Highlights:

- In rural areas, fewer older adults were homebound in communities with higher civic participation;
- In rural areas, fewer older adults were homebound in with suitable parks or pavements for walking and exercising;
- Appropriately built environments in the neighborhood and community level social capital may reduce homebound status in older adults

1   **Original Article**

2   Title:

3   **Do Community Social Capital and Built Environment associate with Homebound in**

4   **Older Adults? --- from the JAGES Niigata Study**

5   Running title: **Social Determinants of Homebound Status**

6

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39   Article word count: 4,295

40   Abstract word count: 250

41   Number of figures: 2

42   Number of tables: 5

43   Number of Supplementary tables:2

Abstract

Background: Homebound status is one of the most important risk factors associated with

functional decline and long-term care in older adults. Studies show that neighborhood

built environment and community social capital may be related to homebound status. This

study aimed to clarify the association between homebound status for community-dwelling

older adults and community environment—including social capital and neighborhood

built environment—in rural and urban areas.

Methods: We surveyed people aged 65 years and older residing in three municipalities

of Niigata Prefecture, Japan, who were not certified as requiring long-term care. The

dependent variable was homebound status; explanatory variables were community-level

social capital and neighborhood built environment. Covariates were age, sex, household,

marital status, socioeconomic status, instrumental activities of daily living, the geriatric

depression scale-15, self-rated health, number of diseases under care, and individual

social capital. The association between community social capital or neighborhood built

environment and homebound status, stratified by rural/urban areas, was investigated

using multilevel logistic regression analysis.

Results: Among older adults (n=18,099), the homebound status prevalence rate was 6.9%

in rural areas and 4.2% in urban areas. The multilevel analysis showed that, in rural areas,

62 fewer older adults were homebound in communities with higher civic participation and

63 with suitable parks or pavements for walking and exercising. However, no significant

64 association was found between community social capital or neighborhood built

65 environment and homebound status for urban older adults.

66 **Conclusions:** Community social capital and neighborhood built environment were

67 significantly associated with homebound status in older adults in rural areas.

68 *Keywords:* Community social capital, neighborhood built environment, epidemiology,

69 homebound, urban rural differences

Introduction

Although several concepts and definitions exist, the term *homebound*, as

applied to older adults, refers to a situation in which the individual has few

opportunities to leave the home.[1, 2, 3, 4] A study in Japan defined a person as homebound

when their "frequency of going outdoors is less than once per week.[5] Many studies

utilize this definition.[6, 7,8, 9]

Among older individuals, becoming homebound is thought to lead to an

increased risk of mortality or need for long-term care.[6, 7, 10, 11] In Japan, measures were

taken to prevent older adults from becoming homebound, but focused on individual

factors (e.g., instrumental activities of daily living [IADL] and physical capacity).[5]

Namely, a high-risk approach that focused on high risk individuals, such as those with

physical functional declining, was the widely utilized intervention strategy. Recently, to

prevent homebound status, there has been growing interest in the social interactions of

community-dwelling older people.[12] Moreover, the importance of community social

capital (SC) in the local community has been drawing attention;[13] specifically, SC is an

important social determinant of health and a topic of increasing interest in the social

epidemiology and community health fields. [14]

Similarly, the neighborhood built environment is an important factor that

88   influences behavior. For instance, people tend to prefer walking in environments that have

89   parks and walking pavements.[15, 16, 17, 18] A study in a city that was severely affected by the

90   2011 Great East Japan Earthquake showed that having to walk long distances to reach a

91   retail store might be a risk factor of homebound status among older adults.[17] Thus, the

92   literature suggests that the homebound status of community-dwelling older adults relates

93   to both the social and physical environments. However, no prior study has analyzed the

94   relationship between community level SC and homebound status. Additionally, few

95   studies have analyzed the association between neighborhood built environment and the

96   homebound status on older adults.[15, 18]

97   Further, there are significant differences regarding the type of neighborhood

98   built environment between rural and urban areas. Regarding the physical environment,

99   the number of possible destinations (e.g., restaurants, retail stores) in rural areas is lower

100   than in urban areas. Regarding the social environment, social contact/connectedness is

101   often higher in rural than in urban areas.[19] Thus, the impact of the social and physical

102   environments on homebound status might differ between rural and urban areas.

103   Thence, this study aimed to clarify the association between the homebound

104   status on older adults and the community environment—including SC and neighborhood

105   built environment—in rural and urban areas.

7

106   **Methods**

107   **Data**

108   This study used cross-sectional data from the 2013 Japan Gerontological

109   Evaluation Study (JAGES) Niigata survey.[12] The project has accumulated data on older

110   people over the age of 65 years who have not been certified as requiring long-term care.

111   Research participants were recruited from Niigata City, Tokamachi City, and Aga Town.

112   Niigata City is the prefectural capital and a city designated by ordinance with a

113   population of approximately 0.8 million and a population density of $1115.2/km^2$. It is

114   divided into urban, suburban resident, and countryside areas. Tokamachi City

115   (population = 55,491 [as of 2015], population density = $93.0/km^2$) and Aga Town

116   (population = 11,946 [as of 2015], population density = $12.3/km^2$) are located in

117   mountainous regions and have urban and deep rural areas. Taken together, there is a rich

118   variation in the environmental characteristics of the two cities and the town. Thus, we

119   targeted these sites to conduct this research.

120   By stratified random sampling, we extracted 8,000 older people (4.9%) in

121   Niigata City (from a total of 164,206 older people). The researchers conducted an

122   inventory survey in Tokamachi City and Aga Town, targeting 15,730 and 4,192 older

123   people, respectively.

