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Epstein-Barr virus antibody titer as a stress biomarker and its association with social capital in rural Fujian communities, China.

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Abstract

Objectives: There has been little research on the association between social capital and psychological stress measured using a biomarker, particularly in developing countries. Our objective was to investigate the association between Epstein-Barr virus (EBV) antibody titer, an indicator of cellular immune function previously shown to be associated with psychological stress, and social capital among rural community dwellers in Fujian Province, China.

Methods: We conducted a cross-sectional survey in seven rural communities in Fujian in 2015. We used questionnaire data and dried blood spot samples for the measurement of biomarkers collected from 734 local residents for the analysis. We conducted a mixed effects regression analysis to investigate the association between EBV antibody titer and four social capital variables, which included cognitive and structural social capital assessed both at individual and community levels.

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AUTHOR CONTRIBUTIONS

All the authors contributed to designing the study. AY and YI contributed to data analysis and drafted the manuscript. AY, YI, GC, RT and FH contributed to the data collection. AY and JC contributed to biomarker analysis at the laboratory. MH and TY provided necessary logistical support. CW and TY contributed to critical revision of the manuscript. All authors have read and approved the final manuscript.

Results: Community-level structural social capital was inversely associated with psychological stress (coefficient = -0.96 , 95% confidence interval [CI] = -1.91 , -0.01) while individual-level structural social capital was positively associated with it (coefficient = 0.21 , 95% CI = 0.07 , 0.36). Neither individual- nor community-level cognitive social capital was associated with psychological stress status.

Conclusions: In rural Fujian, China, social capital seemed to be an important determinant of psychological health. While living in a community with active social interaction may benefit the residents psychologically, social interaction in the form of strongly bonded relationships may be a source of psychological stress at the individual level due to the potential demands and obligations which may be associated with such connections.

Keywords

Social capital; Biomarker; Epstein-Barr virus antibody titer; Stress; China

1 | INTRODUCTION

Epstein-Barr virus (EBV) is one of the ubiquitous herpes viruses that have already infected over 90% of the world's population. While EBV is carried in a latent state (regulated by cell-mediated immune function (Macswen & Crawford, 2003; Thorley-Lawson & Gross, 2004)) in normal conditions, chronic stress can disrupt the homeostasis of this function, which could result in the occasional reactivation and replication of the virus and thereby leading to elevated EBV antibody titer in serum (Fagundes et al., 2014; Glaser & Kiecolt-Glaser, 2005; Steptoe et al., 2007).

Research has indicated that EBV antibody titer is elevated when people experience psychological stress as a result of external stressors, e.g., traumatic life events (Esterling, Antoni, Kumar, & Schneiderman, 1993), care giving to family members (Janice K Kiecolt-Glaser, Dura, Speicher, Trask, & Glaser, 1991; J. K. Kiecolt-Glaser et al., 1987), family disagreement in decision making (Panter-Brick, Eggerman, Mojadidi, & McDade, 2008) and academic examinations among medical students (Glaser et al., 1987). Several researchers have also investigated its association with validated questionnaire measures of psychological health; a positive association was shown with the Profile of Mood Stress short form (Lutgendorf et al., 2001) and inverse associations were shown with the domain scores of the abbreviated version of the World Health Organization's Quality of Life questionnaire (Inoue et al., 2014).

While recent methodological developments in the measurement of EBV antibody titer using dried blood spot (DBS) samples (McDade, Stallings, Angold, et al., 2000) have enabled us to assess chronic stress status among those with a language barrier which hinders their ability to respond to commonly used questionnaires or those who live in remote areas where laboratory infrastructure is inadequate for the collection and analysis of other biological samples (McDade, Williams, & Snodgrass, 2007), comparatively few studies have been undertaken to investigate the association between chronic stress status and its determinants in such areas. This might have been an important omission, as developing countries have

been experiencing drastic changes in their living environment and those living in those environments have suffered subsequent psychological stress (Kessler et al., 2009).

