# Melancholy or mahjong? Diversity, frequency, type, and rural-urban divide of social participation and depression in middle- and old-aged Chinese: A fixed-effects analysis

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# Melancholy or mahjong? Diversity, frequency, type, and rural-urban divide of social participation and depression in middle- and old-aged Chinese: A fixed-effects analysis

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**Abstract**

The potential benefit of social participation (SP) to one's mental health has been widely acknowledged. Nevertheless, the specific type and amount of SP that is associated with improved depressive symptoms in middle- and old-aged Chinese awaits further investigation. This study aimed to understand the patterns of depression and SP by comparing urban vs rural China, and according to which, measure the associations between changes in SP and that in depressive symptoms. A total of 10,988 community residents aged 45 years and above were selected from wave 1 (2011), wave 2 (2013), and wave 4 (2015) of the China Health and Retirement Longitudinal Study (CHARLS), a nationally representative survey. The fixed-effects analysis was used to explore the association between the changes in diversity, frequency, and type of SP and the changes in depressive symptoms. The results indicated that rural respondents suffered from a significantly higher risk of depression and took less SP than their urban counterparts. Transitioning from no SP to 1 or more types of SP or to a once a week or higher frequency was associated with a decline in depressive symptoms. For urban respondents, playing mah-jong or cards and joining sports or social clubs predicted a decline in depressive symptoms. For rural residents, interacting with friends regularly was associated with fewer depressive symptoms. In conclusion, more diverse and higher frequency of SP was associated with better mental health, while the social significance of SP varied across different types of SP and between rural and urban areas.

**Keywords:** Social participation, Depression, China, Fixed-effects analysis, Rural-urban disparity

## 1. Introduction

Depression, a non-communicable disease, has attracted wide research and service attention in recent years due to its heavy burden in both developed and developing countries (Malhi & Mann, 2018). Specifically, nearly 350 million people suffer from depressive disorders globally, which is attributable to 12.7% of all-cause mortality (Walker et al., 2015). Moreover, other health problems that often ensue from depression, such as type 2 diabetes (Vancampfort et al., 2016), cardiovascular diseases (Seldenrijk et al., 2015), and suicide (Isacsson et al., 2010), cause secondary comorbidities and result in more burden to the family as well as the community. In addition, the risk of depression peaks in one's middle- and old- age (World Health Organization, 2017a; Yaka et al., 2014). As the worldwide ageing population roars, the threat will possibly be exacerbated, which calls for effective interventions for this disadvantaged group.

China, one of the low- and middle-income countries (LMICs) (World Bank, 2018), accounts for nearly 18% of the global population, and roughly 17% of the global disease burden of mental disorders (Liu & Page, 2016). In addition, China is experiencing rapid population ageing (Wang & Chen, 2014). Specifically, over 110 million residents were 65 years or above in 2011, whilst the figure was projected to reach 400 million by 2050 (Fang et al., 2015). Thus, addressing this daunting challenge to China is critical to the global improvement of mental health as well.

Facing the growing need, however, similar to other LMICs, China suffers greatly from insufficient professional resources on the supply side. Currently, there are less than 8.75 mental health workers per 100,000 residents in China's mental health system (World Health Organization, 2017b). This figure is just above the average of LMICs, less than that of the global average, and far less than that of upper-middle income countries (World Health Organization, 2018). The large gap between supply and need indicates that, although conventional interventions such as cognitive behavioural therapy and medication are effective approaches to treating patients with depression, they are unable to grapple with this challenge to China or

other LMICs in similar conditions, due to their high demands for professional resources (Milner et al., 2015). In this case, delving into novel approaches with better accessibility is inevitable and imperative.

In recent years, social participation (SP) has attracted substantial research attention owing to its low cost and wide accessibility as well as its expected effect on one's mental health. Under the umbrella concept of structural/cognitive social capital (Harpham et al., 2002; Hikichi et al., 2018), prior literature suggested that social interaction/communication during participating in social activities may incentivize mutual support, and provide one with a sense of belonging and largely reduce social isolation (Hikichi et al., 2017; Lin et al., 1999), which therefore, may improve mental health or prevent depression (Almedom, 2005). However, as SP covers a wide range of social activities, limited studies have revealed that the direction of the association and the magnitude varies between different types of activity, but failed to reach an agreement on the type or amount of SP that is associated with lower odds of depression (Hao et al., 2017; Roh et al., 2015; Vogelsang, 2016). One potential underlying reason may be that the social significance of SP varies amongst specific types and across the cultural contexts of investigation (Chiao et al., 2011). For instance, hobby clubs in prior literature were often referred to painting or music (Nummela et al., 2008; Tomioka et al., 2017), which are much less popular amongst middle- and old-aged Chinese. Instead, mah-jong ("麻将" in Chinese) is one of the most popular hobbies in China's context and other Asian ethnic groups (Cheng et al., 2006). Similarly, voluntary work investigated in prior studies (Turner et al., 1999) mainly focused on formal voluntary work such as joining non-profit organisations (Bourassa et al., 2017), whereas Chinese, especially the senior, tend to carry out informal voluntary activities such as helping others without compensation. Considering that the majority of the limited studies were conducted in western countries with LMICs largely under-investigated, whether the inverse correlation between these types of SP and depression still exists in China's context has been largely inconclusive, and therefore, calls for further examination.

Additionally, rural and urban China represent two distinctive classes (Yip et al., 2007). For instance, due to the household registration (Hukou or "户口" in Chinese) system, compared with their urban counterparts, rural residents are more likely to be farmers with lower level of education and income (Gu et al., 2019), fewer community infrastructures (Li et al., 2015), and also less access to government-sponsored public resources or healthcare services (Li et al., 2016). This is especially true among elderly. The resource-deprived context not only triggers higher risk of health problems, but also limits their opportunities to take part in various SP, and in turn, may result in a different behaviour toward SP amongst rural residents (Guo et al., 2018). Moreover, the pathway and mechanism through which social determinants affect health may vary largely between rural and urban areas. For instance, Chen and Meltzer (2008) suggested a significant rural-urban split in the effects of relative income on one's health outcome, and Chen and Crawford (2012) have illustrated that the association between income inequality and health varies across different geographical levels. In this case, the scarcity of studies that investigated the patterns of SP and their association with depression by considering rural-urban disparity warrants the identification of the relationship in the specific rural and urban contexts, in order to improve the validity of findings.

Furthermore, most of the published studies are cross-sectional considering only observable variables. In this case, the calculated association includes not only the effect of SP, but also that from other unmeasurable or unmeasured individual-level confounding factors, which may be associated with both SP and depression (Croezen et al., 2015). For instance, compared with those who are not very confident, individuals who have a high sense of self-confidence are more likely to participate in various social activities, and also less likely to feel depressed (Liu et al., 2019). Additionally, there are some other potential confounding factors, including personality, childhood experience, intellectual abilities, etc. (Croezen et al., 2015). In other words, the association together with the effect size of SP calculated in these studies may be overestimated, which may risk resulting in spurious correlation or effect.