124   The community unit of this study was set based on the school districts or living

125   areas where the target people lived; in total, there were 57 communities in Niigata City,

126   19 in Tokamachi City, and 12 in Aga Town. The survey was conducted by the mail survey

127   method in all municipalities. We targeted people who did not lack any sex, age, or resident

128   community information.

129   **Outcome Measure**

130   The dependent variable was the homebound status, defined as going out of the

131   house less than once a week. [5, 9] For the question "How often do you go out? (including

132   farms/fields, neighbors' homes, shopping, hospitals, etc.)," there were six answer options:

133   "4 or more times a week," "2 to 3 times a week," "Once a week," "1 to 3 times/month,"

134   "Several times/year," and "None." People was considered as under the homebound status

135   if they answered "1 to 3 times/month," "several times/year," or "never."

136   **Definition of rural or urban areas**

137   Communities in a habitable area with a population density of at least 1,000

138   people/km^2 or more were considered as urban; those under 1,000 people/km^2 were

139   considered as rural. [20] The total population of each district was calculated using data from

140   the 2010 National Census.

141   **Independent Variables**

9

142   The independent variables included two types of community level variables:

143   Community SC and neighborhood built environment. We used the measurement index

144   developed by Saito et al. to assess community SC.[21] It is a 11-item measurement with

145   three indices/subscales: Civic Participation (5 items, hereinafter SC-CP), Social Cohesion

146   (3 items, SC-SC), and reciprocity (3 items, hereinafter SC-RC). The SC-CP has questions

147   on whether people participated in local meetings or the following group activities:

148   Volunteering, sports, hobbies, learning and education, and the passing down of experience.

149   After calculating the percentage of those who participated in each activity on a

150   community-by-community basis, the score in this component was calculated as:

151   Percentage of volunteer group participants × 0.6 + percentage of sports group participants

152   × 0.8 + percentage of hobbies group participants × 0.9 + percentage of learning and

153   education group participants × 0.7 + percentage of passing down of experience group

154   participants × 0.5.

155   The SC-SC has questions on community trust, mutual help, and community

156   attachment. After calculating the percentage of those who answered positively ("I think

157   so" or "I think") on a community-by-community basis, the score in this component was

158   calculated as: Percentage of positive community trust × 0.9 + percentage of positive

159   mutual help × 0.8 + percentage of positive community attachment × 0.7.

160   The SC-RC has questions on whether participants provide/receive

161   emotional/instrumental support. The percentage of those who provide/receive such social

162   support on community-by-community basis, the score of this component was calculated

163   as: Percentage of people who receive emotional support × 0.8 + percentage of people who

164   provide emotional support × 0.7 + percentage of people who receive instrumental support

165   × 0.6. All indices were dichotomized into high/low groups by the median value of the

166   calculated indices.

167   Three types of neighborhood built environment were measured in this study:

168   1) Suitable parks or pavements for walking and exercising; 2) possible dangerous places

169   or intersections that evoke risk for traffic accidents; and 3) grocery or mobile shops in

170   which you can get fresh food. The question was: "How many facilities/places like these

171   are present within approximately 1 kilometer from your house?" Participants chose one

172   of five options: "many," "some," "few," "none," or "don't know." We calculated the

173   percentage of participants who answered "many" or "some" in each community. Then,

174   these percentages were dichotomized into high/low groups by median value.

175   **Covariates**

176   We adjusted for the following possible confounding factors: age,[22] sex,[22]

177   household, marital status,[22] educational attainment,[23] equivalized annual household

178   income,[23] categorized with depressive status by the Geriatric Depression Scale-15 (GDS-

179   15) score,[22, 23, 24, 25 26 27] IADL,[24] self-rated health (SRH),[22, 28] number of medical diseases

180   under care or of sequelae,[22] and individual SC.[13]

181   Age was categorized into five-year groups: 65-69, 70-74, 75-79, 80-84, and 85

182   or older; household into living alone and living with family members; marital status into

183   married, widowed, divorced, single, and other; educational attainment into ≤9 years and

184   ≥10 years; equivalized annual household income into <1 million yen, 1 million to <4

185   million yen, and ≥4 million yen; and GDS-15 score into no depression (≤4), mild

186   depression (5-9), and depression (≥10).[28] IADL was categorized by five items of

187   instrumental independence corresponding to each IADL and comprising the subscales of

188   the Tokyo Metropolitan Institute of Gerontology Index.[29] Self-rated health (SRH) was

189   classified as "very good/well" and "not very good/not good." Number of medical diseases

190   under care or of sequelae were categorized into "none," "one," "two," and "three or more."

191   For individual SC, we used the same indices for community SC: Civic

192   Participation, Social Cohesion, and Reciprocity. Civic participation was divided into five

193   categories by the number of groups/activities people participated in: "none," "one," "two,"

194   "three," and "four or more." Social cohesion into four categories by the number of

195   positive responses to three questions about community trust, mutual aid, and community

196   attachment: "none," "one," "two," and "three." Reciprocity comprised three items

197   regarding community social support: Receiving and giving emotional support, and

198   receiving instrumental support. Reciprocity was divided into four categories based on the

199   number of items with responses other than "no one:" "none," "one," "two," and "three."

200   **Statistical Analysis**

201   To describe diverse prevalence rates for homebound status by community, we

202   produced three graphs (for all 88 communities in rural and urban areas). To compare

203   community characteristics between areas, we calculated the average value and standard

204   deviation (SD) of the social and physical environmental indices and calculated the

205   prevalence for homebound status for rural and urban areas. We applied the Welch's t test

206   to evaluate statistical differences. We also calculated the age- and sex-adjusted

207   standardized prevalence rates for homebound status.

208   Participants' demographic characteristics were divided and compared by rural

209   and urban areas using a Chi-square test.

