Rotating savings and credit association, its members’ diversity, and higher-level functional capacity: A 3-year prospective study from the Japan Gerontological Evaluation Study

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Introduction

Social capital is recognized as an important social determinant of functional capacity in later life.1,2 Putnam defines social capital as “features of social organization, such as trust, norms and networks, that can improve the efficiency of society by facilitating coordinated actions.”3 In his book, Putnam exemplifies social capital by referring to rotating savings and credit associations (ROSCA), which are informal local microfinance groups that exist globally.3 In a ROSCA, members regularly participate in meetings and need to deposit a fixed amount of money; an assigned member then receives the aggregate deposit. The same process continues until all members take an aggregate deposit, and those who have received money cannot drop out of the group at this time. Therefore, members must trust each other, facilitating the building of cohesive social capital. Some studies examining ROSCA in developing countries suggested beneficial associations of participation in ROSCA with health outcomes.4–6 Japanese ROSCA are called mujin (also known as tanomoshi-ko, yui or moai). Although mujin have largely disappeared as formal banking systems developed after World War II, they remain active in some regions. Currently, the purpose of mujin is to promote friendship rather than mutual financial aid.7 For example, mujin are still actively organized in Yamanashi Prefecture. In 2013, its residents were reported to enjoy the longest healthy life expectancy (defined as “expectation of life free of limitations for activities of daily living”)
Among Japan’s 47 prefectures. Given the cohesive social capital they build, mujin activity might be the secret to their healthy longevity.

A few studies examined the associations between mujin and health in older populations. Kondo et al. found that older adults with a higher level of engagement (i.e., participation history, maximum number of memberships and duration of membership) in mujin had greater social role performance than non-participants. In their later work, they used cohort data, and suggested that those who enjoyed mujin and participated frequently less likely experienced the onset of functional disability during an 8-year study period. However, these previous studies did not address reverse causation: mujin participants could have already been healthier than non-participants. Those who had lost their higher-level functional capacity would have had difficulties participating in mujin. Given that the loss of higher-level functional capacity is a precursor to disability, a longitudinal study that addresses reverse causation is required to confirm the effect of mujin on prolonging healthy life expectancy.

The present study develops those of Kondo et al. using stabilized inverse probability weights (IPW) to address potential reverse causation. After balancing covariates, including various health conditions between the groups of mujin participants and non-participants at baseline, we compared higher-level functional capacity in mujin participants with controls over a period of 3 years. Furthermore, it is unclear whether the effect differs by the structural characteristics of mujin (i.e., sex ratio, area of residence, age composition and members’ social standing). We examined variations in effectiveness across different structural characteristics of mujin.

Methods

Study participants

We obtained panel data from the Japan Gerontological Evaluation Study (JAGES), an ongoing cohort study of physically and cognitively independent Japanese people aged ≥65 years. From October to December 2013, self-reported questionnaires were mailed to eligible residents in 24 municipalities in 10 (out of 47) prefectures, including two municipalities in Yamanashi Prefecture. Random sampling methods were used in 12 large municipalities, whereas a census of all eligible residents was carried out in 12 smaller municipalities. Of the 31,500 people invited to participate, 22,121 returned the questionnaires, corresponding to a response rate of 71.0%. A total of 1373 individuals, whose sex and age could not be confirmed, were excluded. From October to November 2016, a follow-up survey was carried out. We could follow up with 12,271 individuals, corresponding to a follow-up rate of 59.1%. From the analysis, we excluded those who did not respond to the question of whether he or she participated in mujin at baseline (n = 1280). Thus, our analytic sample comprised 10,991 participants. The study protocol was reviewed and approved by the ethics committees at the University of Tokyo, Nihon Fukushi University, National Center for Geriatrics and Gerontology, and Chiba University.