Therefore, this study was carried out with two aims: 1) to understand the prevalence of depression and patterns of SP in middle- and old-aged Chinese by comparing urban vs rural China; and 2) to examine the association between SP and depressive symptoms in urban and rural China by taking different dimensions of SP into consideration. In order to account for the endogeneity and to reduce biases associated with omitted time-invariant variables, a fixed-effects analysis was used to examine the association between the changes in SP and that in depressive symptoms.

## 2. Methods

### *2.1 Sample and data collection*

The primary database used in the present study was from the China Health and Retirement Longitudinal Study (CHARLS). CHARLS is a nationwide survey that aims to provide comprehensive and quality data on the demographic background, family characteristics, health behaviour and status, and retirement information of the middle- and old-aged residents in China (Zhao et al., 2014). This longitudinal study adopted a four-stage, stratified, cluster sampling method to enrol community-dwelling residents from 450 villages and 150 counties in 28 provinces in China. Detailed sampling technique can be found elsewhere (Feng et al., 2014). The baseline national (wave 1) study was conducted in 2011, in which 17,596 community-dwelling residents participated, followed by wave 2 study in 2013 that involved 18,455 respondents. The wave 3 and 4 studies, which were carried out in 2014 and 2015, obtained information from 20,543 and 20,967 residents, respectively. Data from wave 3 were excluded from our study since wave 3 only collected information of one's life history (e.g. experience in one's childhood and adolescent). A total number of 13,436 residents participated in waves 1, 2, and 4. Since the fixed-effects regression investigates the relationships between the change in independent variables and that in dependent variables across each wave, we selected 10,988 participants according to the following criteria: 1) aged 45 and above, and 2) provided information on social participation and depression in all three waves. The detailed sampling

process is shown in Figure 1. Respondents were categorised into urban and rural residents according to their household living regions defined by National Bureau of Statistics of the People's Republic of China (Beaumaster et al., 2018).

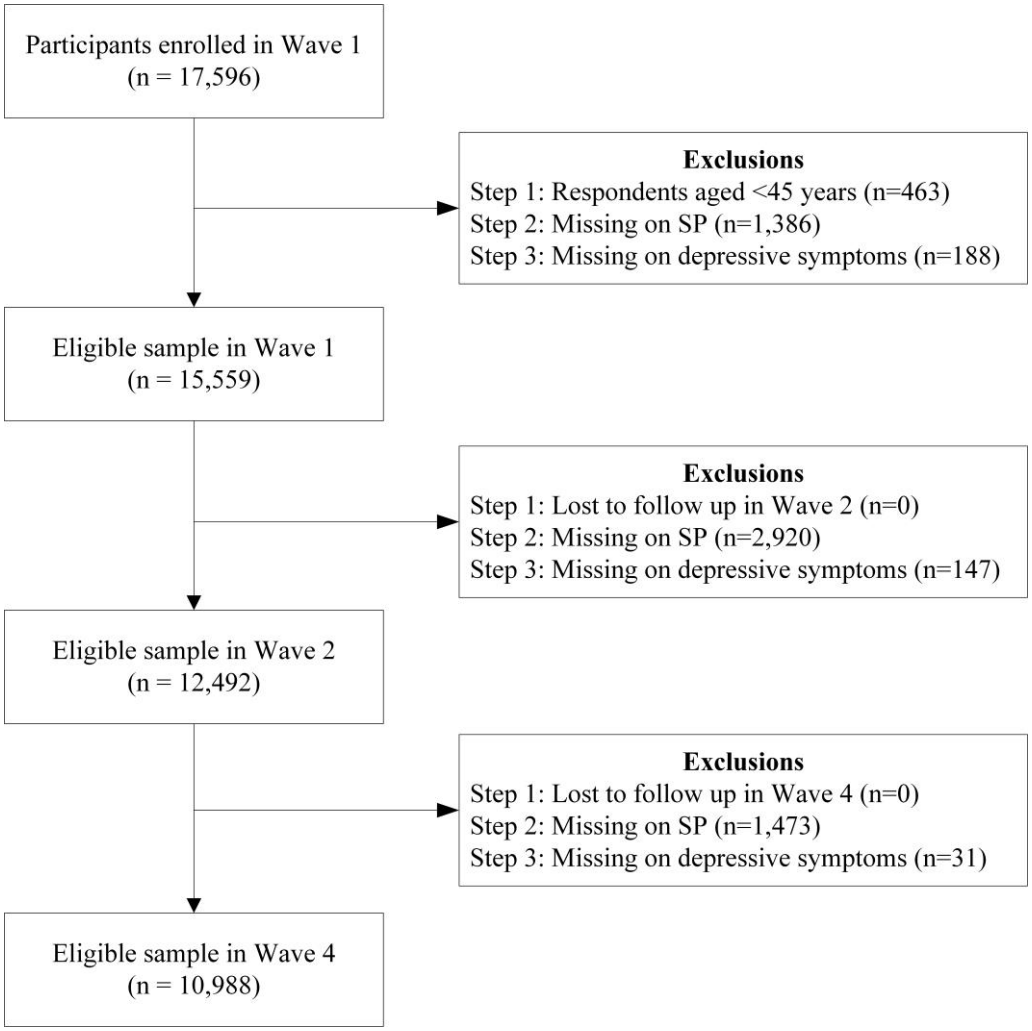


**Figure 1 Flowchart of participant selection**

## *2.2 Variables*

### *2.2.1 Depression*

A 10-item Center for Epidemiologic Studies Depression Scale (CES-D 10) was used to examine the depressive symptoms. The respondents were asked about their positive feelings, negative emotions and somatic symptoms during the last week. The answers for CES-D 10 are on a four-scale metrics coding from

0 to 3. The total score ranges from 0 to 30, with higher scores indicating more depressive symptoms. CES-D 10 has been used in previous studies and showed good internal reliability (Cronbach's alpha=0.815) (Boey, 1999). Several studies have reported a cut-off point of 12 with good validity to identify clinically significant depression (Cheng et al., 2016; Cheng & Chan, 2005). Accordingly, a score of 12 was used as the cut-off point to describe the prevalence of depression, whereas the CES-D 10 score was used in the fixed-effects analysis to examine the association between changes in SP and changes in depressive symptoms during waves 1, 2 and 4.

### *2.2.2 Social Participation*

In waves 1, 2, and 4 of CHARLS, respondents were asked whether they had conducted the following six types of SP in the last month: a) interacting with friends; b) playing mah-jong, chess, cards or going to other community clubs; c) going to a sport, social or other clubs; d) taking part in a community-related organisations; e) undertaking voluntary or charity work; f) providing help to relatives, friends or neighbours who do not live with the respondent for free. Besides the conventional types of SP, we also considered using Internet as one type of SP, given that prior studies have attributed using Internet to a new type of social activity, through which, senior adults can communicate with social ties, and therefore, be socially connected and gain social support by overcoming the barriers posed by mobility and activity limitations (Cotten et al., 2012, 2014). Meanwhile, the CHALRS also included using Internet into one of the options to this question. If the respondents answered "yes" to any of the aforementioned SP, they were asked about the frequency accordingly (almost daily/ almost every week/ not regularly).

