

BMJ Open Are both individual-level and county-level social capital associated with individual health? A serial cross-sectional analysis in China, 2010–2015

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ABSTRACT

Objectives We aimed to examine the associations of both individual-level and county-level social capital with individual health in China during a period of rapid economic growth.

Design and setting A serial cross-sectional study in China.

Participants and methods The participants were 42 829 Chinese adults (aged ≥18 years) from the 2010, 2012, 2013 and 2015 Chinese General Social Survey. The outcomes were self-rated physical and mental health in all time points. We assessed social capital by the individual-level and county-level indicators, including frequency of socialising, civic participation and trust. We conducted multilevel binary logistic regression models to examine the associations of individual-level and county-level social capital with self-rated physical and mental health.

Results At the individual level, high frequency of socialising (2010—OR: 1.49, 95% CI: 1.33 to 1.66; 2012—OR: 1.39, 95% CI: 1.26 to 1.54; 2013—OR: 1.28, 95% CI: 1.15 to 1.42; 2015—OR: 1.36, 95% CI: 1.23 to 1.50) and high trust (2010—OR: 1.34, 95% CI: 1.22 to 1.47; 2012—OR: 1.30, 95% CI: 1.18 to 1.42; 2013—OR: 1.21, 95% CI: 1.10 to 1.33; 2015—OR: 1.41, 95% CI: 1.28 to 1.55) was significantly associated with good physical health in all years. At the individual level, high frequency of socialising (2010—OR: 1.27, 95% CI: 1.14 to 1.42; 2012—OR: 1.21, 95% CI: 1.09 to 1.34; 2013—OR: 1.30, 95% CI: 1.17 to 1.45; 2015—OR: 1.35, 95% CI: 1.22 to 1.61; 2012—OR: 1.42, 95% CI: 1.30 to 1.56; 2013—OR: 1.36, 95% CI: 1.24 to 1.49; 2015—OR: 1.43, 95% CI: 1.30 to 1.57) was also significantly associated with good mental health in all years. No evidence showed that the associations of individual-level frequency of socialising and trust with physical and mental health changed over time. There were no consistent associations of individual-level civic participation or any county-level social capital indicators with physical or mental health.

Conclusion The positive associations of individual-level social capital in terms of socialising and trust with physical and mental health were robust during a period of rapid economic growth. Improving individual-level socialising and trust for health promotion could be a long-term strategy even within a rapidly developing society.

Strengths and limitations of this study

- A major strength of our study is the comparability of the associations between multilevel social capital and health outcomes over time. Hence, our consistent findings provided more solid evidence for associations of the individual-level frequency of socialising and trust with physical and mental health beyond previous mixed results.
- We took advantage of a rapidly developing society (ie, China) as a social laboratory to observe the associations between multilevel social capital and health outcomes.
- We cannot make causal inferences since this study is cross-sectional by nature.
- We only included generalised trust in cognitive social capital. This measurement may not directly capture county-specific trust.
- The study period was relatively short (ie, 6 years), which prohibited us from observing a longer trend of the association.

INTRODUCTION

Social capital, defined as resources available to members of social groups and resources embedded within an individual's social networks,^{1,2} is a critical social determinant in shaping population health. Although debates are ongoing as to whether social capital is an individual attribute or a collective property, previous public health studies suggested that the individual and collective perspectives were not mutually exclusive and might affect individuals' health simultaneously.^{3,4} From an individual perspective, social capital affects health by providing informational, emotional and instrumental support. From a collective perspective, social capital affects health by facilitating collective action, maintaining social norms, and enhancing reciprocity.^{5,6}

The association between multilevel social capital and health

An increasing number of studies employed a multilevel analytical framework to examine

the associations of both individual-level and collective-level social capital with health. Nevertheless, results from these multilevel studies were mixed.^{3 7–10} Most of these studies found that at least one indicator of each level of social capital was associated with health. Some studies only showed an association between individual-level social capital and health, while a handful of studies suggested that only collective-level social capital was associated with health. Although most of these studies indicated that social capital was beneficial for health, several studies reported negative associations between social capital and health.^{11–13} Even studies within the same countries (eg, Japan^{12 14} and China^{13 15}) showed inconsistent results in terms of the directions of the associations between social capital and health.

The above-mentioned inconsistent results may be due to different operationalisations of social capital, different study time points or both. Although different operationalisations of social capital provided insights to understand what specific social capital indicator was beneficial for health among a spectrum of social capital measures, they made it difficult to make meaningful comparisons between studies and to examine whether the association between social capital and health was consistent over time. To our knowledge, only at the individual level did previous studies examine whether the association between social capital and health changed over time. For example, a Chinese study indicated that the association between individual-level social capital and health varied with periods,¹⁶ while a newly published study in Montreal, Canada showed a longitudinal association between individual-level social capital and health.¹⁷ Nevertheless, little is known as to whether the association between multilevel social capital and health changed over time. Hence, it is unclear whether improving social capital could be considered a long-term health promotion strategy.

Theoretical hypotheses

It is theoretically debatable whether the association between multilevel social capital and health changed over time, especially with rapid economic growth. On the one hand, it is argued that economic growth may erode social capital as it can extend market relationships to people's non-economic life.¹⁸ With economic growth, the time available for people's social activities may also reduce, leading to a reduction in social capital. As found in the USA, social capital decreased continuously despite the growing economy.¹⁹ Hence, people's health may depend less on social capital as economy grows, and they can receive health benefits directly from economic growth. In other words, it can be hypothesised that the strength of the association between social capital and health may decline as economy grows.