210   The association between homebound status and the three community SC

211   indices were analyzed through a multilevel logistic regression analysis stratified by rural

212   and urban areas. The multilevel logistic regression analysis was performed in 6 steps:

213   Model 1 was a null model. In Model 2, we included individual-level variables. In the

214 Models 3, 4, and 5, we included variables in Model 2 plus the SC-CP, SC-SC, or SC-RC

215 scores separately. In Model 6, all three community SC indices were added to Model 2 at

216 the same time.

217   To examine the association between homebound status and three indices of

218 neighborhood built environment, we applied another multilevel logistic regression

219 analysis on the data stratified by rural and urban areas. The null model and model adjusted

220 by individual-level variables are similar to Models 1 and 2 in the analyses of community

221 SC indices. In Models 1 to 3, each neighborhood built environment index was included

222 separately. In Model 4, all neighborhood built environment indices were simultaneously

223 included.

224   Moreover, we analyzed a combined model that included all six indices (three

225 community SC and three neighborhood built environment) stratified by rural and urban

226 areas. Additionally, we analyzed models stratified by sex to ensure that the same analyses

227 would be done in the four stratified groups: Rural men, rural women, urban men, and

228 urban women.

229   Statistical significance for all analyzes was set at P=0.05. All analyses were

230 performed using STATA 14.

231 **Ethical Considerations**

232   This study was conducted with ethical approval from the Institutional Review

233   Board of Niigata University (approval numbers: 2015-1504, 2015-2045, and 2015-2046).

234   Participants were informed that participation was voluntary and that returning the self-

235   administered questionnaire would be interpreted as providing consent to participate.

236   **Results**

237   In total, 20,652 (74.0% of 27,922 subjects) responded to the survey. By

238   Excluding 2,224 data with no sex, age, or resident information in the first stage, and 329

239   with no homebound status data in the second stage, we extracted a final sample of 18,099

240   valid questionnaires (Valid response rate = 64.8%) (Figure 1). The number of valid

241   respondents and response rate by municipality was 4,661 (58.3%) in Niigata City, 10,584

242   (67.3%) in Tokamachi City, and 2,854 (61.4%) in Aga Town. Average prevalence rate for

243   homebound status was at its highest as 15.2% and at its lowest as 0% (Figure 2a).

244   Similarly, average prevalence rates for homebound status were divided by rural and urban

245   areas (Figures 2b and 2c): In urban areas, prevalence rates for homebound status (i.e., min

246   0.0% to max 8.3%) were less diverse than in rural areas.

247   **Comparison of community characteristics between rural and urban areas**

248   Out of the 88 communities, 56 were classified as rural and 32 as urban. Table

249   1 shows community characteristics divided by rural and urban areas. As a result of

250   calculating and comparing the average value ± standard deviation (SD) of the three

251   community SC indices, SC-CP was significantly higher in urban (0.63 ± 0.13) than in

252   rural areas (0.48 ± 0.15); SC-SC was significantly higher in urban (0.78 ± 0.15) than in

253   rural areas (0.65 ± 0.14); and SC-RC had similar levels between rural (2.00 ± 0.04) and

254   urban areas (1.99 ± 0.04).

255   For neighborhood built environment, there were many more communities with

256   suitable parks or pavements for walking and exercising in urban (71.2 ± 10.2%) than in

257   rural areas (59.3 ± 13.3%) (P<0.001). There were many more communities with possible

258   dangerous places or intersections that evoke risk for traffic accidents in urban (60.3 ±

259   7.5%) than in rural areas (51.4 ± 9.4%) (P<0.001); and there were many more

260   communities with grocery or mobile shops in which you can get fresh food in urban (76.7

261   ± 10.5%) than in rural areas (55.0 ± 17.9%) (P<0.001).

262   Prevalence rate for homebound status was significantly higher in rural (6.9 ±

263   3.8%) than in urban areas (4.2 ± 2.0%). Age-adjusted prevalence rate for homebound

264   status was 7.4% for rural and 5.0% for urban areas.

265   **Participants' demographic characteristics by rural and urban areas**

266   We analyzed participants demographic characteristics by rural and urban areas

267   and used descriptive statistics (Table 2).

268   All following variables showed significant differences between rural and urban

269   areas: Regarding age, a higher proportion of older people was observed in rural than in

270   urban areas. Living alone was more common in rural (19.7%) than in urban areas (18.0%).

271   Regarding marital status, being married was more common in urban (71.8%) than in rural

272 areas (68.9%). Regarding educational attainment, having ≥10 years of education was

273 more common in urban (53.0%) than in rural areas (38.7%). Regarding equivalized

274 household income, earning less than 1.00 million per year was more common in rural

275 (58.9%) than in urban areas (45.2%). Regarding IADL, people with full scores (5) were

276 more common in rural (21.0%) than in urban areas (18.2%). The percentage of people

277 with "none" or "only one" medical diseases under care or sequelae was higher in rural

278 than in urban areas (none: 23.0% vs. 21.7%; only one: 38.2% vs. 36.1%). Regarding the

279 three individual-level SCs, there was a significantly higher proportion of people in the

280 without much Civic Participation in rural (69.9%) than in urban areas (60.6%), and a

281 significantly higher proportion of people with positive Social Cohesion (total score) in

282 rural (54.9%) than in urban areas (49.6%).

283 **Results of multilevel logistic regression analyses**

284   Tables 3a and 3b show the results of multilevel logistic regression analyses for

285 the association between community SC and homebound status by rural and urban areas.