In this study, we examined SP from three aspects:

1) Diversity: the total number of different types of SP one conducted. It was coded as: None/ 1 type/ $\geq 2$ types;

2) Frequency: the maximum frequency of SP one conducted. Considering that for the majority of these seven types of SP, the proportion of respondents who carried out SP with a frequency of almost daily was less than 0.5%, we then merged the two clusters "almost daily" and "almost every week" and recoded as "≥ 1/week". Therefore, the variable was coded as: None/ not regularly/ ≥ 1/week;

3) Type of SP (interacting with friends/ mah-jong or cards/ sports or social clubs/ community-related organisations/ voluntary or charity work/ using Internet/ providing help): the frequency of each specific SP was conducted. Since the percentages of respondents who went to sports or social clubs, community-related organisations, or used the Internet with a frequency of once a week or more were less than 1%, we then dichotomised these three types of SP into No/ Yes. Since the prevalence of respondents who took voluntary or charity work was less than 0.2%, whilst providing help to other without financial compensation can be attributed to a type of voluntary work, we then merged these two variables into one named "voluntary activity" following Lin (2017). The frequency was the higher one in these two types of SP and was classified into three groups: None/ not regularly/ ≥ 1/week. For the remaining two variables, including interacting with friends and playing mah-jong or cards, respondents were classified into three groups: None/ not regularly/ ≥ 1/week, in order to conduct subsequent in-depth analysis.

### *2.2.3 Potential confounding variables*

The following individual-level characteristics were considered as potential confounding variables (Table 1). Amongst these variables, gender and residency were time-invariant variables, whereas the rest were time-varying variables.

**Table 1 Definition/codes of the potential confounding variables**

| Variable | Codes/definition |
|---|---|
| Gender | 1 = Male; 2 = Female |
| Age | Continuous variable |

| | |
|---|---|
| Residency | 1 = Urban; 2 = Rural |
| Education | 1 = Illiterate; 2 = Primary school and lower; 3 = Junior middle school<br>4 = Senior middle school and higher |
| Retirement | 1 = No; 2 = Yes |
| Marital status | 1 = Single (divorced/widowed/single); 2 = Partnered (married/partnered) |
| Living near children | Whether the respondent has a child who lives in the same city/county as the respondent does.1 = No; 2 = Yes (any child co-resided or any non-co-resided child lived in the same city/county) |
| Household financial situation | Total household income/square root (# of people in the household) |
| Alcohol consumption | Ever consumed any alcohol last year. 1 = No; 2 = Yes |
| Smoke | Ever chewed tobacco, smoked a pipe, or smoked cigarette last year. 1 = No; 2 = Yes |
| # of types of non-communicable diseases (NCD) | 12 item summary of any physical non-communicable disease including hypertension, dyslipidaemia, diabetes, cancer, chronic lun diseases, liver disease, heart attack, stroke, kidney diseases, stomach o other digestive diseases, arthritis or rheumatism, and asthma.<br>1 = None; 2 = 1 type; 3 = 2 types; 4 = ≥3 types |
| # of types of lower body constraints | 4-item summary of any difficulty with mobility activities, including walking 100m, climbing several flights or stairs, getting up from a chair, and stooping or kneeling or crouching. 1 = None; 2 = 1 type; 3 = 2 types; 4 = ≥3 types |
| Wave (year) | 1 = “2011”; 2 = “2013”; 4 = “2015” |

### *2.3 Analytical strategy*

To address the potential endogeneity, longitudinal linear fixed-effects regression model (Sibalija et al., 2018) was employed to estimate the association between changes in SP and changes in depressive symptoms during three waves. This model treats each individual as their own control, and therefore, controls the potential time-invariant confounders that only varied between individuals. This model is particularly

effective in reducing biases brought about by the between-individual and hard-to-observe (such as personality) factors (Milner & LaMontagne, 2017) that influence both SP and depressive symptoms. Meanwhile, the model also allows us to control time-variant factors that do not vary across individuals.

Specification of our model was as follows:

$$\text{CES-D}_{it} = \mu_t + \beta_1 \text{SP}_{it} + \beta_2 x_{it} + \propto_i + \varepsilon_{it}$$

Where $\text{CES-D}_{it}$ refers to CES-D scores for individual i at time t. Similarly, $\text{SP}_{it}$ denotes three dimensions of SP (diversity, frequency and type) of SP for individual i at time t. $x_{it}$ indicates time-varying variables, including age, marital status, education, living near child(ren), retirement status, household financial situation, alcohol consumption, smoke, numbers of types of NCDs, and numbers of types of lower body constraints. $\mu_t$ suggests time (year) effects, $\propto_i$ characteristics the individual-level effect of all time-invariant variables, such as gender and personality, and $\varepsilon_{it}$ is the error term.

To test the feasibility of the fixed-effects model, we firstly implemented F-test between the pooled ordinary least squares (OLS) and fixed-effects model. The test yielded statistical significance ($p < 0.001$), which indicated that the former would be biased. We then employed a Hausman specification test between the fixed-effects model and the random-effects model, which was also statistically significant ($p < 0.001$). Therefore, we chose the fixed-effects model.

In agreement with Milner et al. (2016), who assumed perceived social support would have an immediate effect on one's mental health, we assessed the effects of SP on depression contemporaneously based on the assumption that there may be no or very limited time lag for SP to influence one's depressive symptoms. Coefficients ($\beta_1$) and their 95% Confidence Intervals (95% CIs) were presented as measures of effect. Data were analysed using R Version 3.5.1.

## 3. Results

### *3.1 Basic characteristics of the respondents*

Basic characteristics of the whole sample population, as well as of those who resided in rural and urban areas in wave 1 study (2011) are shown in Table 2. The mean age at baseline was 58 years. Of the 10,988 participants, a greater proportion were rural residents (64.66%), female (52.94%), with a primary school or lower level of education (68.76%), having a partner (88.81%), living near child(ren) (92.04%), and currently working (75.42%). The majority of respondents did not consume alcohol (67.02%) or smoke (69.30%); were affected by at least one type of NCDs (69.55%); and suffered from lower-body constraints (50.16%).

Compared with those residing in urban areas, rural respondents held lower education level (6.49% with senior high school and above education in rural respondents vs. 18.28% in urban counterparts) and poorer household financial situation (6250 RMB vs 16971 RMB), and kept working (83.73% vs 60.21%). Moreover, we observed significantly different patterns in the variety and frequency of SP between respondents in rural and urban areas. Except living near child(ren) and numbers of types of NCDs, all covariates were significantly associated with the variety and frequency of SP.

