not have aging health effect? The present study provides some new evidence. It is observed that the positive association between bonding social capital and subjective health increases with age in urban China, so the aging health effect (the U-shaped association between age and health) can be partly attributed to the positive moderating effect of age on the relationship between bonding social capital and health in urban China. Obviously, bonding social capital does not have a similar effect in rural China, and the association between age and subjective health is a U-shaped one. Although it is unclear why bonding social capital only plays such a role in urban China, urban-rural disparities in various factors matter without any doubt.

Compared to the year of 2005, the positive association between bonding social capital and SRH significantly declined in 2015 in rural China and the positive association between bridging social capital and SRH also declined in 2015 in urban China. With the rapid development of marketization, the alienation[c] of close or strong ties in rural China has emerged to be more and more evident,[42] which may result in poor health. Accordingly, with the rapid development of social economy, more bridging or heterogeneous social capital has gathered in urban China and increased the burden of health gradually. In addition, with the development of modernization and modernity, the number of people with depressive disorder in China has rapidly increased in recent years.[43] Heterogeneous social capital is naturally related to modernization and modernity, so the positive association between bridging social capital and psychological health declines in modern China. The positive association between bonding or homogeneous social capital and psychological health also slightly declines in urban China, which may also be related to this context.

No study has examined whether the association between social capital and health varies with cohort. The present study indicates that the inverse association between bridging social capital and depression varies with successive cohort, and this cohort effect does not have distinct urban-rural disparities. China has witnessed great social changes in the past century: from war era to planned economy era and then market economy era. Individuals who were born earlier are influenced more by traditional cultures in their early life,[44] so

[c] According to Karl Marx, alienation means rules or other things developed by people lose their original normal functions, and people are in turn limited by them, or they become a burden for people.

earlier cohorts tend to be more traditional.[38] Although earlier cohorts have more bridging social capital stocks (Figs. 1 and 2) according to the accumulation of social resources across life span, the cohort variation in the association between social capital and health cannot be determined only by the stock of social capital; many other factors, such as the connotation of social capital in different cohort groups, may also matter. Compared with more recent cohorts, earlier cohorts grow up in a more traditional and blocked society, so they usually own traditional values and behaviors.[38] Owing to their more traditional values and behaviors, earlier cohorts cannot make full use of bridging social capital in psychological health promotion. By contrast, more recent cohorts own more modern values and behaviors, and they have more affinity with heterogeneous or bridging social capital, so the positive association between bridging social capital and psychological health is larger in more recent cohorts.

The aforementioned results provide some suggestive things, and some intervention strategies are proposed accordingly. First, different targeted policies should be implemented for different age groups to cultivate bonding social capital, especially for the elderly in urban China. The forms of community activities should be multiple for the elderly in urban China, and the interactions between older adults and their children should be encouraged to meet the needs of intimate affection in older adults. Second, specific interventions should be taken to address the burden brought by the alienation across China. Government should try to normalize the pattern of social contact in our daily life; also, a standardized human relations management system should be established, especially in rural China. Finally, government should focus on the cultivation of bridging social capital in younger groups in rural China. For example, institutional barriers should be removed, and more external resources should be available; various forms of cultural activities that can connect urban and rural residents together are encouraged to increase the stock of bridging social capital and other resources in rural China so as to give full play to the health-promoting effect of bridging social capital in younger groups.

The present study has the following three main limitations. First, this study only used trust to measure social capital and ignored other components of social capital, such as social network and social participation. Numerous studies have indicated that different components of social capital may have different impacts on health,[24,39] and a comprehensive analysis is more helpful to reveal the secret of temporal heterogeneity of social capital affecting health. However, because the APC analysis requires that the measure of social capital should be comparable between CGSS2005 and CGSS2015, only trust variables can be used to measure social capital in the present study. Second, this study used an interaction (age*-period) in the OLS model to examine cohort effects, but this strategy cannot well reflect the non-linear effects of cohort, as well as its non-linear effects on the association between social capital and health. Nevertheless, this study still observes some significant APC effects of the association between social capital and health, but an overall analysis of this temporal heterogeneity is needed in the future. Finally, this study examined only the bonding/bridging social capital at the individual level. The contextual effect of social capital on health has been discussed in many studies,[14,45] but this study does not examine potential contextual effects that may vary with age, period, and cohort. These are all we need to do in further studies.

Author statements

Ethical approval

Ethical approval was not required because the data we used were public and had anonymous characteristics.

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Competing interests

The authors declare that they have no conflict of interest.

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Appendix

A1: Rotated component matrix of bonding and bridging social capital in urban China

Indicators	Bonding	Bridging
trust5	**0.800**	0.021
trust1	**0.762**	0.159
trust6	**0.751**	0.242
trust2	**0.657**	0.346
trust8	**0.619**	0.335
trust13	-0.042	**0.759**
trust10	0.262	**0.758**
trust9	0.267	**0.730**
trust12	0.257	**0.684**
trust7	0.364	**0.597**

Note: Extraction method is principal component analysis, and rotation method is Varimax with Kaiser normalization. The Kaiser-Meyer-Olkin (KMO) is 0.864, and the cumulative variance is 57.6%. Corresponding indices of each factor has been marked as bold in the table.

A2: Rotated component matrix of bonding and bridging social capital in rural China

Indicators	Bonding	Bridging
trust3	**0.837**	0.207
trust1	**0.815**	0.075
trust2	**0.786**	0.281
trust4	**0.782**	0.320
trust5	**0.684**	-0.010
trust13	-0.052	**0.792**
trust7	0.259	**0.717**
trust9	0.236	**0.666**

Note: Extraction method is principal component analysis, and rotation method is Varimax with Kaiser normalization. The KMO is 0.852, and the cumulative variance is 62.5%. Corresponding indices of each factor has been marked as bold in the table.