On the other hand, it is also argued that social capital may still be important for people's health during rapid economic development. Rapid economic growth often coexists with social change; thus, formal institutions may not be well established in a rapidly developing society,

and people may need to rely on informal institutions, which encompasses the concepts of norms of behaviour and social conventions that significantly overlap with the notion of social capital.²⁰ Also, social change may lead to social uncertainties; in other words, social capital is important for obtaining information and support from others to address these uncertainties.²¹ For instance, a Chinese study found that social capital could reduce suicide ideation by reducing uncertainty stress.²² In this light, it can be hypothesised that the strength of the association between social capital and health does not vary significantly over time with economic growth.

Study setting and research questions

China is an ideal setting to examine whether the association of social capital with health changed during a period of rapid economic growth. China has experienced rapid economic development over the past four decades. Its gross domestic product increased rapidly from 1.8% of the global economy in 1978 to 15% in 2018.²³ This rapid economic transition allows us to use a relatively short period to observe whether the association between multilevel social capital and health changed with socio-economic development. It also allows us to compare the difference in the change of association of multilevel social capital with health between the traditionally long-term developed western societies and those with more recent and rapid economic development. Additionally, China is also characterised by its traditional culture of relationship traceable back to Confucian ethics.²⁴ Collectivistic culture in China institutionalises the legitimacy of individuals' dependence on social networks.²⁵ This distinction of the Chinese culture from other western societies, where individualistic culture generally facilitates independence from each other,²⁶ may give us further insights into the association between social capital and health that may be overlooked previously.

We specifically examined: (1) how individual-level social capital, county-level social capital and health changed during a period of rapid economic growth; (2) what the associations of individual-level and county-level social capital with health were in each survey year; and (3) whether the associations changed during a period of rapid economic growth.

METHODS

Data source and participants

We collected data from the 2010, 2012, 2013 and 2015 waves of the Chinese General Social Survey (CGSS), which is publicly available. The participants were Chinese adults aged 18 years or above. Health outcomes, social capital, sociodemographic and socioeconomic factors were consistently collected throughout the 4 years. The CGSS is a national representative survey project in Mainland China conducted by the Renmin University of China. The sampling strategy was described in further details in a previous study.¹³

Measurements

Health outcomes

Health outcomes were self-rated physical and mental health. For physical health, respondents answered the question 'How do you think about your current physical health?' Responses were divided into 'poor' (including 'very unhealthy', 'unhealthy' and 'neutral') and 'good' (including 'healthy' and 'very healthy') physical health. For mental health, respondents answered the question 'During the past 4 weeks, how often have you felt depressed or downhearted?' This question is taken from the 12-item Short-Form Health Survey.²⁷ Responses were categorised into 'poor' (including 'always', 'often' and 'sometimes') and 'good' (including 'seldom' and 'never') mental health. The two self-rated health indicators were used in previous studies.^{28–30}

Social capital

Social capital can be separated into structural and cognitive dimensions. Structural social capital refers to actual network connections and civic engagement, while cognitive social capital refers to perceptions of trust and norms.³ We measured individual-level structural social capital by respondents' frequency of socialising (high, low) and civic participation (yes, no). We measured individual-level cognitive social capital by respondents' trust of others (high, low). Details of the questions are shown in online supplemental material 1.

We calculated county-level social capital by using individual-level social capital variables. Counties are the primary sampling units in CGSS.¹³ On average, each county included 81 respondents in 2010, 85 in 2012, 85 in 2013 and 79 in 2015. Following previous studies,^{31–33} we conducted two-level random intercept logistic regressions to calculate county-level social capital, with individuals as level 1 and counties as level 2. We treated each of the three abovementioned individual-level social capital variables as a dependent variable. We calculated county-level social capital by adding the grand mean of county social capital to the residuals at the county level. Details are shown in online supplemental material 2. Higher percentages indicated higher county-level social capital.

Sociodemographic and socioeconomic factors

We included gender (male, female), age (years), ethnicity (*Han*, non-*Han*) and marital status (married/cohabitation, never married/divorced/separated/widowed) as sociodemographic factors, and education (primary school or below, junior secondary school, senior secondary school and college or above), occupation, poverty and places of residence (rural, urban) as socioeconomic factors. There are 56 ethnic groups in China and *Han* is the majority. The heterogeneity across ethnic groups in terms of socioeconomic experience and culture may affect both people's health and social capital.³⁴ Thus, we controlled for ethnicity in our study. Details of the occupation and poverty are shown in online supplemental material 3.

Statistical analysis

We reported weighted means with SD for continuous variables and weighted percentages for categorical variables. We calculated individual weighting factors by the distribution of gender, age and place of residence according to the 2010 China population census data,³⁵ and county weighting factors according to the distribution of the numbers of counties in each province in 2010 based on the China Statistical Yearbook 2011.³⁶ To examine how social capital and health changed over time, following the methodology in previous studies,^{37–38} we assessed the trends of health and individual-level social capital by conducting binary logistic regression models with calendar year as the independent variable. The results of the regressions indicated whether the health variations and the individual-level social capital variations between years were statistically significant. Similarly, with calendar year as the independent variable, we assessed the trends of county-level social capital by linear regression models. Years were treated as fixed effects in the abovementioned models.

To examine the associations of individual-level and county-level social capital with health, we employed two-level binary logistic regression models adjusting for socio-demographic and socioeconomic factors. The two levels specified in our models were individuals at Level 1 nested within counties at Level 2. The intercepts at the county level were treated as random. We compared the results of regression models with weighted and unweighted data for robustness check. The weighting method is shown in online supplemental material 4. We also treated physical and mental health as ordinal variables and conducted two-level ordinal regression models for robustness check. To examine whether the associations of social capital with physical and mental health changed over time, we performed interaction tests between social capital indicators and survey year. Following previous studies,^{39–40} we tested the significance of interaction terms by adding each interaction term, one at a time, to the full models.