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**Table 2 Sample characteristics of the selected respondents at baseline**

| | Residency | | | | Variety | | | | Frequency | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total (n=10988) | Urban (n= 3883) | Rural (n= 7105) | *p* | None (n=5595) | 1 type (n=3611) | ≥2 types (n=1782) | *p* | None (n=5595) | Not regularly (n=1539) | ≥ 1/week (n=3854) | *p* |
| | n (%) | n (%) | n (%) | | n (%) | n (%) | n (%) | | n (%) | n (%) | n (%) | |
| **Gender** | | | | 0.033[a] | | | | <0.001[a] | | | | 0.008 [a] |
| Male | 5171 (47.06) | 1774 (45.69) | 3397 (47.81) | | 2596 (46.40) | 1622 (44.92) | 953 (53.48) | | 2596 (46.4) | 781 (50.75) | 1794 (46.55) | |
| Female | 5817 (52.94) | 2109 (54.31) | 3708 (52.19) | | 2999 (46.40) | 1989 (55.08) | 829 (46.52) | | 2999 (53.6) | 758 (49.25) | 2060 (53.45) | |
| **Age** | | | | <0.001[b] | | | | <0.001[d] | | | | <0.001[d] |
| Mean (SD) | 58 (8.80) | 58 (9.00) | 58 (8.69) | | 59 (8.70) | 58 (8.96) | 57 (8.62) | | 59 (8.7) | 57 (8.28) | 58 (9.07) | |
| **Education** | | | | <0.001[a] | | | | <0.001[a] | | | | <0.001[a] |
| illiterate | 3001 (27.31) | 687 (17.69) | 2314 (32.57) | | 1704 (30.47) | 996 (27.58) | 275 (15.44) | | 1704 (30.47) | 362 (23.52) | 909 (23.59) | |
| ≤primary school | 4555 (41.45) | 1501 (38.66) | 3054 (42.98) | | 2386 (30.47) | 1523 (42.18) | 682(38.29) | | 2386 (42.67) | 664 (43.14) | 1541 (39.99) | |
| middle school | 2261 (41.45) | 985 (25.37) | 1276 (17.96) | | 1085 (19.40) | 706 (19.55) | 458 (25.72) | | 1085 (19.4) | 346 (22.48) | 818 (21.23) | |
| ≥high school | 1171 (10.66) | 710 (18.28) | 461 (6.49) | | 417 (7.46) | 386 (10.69) | 366 (20.55) | | 417 (7.46) | 167 (10.85) | 585 (15.18) | |
| **Household financial situation[1]** | | | | <0.001[c] | | | | <0.001[d] | | | | <0.001[d] |
| Median (Min, Max) | 9256 (-115117, 1099100) | 16971 (-115117, 1099100) | 6250 (-91600, 593689) | | 7509 (-115117, 1099100) | 9873 (-58138, 1099100) | 14,411 (-87600, 282843) | | 7509 (-115117, 1099100) | 9180 (-36027, 659824) | 12,704 (-87600, 1099100) | |
| **Marital status** | | | | 0.583[a] | | | | 0.032[a] | | | | 0.01[a] |
| Single | 1230 (11.19) | 426 (10.97) | 804 (11.32) | | 633 (11.31) | 428 (11.85) | 169 (9.48) | | 633 (11.31) | 139 (9.03) | 458 (11.88) | |
| Partnered | 9758 (88.81) | 3457 (89.03) | 6301 (88.68) | | 4962 (88.69) | 3183 (88.15) | 1613 (90.52) | | 4962 (88.69) | 1400 (90.97) | 3396 (88.12) | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Living near child(ren)[2]** | | | <0.001[a] | | | 0.174[a] | | | | 0.569[a] |
| No | 855 (7.96) | 248 (6.54) | 607 (8.74) | 420 (7.70) | 277 (7.83) | 158 (9.06) | | 420 (7.7) | 126 (8.37) | 309 (8.19) | |
| Yes | 9881 (92.04) | 3546 (93.46) | 6335 (91.26) | 5037 (92.30) | 3259 (92.17) | 1585 (90.94) | | 5037 (92.3) | 1380 (91.63) | 3464 (91.81) | |
| **Retirement[3]** | | | <0.001[a] | | | <0.001[a] | | | | <0.001[a] |
| No | 8262 (75.42) | 2330 (60.21) | 5932 (83.73) | 4319 (77.47) | 2666 (74.03) | 1277 (71.78) | | 4319 (77.47) | 1271 (82.69) | 2672 (69.53) | |
| Yes | 2693 (24.58) | 1540 (39.79) | 1153 (16.27) | 1256 (22.53) | 935 (25.97) | 502 (28.22) | | 1256 (22.53) | 266 (17.31) | 1171 (30.47) | |
| **Alcohol consumption** | | | 0.591[a] | | | <0.001[a] | | | | <0.001[a] |
| No | 7364 (67.02) | 2615 (67.34) | 4749 (66.84) | 3890 (69.53) | 2428 (67.24) | 1046 (58.7) | | 3890 (69.53) | 925 (60.1) | 2549 (66.14) | |
| Yes | 3624 (32.98) | 1268 (32.66) | 2356 (33.16) | 1705 (30.47) | 1183 (32.76) | 736 (41.3) | | 1705 (30.47) | 614 (39.9) | 1305 (33.86) | |
| **Smoke[4]** | | | <0.001[a] | | | <0.001[a] | | | | <0.001[a] |
| No | 7614 (69.30) | 2797 (72.05) | 4817 (67.80) | 3929 (70.22) | 2538 (70.3) | 1147 (64.37) | | 3929 (70.22) | 997 (64.78) | 2688 (69.76) | |
| Yes | 3373 (30.70) | 1085 (27.95) | 2288 (32.20) | 1666 (29.78) | 1072 (29.7) | 635 (35.63) | | 1666 (29.78) | 542 (35.22) | 1165 (30.24) | |
| **Types of NCDs[5]** | | | 0.075[a] | | | 0.756[a] | | | | 0.102[a] |
| No NCD | 3214 (30.45) | 1095 (29.36) | 2119 (31.04) | 1621 (30.00) | 1060 (30.82) | 533 (31.12) | | 1621 (30) | 460 (31.42) | 1133 (30.72) | |
| 1 type | 3092 (29.29) | 1073 (28.77) | 2019 (29.57) | 1612 (29.83) | 1005 (29.22) | 475 (27.73) | | 1612 (29.83) | 451 (30.81) | 1029 (27.9) | |
| 2 types | 2178 (20.63) | 789 (21.16) | 1389 (20.35) | 1119 (20.71) | 703 (20.44) | 356 (20.78) | | 1119 (20.71) | 267 (18.24) | 792 (21.48) | |
| ≥3 types | 2072 (19.63) | 772 (20.70) | 1300 (19.04) | 1052 (19.47) | 671 (19.51) | 349 (20.37) | | 1052 (19.47) | 286 (19.54) | 734 (19.9) | |
| **Lower body mobility** | | | <0.001[a] | | | <0.001[a] | | | | <0.001[a] |
| No constraint | 5366 (48.84) | 2083 (53.64) | 3283 (46.21) | 2583 (46.17) | 1756 (48.63) | 1027 (57.63) | | 2583 (46.17) | 705 (45.81) | 2078 (53.92) | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 type | 2308 (21.00) | 815 (20.99) | 1493 (21.01) | | 1193 (21.32) | 770 (21.32) | 345 (19.36) | | 1193 (21.32) | 340 (22.09) | 775 (20.11) | |
| 2 types | 1621 (14.75) | 503 (12.95) | 1118 (15.74) | | 823 (14.71) | 574 (15.9) | 224 (12.57) | | 823 (14.71) | 268 (17.41) | 530 (13.75) | |
| ≥3 types | 1693 (15.41) | 482 (12.41) | 1211 (17.04) | | 996 (17.80) | 511 (14.15) | 186 (10.44) | | 996 (17.8) | 226 (14.68) | 471 (12.22) | |
| **Residency** | | | | -- | | | | <0.001[a] | | | | <0.001[a] |
| Urban | -- | -- | -- | | 1849 (33.05) | 428 (11.85) | 825 (46.3) | | 1849 (33.05) | 467 (30.34) | 1567 (40.66) | |
| Rural | -- | -- | -- | | 3746 (66.95) | 3183 (88.15) | 957 (53.7) | | 3746 (66.95) | 1072 (69.66) | 2287 (59.34) | |