Outcome variable

We used the Tokyo Metropolitan Institute of Gerontology Index of Competence (TMIG-IC) to measure higher-level functional capacity. The TMIG-IC is a multidimensional 13-item index developed on the basis of Lawton’s model of competence of older adults. Validity and reliability of the index have been confirmed, and it has been widely used. The TMIG-IC comprises three subscales: (i) instrumental self-maintenance, or instrumental activities of daily living (IADL); (ii) intellectual activity (IA); and (iii) social role (SR; see Table S1 for the 13-item list of the TMIG-IC). The score of each subscale was calculated by summing answers (yes = 1, no = 0). Full marks of IADL, IA and SR are 5, 4 and 4 points, respectively. Those who reported full marks were considered to be independent, and we constructed binary variables to indicate independent (1) or dependent (0) for the total score of TMIG-IC and each of the subscales.

Explanatory variable

Our primary explanatory variable was participation in mujin at baseline, measured by a question asking, “Do you take part in mujin activities?” In addition, we asked participants about the following characteristics of the mujin in which they participated (if one participated in multiple groups, they were asked to answer according to the group they found most important): (i) sex ratio (men or women only/more men than women/more women than men/roughly an equal proportion of men to women); (ii) area of residence (only people from the same municipality/some people from other municipalities); (iii) age composition (mostly people of the same generation/mixture of different generations [age difference of at least 20 years]); and (iv) social standing (there is a person or people of high social standing [e.g., residents’ association official, politician, city council member, company or trade association executive, doctor, lawyer etc.] there are no people of high social standing). We also examined whether participants in mujin with specific characteristics achieved better outcomes compared with non-participants.

Covariates

We adjusted for potential confounders measured at baseline, namely sex, age, marital status (married and spouse is alive or other [divorced, widowed and never married]), educational attainment (≤9 years, 10–12 years and ≥13 years), annual equivalized household income (≤¥1.9 million, ¥2.0–3.9 million and ≥¥4.0 million), occupational status (working or not working), depressive symptoms assessed with the short version of the Geriatric Depression Scale17 (non-depressed [≤5] or depressed [≥5]), self-rated health (very good/very good vs poor/very poor), self-reported medical condition (no illness or having illness), social participation other than mujin (measured by the number of the following groups attended in a month: volunteer groups, sports groups, hobby activities, study or cultural groups and activities for teaching skills), alcohol consumption (drinker or non-drinker), smoking status (smoker or non-smoker) and functional independence at baseline assessed with the TMIG-IC (IADL, IA and SR).

Statistical analysis

We addressed potential reverse causation between exposure (i.e., participation in mujin) and outcome using stabilized IPW. We calculated propensity scores of participation in mujin using a logistic regression model with the aforementioned covariates. After checking whether calculated weights balanced covariates measured at baseline between the groups, we incorporated them into multivariable logistic regressions with the same covariates on functional independence in the follow up. To address potential bias caused by missing values, we used multiple imputation under the missing at random assumption (i.e., a missing mechanism is related to the other variables measured in the same survey for that participant). Incomplete variables were imputed by a multivariate
normal model using all the variables as explanatory variables. We created 20 imputed datasets, and the estimates were combined. All analyses were carried out using Stata, version 14.2 (StataCorp, College Station, TX, USA).

Results

Table 1 delineates the characteristics of the participants. The proportion of those who reported independence in IADL at the follow-up increased compared with baseline, whereas 4.8% of participants experienced a decline of the subscore of IADL. The proportion of those who reported independence in the total score of TMIG-IC, IA and SR declined, and 29.9%, 15.2% and 25.3% of participants experienced a decline of the total score of TMIG-IC and the subscore of IA and SR, respectively. In our analytic sample, 406 individuals participated in mujin at baseline. Participation rates of mujin were 33.6% in Yamanashi Prefecture and 24.4% in other prefectures.

Table 2 shows the characteristics of mujin and its participants. In our sample, one-third of mujin participants resided in Yamanashi Prefecture, whereas people residing within the prefecture were composed of 2.8% of non-participants. Mujin consisting of only men or only women were the fewest compared with other categories of gender makeup. Most mujin were organized by people from the same municipality. Approximately half of mujin were composed of people of the same generation, whereas the other half involved different generations with more than 20-year age differences. One-third of mujin included a person or people of high social standing.