We used Stata/MP V.14.2 to conduct all data analysis with a two-tailed p value <0.05 as the significance level.

Patient and public involvement

All data in this study were derived from the CGSS dataset. No patients and the public were involved in the design or planning of this study.

RESULTS

Our study included a total of 42 829 respondents. Specifically, there were 10 827 respondents nested in 133 counties in 2010, 11 104 in 131 counties in 2012, 10 663 in 126 counties in 2013 and 10 235 in 130 counties in 2015. **Table 1** presents the weighted sample characteristics in 2010, 2012, 2013 and 2015; the missing data values are listed in online supplemental table 1; and the unweighted results are shown in online supplemental table 2. Generally, the percentages of good physical and

**Table 1** Sample characteristics, 2010–2015

	2010	2012	2013	2015
	Mean±SD/%	Mean±SD/%	Mean±SD/%	Mean±SD/%
Individual level	N=10827	N=11104	N=10663	N=10235
Physical health				
Poor	36.43	37.75	30.36	32.21
Good	63.57	62.25	69.64	67.79
Mental health				
Poor	32.83	33.03	27.35	30.19
Good	67.17	66.97	72.65	69.81
Sociodemographic factors				
Gender				
Female	49.48	49.48	49.48	49.48
Male	50.52	50.52	50.52	50.52
Age (years)	42.76±16.35	42.76±16.39	42.74±16.36	42.74±16.38
Ethnicity				
Non-Han	9.97	9.82	9.64	8.68
Han	90.03	90.18	90.36	91.32
Marital status				
Single/separated/divorced/widowed	24.16	24.40	25.17	25.78
Cohabit/married	75.84	75.60	74.83	74.22
Socioeconomic factors				
Education				
Primary school or below	33.77	32.50	31.25	29.95
Junior secondary school	31.33	30.04	30.89	30.75
Senior secondary school or equal	19.35	19.85	19.64	19.66
College or above	15.55	17.62	18.22	19.64
Occupation*				
Skill 3 or 4	10.62	13.40	11.93	11.88
Skill 2	53.53	51.75	51.15	47.33
Skill 1	3.58	2.71	3.40	4.56
Non-employed	32.27	32.14	33.52	36.22
Poverty				
Poor	11.59	15.23	13.24	14.71
Non-poor	81.08	76.44	77.79	79.76
Do not know income	7.33	8.33	8.97	5.53
Place of residence				
Urban	51.76	51.76	51.76	51.76
Rural	48.24	48.24	48.24	48.24
Social capital				
Frequency of socialising				
Low	77.11	72.51	71.58	71.94
High	22.89	27.49	28.42	28.06
Civic participation				
No	55.78	54.06	58.48	56.44
Yes	44.22	45.94	41.52	43.56
Trust				

Continued

Table 1 Continued

	2010	2012	2013	2015
	Mean±SD/%	Mean±SD/%	Mean±SD/%	Mean±SD/%
Low	35.44	37.34	45.13	37.92
High	64.56	62.66	54.87	62.08
County level	n=133	n=131	n=126	n=130
Social capital				
Frequency of socialising (%)	19.09±6.36	31.99±9.10	35.36±10.99	40.39±9.78
Civic participation (%)	24.62±12.65	21.02±9.79	17.74±9.77	21.03±10.82
Trust (%)	47.71±7.41	46.07±9.88	43.39±9.03	44.39±5.82

Weighted percentages for categorical variables and weighted means for continuous variables with SDs.

*Skill level 3 or 4: managers, professionals and technicians and associate professionals; skill 2: clerical support workers; services and sales workers; skilled agricultural, forestry and fishery workers; craft and related trades workers; plant and machine operators and assemblers; skill 1: elementary occupations (for more details, please see online supplemental material 2).
SD, Standard deviation.

mental health fluctuated over the study period, but both the percentages were lowest in 2012 and peaked in 2013. For individual-level social capital, high frequency of socialising increased generally and peaked in 2013; civic participation peaked in 2012 and reached the lowest level in 2013; high trust decreased to the bottom in 2013 and then slightly rebounded in 2015. For county-level social capital, the percentage of high frequency of socialising increased; the percentage of civic participation decreased and dropped to the bottom in 2013; the percentage of trust decreased from 2010 to 2013 and then increased in 2015.

Figure 1 shows the trends of physical and mental health, individual-level social capital and county-level social capital over time. Figure 1A indicates that the likelihood of good physical health in 2012 (OR: 0.95, 95% CI: 0.89 to 1.00) was marginally significantly ($p=0.062$) lower than that in 2010 (reference). However, this likelihood in 2013 (OR: 1.31, 95% CI: 1.24 to 1.40) and 2015 (OR: 1.21, 95% CI: 1.13 to 1.28) was significantly higher than that in 2010. The likelihood of good mental health in 2013 (OR: 1.30, 95% CI: 1.22 to 1.38) and 2015 (OR: 1.13, 95% CI: 1.06 to 1.21) was also significantly higher than that in 2010. No significant difference in mental health was observed between 2010 and 2012.

Figure 1B shows that the likelihood of high frequency of socialising in 2012 (OR: 1.28, 95% CI: 1.19 to 1.37), 2013 (OR: 1.34, 95% CI: 1.25 to 1.43) and 2015 (OR: 1.31, 95% CI: 1.22 to 1.41) was significantly higher than that in 2010. The likelihood of civic participation in 2012 (OR: 1.07, 95% CI: 1.01 to 1.14) was significantly higher than that in 2010. However, it decreased and became significantly lower in 2013 (OR: 0.90, 95% CI: 0.84 to 0.95) than that in 2010. No evidence showed that the likelihood of civic participation in 2015 was significantly different from that in 2010. The likelihood of high trust in 2012 (OR: 0.92, 95% CI: 0.87 to 0.98), 2013 (OR: 0.67, 95% CI: 0.63 to 0.71) and 2015 (OR: 0.90, 95% CI 0.84 to 0.96) was significantly lower than that in 2010.