N.B. The total percentage may not equal to 100 due to rounding. [1]: missing data n = 1,544; [2]: missing data n = 252; [3]: missing data n = 33; [4]: missing data n = 1; [5]: missing data n = 432; [a]: outcomes of Chi-square test; [b]: outcome of Student-t test; [c]: outcome of Wilcoxon rank sum test; [d]: outcome of Kruskal-Wallis test.

### *3.2 Social Participation in rural and urban residents*

Table 3 presents the diversity, frequency, and type of SP rural and urban respondents took in all three waves. A relatively large proportion of respondents did not take part in any SP in all three waves (50.92% in 2011, 43.97% in 2013, and 49.51% in 2015), especially joining community organisations (98.63%, 97.99% and 97.64% in 2011, 2013 and 2015, respectively) or using Internet (98.37%, 97.38% and 96.88% in three waves). Amongst those who had SP, the majority took part in 1 type of SP (66.95%, 60.65% and 57.75% in three waves), and with a frequency of more than once a week (71.45%, 71.83% and 68.65% in 2011, 2013 and 2015). Amongst 6 types of SP, urban and rural respondents were more likely to interact with friends or play mah-jong or cards.

Patterns of SP varied remarkably between rural and urban areas. Compared with urban respondents, rural respondents were less likely to participate in more types of social activities (13.47% respondents took part in two or more types of SP vs 21.25% urban counterparts in 2011, with 18.30% vs 28.92% in 2013 and 18.20% vs 27.07% in 2015) with higher frequency (32.19% rural respondents join SP more than once a week vs 40.36% in urban counterparts, with 36.26% vs 47.51% in 2013 and 31.44% vs 40.54% in 2015). This is especially the case in sports or social clubs (1.00% vs 12.98%, 3.32% vs 15.71%, and 4.70% vs 12.26% in three waves), Internet use (0.20% vs 4.25%, 0.56% vs 6.39%, and 1.07% vs 6.88% in three waves), and community organisations (0.73% vs 2.55%, 1.14% vs 3.61%, and 1.51% vs 3.91% in three waves).

Generally speaking, the proportion of those who took SP slightly increased during the past three waves. The increase was salient in those who carried out voluntary activities (7.56%, 13.83% and 14.96% in three waves). However, a decreasing trend was observed in those who interacted with friends regularly and the trend was more prominent in rural residents (26.15%, 27.53% and 21.93% in 2011, 2013 and in 2015).

**Table 3 Social participation of the selected respondents (%)**

| | Wave 1 (2011) | | | Wave 2 (2013) | | | Wave 4 (2015) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total (n=10988) | Urban (n=3883) | Rural (n=7105) | Total (n=10988) | Urban (n=3883) | Rural (n=7105) | Total (n=10988) | Urban (n=3883) | Rural (n=7105) |
| **Diversity** | | | | | | | | | |
| None | 50.92 | 47.62 | 52.72 | 43.97 | 38.58 | 46.91 | 49.51 | 43.83 | 52.61 |
| 1 type | 32.86 | 31.14 | 33.81 | 33.98 | 32.50 | 34.79 | 29.16 | 29.10 | 29.19 |
| ≥ 2 types | 16.22 | 21.25 | 13.47 | 22.05 | 28.92 | 18.30 | 21.33 | 27.07 | 18.20 |
| **Frequency** | | | | | | | | | |
| None | 50.92 | 47.62 | 52.72 | 43.98 | 38.58 | 46.94 | 49.52 | 43.83 | 52.62 |
| Not regularly | 14.01 | 12.03 | 15.09 | 15.78 | 13.91 | 16.81 | 15.83 | 15.63 | 15.93 |
| ≥ 1/week | 35.07 | 40.36 | 32.19 | 40.23 | 47.51 | 36.26 | 34.66 | 40.54 | 31.44 |
| **Voluntary activities** | | | | | | | | | |
| None | 92.44 | 92.17 | 92.58 | 86.18 | 84.75 | 86.95 | 85.04 | 84.57 | 85.29 |
| Not regularly | 5.42 | 5.33 | 5.48 | 9.96 | 10.43 | 9.70 | 11.21 | 11.77 | 10.91 |
| ≥ 1/week | 2.14 | 2.50 | 1.94 | 3.87 | 4.82 | 3.35 | 3.75 | 3.66 | 3.80 |
| **mah-jong, cards, chess or other clubs** | | | | | | | | | |
| None | 81.59 | 78.34 | 83.36 | 79.31 | 75.59 | 81.35 | 81.34 | 76.95 | 83.74 |
| Not regularly | 7.66 | 7.13 | 7.95 | 7.86 | 7.62 | 7.99 | 7.35 | 7.83 | 7.09 |
| ≥ 1/week | 10.75 | 14.52 | 8.68 | 12.82 | 16.79 | 10.65 | 11.30 | 15.22 | 9.16 |
| **Interacting with friends** | | | | | | | | | |
| None | 64.52 | 66.93 | 63.21 | 59.85 | 58.79 | 60.42 | 65.50 | 63.12 | 66.80 |
| Not regularly | 10.29 | 9.66 | 10.64 | 12.58 | 13.55 | 12.05 | 12.32 | 14.24 | 11.27 |
| ≥ 1/week | 25.18 | 23.41 | 26.15 | 27.58 | 27.66 | 27.53 | 22.18 | 22.64 | 21.93 |
| **Sports or social clubs** | | | | | | | | | |
| No | 94.77 | 87.02 | 99.00 | 92.30 | 84.29 | 96.68 | 92.63 | 87.74 | 95.30 |
| Yes | 5.23 | 12.98 | 1.00 | 7.70 | 15.71 | 3.32 | 7.37 | 12.26 | 4.70 |
| **Internet** | | | | | | | | | |
| No | 98.37 | 95.75 | 99.80 | 97.38 | 93.61 | 99.44 | 96.88 | 93.12 | 98.93 |
| Yes | 1.63 | 4.25 | 0.20 | 2.62 | 6.39 | 0.56 | 3.12 | 6.88 | 1.07 |
| **Community organisation** | | | | | | | | | |
| No | 98.63 | 97.45 | 99.27 | 97.99 | 96.39 | 98.86 | 97.64 | 96.09 | 98.49 |
| Yes | 1.37 | 2.55 | 0.73 | 2.01 | 3.61 | 1.14 | 2.36 | 3.91 | 1.51 |

N.B. To some variables, the total percentage may not equal to 100 due to rounding.