We compared covariates measured at baseline between mujin participants and non-participants before and after weighting in Table 3 (see Table S2 for the logistic model calculating propensity scores). Before weighting, mujin participants were more likely to be men, younger, married, educated, working, independent in IA and SR, smokers, and to partake in social activities than non-participants. They were also less likely to be depressed and report poor self-rated health. After weighting, absolute values of the standardized difference between the groups were <0.1; thus, the two groups were well-balanced at baseline.

Our logistic regression with stabilized IPW showed that participation in mujin at baseline had a positive effect on the maintenance of independence in the total score of TMIG-IC (odds ratio [OR] 1.75, 95% confidence interval [CI] 1.29–2.39) and the subscore of SR (OR 1.71, 95% CI 1.24–2.37) in 3 years (Table 4). The point estimates of the effects of mujin also showed a positive effect on independence in IADL and IA, though they did not reach significant levels. We also tested a dummy variable, in the regression model, indicating residence in Yamanashi Prefecture to consider the special characteristics of this prefecture, given the concentration of mujin participants there. However, the dummy variable did not show any associations.

In Figure 1, we further examined effect variation on functional independence across different characteristics of mujin. As shown in Figure 1a, mujin that comprised of an equal number of both sexes showed beneficial effects, not only in SR (OR 2.06, 95% CI 1.20–3.54), but also in IA (OR 2.49, 95% CI 1.01–6.15). In contrast, mujin composed of single-sex and more women than men did not show any salutary effects of significant levels (Fig. 1a). In addition, mujin involving people of high social standing showed beneficial effects, not only in SR (OR 1.94, 95% CI 1.10–3.43), but also in IA (OR 2.04, 95% CI 1.001–4.15; Fig. 1d).

Table 1 Participants’ characteristics

| Category | n   | %     | Mean (SD) |
|----------|-----|-------|-----------|
| Male     | 5076| 46.5  |           |
| Age (years) | 10 911 | 100.0 | 72.91 (5.58) |
| Marital status |       |       |           |
| Married and spouse is alive | 8107 | 74.3  |           |
| Other    | 2665 | 24.4  |           |
| Missing  | 139  | 1.3   |           |
| Education (years) |       |       |           |
| Low (≤9) | 4082 | 37.4  |           |
| Middle (10–12) | 4281  | 39.2  |           |
| High (≥13) | 2403  | 22.0  |           |
| Missing  | 145  | 1.3   |           |
| Household income (million JPY) |       |       |           |
| Low (≤1.9) | 4436  | 40.7  |           |
| Middle (2.0–3.9) | 3826  | 35.1  |           |
| High (≥4.0) | 1065  | 9.8   |           |
| Missing  | 1584 | 14.5  |           |
| Occupational status |       |       |           |
| Working  | 2574 | 23.6  |           |
| Not working | 7730  | 70.8  |           |
| Missing  | 607  | 5.6   |           |
| Depressive symptoms (GDS) |       |       |           |
| Not depressed (<5) | 7317  | 67.1  |           |
| Depressed (≥5) | 2128  | 19.5  |           |
| Missing  | 1466 | 13.4  |           |
| Self-rated health |       |       |           |
| Very good or good | 9198  | 84.3  |           |
| Very poor or poor | 1464  | 13.4  |           |
| Missing  | 249  | 2.3   |           |
| Self-reported medical condition |       |       |           |
| No illness | 1788  | 16.4  |           |
| Having illness | 8503  | 77.9  |           |
| Missing  | 620  | 5.7   |           |
| Social participation |       |       |           |
| 8987 | 82.4  | 0.85 (1.03) |
| Missing  | 1924 | 17.6  |           |
| Alcohol consumption |       |       |           |
| Drinker  | 3974 | 36.4  |           |
| Non-drinker | 6830  | 62.6  |           |
| Missing  | 107  | 1.0   |           |
| Smoking  |       |       |           |
| Smoker   | 1048 | 9.6   |           |
| Non-smoker | 9733  | 89.2  |           |
| Missing  | 130  | 1.2   |           |
| TMIG-IC score (2013) |       |       |           |
| Total Independent (13) | 4697  | 43.0  |           |
| Dependent (≤12) | 5696  | 52.2  |           |
| Missing  | 518  | 4.7   |           |
| IADL Independent (5) | 9106  | 83.5  |           |
| Dependent (≤4) | 1599  | 14.7  |           |
| Missing  | 206  | 1.9   |           |
| IA Independent (4) | 7862  | 72.1  |           |
| Dependent (≤3) | 2805  | 25.7  |           |