Figure 1C shows that county-level frequency of socialising in 2012 ($\beta=12.91$, 95% CI: 10.52 to 15.29), 2013 ($\beta=16.28$, 95% CI: 13.76 to 18.79) and 2015 ($\beta=21.30$, 95% CI: 18.95 to 23.66) was significantly higher than that in 2010. County-level civic participation in 2012 ($\beta=-3.59$, 95% CI: -6.92 to -0.26), 2013 ($\beta=-6.87$, 95% CI: -10.21 to -3.53) and 2015 ($\beta=-3.59$, 95% CI: -7.00 to -0.17) was significantly lower than that in 2010. County-level trust in 2013 ($\beta=-4.32$, 95% CI: -6.72 to -1.93) and 2015 ($\beta=-3.32$, 95% CI: -5.21 to -1.44) was significantly lower than that in 2010. No evidence showed that county-level trust in 2012 was significantly different from that in 2010.

Table 2 shows the associations of both individual-level and county-level social capital with physical health. Among the individual-level social capital indicators, high frequency of socialising (2010—OR: 1.49, 95% CI: 1.33 to 1.66; 2012—OR: 1.39, 95% CI: 1.26 to 1.54; 2013—OR: 1.28, 95% CI: 1.15 to 1.42; 2015—OR: 1.36, 95% CI: 1.23 to 1.50) and high trust (2010—OR: 1.34, 95% CI: 1.22 to 1.47; 2012—OR: 1.30, 95% CI: 1.18 to 1.42; 2013—OR: 1.21, 95% CI: 1.10 to 1.33; 2015—OR: 1.41, 95% CI: 1.28 to 1.55) were significantly associated with good physical health in all years. No evidence supported that there was a significant association between civic participation and physical health after adjustment in any year. Among county-level social capital indicators, after adjustments, higher percentages of frequency of socialising was significantly positively associated with good physical health in 2015 (OR: 1.01, 95% CI: 1.00 to 1.02). In contrast, a higher percentage of civic participation was significantly negatively associated with good physical health in 2015 (OR: 0.99, 95% CI: 0.98 to 1.00); nevertheless, the ORs were close to 1.

Table 3 presents the associations of both individual-level and county-level social capital with mental health. The associations were similar to that of social capital with physical health in terms of directions and significance. Among individual-level social capital indicators, high frequency of socialising (2010—OR: 1.27, 95% CI: 1.14 to