We focused on social capital as a potential determinant of psychological stress status. Social capital, defined as the institutions, relationships and norms that shape the quality and frequency of social interactions (Putnam, 1995), has been shown to have an effect on many types of health outcomes. For example, reports from the literature indicate that greater individual-level social capital is associated with a reduced risk of mortality and chronic diseases such as cardiovascular disease, obesity, hypertension, and mental illness (De Silva, McKenzie, Harpham, & Huttly, 2005; Hyypä, Mäki, Impivaara, & Aromaa, 2007; Moore, Daniel, Paquet, Dube, & Gauvin, 2009; Yazawa et al., 2016). Other researchers have operationalized social capital at the community level and reported positive associations with self-rated health, life satisfaction, cardiovascular health and psychological well-being (Hamano et al., 2010; Hu et al., 2014; Maass, Kloeckner, Lindstrøm, & Lillefjell, 2016).

We designed our study to extend previous research in several ways. First, there has been comparatively little research on the association between social capital and psychological health in developing countries and the observed associations have been inconsistent. For instance, Godoy et al. (2006) found that a lower level of village social capital was associated with negative emotions in the Bolivian Amazon whereas Harpham, Grant and Rodriguez (2004) found a relatively weak association between social capital and self-reported mental health in Colombia. Yip et al. (2007) conducted a study in rural China and found significant associations between cognitive social capital (i.e., trusting people from the same village) and psychological health and subjective well-being, but did not find any significant association between structural social capital (i.e., organizational membership) and any of the health outcomes. Therefore, we measured social capital in more detailed manner (i.e., cognitive and structural social capital at both the individual and community level) to better describe the social capital and its association with health among community dwellers.

Second, we focused on psychological stress in rural China, where the frequency of mental health problems is increasing rapidly (Fengyu & Jingping, 2015). In the last few decades, Chinese people have experienced drastic societal changes, e.g., dissolution of social safety net and growing income inequality (Easterlin et al., 2012). Investigating the potential protective effect of social capital on psychological stress in this context may facilitate our understanding of how to help mitigate the negative impacts of societal transitions in these communities. Third, as previously stated, we measured an aspect of cellular immune function using EBV antibody titer (a biomarker of chronic stress status). This is particularly important as it can be obtained from people who speak any language and is not subject to the different forms of bias that can be associated with self-reported measures of health.

Our objective in this study was therefore to investigate the association between EBV antibody titer, an indicator of cellular immune function previously shown to be associated with psychological stress, and social capital variables among rural community dwellers in Fujian, China. We hypothesized that chronic stress of people living in the rural Fujian communities may be lower when they had higher social capital compared to those with lower social capital.

2 | METHODS

2.1 Research location

Fujian Province is located on the southeast coast of mainland China (Figure 1); it is situated between latitude 23°33' to 28°20'N and longitude 115°50' to 120°40'E, having an area of 121,400 square kilometers. Approximately 38.06 million people live in the province as of 2014 with the majority being Han (98%), with other smaller ethnic minorities (Fujian Provincial Bureau of Statistics, 2015).

Fujian Province has experienced rapid economic growth since the early 1980s; its gross domestic product increased from 20 billion RMB in 1985 to 2406 billion RMB in 2014. While this economic growth improved residents' standard of living as a whole, it was also accompanied by an increase in the urban-rural income gap. Specifically, while the income of urban residents was 1.85 times as much as that of rural residents in 1985 (733 vs. 396 RMB), it became 2.43 times in 2014 (30,722 vs. 12,650 RMB) (Fujian Provincial Bureau of Statistics, 2015). The economic growth also created new employment opportunities and resulted in an increase in the numbers of rural-to-urban migrants, which eventually accelerated the population aging of the rural communities. These socio-demographic changes associated with the economic growth may have resulted in chronic stress among those living in rural communities.

In this context, we selected seven rural communities from one county in Nanping City, which is located 170 km from Fuzhou City, the provincial capital. We chose this county because it had an average ranking in terms of the degree of its economic development and population size among the counties in Nanping City.

2.2 Field survey

We conducted a field survey in August 2015. We invited all residents aged 18 years or older and residing in the study communities to participate in the survey. Trained interviewers conducted all of the interviews individually in either Mandarin Chinese or the Fujian dialect. We obtained information on socio-demographic variables such as age, sex, marital status, educational attainment, household income, household size and social capital through the use of a questionnaire.