### *3.3 Prevalence of depression in urban and rural residents*

A great variation in the prevalence of depression was observed between rural and urban areas (Figure 2). Compared with urban counterparts, rural respondents suffered from higher risks of depression in all three waves (31.65 vs 21.19%, 26.09% vs 18.67%, and 30.12% vs 21.17% in 2011, 2013 and 2015, respectively). The prevalence of depression slightly declined from 2011 to 2013 in both urban and rural residents, whereas a slight increase was observed between 2013 and 2015.

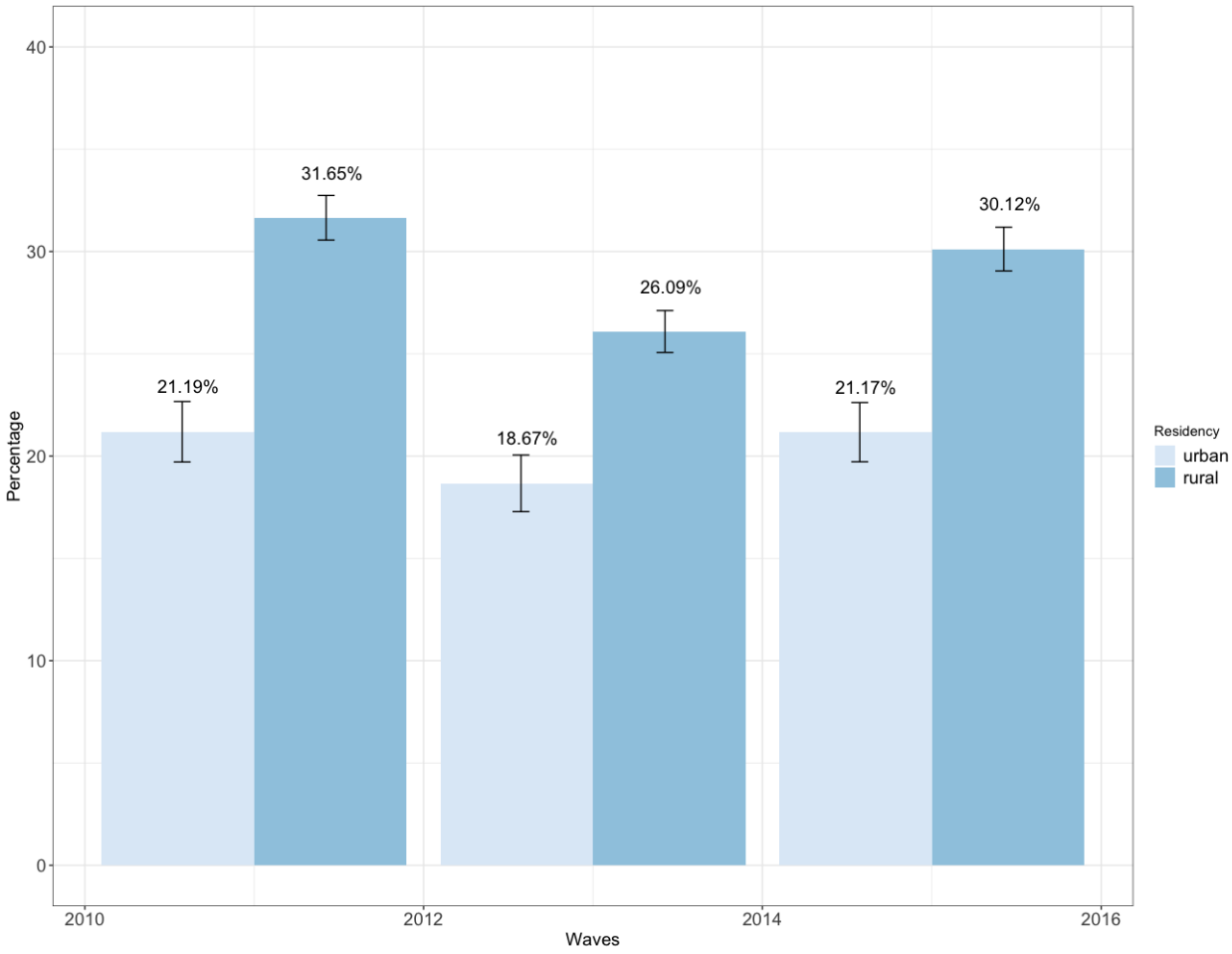


**Figure 2 Prevalence of depression in urban and rural respondents**

N.B. The 95% CIs for urban and rural respondents in 2011 were 1.48% and 1.09%, respectively. The figures were 1.38% and 1.02% in 2013, and 1.45% and 1.07% in 2015.

### *3.4 Relationship between SP and depressive symptoms in urban and rural residents*

Table 3 outlines the contemporaneous association between the depressive symptoms and the diversity, frequency and type of SP between waves 1, 2 and 4 with other time-varying confounders controlled. Broadly speaking, transiting from no SP to one or more types of SP (1 type: β= −0.242, 95% CI: −0.443, −0.040; ≥ 2 types: β= −0.371, 95% CI: −0.641, −0.102) or to once a week or higher frequency (β= −0.409, 95% CI: −0.622, −0.196) was significantly associated with a decline in depressive symptoms. Interacting with friends regularly (β= −0.344, 95% CI: −0.559. −0.128), playing mah-jong regularly (β= −0.465, 95% CI: −0.835, −0.095) and joining sports or social clubs ($\beta_{=}$ −0.461, 95% CI: −0.844, −0.078) also predicted a decline in depressive symptoms. No significant association between depressive symptoms and voluntary activities, community organisations or Internet use was observed.

The association varied significantly between urban and rural respondents. Significantly negative association between depressive symptoms and mah-jong playing (β= −0.554, 95% CI: −1.155, 0.048 for not regular, β= −0.678, 95% CI: −1.211, −0.144 for once a week or more frequent), sports or social club participation (β= −0.455, 95% CI: −0.904, −0.005) was only observed in urban respondents. Similarly, a significant association between regular interaction with friends and a decline in depressive symptoms (β= −0.487, 95% CI: −0.760, −0.215) was only observed in rural respondents but not in urban counterparts.