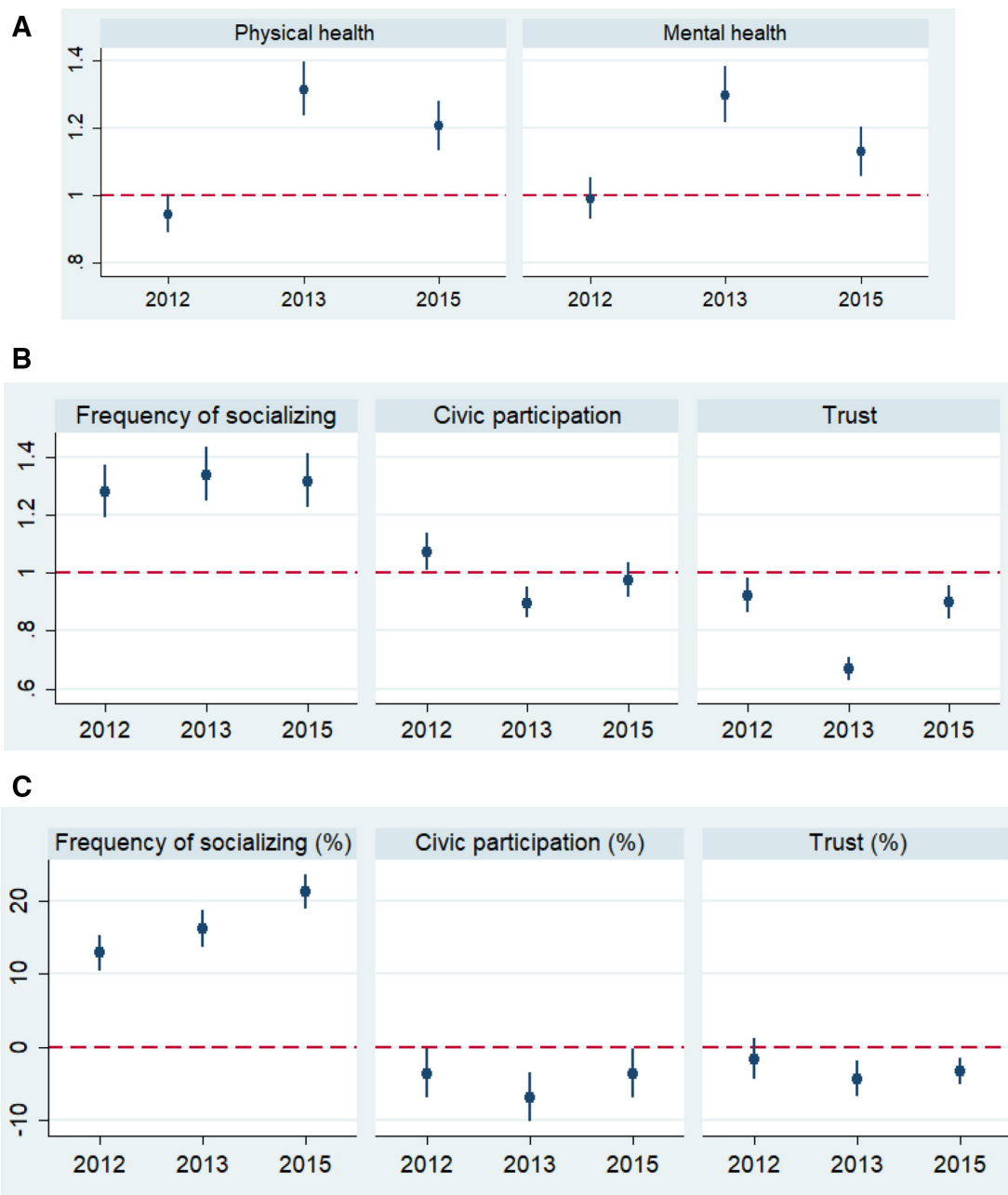


Figure 1 Trends of health outcomes, individual-level social capital and county-level social capital, 2010–2015. (A) Trends of health outcomes, 2010–2015 (N=42 829). ORs with 95% CI were reported with 2010 as the reference year based on binary logistic models; ‘poor’ physical health and ‘poor’ mental health were references of the dependent variables in each model. (B) Trends of individual-level social capital, 2010–2015 (N=42 829). ORs with 95% CI were reported with 2010 as the reference year based on binary logistic models; ‘low’ frequency of socialising, ‘low’ trust and ‘no’ civic participation were references of the dependent variables in each model. (C) Trends of county-level social capital, 2010–2015 (N=520). Coefficients (β) with 95% CI were reported with 2010 as the reference year based on linear regression models.

1.42; 2012—OR: 1.21, 95% CI: 1.09 to 1.34; 2013—OR: 1.30, 95% CI: 1.17 to 1.45; 2015—OR: 1.35, 95% CI: 1.22 to 1.50) and high trust (2010—OR: 1.47, 95% CI: 1.34 to 1.61; 2012—OR: 1.42, 95% CI: 1.30 to 1.56; 2013—OR: 1.36, 95% CI: 1.24 to 1.49; 2015—OR: 1.43, 95% CI: 1.30 to 1.57) were significantly associated with good mental health. Civic participation was only positively associated with good mental health in 2013 (OR: 1.17, 95% CI: 1.05 to 1.29). No significant association between any

county-level social capital indicator and mental health in the 4 years was observed.

The intraclass correlations (ICCs) ranged from 0.052 to 0.107 for physical health (table 2) and ranged from 0.060 to 0.125 for mental health (table 3) in each year; in other words, 5.2%–10.7% of the total variance in physical health and 6.0%–12.5% of the total variance in mental health occurred at the county level.

Table 2 Associations of individual-level and county-level social capital with physical health, 2010–2015 (two-level binary logistic model, with ‘poor’ physical health as the reference group)

	2010	2012	2013	2015
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Sociodemographic factors				
Gender				
Female	1	1	1	1
Male	1.31 ^{***} (1.20 to 1.43)	1.30 ^{***} (1.19 to 1.42)	1.20 ^{***} (1.09 to 1.32)	1.31 ^{***} (1.19 to 1.43)
Age	0.96 ^{***} (0.96 to 0.96)	0.96 ^{***} (0.96 to 0.97)	0.96 ^{***} (0.96 to 0.96)	0.96 ^{***} (0.96 to 0.97)
Ethnicity				
Non-Han	1	1	1	1
Han	0.89 (0.73 to 1.09)	1.02 (0.84 to 1.24)	0.94 (0.77 to 1.16)	1.08 (0.88 to 1.33)
Marriage				
Single/separated/divorced/widowed	1	1	1	1
Cohabit/married	1.02 (0.90 to 1.14)	0.90 (0.81 to 1.01)	1.01 (0.90 to 1.14)	0.93 (0.83 to 1.04)
Socioeconomic factors				
Education				
Primary school or below	1	1	1	1
Junior secondary school	1.18 ^{**} (1.05 to 1.33)	1.20 ^{**} (1.07 to 1.34)	1.27 ^{***} (1.13 to 1.43)	1.12 (1.00 to 1.26)
Senior secondary school or equal	1.31 ^{***} (1.14 to 1.51)	1.40 ^{***} (1.22 to 1.60)	1.49 ^{***} (1.28 to 1.73)	1.40 ^{***} (1.21 to 1.62)
College or above	1.42 ^{***} (1.18 to 1.70)	1.52 ^{***} (1.27 to 1.81)	1.60 ^{***} (1.32 to 1.94)	1.61 ^{***} (1.33 to 1.95)
Poverty				
Poor	1	1	1	1
Non-poor	1.58 ^{***} (1.38 to 1.82)	1.68 ^{***} (1.48 to 1.90)	1.64 ^{***} (1.44 to 1.87)	1.55 ^{***} (1.37 to 1.76)
Do not know income	1.54 ^{***} (1.24 to 1.93)	1.43 ^{***} (1.18 to 1.74)	1.49 ^{***} (1.23 to 1.81)	1.31 [†] (1.05 to 1.64)
Occupation				
Skill level 3 or 4	1	1	1	1
Skill level 2	0.89 (0.74 to 1.07)	0.94 (0.80 to 1.11)	0.94 (0.78 to 1.13)	0.96 (0.79 to 1.17)
Skill level 1	1.19 (0.89 to 1.58)	1.03 (0.77 to 1.37)	0.99 (0.74 to 1.34)	0.87 (0.66 to 1.16)
Non-employed	0.66 ^{***} (0.55 to 0.80)	0.77 ^{**} (0.65 to 0.90)	0.63 ^{***} (0.52 to 0.76)	0.76 ^{**} (0.63 to 0.93)
Place of residence				
Rural	1	1	1	1
Urban	1.08 (0.96 to 1.21)	1.13 [†] (1.01 to 1.27)	1.29 ^{***} (1.15 to 1.46)	1.29 ^{***} (1.15 to 1.45)
Individual-level social capital				
Frequency of socialising				
Low	1	1	1	1
High	1.49 ^{***} (1.33 to 1.66)	1.39 ^{***} (1.26 to 1.54)	1.28 ^{***} (1.15 to 1.42)	1.36 ^{***} (1.23 to 1.50)
Civic participation				
No	1	1	1	1