(Continued)
Table 1  Continued

|                     | n    | %    | Mean (SD) |
|---------------------|------|------|-----------|
| Missing             | 244  | 2.2  |           |
| SR                  |      |      |           |
| Independent (4)     | 6278 | 57.5 |           |
| Dependent (≤3)      | 4359 | 40.0 |           |
| Missing             | 274  | 2.5  |           |
| TMIG-IC score (2016)|      |      |           |
| Total               |      |      |           |
| Independent (13)    | 4056 | 37.2 |           |
| Dependent (≤12)     | 5888 | 54.0 |           |
| Missing             | 967  | 8.9  |           |
| IADL                |      |      |           |
| Independent (5)     | 9539 | 87.4 |           |
| Dependent (≤4)      | 1073 | 9.8  |           |
| Missing             | 299  | 2.7  |           |
| SR                  |      |      |           |
| Independent (4)     | 5444 | 49.9 |           |
| Dependent (≤3)      | 4940 | 45.3 |           |
| Missing             | 527  | 4.8  |           |
| Mujin participant   | 406  | 3.7  |           |
| Residence           |      |      |           |
| Yamanashi           | 150  | 36.9 |           |
| Other prefectures   | 256  | 63.1 |           |

Table 2  Characteristics of mujin and its participants

|                      | n    | %    |
|----------------------|------|------|
| Residence            |      |      |
| Yamanashi            | 150  | 36.9 |
| Other prefectures    | 256  | 63.1 |
| Age composition      |      |      |
| Men or women only    | 67   | 17.8 |
| More men than women  | 114  | 30.2 |
| More women than men  | 77   | 20.4 |
| Roughly and equal proportion of men to women | 119 | 31.6 |
| Area of residence    |      |      |
| Only people from the same municipality | 327 | 83.9 |
| Some people from other municipalities | 63 | 16.2 |
| Social standing      |      |      |
| There is a person or people of high social standing | 121 | 32.4 |
| There are no people of high social standing | 253 | 67.7 |

The present study, we found that ROSCA can delay the deterioration of SR functioning, especially given that SR is the most complex function among the higher-level functional capacities,11 and SR functioning is most likely to be lost with advancing age, followed by IA and IADL.12

We believe that the beneficial effects of mujin derive from its role as social participation. Social participation has been shown to promote the maintenance of functional capacity in older adults.19-22 One challenge faced by interventions involving social participation is the gender gap in participation rates; older men are less likely to participate in social activities than older women.23,24 In contrast to this tendency, we found that men were more likely to participate in mujin than women (Tables 3,S2 S3). This can be explained by the historical and cultural context of Japan; until recently, the man has been the householder responsible for the family budget, and therefore has participated in mujin more actively, given that mujin is originally a financial activity.9

Furthermore, we showed that participation in mujin was independently associated with the maintenance of functional capacity after adjusting for engagement in paid work and other social activities (i.e. volunteer groups, sports groups, hobby activities, study or cultural groups and activities for teaching skills). This suggests that mujin is distinct from such social activities. For example, the financial investment component of mujin can motivate consistent commitment to participate in the activity, leading to habit formation.25 In fact, a previous study showed that approximately 80% of participants stayed members of mujin for ≥10 years.9 In addition, mujin has higher proportions of participants who have low household income, depressive symptoms, poor self-rated health, and some illness than paid work and other social activities (Table S3). Such broad-based characteristics of mujin might differentiate it from other activities.