286 In the null model, community level variance was 0.149 in rural areas. However, there was

287 no significant variation between communities in urban areas, in which community level

288 variance was 4.7×10^{-27}. The proportional changes in variance are shown at the bottom

289 of Tables 3a and 3b, which indicate community level variance owing to SC. SC-CP was

290   significantly associated with homebound status (OR=0.67, 95%CI 0.51-0.88) in rural

291   areas (Model 3). SC-SC was marginally associated with homebound status (OR=0.74,

292   95%CI 0.54-1.01) (Model 4). There was no significant association between SC-RP and

293   homebound status (Model 5). In Model 6, we observed similar associations for all three

294   community SC indices. In urban areas, as shown in Table 3b, there was no significant

295   association between homebound status and the community SC indices.

296   For the neighborhood built environment indices, only the presence of suitable

297   parks or pavements for walking and exercising tended to be inversely associated with

298   homebound status in rural areas (OR=0.72, 95%CI 0.52-1.01) (Table 4a). In urban areas,

299   we observed no significant association between neighborhood built environment indices

300   and homebound status (Table 4b). In the models with the three community SC and the

301   three neighborhood built environment indices, only Civic Participation in rural areas

302   show a statistically significant association with homebound status (P=0.015) (Table 5).

303   As a result of multilevel logistic regression analysis stratified by sex and area,

304   SC-CP was significantly associated with homebound status in rural women ([OR]: 0.54,

305   [95% CI]: 0.33-0.88) and SC-SC had a slightly significant association among rural

306   women ([OR]: 0.66, [95%CI]: 0.41-1.08) (Supplementary Table 1a). The neighborhood

307   built environment indices did not show any significant associations with homebound

308   status (Supplementary Table 1b).

Discussion

310   This study investigated the associations between homebound status and

311   community SC or neighborhood built environment in older adults in Niigata prefecture,

312   Japan. We divided communities by area (i.e., rural and urban) and applied multilevel

313   logistic regression analysis. After adjusting for individual factors, the results showed that

314   community level civic participation—one of the indices in the community SC scale—and

315   the presence of suitable parks or pavements for walking and exercising can prevent

316   homebound status on older people.

317   **Prevalence Rates of Homebound Status**

318   Our results showed that the prevalence of homebound status on older adults

319   was higher in rural than in urban areas, concurring with the literature.[3, 6, 30, 31] Compared

320   with urban, rural areas offer fewer within-community destinations and group types to

321   participate in (e.g., hobby, sports, or volunteer groups), meaning fewer options/reasons

322   for going out; accordingly, people in rural areas may find lesser opportunities/reasons to

323   go out. Additionally, public transportation in rural areas of Japan is less frequent and less

324   convenient.[32] Nonetheless, we highlight a possible methodological limitation that justifies

325   this between-group difference: Some rural area residents might understand the "going

326   outdoors" phrase in our question as going out with a specific purpose (e.g., shopping,

327 medical consultation); thus, even if people in rural areas may regularly go out to do farm

328 work or see their neighbors, they might not have considered this as "going outdoors."

329 **Association between Community SC and Homebound Status**

330   Some factors may explain why we observed a diminished prevalence of

331 homebound status on older adults with ample opportunities for civic participation in rural

332 areas. Older adults' participation in community activities may change their lives by:

333 Empowering them through the development of community attachment; making them feel

334 more safe and less anxious; recovering communication with neighbors, etc.[33] Nonetheless,

335 in rural areas, there are limited places to go and groups and activities to participate in, so

336 rural older adults lack opportunities to go outdoors and into the community. Based on

337 prior research, it may be that increasing the number of group activities and places to

338 go/reasons to go outside in rural areas will reduce homebound status on older adults.

339 Oppositely, in urban areas, older adults tend to have many opportunities to enter groups

340 or to partake in activities, such as hobbies, sports, or volunteering work; they also have

341 many reasons to go outside owing to the number of facilities at their disposal (e.g.,

342 community center, gymnasium, grocery store).

343   We found some differences in the types of civic participation between people in

344 rural and urban areas. Correlatively, Saito et al. showed that hobby activities are more

22

345   popular in urban than in rural areas.[31] Tamakoshi showed that social and voluntary

346   activities are more popular in rural than in urban areas. [34] Our results showed that 19.1%

347   of the rural sample and 28.4% of the urban sample participated in hobby groups; 12.9%

348   of the rural and 18.2% of the urban in sports group; and 9.8% of the rural and 8.5% of the

349   in volunteering (Supplementary Table 2). Thus, we need to pay attention to between-area

350   differences regarding civic participation type, as such knowledge may allow for well-

351   informed suggestions toward improvements in civic participation of older adults in rural

352   and urban areas.

353   In the additional models stratified by sex, civic participation was significantly

354   associated with older women in rural areas. In rural Japan, most women are homemakers

355   and do not have enough opportunities for social participation. In such traditional contexts,

356   women generally face hinderances to customary outings. Specifically, Japanese rural

357   women tend to hesitate frequent home outings because they prefer not to be seen leaving

358   the home by the neighbors, thereby being a cultural custom that obstructs their social

359   participation.[35] Under such circumstances, a civic participation activity may be a precious

360   opportunity to allow these women to go outdoors and participate in social activities.

361   Moreover, we found no significant association between homebound status and

362   the remaining two community SC indices in both rural and urban areas. Sato et al [20]

363   showed that the impact of SC-SC on self-rated health varied by urbanization level: It

364   improved in urban areas, but not in rural ones. We could not compare such results directly

365   with our findings owing to between-study differences regarding urbanization and

366   different outcome settings. Notwithstanding, stakeholders should take between-area

367   differences into account when considering the effects of SC on homebound status.