Continued



Table 2 Continued

	2010	2012	2013	2015
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Yes	1.01 (0.91 to 1.11)	1.01 (0.92 to 1.11)	1.01 (0.91 to 1.11)	0.99 (0.90 to 1.10)
Trust				
Low	1	1	1	1
High	1.34*** (1.22 to 1.47)	1.30*** (1.18 to 1.42)	1.21*** (1.10 to 1.33)	1.41*** (1.28 to 1.55)
County-level social capital				
Frequency of socialising (%)	0.99 (0.97 to 1.01)	1.00 (0.99 to 1.01)	1.00 (0.99 to 1.01)	1.01** (1.00 to 1.02)
Civic participation (%)	1.00 (0.99 to 1.01)	0.99 (0.98 to 1.00)	0.99 (0.98 to 1.00)	0.99** (0.98 to 1.00)
Trust (%)	1.00 (0.99 to 1.02)	1.01 (1.00 to 1.02)	1.01 (0.99 to 1.02)	1.01 (1.00 to 1.03)
Number of individuals	10827	11104	10663	10235
Number of counties	133	131	126	130
ICC	0.081	0.055	0.107	0.052

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

ICC, intraclass correlation; OR, Odds ratio.

As for sociodemographic and socioeconomic factors, being male, non-poor and having a higher education level were significantly associated with good physical and mental health in all years. Being older was negatively associated with good physical and mental health in all years. Additionally, being non-employed was significantly associated with a lower likelihood of having good physical health comparing with having occupations at skill level 3 or 4 (reference) in all years, but not significantly associated with mental health. Being married or cohabiting was significantly associated with good mental health in all years, but not associated with physical health.

The results stratified by place of residence (ie, rural and urban) showed similar patterns to the results from the whole sample in each year in terms of the associations of individual-level frequency of socialising and trust with physical and mental health (online supplemental tables 3 and 4). The results from the pooled data between 2010 and 2015 also showed that individual-level social capital in terms of frequency of socialising and trust was associated with physical and mental health after adjustment (online supplemental table 5).

We further examined the interactions between social capital indicators and survey year (online supplemental tables 6 and 7). For physical health, the interaction effect between county-level frequency of socialising and year (high frequency of socialising × 2015—OR: 1.02, 95% CI: 1.01 to 1.03), and the interaction effect between county-level civic participation and year (civic participation (yes) × 2012—OR: 0.99, 95% CI: 0.99 to 1.00) were significant. For mental health, the interaction effect between county-level frequency of socialising and year (high frequency of socialising × 2015—OR: 1.02, 95% CI: 1.01 to 1.03), the

interaction effect between county-level civic participation and year (civic participation (yes) × 2013—OR: 0.99, 95% CI: 0.99 to 1.00), and the interaction effect between county-level trust and year (high trust × 2012—OR: 1.01, 95% CI: 1.01 to 1.02; high trust × 2013—OR: 1.01, 95% CI: 1.00 to 1.02) were significant. Nevertheless, the ORs for both physical and mental health were close to 1.

We repeated the two-level binary regression models based on the whole weighted sample of each year (ie, tables 2 and 3). The associations between both levels of social capital and health outcomes (online supplemental tables 8 and 9) were similar to our unweighted results in tables 2 and 3. We also conducted sensitivity analyses by treating physical and mental health as ordinal variables. The associations between both levels of social capital and health outcomes (online supplemental tables 10 and 11) were consistent with our previous results as presented in tables 2 and 3.

DISCUSSION

Main findings

To our knowledge, this is the first serial cross-sectional study in China examining the associations of multilevel social capital with individuals' physical and mental health with nationally representative data. We found that the likelihood of having good physical and mental health fluctuated during a period of rapid economic development; in other words, the likelihood of having good physical and mental health did not consistently increase with economic growth during this study period. Among the indicators of individual-level social capital, in general, the likelihood of high frequency of socialising increased, the

Table 3 Associations of individual-level and county-level social capital with mental health, 2010–2015 (two-level binary logistic model, with ‘poor’ mental health as the reference group)