Furthermore, we found that some types of mujin, namely those consisting of an equal number of both sexes and involving people of high social standing, have a further beneficial effect on the maintenance of independence in IA. This might be explained by the characteristics of social capital. Social capital is often characterized as “bonding,” “bridging” and “linking” types.26 Bonding social capital refers to resources that are shared within networks where members share similar backgrounds, such as social class or race/ethnicity. This type of social capital provides members with cohesive relationships, and mujin can be categorized as essentially bonding social capital. In contrast, bridging social capital refers to resources that are accessed across networks that bridge individuals from different backgrounds. Mujin consisting of both sexes, people from other municipalities and different generations play a role in bridging different networks. This type of social capital enables individuals to access resources outside their networks, and might provide them with opportunities for better health.27,28 In accordance with the present findings, a previous study found that older adults who participated in social groups with diverse membership were more likely to report better self-rated health than those who participated in less diverse groups; furthermore, gender was the key dimension of diversity.29 While bridging social capital is characterized by horizontal relationships, linking social capital is characterized by vertical relationships across different social classes. Mujin that include people of high social standing provides members with linking social capital. Connecting with authorities (e.g. doctors, lawyers etc.) might provide individuals with information, advice and instrumental assistance that can help them solve problems. The present findings suggest that mujin that combine roles of bridging or linking can be more effective at slowing decline in functional capacity in older adults than mujin that work by only bonding homogeneous members.

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Discussion

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Table 4  Logistic regressions of participation in mujin on higher-level functional capacity with stabilized inverse probability weighting

|                          | Total | IADL | IA | SR |
|--------------------------|-------|------|----|----|
|                          | OR    | 95% CI | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| Mujin                    | 1.75*** | 1.29 | 2.39 | 1.37 | 0.82 | 2.30 | 1.30 | 0.91 | 1.84 | 1.71** | 1.24 | 2.37 |
| Male                     | 0.60*** | 0.53 | 0.67 | 0.51*** | 0.42 | 0.61 | 0.87* | 0.77 | 0.99 | 0.59*** | 0.53 | 0.66 |
| Age                      | 0.99*** | 0.98 | 0.99 | 0.95*** | 0.94 | 0.96 | 1.00 | 0.99 | 1.01 | 0.98*** | 0.97 | 0.99 |
| Married                  | 1.17*  | 1.04 | 1.31 | 0.84 | 0.70 | 1.02 | 1.21** | 1.06 | 1.37 | 1.19** | 1.06 | 1.34 |
| Education                | 0.88  | 0.77 | 1.01 | 0.70** | 0.56 | 0.87 | 0.54*** | 0.47 | 0.63 | 1.18* | 1.03 | 1.36 |
| Household income         | 1.00  | 0.88 | 1.13 | 0.76* | 0.61 | 0.94 | 0.86* | 0.74 | 0.99 | 1.05 | 0.93 | 1.20 |
| TMIG-IC independence     |       |      |     |     |      |      |      |     |      |      |      |     |
| IADL                     | 1.90*** | 1.59 | 2.26 | 10.41*** | 8.89 | 12.19 | 1.29** | 1.11 | 1.49 | 1.26** | 1.09 | 1.46 |
| IA                       | 4.84*** | 4.21 | 5.57 | 1.50*** | 1.27 | 1.77 | 10.39*** | 9.31 | 11.60 | 1.43*** | 1.27 | 1.61 |
| SR                       | 6.19*** | 5.53 | 6.92 | 1.23*  | 1.05 | 1.45 | 1.44*** | 1.29 | 1.60 | 8.89*** | 8.05 | 9.81 |
| Depressed                | 0.86*  | 0.74 | 0.99 | 0.87 | 0.72 | 1.04 | 0.87* | 0.76 | 0.99 | 0.77*** | 0.67 | 0.88 |
| Poor self-rated health   | 0.80** | 0.68 | 0.94 | 0.67*** | 0.55 | 0.82 | 0.83* | 0.71 | 0.96 | 0.85* | 0.73 | 0.99 |
| Having illness           | 1.22** | 1.07 | 1.38 | 1.24 | 0.98 | 1.56 | 1.13 | 0.97 | 1.30 | 1.15** | 1.01 | 1.31 |
| Social participation     | 1.15*** | 1.10 | 1.19 | 1.09** | 1.02 | 1.16 | 1.05* | 1.01 | 1.10 | 1.16*** | 1.11 | 1.20 |
| Drinker                  | 1.11  | 0.99 | 1.25 | 1.01 | 0.85 | 1.19 | 1.19** | 1.05 | 1.34 | 1.06 | 0.95 | 1.18 |
| Smoker                   | 0.94  | 0.79 | 1.12 | 0.98 | 0.77 | 1.24 | 0.82* | 0.69 | 0.97 | 0.96 | 0.82 | 1.14 |
| Constant                 | 1.01  | 0.04 | 0.21 | 92.94*** | 29.39 | 293.93 | 0.51 | 0.23 | 1.15 | 0.55 | 0.26 | 1.19 |