368   Our results also showed that individual-level social cohesion occurred more

369   frequently in rural than in urban areas, whereas community level SC-SC (social cohesion)

370   occurred more frequently in urban than in rural areas. This may be because a specific

371   number of individuals with either high or low social cohesion scores were clustered in

372   rural areas, also indicating higher variances at the community level. This may also be why

373   we observed relatively lower average scores in community -level SC-SC in rural areas.

374   To discuss SC-SC, we need to take into account the dark side of social capital. [36]

375   Sometimes, higher levels of social cohesion may have harmful effects on health owing to

376   exclusive attitudes toward newcomers.

377   **Association between Neighborhood built environment and Homebound Status**

378   All three neighborhood built environment indices were lower in rural than in

379   urban areas, indicating that rural people perceive that they do not have an appropriately

380   neighborhood built environment (e.g., not enough facilities within walking distance).

381   Moreover, the presence of suitable parks or pavements for walking and exercising was

382   significantly associated with diminished homebound status only in rural areas. Indeed,

383   outdoor places in which people can go for walking and exercising may be potential

384   destinations for older adults who do not have easy access to commercial or non-residential

385   facilities.[32] Specifically, the presence of parks or pavements explained 2.1% of the

386   variance at the community level. Older adults surrounded by an environment that allows

387   walking and exercising do not tend to be associated with the homebound status.

388   However, we found no significant association between grocery or mobile shops

389   and homebound status. This result was not compatible with prior literature.[18] Moreover,

390   the presence of possible danger places or intersections for people who are walking, that

391   evoke risk for traffic accidents, was not associated with homebound status in rural areas.

392   This may be explained by the lack of traffic accidents in rural areas owing to limited

393   traffic.

394   By analyzing the model with all community SC and neighborhood built

395   environment indices, only community SC-CP was significantly associated with

396   homebound status in rural areas. Thus, the effect of the presence of suitable parks or

397   pavements disappeared in this model; this may be because there may have been a degree

398   of correlation between social participation and the presence of such parks/pavements

399   (correlation coefficient = 0.57). In urban areas, we observed no significant associations

400   between neighborhood built environment indices and homebound status on older adults.

401   One of the reasons for this lack of correlation may relate to diminished variances in urban

402   communities in the first place. In other words, there may be poor environmental variation

403   in urban rather than rural areas.

404   **Strengths and Limitations**

405   We acknowledge three strengths in this study. First, we placed homebound status

406   as an outcome variable to evaluate its correlation with community level factors. The

407   homebound status is deemed as a visible index because family members and neighbors

408   can recognize it even at its early stages. Second, our study was conducted in the Niigata

409   prefecture, which has both urban areas typical to Japan and deep mountainous rural areas;

410   this allowed for us to compare between-area differences in the same prefecture. Third, we

411   applied a multilevel logistic regression analysis to consider not only participants'

412   individual characteristics but also community-level SC.

413   However, our study also has limitations. First, our results are limited to data from

414   only three municipalities in a single prefecture (Niigata), so its representability is hindered.

415   Second, there may be sample bias in our study results because, generally, 64% of our

416   study participants who responded to the questionnaire were healthier than those who did

26

417 not respond. Third, as remarked earlier, some Japanese rural residents might understand

418 the question about "going outdoors" as referring to activities such as shopping or medical

419 consultations, which have specific purposes; thus, they may not considered the their daily

420 farm work or visits to their neighbors as "going outdoors."

421   We propose the following suggestions for future studies: first, longitudinal

422 research is warranted to clarify causal relationships between being homebound and

423 community social capital. Second, a similar analysis is needed using data from multiple

424 prefectures with wide variations, as variety in the data is relatively limited within a single

425 prefecture.

426 **Conclusion**

427   Concluding, using multilevel analysis, our results indicated that there was a

428 negative association between homebound status on rural older adults and the lack of

429 community level civic participation and of suitable parks/pavements. Although these

430 results were relevant only in rural areas, our study provides evidence that appropriately

431 built environments in the neighborhood and community level SC may reduce homebound

432 status; this is indicative of an effective public strategy that may be used by relevant

433 stakeholders interested in improving Japanese older adults' health and active ageing.

434 Moreover, our results suggest the need to consider differences between rural and urban

435   areas when developing intervention strategies to be applied in specific communities.

436   Concluding, community-level improvements in SC and in the neighborhood built

437   environment can promote active ageing in rural areas.

465

466 **Conflicts of Interest**

467 The authors declare no conflict of interest.

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Figure 1. Flow chart of the sampling procedures

Figure 2. Prevalence rates of homebound status on older adults

The prevalence rates in each community was represented from low to high prevalence among all analyzed 88 communities: (a) 52 communities in rural areas; (b) 32 in urban areas; and (c).

Subjects recruited for JAGES 2013 in Niigata Prefecture:
Niigata, Tokamachi, and Aga
($N = 27,922$)

Did not respond to the survey
($n = 7,270$)

Respondents to JAGES 2013
($n = 20,652$; response rate = 74.0%)

Missing data for gender, age, or district name
($n = 2,224$)

Missing data for homebound
($n = 329$)