	2010	2012	2013	2015
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Sociodemographic factors				
Gender				
Female	1	1	1	1
Male	1.24 ^{***} (1.13 to 1.35)	1.32 ^{***} (1.21 to 1.44)	1.11 [†] (1.01 to 1.22)	1.25 ^{***} (1.14 to 1.37)
Age	0.99 ^{***} (0.99 to 0.99)	0.99 ^{***} (0.99 to 1.00)	0.99 ^{***} (0.99 to 0.99)	0.99 ^{***} (0.99 to 1.00)
Ethnicity				
Non-Han	1	1	1	1
Han	0.87 (0.72 to 1.06)	1.06 (0.87 to 1.28)	0.94 (0.77 to 1.16)	0.99 (0.81 to 1.23)
Marriage				
Single/separated/divorced/widowed	1	1	1	1
Cohabit/married	1.25 ^{***} (1.12 to 1.40)	1.21 ^{***} (1.09 to 1.35)	1.29 ^{***} (1.15 to 1.44)	1.21 ^{***} (1.08 to 1.35)
Socioeconomic factors				
Education				
Primary school or below	1	1	1	1
Junior secondary school	1.35 ^{***} (1.20 to 1.51)	1.24 ^{***} (1.11 to 1.39)	1.23 ^{***} (1.09 to 1.39)	1.28 ^{***} (1.13 to 1.44)
Senior secondary school or equal	1.44 ^{***} (1.25 to 1.66)	1.53 ^{***} (1.33 to 1.76)	1.37 ^{***} (1.18 to 1.59)	1.62 ^{***} (1.40 to 1.88)
College or above	1.58 ^{***} (1.32 to 1.90)	1.51 ^{***} (1.27 to 1.80)	1.51 ^{***} (1.25 to 1.83)	1.71 ^{***} (1.42 to 2.07)
Poverty				
Poor	1	1	1	1
Non-poor	1.80 ^{***} (1.58 to 2.06)	1.77 ^{***} (1.57 to 1.99)	1.77 ^{***} (1.56 to 2.02)	1.54 ^{***} (1.36 to 1.74)
Do not know income	1.88 ^{***} (1.52 to 2.33)	1.55 ^{***} (1.28 to 1.87)	1.36 ^{**} (1.13 to 1.65)	1.37 ^{**} (1.11 to 1.71)
Occupation				
Skill level 3 or 4	1	1	1	1
Skill level 2	1.01 (0.85 to 1.21)	1.01 (0.86 to 1.19)	1.03 (0.86 to 1.23)	1.21 (1.00 to 1.46)
Skill level 1	1.16 (0.88 to 1.54)	0.99 (0.75 to 1.32)	1.04 (0.77 to 1.40)	1.13 (0.86 to 1.50)
Non-employed	0.94 (0.79 to 1.13)	1.04 (0.89 to 1.23)	0.92 (0.77 to 1.11)	1.05 (0.87 to 1.27)
Place of residence				
Rural	1	1	1	1
Urban	1.07 (0.96 to 1.20)	0.99 (0.88 to 1.11)	1.07 (0.95 to 1.21)	1.17 ^{**} (1.04 to 1.31)
Individual-level social capital				
Frequency of socialising				
Low	1	1	1	1
High	1.27 ^{***} (1.14 to 1.42)	1.21 ^{***} (1.09 to 1.34)	1.30 ^{***} (1.17 to 1.45)	1.35 ^{***} (1.22 to 1.50)
Civic participation				
No	1	1	1	1
Yes	0.98 (0.89 to 1.08)	1.04 (0.95 to 1.14)	1.17 ^{**} (1.05 to 1.29)	1.01 (0.92 to 1.12)
Trust				

Continued



Table 3 Continued

	2010	2012	2013	2015
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Low	1	1	1	1
High	1.47*** (1.34 to 1.61)	1.42*** (1.30 to 1.56)	1.36*** (1.24 to 1.49)	1.43*** (1.30 to 1.57)
County-level social capital				
Frequency of socialising (%)	0.99 (0.98 to 1.01)	1.00 (0.99 to 1.01)	1.00 (0.99 to 1.01)	1.01 (1.00 to 1.02)
Civic participation (%)	1.01 (1.00 to 1.01)	1.01 (1.00 to 1.02)	1.00 (0.98 to 1.01)	1.00 (1.00 to 1.01)
Trust (%)	0.99 (0.98 to 1.00)	1.01 (1.00 to 1.02)	1.00 (0.98 to 1.01)	1.00 (0.99 to 1.02)
Number of individuals	10 827	11 104	10 663	10 235
Number of counties	133	131	126	130
ICC	0.060	0.061	0.125	0.062

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

ICC, intraclass correlation; OR, Odds ratio.

likelihood of civic participation fluctuated and the likelihood of high trust decreased during the survey period. Among the indicators of county-level social capital, in general, the percentage of high frequency of socialising increased, the percentage of civic participation and the percentage of high trust decreased. We also found that higher levels of individual-level social capital in terms of frequency of socialising and trust were consistently associated with good physical and mental health during the period of rapid economic development. However, we did not find evidence for a consistent association of any county-level social capital indicator with physical or mental health during the same period.

Interpretations

Putting the results together, our study suggests that no matter how people's physical and mental health changed during a period of rapid economic growth, individual-level social capital in terms of socialising and trust consistently played a pivotal role in protecting individuals' physical and mental health. Therefore, we should especially pay attention to improve people's trust for health promotion purpose, and that the decreased individual-level trust within the observed period should be of concern.

The provision of informational, instrumental and emotional support may be plausible reasons why the individual-level frequency of socialising was associated with our health outcomes.^{6 41} Socialising helps maintain and extend individuals' social networks, from which individuals can obtain monetary, material and mental assistance, and health-rated information. Additionally, a higher frequency of socialising is beneficial for mental health by fulfilling the human need for social connectedness, increasing people's sense of belonging and reducing the perceived isolation.⁴² Moreover, people with high trust are more likely to consider healthcare systems and health-related information as trustful social resources,^{43 44}

and more likely to perceive emotional support.⁴⁵ They also have less sense of social anxiety.⁴⁶