We collected dried blood spot (DBS) samples of whole blood on a specific type of filter paper (903 Protein Saver Cards, Whatman) following a simple finger prick by local health professionals. After complete desiccation, the samples were stored at room temperature for a few weeks during the survey and then preserved at -20°C in the laboratory at Fujian Medical University.

2.3 Measurement of EBV antibody titer

We analyzed the EBV antibody titer using enzyme-linked immunosorbent assay (ELISA). We measured anti-EBV viral capsid antigen (VCA) IgG using a commercial kit (Mikrogen recomWell EBV VCA IgG kit [Cat.#7204], Neuried, Germany). One disk of dried blood (1/8 inch) was eluted overnight at 4°C in 250 µL of sample diluent buffer. On the following

day, the eluted sample was diluted x20 again with sample diluent buffer, and then 100 µL of the extraction was put onto microtiter wells coated with anti-EBV VCA antibody. After incubating at 37°C for 1 hour, secondary antibody was added and again incubated at 37°C for 30 minutes, after which 100 µL of substrate was added to the wells and incubated at room temperature in the dark for 30 minutes. After 100 µL of stop solution was added, absorbance was read at 450 nm using a reference wavelength of 620 – 650 nm by microplate photometer (Molecular Devices SPECTRA max PLUS 384, California, United States [U.S.]). We used a cut-off value of 20 ELISA Units as being indicative of no detectable EBV VCA IgG levels, i.e., seronegative. Only individuals with EBV values > 20 ELISA Units were included in subsequent analyses. The inter-assay variation was 8%. We based our protocol for EBV antibody titer from DBS described above on that developed by the Department of Anthropology at the University of Oregon (Eick, Urlacher, McDade, Kowal, & Snodgrass, 2016).

To identify individuals at an acute stage of systemic inflammation, infection, or tissue injury (Libby & Ridker, 2004), we also measured C-reactive protein (CRP) concentration using DBS with the previously established protocol, i.e., a high-sensitivity sandwich enzyme immunoassay using monoclonal antibodies (Monoclonal Antibody to Human CRP #M86005M for primary antibody, and #M01319B for secondary antibody, Meridian, U.S.) (Brindle, Fujita, Shofer, & O'Connor, 2010). We excluded samples that exceeded 6.25 mg/L in DBS CRP, equivalent to 10 mg/L in serum CRP (Blevins, Sagui, & Bennett, 2016; Brindle et al., 2010; Thompson et al., 2014), from the analysis.

2.4 Evaluation of social capital

We obtained information on two forms of social capital with the use of a questionnaire which was developed on the basis of fieldwork observations and interviews with local health professionals. We also followed the approaches of previous studies that were conducted in developing countries (i.e., the Integrated Questionnaire for the Measurement of Social Capital (SC-IQ)) (Christiaan and others, 2004).

We assessed cognitive social capital in terms of trust, reciprocity and attachment to other community members, and measured this construct with the following questions; “Generally speaking, do you trust people in your community?”, “Do people in your community try to be helpful to others?” and “How attached do you feel to your community?”, respectively. Participants answered using a five-point Likert scale (i.e., *never, rarely, sometimes, most of the time, always*); we categorized who answered *most of the time* or *always* as “1” (i.e. as possessing cognitive social capital).

As for structural social capital (i.e., social participation), we measured it by the frequency of eating together with people from other households and participating in wedding ceremonies and/or funerals in the previous year, as these are the most commonly observed form of structural social capital in this area. We categorized those the participants who ate together with the members of other households at least once in a two- or three-month period, or had participated in wedding ceremonies or funerals at least once in the past year as “1” (possessing structural social capital); we categorized those participants who had rarely ate

together with members from other households and not participated at a wedding ceremony or funeral in the past year as “0” (not possessing structural social capital).

Individual response to cognitive and structural social capital components were then summed to generate a composite score (range: 0 – 3 and 0 – 2 for cognitive and structural social capital, respectively) and divided into two categories (i.e., 0 vs. 1 or more). Community-level social capital variables were calculated as the mean values of individual-level social capital responses from the same community members for both the cognitive and structural social capital variables.