**Table 4 Associations between depressive symptoms and SP diversity, frequency and type using the fixed-effects regression**

| | Model 1: Whole sample (n= 10,988) | | Model 2: Urban (n= 3,883) | | Model 3: Rural (n= 7,105) | |
|---|---|---|---|---|---|---|
| | β | 95% CI | β | 95% CI | β | 95% CI |
| Variety (reference: None) | | | | | | |
| 1 type | **−0.242*** | **−0.443, −0.040** | −0.202 | −0.541, 0.138 | **−0.261*** | **−0.511, −0.011** |
| ≥ 2 types | **−0.371**** | **−0.641, −0.102** | **−0.481*** | **−0.895, −0.067** | −0.292 | −0.645, 0.062 |
| Frequency (reference: None) | | | | | | |
| Not regularly | −0.042 | −0.296, 0.212 | −0.295 | 0.645, 0.226 | 0.027 | −0.286, 0.340 |

| | | | | | | |
|---|---|---|---|---|---|---|
| ≥ 1/week | **−0.409*** ** | **−0.622, −0.196** | **−0.328+** | **−0.672, 0.025** | **−0.454*** ** | **−0.724, −0.185** |
| Interacting with friends (reference: None) | | | | | | |
| Not regularly | 0.028 | −0.242, 0.299 | 0.101 | −0.332, 0.535 | −0.004 | −0.350, 0.341 |
| ≥ 1/week | **−0.344**** | **−0.559, −0.128** | −0.047 | −0.398, 0.303 | **−0.487*** ** | **−0.760, −0.215** |
| mah-jong (reference: None) | | | | | | |
| Not regularly | −0.270 | −0.645, 0.105 | **−0.554+** | **−1.155, 0.048** | −0.106 | −0.584, 0.372 |
| ≥ 1/week | **−0.465*** | **−0.835, −0.095** | **−0.678*** | **−1.211, −0.144** | −0.310 | −0.816, 0.195 |
| Voluntary activities (reference: None) | | | | | | |
| Not regularly | 0.074 | −0.224, 0.371 | −0.361 | −0.840, 0.119 | 0.294 | −0.084, 0.673 |
| ≥ 1/week | −0.340 | −0.887, 0.088 | −0.353 | −1.074, 0.368 | −0.476 | −1.113, 0.176 |
| Sports (reference: No) | | | | | | |
| Yes | **−0.461*** | **−0.844, −0.078** | **−0.455*** | **−0.904, −0.005** | −0.318 | −0.969, 0.333 |
| Internet (reference: No) | | | | | | |
| Yes | 0.022 | −0.754, 0.799 | −0.016 | −0.871, 0.839 | 0.083 | −1.486, 1.651 |
| Community organisation (reference: No) | | | | | | |
| Yes | 0.048 | −0.574, 0.669 | −0.215 | −0.984, 0.555 | 0.381 | −0.608, 1.371 |

N.B. All models controlled time-varying variables, including wave, age, education, marital status, living near children, retirement status, household financial situation, alcohol consumption, smoke, # of types of NCDs, and # of types of lower body constraints; + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

## 4. Sensitivity analysis

Considering that the fixed-effects analysis examined the relationship between changes in independent variables and dependent variables across waves, we only included respondents who participated and provided information regarding both SP and depressive symptoms in all three waves by assuming that the missing variables were missing completely at random (MCAR). In addition, we used multiple imputation techniques (using demographics, health behaviour and health outcome variables as predictors) to deal with the missing values amongst those who participated in all three waves (n=13,091) and to check the

robustness of our results. In conclusion, findings yielded using multiple imputation techniques did not differ much from those resulted from the complete cases: the direction and magnitude of effects stayed similar, whereas only some associations became statistically significant under the new sample population. Detailed results can be found in the supplementary document.

As some prior studies have observed a gender disparity in the association between SP and mental health (Takagi et al., 2013; Tomioka et al., 2017), we also stratified the sample by gender to better understand this relationship. The findings suggested negative associations between SP and depressive symptoms in both women and men alike. Meanwhile, the difference between women and men in terms of the associations was smaller than that between rural and urban respondents. In this case, we focused our attention on the rural-urban disparity.

## 5. Discussion

This study explored the prevalence of SP and depression in middle- and old-aged residents in both rural and urban China, based on which, further examined the association between changes in SP and that in depressive symptoms by considering three dimensions of SP, including diversity, frequency and type. The findings revealed that: 1) compared with urban counterparts, rural respondents had significantly higher risk of depression; 2) the patterns of SP varied largely between rural and urban respondents with a significantly lower prevalence of SP in rural areas; and 3) SP was related to lower risk of depression, whereas the magnitude depended largely on the type of SP and the residency of respondents.

### *5.1 Prevalence of depression*

To sum up, the findings outlined a high prevalence of depression risk in middle- and old-aged Chinese (over 25% in all three waves). It is consistent with the figures calculated by some recent studies concerning

the senior population in China (Li et al., 2014; Li et al., 2012), and is significantly higher than that was found two decades ago (3.86%) (Chen et al., 1999). Moreover, it is far beyond the average level of LMICs (Stubbs et al., 2016; Vancampfort et al., 2018) and even some developed countries (Jung et al., 2018; Mc Dowell et al., 2018). This not only warns about the daunting challenge China faces in terms of the increasing burden of depression, but also reminds us the urgent need for more accessible and viable approaches in a context with insufficient professional resources. In addition, a substantial difference in the risk of depression between rural and urban residents was observed: rural residents suffered from a higher odds of depression than urban residents did, which can be supported by prior studies regarding China's context (Li et al., 2016). The finding suggests that the mental health of middle- and old-aged Chinese in rural areas deserves special attention.

### *5.2 Patterns of Social Participation in urban and rural areas*

This study outlined significant differences in the patterns of SP between urban and rural areas: compared with urban respondents, rural respondents were much less likely to take part in social activities, and the gap was especially significant in mah-jong or cards clubs, sports or social clubs and Internet use. This finding is in line with prior studies (Guo et al., 2018; He et al., 2017; Meng & Chen, 2014; Vogelsang, 2016). Underlying reasons might be attributed to: 1) we found that more than 80% of the rural respondents were still working whereas more than 70% did not finish primary school, which indicates that, on the one hand, the heavier financial stress did not leave rural residents much leisure time for these non-profitable social activities, and on the other hand, the lower education may be a barrier to appreciate the benefit of SP (Lin, 2017); 2) some social activities require suitable facilities such as walkable roads (Vogelsang, 2016) and Internet infrastructure, but the poorer community infrastructure failed to provide sufficient encouragement and opportunities for rural residents to widely participate in social activities (Bowling & Stafford, 2007; He et al., 2017).

Nevertheless, irrespective of the relatively low prevalence, we also observed a general uptrend in rural residents participating in social activities. The trend is especially remarkable in voluntary activities and sports or social clubs. This indicates that it is viable to promote SP in middle- and old-aged Chinese as long as a SP-related facilities/environment are well established.

### *5.3 Association between social participation and depression*

This study found that taking part in more diverse social activities and with a once a week or higher frequency predicted a decline in depressive symptoms in both urban and rural residents. Similar findings are seen in prior studies (Guo et al., 2018; Vogelsang, 2016). Moreover, this study also found that the strength of the association mainly depended on residency and type of activity. To be more specific, significantly negative relationship between depressive symptoms and sports or social clubs and mah-jong or cards clubs were observed in urban residents but not rural residents, whereas, interacting with friends was the only type of social activity that was negatively related to depressive symptoms.