***P < 0.001, **P < 0.01, *P < 0.05. CI, confidence interval; IA, intellectual activity; IADL, instrumental activities of daily living; OR, odds ratio; SR, social role; TMIG-IC, Tokyo Metropolitan Institute of Gerontology Index of Competence.
The present study had several limitations. First, although we used an IPW method to address potential reverse causation between exposure and outcome (i.e., healthier people are more likely to participate in mujin) and successfully balanced both groups at baseline, this method cannot treat unobserved factors. Second, previous studies suggested that the extent and intensity of participation in mujin (i.e., maximum number of memberships, duration of membership, frequency of meeting and feelings of pleasure) matter, but we did not collect such detailed information on individual participation. However, we were able to obtain valuable information on the structural characteristics of mujin (i.e., sex ratio, area of residence, age composition and members’ social standing) and show variation in the impact on higher-level functional capacity based on the three types of social capital, which the previous studies have not examined. Third, higher-level functional capacity was self-reported, and thus misclassification is possible. Fourth, we examined various characteristics of mujin, which might induce the type I error as a result of multiple testing. One should carefully interpret the results based on point estimates and confidence intervals.

In summary, the present study suggests that participation in mujin, a traditional Japanese ROSCA, can help older adults maintain their independence in higher-level functional capacity, especially SR functioning. In addition, mujin characterized not only by “bonding,” but also by “bridging” or “linking” social capital (i.e., the involvement of both sexes equally and of people of high social standing), showed a further impact on independence in IA. As social capital is developed in the historical and cultural context of each community, it is important for social epidemiology research to understand, not only the characteristics of social capital, but also how it can be adapted for interventions that promote healthy aging.

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Figure 1 Participation in mujin and higher-level functional capacity by characteristics of mujin. The estimates were obtained from logistic regressions with stabilized inverse probability weights adjusted for sex, age, marital status, educational attainment, annual equivalized household income, occupational status, depressive symptoms, self-rated health, self-reported medical condition, social participation other than mujin, alcohol consumption, smoking status and functional independence at baseline. the reference is non-participants. *P < 0.05, **P < 0.01, ***P < 0.001. IA, intellectual activity; IADL, instrumental activities of daily living; SR, social role.
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Disclosure statement

The authors declare no conflict of interest.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher’s website:

Table S1 Tokyo Metropolitan Institute of Gerontology Index of Competence

Table S2 Logistic regression for propensity score of participation in mujin

Table S3 Comparisons of characteristics of participants between mujin and other social activities

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