2.5 Socio-demographic information

Information collected on socio-demographic variables included age (in years), sex (male, female), marital status, educational attainment, household income and household size. We categorized marital status into two: has a partner and does not have a partner. We divided educational attainment into three categories: illiterate (cannot read or write); graduated from elementary school (6 years of schooling); and junior high school or above (9 years of schooling or above). For household income, following the lead of a survey that targets older people in China, the China Health and Retirement Longitudinal Study (National School of Development, Peking University), we asked participants about their economic status relative to other households in their community using the following question: “Suppose that the household income of the poorest in your community is 0 and that of the richest is 10, how would you rate your household income on a scale from 0 to 10?” We dichotomized the responses into two at the median (i.e., $/ < 5$).

2.6 Statistical analysis

After excluding those with missing information on social capital variables, age, household size and household income ($n = 33$), those who lacked blood sample ($n = 3$) and those with a serum-equivalent CRP concentration of higher than 10 mg/L ($n = 27$), our final sample size for the analysis was 734.

We used a mixed effects regression analysis with a random effects model to account for multiple individuals in each community to investigate the association between log-transformed EBV antibody titer and social capital variables. Model 1 included biological and socio-demographic characteristics (i.e., age, age squared, sex, marital status, educational attainment, household income, household size and log-transformed CRP concentration). We included CRP concentration since an accelerated inflammatory status can drive EBV reactivation (Bennett et al., 2012). Model 2 included individual-level cognitive social capital while Model 3 included individual-level structural social capital. Models 4 and 5 additionally included community-level cognitive and structural social capital, respectively.

To test the robustness of the study findings, we also conducted sensitivity analyses in which (1) we used social capital indicators as scores ranging 0 – 3 and 0 – 2 (treated as categorical variables) for cognitive and structural social capital, respectively and (2) we stratified the analysis by age group (i.e., < 60 years old vs. 60 years old and above). For the former, community-level variables were operationalized as the mean of individual-level social

capital scores and covariates for Models 4 and 5 of the main analyses were incorporated in the models for cognitive and structural social capital, respectively.

All statistical analyses were conducted using Stata 13.1 (StataCorp, College Station, TX). The level of statistical significance was set at $p < 0.05$ (two-tailed).

2.7 Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The research protocol was officially approved by the appropriate sectors of the Chinese government. The field surveys were conducted after obtaining approval from the Ethics Committee for Medical Research at the University of Tokyo (No. 10515-(1)) and the Ethics Committee of the Institute of Tropical Medicine at Nagasaki University (No. 120910100). Informed consent was obtained from all individual participants included in the study.

3 | RESULTS

3.1 Characteristics of the study participants

The basic characteristics of the participants are shown in Table 1. The mean age was 58.9 years and 38.7% of the participants were male. Median EBV antibody titer was 125.0 ELISA Units. The proportions of participants who reported any forms of social capital were 80.9% for cognitive social capital and 76.7% for structural social capital.

3.2 Factors associated with EBV antibody titer

The results of Models 1 through 5 are shown in Table 2. In Model 1, there was a quadratic relationship between age and EBV antibody titer (age: coefficient = -0.03 , 95% confidence interval [CI] = -0.06 , 0.01 ; age squared: coefficient = 2.89×10^{-4} , 95% CI = 0.09×10^{-4} , 5.87×10^{-4}), which indicated that EBV antibody titer was lowest at the age of approximately 48.2 years and higher among those who were both younger and older. Female sex was associated with higher EBV antibody titer (coefficient = 0.14 , 95% CI = 0.01 , 0.27). Marital status, education, household income, household size and CRP concentration were not associated with EBV antibody titer.

In Models 3 and 5, participants with higher individual-level structural social capital had a significantly higher level of EBV antibody titer (coefficient = 0.20 , 95% CI = 0.05 , 0.35 ; coefficient = 0.21 , 95% CI = 0.07 , 0.36 , respectively), while community-level structural social capital was inversely associated with EBV antibody titer; people living in communities with greater structural social capital had a lower level of EBV antibody titer (coefficient = -0.96 , 95% CI = -1.91 , -0.01). On the other hand, neither individual- nor community-level cognitive social capital was associated with EBV antibody titer (Models 2 and 4).