Participants analyzed
($n = 18,099$; response rate = 64.8%)
Rural: 12,494,   Urban: 5,605
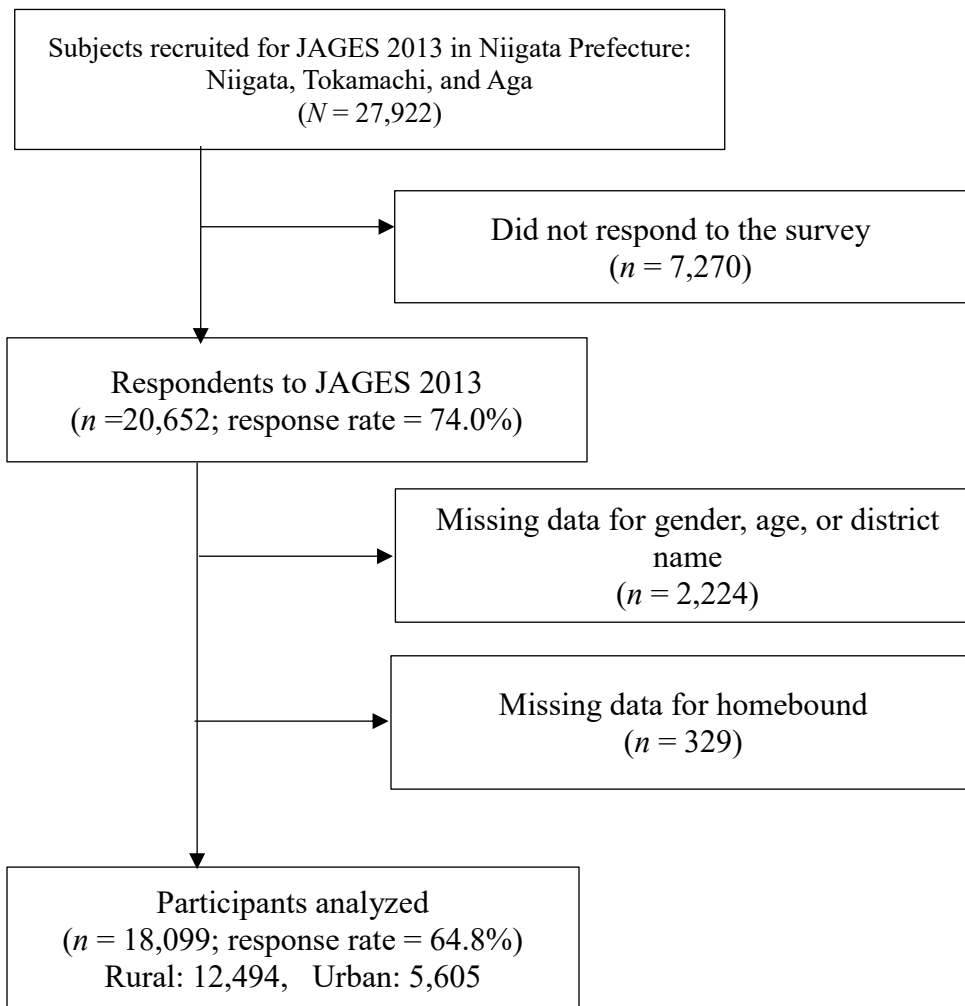
Figure 1. Flow chart of the sampling procedures
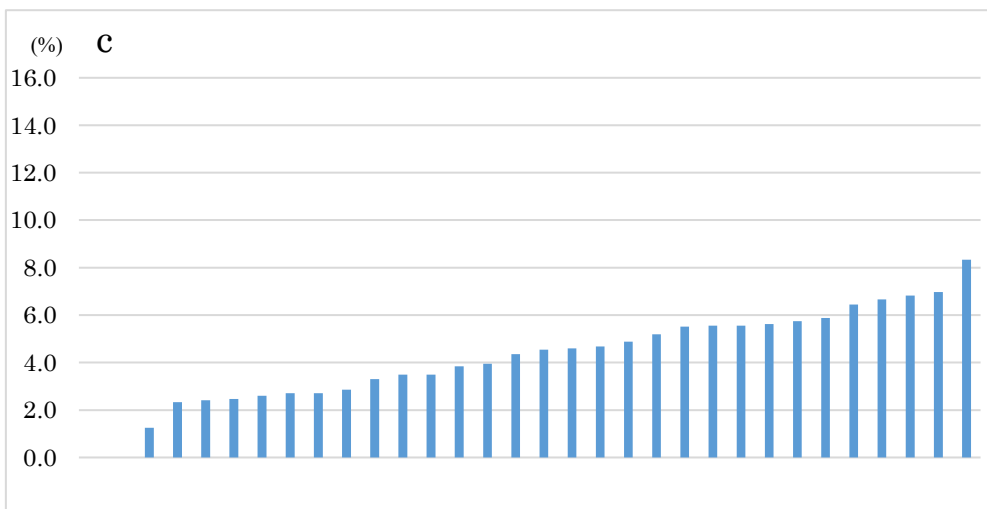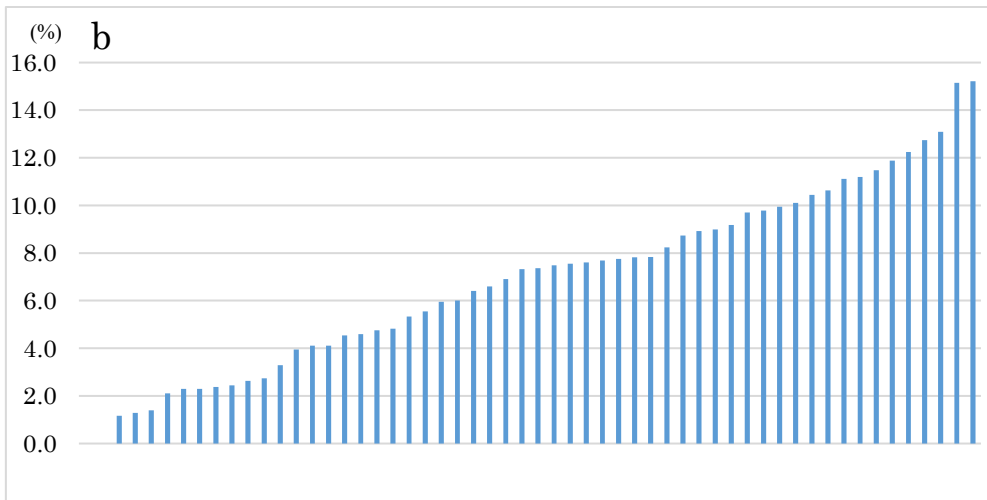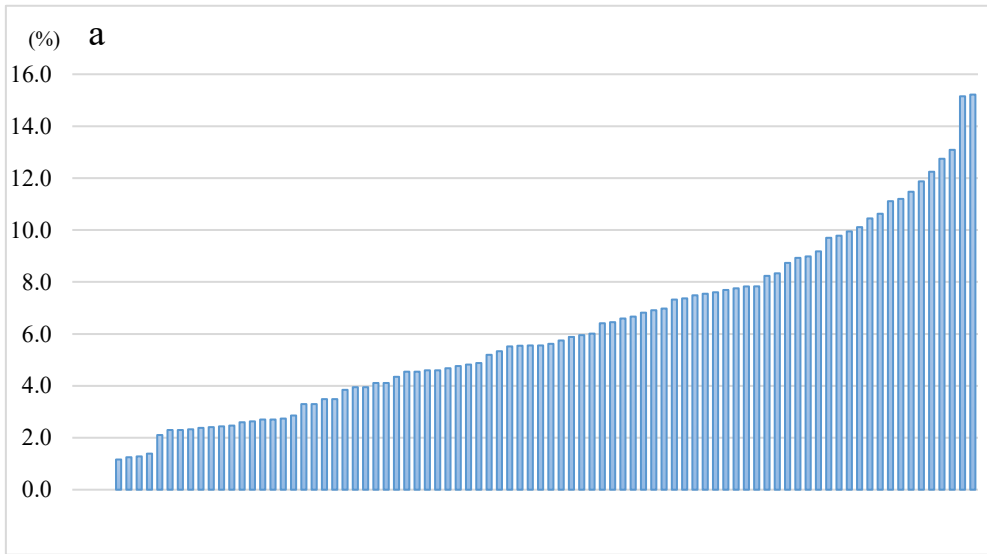
Figure 2. Prevalence rates of homebound status on older adults
The prevalence rates in each community was represented from low to high
prevalence among all analyzed 88 communities: (a) 52 communities in
rural areas; (b) 32 in urban areas; and (c).