Regarding mah-jong, chess, card playing and other community clubs, to the best of our knowledge, this is the first study that examined the relationship between mah-jong playing, a traditional Chinese entertainment, and depressive symptoms in middle- and old-aged Chinese. This study discovered a significantly negative association between mah-jong playing and depressive symptoms in urban respondents. A similar study (Zhu et al., 2009) suggested that playing mah-jong for entertainment could help one gain more social support, which may result in fewer depressive symptoms. In urban areas, mah-jong is a popular social activity that urban residents usually choose to accompany family members or friends, or to pass the time (Wang, 2014). This is especially the case for residents after retirement. In this case, increased social contacts may be the underlying reason for urban residents to benefit from playing mah-jong. However, mah-jong tends to be a popular type of gambling in rural China (Steinmueller, 2011). Therefore, the eagerness to win and the sense of loss when losing money may offset the potential benefit brought by social network

established in mah-jong playing, and may explain the reason why no such negative association was observed in rural residents. This finding, on the one hand, reveals how China's own culture influences one's behaviour and its association with their mental health, and on the other hand, implies that the causal mechanism of mah-jong playing on depressive symptoms worth further investigation in order to develop target policies to promote the mental health of urban residents.

Regarding sports and social clubs, this study yielded two findings: first, the prevalence rate of joining sports or social clubs in urban areas was more than double of that in rural areas. Second, this type of SP predicted a decline in depressive symptoms in urban areas, whereas the association was not observed in rural areas. Combining these two findings, we speculate that joining sports and social clubs is a relatively popular type of SP in urban areas. One who takes part in activities such as square dance and Tai Chi tends to be accompanied by others in the community (He et al., 2017). The social interaction may help them establish their own social networks, and therefore, develop a sense of belonging (Zhang & Chen, 2014). The finding is consistent with that revealed by Croezen et al. (2015) and Vogelsang (2016). On the contrary, the majority of rural residents are farmers who spend considerably long time on labour work (vigorous physical activity), who may be less interested in taking part in other sports or social clubs. Compared with their urban counterparts, the lower prevalence suggests the smaller scale of sports or social clubs in rural areas, which may result in smaller social network and less social capital one can gain in rural areas.

Interacting with friends is the only type of SP found to be negatively associated with depressive symptoms in rural residents. Potentially underlying reasons might be the type of social ties: urban residents tend to have a social network that consists of weak ties with people from various backgrounds but of low intimacy, nevertheless, the social relationship in rural China is still dominated by the conventional kinship and neighbourhood networks (Norstrand & Xu, 2012). In other words, compared with their urban counterparts, the social network amongst rural residents is limited but strong and stable (Lin & Si, 2010; Liu et al., 2019). The higher level of bonding may help rural residents to increase their social identity, develop trust on their

435 friends, gain more emotional support from the strong ties (Mair & Thivierge-Rikard, 2010), and therefore,
436 protect their mental health (Wang et al., 2009; Yip et al., 2007). The downward trend of interaction with
437 friends, therefore, reminds the necessity of paying more attention to those who reduced interaction with
438 friends in rural areas.
439
440 It is counterintuitive that no significant association between depressive symptoms and voluntary activities
441 was observed as that was in some studies conducted in western countries (Piliavin & Siegl, 2007; von
442 Bonsdorff & Rantanen, 2011). There might be two underlying reasons. The first potential reason for the
443 disagreement may be the types of voluntary activities: due to the high popularity of participation in
444 voluntary and charity work, previous studies conducted in western countries tended only to include those
445 participated in formal voluntary work (Bourassa et al., 2017). This type of formal voluntary work may help
446 one gain social support and feel less isolated through helpful social interaction with people in their
447 community (Lin et al., 1999; Musick & Wilson, 2003). However, in this study, given the limited number
448 of respondents who participated in formal voluntary activities, most of the respondents included in this
449 variable were who helped others without compensation. As Musick and Wilson (2003) revealed, the social
450 significance of voluntary work varies between different types of activity, helping others may come with a
451 sense of obligation and may even induce fatigue feelings (Li & Ferraro, 2005), which may largely offset
452 the emotional benefit it brings to middle- and old-aged residents, especially rural residents who live in lower
453 SES. Second, we have conducted a power analysis between depressive symptoms and voluntary activities
454 and found that the required sample size to reject the null hypothesis for the relationship between voluntary
455 activities and depressive symptoms was 957. Considering that only 235 and 385 respondents took part in
456 voluntary activities with a frequency of once a week or higher in 2011 and 2015, the lack of significant
457 association may be attributed to a lack of sufficient sample size.
458
459 *5.4* Strength and limitations

To the best of our knowledge, the study is the first one to measure the association between social participation and depression in middle- and old-aged Chinese using fixed-effects analysis that rules out the potential endogeneity. By assessing the net association between changes in SP and changes in depressive symptoms, this study confirmed that larger diversity and higher frequency of SP was associated with a decline in depressive symptoms. Meanwhile, this study is also one of the very few studies that took into consideration the rural-urban disparity and mah-jong, one of the most popular means of entertainment, in China's context. The findings revealed huge rural-urban differences in depression, patterns of SP and the association between SP and depressive symptoms, whereas outlined the association between playing mah-jong and decline in depressive symptoms in urban areas. These findings not only informed the type and amount of SP that is associated with better mental health, but also reminded the necessity of taking residency and culture into consideration when further investigating the causal relationship, which may contribute to the development of more targeted strategies in China's context.

The findings should be interpreted with caution because of the following limitations. First, considering both that SP brings contemporaneous effects to depression whereas some short-term benefits may diminish over time (Croezen et al., 2015), and that there was a 2 year timespan between each wave of study (2011, 2013 and 2015), this study used SP and depressive symptoms in all three waves rather than a lagged model. The sample size in this study was indeed larger than it would be in a lagged model, however, the exact causal relationship still awaits further investigation. Second, while the fixed-effects analysis indeed controlled individual-level time-invariant confounders, there might be unmeasurable or unmeasured time-varying variables that had not been included in this study. Third, the sample sizes for those who took part in voluntary activities or community organisations, or used Internet were significantly smaller than the minimum sample size to reject the null hypothesis. In this case, the relationships between these three types of SP and depressive symptoms await future studies with larger sample size.

## 6. Conclusions

In summary, this study has three main findings. First, rural respondents suffered from significantly higher risk of depression and took less SP than their urban counterparts. Second, more diverse and higher frequency of SP predicted a lower level of depressive symptoms in both rural and urban residents. This finding confirmed that after controlling all individual-level time-invariant confounding variables and some measurable time-varying confounding factors, the association between taking SP and better mental health still held. Third, the association between SP and depression did vary across different types of activities and between rural and urban residents. Specifically speaking, playing mah-jong or cards and joining sports or social clubs were associated with fewer depressive symptoms in urban residents, whereas interacting with friends regularly predicted a decline in depressive symptoms in rural areas. The findings, especially the potential effect of playing mah-jong, not only implied the amount and type of SP that may be associated with better mental health, but also reminded the need to consider China's cultural context, especially urban-rural disparity, when designing targeted interventions in China.

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