3.3 Results of sensitivity analysis

When we treated individual-level social capital indicators as categorical variables, we found that those who scored 1 had significantly higher EBV antibody titer than those who reported no social capital components for both cognitive and structural social capital (cognitive social capital: coefficient = 0.23, 95% CI = 0.04, 0.42; structural social capital: coefficient = 0.23, 95% CI = 0.08, 0.38) (Supplementary Table 1). Those participants who scored 2 and above tended to have higher EBV antibody titer, while such differences were not statistically significant. The finding in relation to the inverse association between community-level structural social capital and EBV antibody titer did not substantially change in the sensitivity analysis. The analysis stratifying by age group (i.e., < 60 years old vs. 60 years old and above) showed that the inverse association between community-level structural social capital and EBV antibody titer was more evident among the younger age group (Supplementary Table 2).

4 | DISCUSSION

4.1 Summary of the findings

We found that in rural Fujian, China, community-level structural social capital was inversely associated with EBV antibody titer, an indicator of cellular immune function previously shown to be associated with psychological stress, whereas individual-level structural social capital was positively associated with EBV antibody titer. This suggests that community-level structural social capital may protect people from psychological stress whereas individual-level structural social capital is rather linked directly with psychological stressors, i.e., individuals with more structural social capital also have greater levels of psychological stress.

4.2 Community-level structural social capital and psychological stress

In our study population, higher community-level structural social capital was associated with lower chronic stress status, which was agreement with the results of Godoy et al. (2006), who conducted a study in the Bolivian Amazon and found that village social capital was inversely associated with negative emotions. Hamano et al. (2010), working in Japan, also reported that community-level structural social capital had a positive effect on psychological well-being.

The association between community-level structural social capital (the occurrence of social interaction in the community (i.e., attendance at funerals, marriages and sharing meals)) and psychological stress that we observed suggests that living in communities with higher levels of active social interaction can be associated with a reduced level of psychological stress among residents. Although the exact mechanisms underlying this association need to be elucidated in this particular setting, earlier research in other locations has indicated that social interaction reduces psychological stress through the increased sense of companionship and belonging it engenders (Thoits, 2011; Yang, Boen, & Mullan Harris, 2015), which can act to prevent social isolation within a community. This might be particularly important in rural China where older people are in need of help in their daily lives because their younger family members have out-migrated to cities, leaving them behind in the village (Ye, Wang,

Wu, He, & Liu, 2013). Living in a community with active social interaction might protect them from social isolation and lack of social support while our sensitivity analysis suggested that this protective effect may be stronger among those participants who are relatively younger in the rural communities (e.g., those aged younger than 60 years old).

4.3 Individual-level structural social capital and psychological stress

On the other hand, higher individual-level structural social capital was associated with greater psychological stress. This result is in agreement with the findings reported by previous researchers in several studies who have shown an inverse association between individual-level structural social capital and psychological health. For example, Mitchell and LaGory (2002) demonstrated that in impoverished communities in the U.S., individual-level structural social capital (i.e., group membership) was associated with higher depressive symptoms. Myroniuk and Anglewicz (2015) assessed the association between health-related quality of life and social participation in rural Malawi and found that social participation was associated with a worse psychological health status two years later, although it was associated with better physical health.

Although it should be noted that a number of reports from the literature indicate that individual-level structural social capital has a protective effect on psychological health (Hamano et al., 2010; Murayama et al., 2013; Takagi, Kondo, & Kawachi, 2013; Yip et al., 2007), one of the reasons for the positive association we observed and which has been reported by previous researchers might be related to the fact that social interaction occasionally may involve demands and obligations that outweigh the positive benefits, thus causing the interaction to become a source of stress. Older people predominated in our study communities because of the outmigration of young generation. Given the comparative absence of working age adults, it is conceivable that those individuals actively engaging in social activities might have also been burdened by a greater workload, more obligations and thus greater stress. The bonding nature of these relationships might also have been associated with greater social regulation and hence more psychological stress among those people in the study communities, a phenomenon which has been termed the “dark side” of social capital (van Deth & Zmerli, 2010). This supposition is consistent with findings reported in previous studies using stress-related biomarkers; for example, Hanna (1998) showed that among Samoan adults who migrated to Hawaii, the presence of other Samoans who made demands for resources or assistance was associated with higher urinary epinephrine concentration. In addition, McDade (2001) used EBV antibody titer among Samoan adolescents and showed that lifestyle incongruity stress (i.e., inconsistency between a household’s material style of life and its socioeconomic status) was pronounced among those with a higher degree of social integration (i.e., pro-social orientation and satisfaction with social relationships), suggesting that extended kin networks in Samoa could cause social burden.