Table 1. Community characteristics differences by rural and urban areas

	Rural (n = 56)	Urban (n = 32)	P-value [a]
	Mean ± SD	Mean ± SD	
Community social capital			
Civic participation	0.48 ± 0.15	0.63 ± 0.13	< .001
Social cohesion	0.65 ± 0.14	0.78 ± 0.15	< .001
Reciprocity	2.00 ± 0.04	1.99 ± 0.04	.235
Built environment			
Suitable parks or pavements for walking and exercising, %	59.3 ± 13.3	71.2 ± 10.2	< .001
Possible dangerous places or intersections that evoke risk of traffic accidents, %	51.4 ± 9.4	60.3 ± 7.5	< .001
Grocery or mobile shops in which you can get fresh food, %	55.0 ± 17.9	76.7 ± 10.5	< .001
Prevalence of homebound status			
Crude, %	6.9 ± 3.8	4.2 ± 2.0	< .001
Age and sex adjusted, %	7.4	5.0	-

[a] Welch's *t* test was applied.

Table 2. Participants' demographic characteristics by rural and urban areas

	Rural (n = 12,494)		Urban (n = 5,605)		P [a]
	n	%	n	%	
Sex					
Men	5,690	45.5	2,560	45.7	.869
Women	6,804	54.5	3,045	54.3	
Age					
65-69	3,264	26.1	1,529	27.3	<.001
70-74	3,035	24.3	1,608	28.7	
75-79	2,805	22.5	1,264	22.6	
80-84	2,071	16.6	761	13.6	
≥ 85	1,319	10.6	443	7.9	
Household					
Living with others	10,028	80.3	4,598	82.0	.005
Living alone	2,466	19.7	1,007	18.0	
Marital status					
Married	8,608	68.9	4,023	71.8	<.001
Widowed, unmarried, other	3,169	25.4	1,419	25.3	
Missing data	717	5.7	163	2.9	
Educational attainment (in years)					
≤ 9	7,361	58.9	2,535	45.2	<.001
≥ 10	4,830	38.7	2,973	53.0	
Missing data	303	2.4	97	1.7	
Equivalized annual household income (in million yen)					
< 1	7,361	58.9	2,535	45.2	<.001
1-3.99	4,830	38.7	2,973	53.0	
≥ 4	303	2.4	97	1.7	
Missing data	7,361	58.9	2,535	45.2	
Geriatric depression scale-15 score					
0-4	7,021	56.2	3,211	57.3	.326
5-9	2,373	19.0	1,024	18.3	
≥ 10	735	5.9	347	6.2	
Missing data	2,365	18.9	1,023	18.3	
Instrumental activities of daily living					
0-4	9,477	75.9	4,432	79.1	<.001
5	2,626	21.0	1,020	18.2	
Missing data	391	3.1	153	2.7	
Self-rated health					
Fair	9,806	78.5	4,479	79.9	.092
Poor	2,281	18.3	959	17.1	
Missing data	407	3.3	167	3.0	
Number of medical diseases under care or sequelae					
0	2,873	23.0	1,218	21.7	<.001
1	4,772	38.2	2,025	36.1	
2	2,900	23.2	1,403	25.0	
≥3	1,949	15.6	959	17.1	
Individual social capital: Civic participation[b]					
0	8,728	69.9	3,399	60.6	<.001
1	2,137	17.1	1,137	20.3	
2	995	8.0	689	12.3	
≥ 3	634	5.1	380	6.8	
Individual social capital: Social cohesion[c]					
0	1,516	12.1	747	13.3	<.001
1	1,744	14.0	892	15.9	
2	2,372	19.0	1,187	21.2	
3	6,862	54.9	2,779	49.6	
Individual social capital: Reciprocity[d]					
0	89	0.7	49	0.9	.096
1	287	2.3	153	2.7	
2	826	6.6	338	6.0	
3	11,292	90.4	5,065	90.4	

[a] Chi-square test.