We argue that some of the mechanisms above may have little changes in a rapidly developing society, resulting in the observed consistent associations of individual-level socialising and trust with physical and mental health. First, a rapidly developing economy is almost always accompanied by social change. Under such circumstances, the formally established health-related institutions and information channels may not fulfil people's needs while the new ones may not be completely established or may not operate steadily. Hence, people need to obtain support from informal channels, such as family members, friends and acquaintances. Second, a rapidly developing society is often accompanied by technological innovation and information explosion. An individual is almost unlikely to know everything about new health-related technology and information on his or her own. In this light, socialising could reduce individuals' costs to learn new health-related technology and obtain new information through social networks. Also, people with high trust may be more likely to consider emerging health-related institutions, technology and information in a rapidly developing society as trustworthy, and are thus more willing to use them. An example is online prescription drug services. A study in the USA found that people with higher trust had greater intention of adopting online prescription drug services.⁴⁷ However, more study is needed to examine whether this is also the case in China, as the radius of trust is different between China and the USA, where Chinese are more prone to consider general trust as trust in strong ties, while Americans as trust in weak ties.⁴⁸ Additionally, a rapidly developing society may also be accompanied by high social mobility and great social uncertainty, whereby people do not have enough information to predict others' behaviours.²¹ In such situation, people with a high trust of

others are less likely to worry about others' intention to harm them; hence, they might suffer from less anxiety.

On the other hand, we did not find consistent associations of individual-level civic participation with physical and mental health. Previous studies showed mixed associations between individual-level civic participation and health outcomes.^{45 49 50} We measured civic participation by voting in the neighbourhood/village committee election. Previous studies argued that local political participation (eg, voting) could affect welfare policies provided by governments.^{51 52} Nevertheless, neighbourhood/village committees in China have no right to make policies. Additionally, voting is a social-specific and political-specific indicator for civic participation, and may have different connotations in different contexts, thereby resulting in inconsistent associations between civic participation and health in different societies.

We also did not find consistent associations of any county-level social capital indicators with physical or mental health. Previous studies showed mixed results as to the associations between collective-level social capital and health.^{45 49 50 53} The mixed results may be due to different geographic scales where study areas were located. For example, studies in the UK defined collective-levels as postcode sectors,^{50 54} while studies in the USA measured collective-level social capital at the state level.^{51 55} While a previous Chinese study measured collective-level social capital at the village level,⁴⁵ the present study measured collective-level social capital at the county level. Also, the social capital indicators in these studies were not the same; hence, it is difficult to make straightforward comparisons with other studies.

It should be noticed that our social capital indicators are not exactly the same as in the previous Chinese studies.^{13 49 56–59} The definition of social capital is still debatable and there is no single best measure of social capital.² As we intended to make comparisons across years, we only used the variables which were collected in all the survey years. In previous studies, one of the approaches on social capital measurement is 'Position Generator',⁶⁰ and several Chinese studies found associations between social capital and health outcomes using the 'Position Generator'.^{58 59 61} Other previous Chinese studies also employed multiple items and combined the items as social capital indexes,^{13 16 62–65} while some studies employed different single items as different dimensions of social capital (eg, studies used social relationship⁶⁶ and organisation membership^{49 67 68} as structural social capital and trust as cognitive social capital).^{61 66 69} Trust is the most common measurement of social capital shown to be associated with different health outcomes, which was consistent with our results. However, we used frequency of socialising and voting behaviour as structural social capital, which were not commonly used in previous studies. The difference in measurements should be taken into account when comparing our results with results in other studies.

Strengths and limitations

A major strength of our study is the comparability of the associations between multilevel social capital and health outcomes over time. Our consistent findings provided more solid evidence for associations of the individual-level frequency of socialising and trust with physical and mental health beyond previous mixed results. Another strength is that we took advantage of a rapidly developing society (ie, China) as a social laboratory to observe the associations between multilevel social capital and health outcomes.

A limitation of our study is that we cannot make causal inferences since this study is cross-sectional by nature. However, our health outcomes were 'current' physical health and mental health in the 'past 4 weeks', and our frequency of socialising was socialising 'in the past year'. The timeline helped us to partially avoid reverse associations between individual-level frequency of socialising and health outcomes. Second, we only included generalised trust in cognitive social capital. While this measurement cannot directly capture county-specific trust (eg, trust in neighbours), it was used in previous studies.^{50 53 55 70} Third, the study period was relatively short (ie, 6 years), which prohibited us from observing a more long-term trend of the association. However, as we observed the association in a rapidly developing and changing society and the development and changes are ongoing, we speculate that the associations we observed will remain in the long run. Fourth, the two single-item questions on measuring physical and mental health may be subject to validity and reliability issues. As compared with multiple-item scales, the measurement errors of single-item questions may be higher. Nevertheless, previous studies found that self-rated health was a predictor for mortality.⁷¹ Further studies using established instruments to assess physical and mental health are needed. Last but not least, we could not estimate the independent causal effect of county-level social capital on individuals' health. We used multilevel regression models instead of aggregating individual-level responses to estimate the county-level social capital, taking individual characteristics into account. However, we could not adjust for all individual characteristics in the models. Further studies using other study designs, such as natural experiments or randomised community trials, are needed.

CONCLUSION

Our findings suggest that individual-level social capital in terms of frequency of socialising and trust is a robust social determinant of health during a period of rapid economic growth. Hence, improving individual-level social capital for health promotion could be a long-term strategy even in a rapidly developing society. Interventions can be designed to increase opportunities for socialising and to improve trust. Given that people with less socialising and lower trust appear to be at a higher risk of poor health, interventions could consider a population segmentation strategy based

on social capital indicators to target individuals with lower frequency of socialising and lower trust. It may be difficult for policies to target individuals directly, but they can be designed as a ‘nudge’ for individuals’ socialising and trust. For example, governments can consider providing freely accessible public space (eg, parks, activity centres) for people’s social interaction, and they can also extend operation hours of public transports to encourage socialisation. Trustworthy and transparent health-related information channels should also be established. On the other hand, policymakers may pay attention to avoid damaging social capital when implementing other policies.

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