4.4 Individual-level and community-level cognitive social capital

We have demonstrated that cognitive social capital was not significantly associated with psychological stress at either the individual or community level. In addition, our sensitivity analysis showed that those who scored 1 had significantly higher EBV antibody titer than

those without any social capital. These results do not agree with the findings reported by Yip et al. (2007), who included in their study population 2,401 people living in 192 rural Shandong communities in China and found that individual- and community-level cognitive social capital were both inversely associated with poor mental health as measured by the 12-item General Health Questionnaire. One of the reasons which might underlie this difference is that social interaction may operate differently at different community levels, i.e., the spatial unit (e.g., community, city or country) influences the ways in which people interact with others. This might be particularly relevant in this context, as our participants were on average older than those who participated in Yip et al. (58.9 vs. 41 years old), which suggests that they may have interacted with others in a smaller geographic area due to the physical exertion required to “get out and about.” Lack of variation in the extent to which people interacted with others in the community might have resulted in lack of variation in cognitive social capital, which in turn may have resulted in our finding of a non-significant association between stress and cognitive social capital.

4.5 Strengths and limitations of our study

We have extended the work of previous researchers in several ways. First, to the best of our knowledge, we are the first to examine the association between social capital and EBV antibody titer as a marker of stress. We believe that this makes a significant contribution to the research in this field as this method is independent from language ability and can be applied to other contexts. Serum EBV antibody titer has also been shown to be more stable (compared with other stress biomarkers) across time - it does not have a circadian rhythm (McDade, Stallings, & Worthman, 2000) and has a half-life of approximately 20 days in serum (Cacioppo et al., 2002). Second, we investigated the association between social capital and psychological stress in rural communities in China, which, similar to other developing countries, is experiencing rapid social changes; studying the effect of social capital in relation to psychological stress may increase understanding about how to protect and promote the mental health of people in such countries.

Our study also has several limitations. First, the cross-sectional nature of our study design prevented us from making any causal inferences. Reverse causality may have also been an issue in relation to social capital and its association with psychological stress, i.e., people having mental health problems may hesitate to participate in social activities. Second, our participants might not have fully represented people living in rural communities in China or in Fujian as we recruited participants from only one city in Fujian and we did not use a random sampling procedure. Third, while social capital was measured after discussion with local health professionals, future study should be cautious about its effectiveness in other study locations. Fourth, there are several variables for which we were unable to obtain reliable data and which would have better explained the association between social capital and EBV antibody titer, such as traumatic life events across their life course, and personal medical history.

CONCLUSION

Our results suggest that in rural Fujian, China, community-level structural social capital was inversely associated with psychological stress, i.e., living in a community with higher structural social capital was associated with lower psychological stress. On the other hand, participants with higher individual-level structural social capital had more psychological stress than participants who engaged in less social interaction. A greater focus needs to be placed on how to measure social capital and evaluate its health impact in developing countries to fully elucidate the mechanisms linking social capital and psychological well-being.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Map of Fujian

Table 1.

Basic characteristics of the participants in rural Fujian communities, China (2015) (N = 734)

	Mean [SD]/n (%)
Age (in years)	58.9 [12.9]
Sex (male)	284 (38.7)
Marital status (has a partner)	593 (80.8)
Education	
Illiterate	272 (37.1)
Less than elementary school	291 (39.6)
Junior high school or more	171 (23.3)
Household income (high)	409 (55.7)
Household size ^a	4 [3 – 6]
EBV antibody titer (ELISA unit) ^a	125.0 [74.0 – 241.6]
CRP concentration (mg/L) ^a	0.68 [0.33 – 1.51]
Cognitive social capital	
Trust (high)	408 (55.6)
Reciprocity (high)	430 (58.6)
Attachment (high)	471 (64.2)
0	140 (19.1)
1	144 (19.6)
2	185 (25.2)
3	265 (36.1)
Structural social capital	
Eating together with neighbors (yes) ^b	542 (73.8)
Participation in wedding and/or funeral (yes) ^c	129 (17.6)
0	171 (23.3)
1	455 (62.0)
2	108 (14.7)

Mean and standard deviation (SD) for continuous variables and the number and percentage of the participants for categorical variables are shown.

^aMedian and interquartile range are shown for household size, EBV antibody titer and CRP concentration.

^bWhether participants ate together with members of other households at least once in a two- or three-month period or not.

^cParticipation in wedding ceremonies or funerals at least once in the past year.

Table 2.

Associations between EBV antibody titer and social capital variables in rural Fujian communities, China (2015) (N = 734)

	Model 1	Model 2	Model 3	Model 4	Model 5
Individual-level social capital					
Cognitive social capital (ref. None)		0.10 (−0.06, 0.25)		0.10 (−0.05, 0.25)	
Structural social capital (ref. None)			0.20** (0.05, 0.35)		0.21** (0.07, 0.36)
Community-level social capital ^a					
Cognitive social capital				−1.08 (−3.15, 0.98)	
Structural social capital					−0.96* (−1.91, −0.01)
Age (in years)	−0.03 (−0.06, 0.01)	−0.03 (−0.06, 0.01)	−0.03 (−0.06, 0.01)	−0.03 (−0.06, 0.01)	−0.03 (−0.06, 0.01)
Age squared	2.89×10 ^{−4} (−0.09×10 ^{−4} , 5.87×10 ^{−4})	2.95×10 ^{−4} (−0.03×10 ^{−4} , 5.93×10 ^{−4})	3.13×10 ^{−4} * (0.16×10 ^{−4} , 6.10×10 ^{−4})	2.96×10 ^{−4} (−0.02×10 ^{−4} , 5.94×10 ^{−4})	3.15×10 ^{−4} * (0.18×10 ^{−4} , 6.12×10 ^{−4})
Sex (ref. Male)	0.14* (0.01, 0.27)	0.14* (0.01, 0.27)	0.14* (0.01, 0.27)	0.14* (0.01, 0.27)	0.13* (0.00, 0.26)
Marital status (ref. Has a partner)	−0.03 (−0.20, 0.14)	−0.02 (−0.19, 0.15)	0.01 (−0.16, 0.18)	−0.02 (−0.19, 0.15)	0.02 (−0.15, 0.19)
Education (ref. Illiterate)					
Less than elementary school	−0.13 (−0.28, 0.02)	−0.13 (−0.27, 0.02)	−0.16* (−0.30, −0.01)	−0.13 (−0.27, 0.02)	−0.16* (−0.31, −0.01)
Junior high school or more	−0.13 (−0.32, 0.07)	−0.13 (−0.32, 0.06)	−0.16 (−0.35, 0.03)	−0.13 (−0.32, 0.06)	−0.16 (−0.35, 0.03)
Household income (ref. Low)	−0.04 (−0.17, 0.08)	−0.05 (−0.18, 0.07)	−0.04 (−0.17, 0.08)	−0.05 (−0.17, 0.07)	−0.04 (−0.16, 0.09)
Household size (log-transformed)	−0.07 (−0.20, 0.06)	−0.07 (−0.20, 0.06)	−0.09 (−0.22, 0.04)	−0.07 (−0.20, 0.06)	−0.08 (−0.21, 0.05)
CRP (log-transformed)	0.05 (−0.01, 0.11)	0.05 (−0.01, 0.11)	0.05 (−0.00, 0.11)	0.05 (−0.01, 0.11)	0.05 (−0.01, 0.11)

Coefficient and 95% confidence interval are shown.

^aCommunity-level social capital was calculated as the mean value of individual-level social capital responses from the same community members.

*** : p < 0.01;

* : p < 0.05