[b] Groups in which subjects participated more than once/month

[c] Items with a positive response

[d] Items with a response other than "no one"

Table 3a. Result of multilevel logistic regression analysis to examine the association between community level SC and homebound status in rural areas

Rural

	Model 1 OR	Model 1 95%CI		Model 1 P^a	Model 2 OR	Model 2 95%CI		Model 2 P^a	Model 3 OR	Model 3 95%CI		Model 3 P^a	Model 4 OR	Model 4 95%CI		Model 4 P^a	Model 5 OR	Model 5 95%CI		Model 5 P^a	Model 6 OR	Model 6 95%CI		Model 6 P^a
n=	12,494				7,536				7,536				7,536				7,536				7,536			
Sex																								
Men					Ref.				Ref.				Ref.				Ref.				Ref.			
Women					1.47	1.18	1.84	.001	1.45	1.16	1.82	.001	1.48	1.18	1.85	.001	1.47	1.18	1.84	.001	1.46	1.16	1.82	.001
Age																								
65-69					1.00				1.00				1.00				1.00				1.00			
70-74					1.09	0.76	1.56	.653	1.08	0.75	1.55	.686	1.09	0.76	1.57	.631	1.09	0.76	1.56	.652	1.08	0.75	1.56	.668
75-79					1.40	0.99	1.99	.058	1.40	0.99	1.99	.059	1.41	0.99	2.00	.056	1.40	0.99	1.99	.057	1.41	0.99	2.00	.055
80-84					2.24	1.57	3.18	.000	2.21	1.55	3.14	<.001	2.24	1.57	3.19	<.001	2.24	1.57	3.18	<.001	2.22	1.56	3.15	<.001
≥85					4.12	2.86	5.92	.000	4.08	2.83	5.86	<.001	4.12	2.86	5.93	<.001	4.12	2.86	5.92	<.001	4.09	2.84	5.89	<.001
Household																								
Living with others					Ref.				Ref.				Ref.				Ref.				Ref.	Ref.		
Living alone					0.93	0.69	1.25	.611	0.92	0.68	1.24	.590	0.94	0.70	1.27	.694	0.93	0.69	1.25	.615	0.94	0.70	1.27	.683
Marital status																								
Married					Ref.				Ref.				Ref.				Ref.				Ref.			
Widowed, unmarried, other					1.49	1.17	1.91	.001	1.49	1.16	1.90	.002	1.47	1.15	1.89	.002	1.49	1.17	1.91	.001	1.47	1.15	1.88	.002
Educational attainment (in years)																								
≤9					Ref.				Ref.				Ref.				Ref.				Ref.			
≥10					0.84	0.66	1.08	.173	0.84	0.66	1.07	.155	0.86	0.67	1.09	.216	0.84	0.66	1.08	.175	0.85	0.67	1.09	.201
Equivalized annual household income (in million yen)																								
<1					Ref.				Ref.				Ref.				Ref.				Ref.			
1-3.99					0.60	0.47	0.77	<.001	0.61	0.48	0.77	<.001	0.60	0.47	0.77	<.001	0.60	0.47	0.77	<.001	0.61	0.48	0.78	<.001
≥4					0.64	0.41	1.00	.049	0.65	0.42	1.01	.054	0.65	0.42	1.01	.053	0.64	0.41	1.00	.048	0.66	0.42	1.02	.060
Geriatric depression scale-15 score																								
0-4					Ref.				Ref.				Ref.				Ref.				Ref.			
5-9					1.60	1.27	2.03	<.001	1.61	1.27	2.03	<.001	1.61	1.27	2.03	<.001	1.60	1.26	2.03	<.001	1.61	1.28	2.04	<.001
≥10					1.49	1.06	2.10	.022	1.49	1.06	2.09	.023	1.51	1.07	2.12	.019	1.49	1.06	2.10	.022	1.50	1.07	2.12	.020
Instrumental activities of daily living																								
0-4					Ref.				Ref.				Ref.				Ref.				Ref.			
5					3.15	2.52	3.94	<.001	3.16	2.53	3.95	<.001	3.13	2.51	3.92	<.001	3.15	2.52	3.94	<.001	3.14	2.51	3.92	<.001
Self-rated health																								
Fair					Ref.				Ref.				Ref.				Ref.				Ref.			
Poor					2.03	1.60	2.58	<.001	2.05	1.61	2.60	<.001	2.03	1.59	2.58	<.000	2.03	1.60	2.58	<.001	2.04	1.60	2.59	<.001
Number of medical diseases under care or sequelae					Ref.				Ref.				Ref.				Ref.				Ref.			
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					1.04	0.76	1.41	.824	1.03	0.76	1.40	.864	1.04	0.76	1.41	.815	1.04	0.76	1.41	.824	1.03	0.76	1.40	.848
2					0.98	0.70	1.37	.920	0.98	0.70	1.37	.908	1.00	0.71	1.39	.993	0.98	0.70	1.37	.921	1.00	0.71	1.39	.989
≥3					0.91	0.63	1.30	.588	0.90	0.63	1.28	.548	0.92	0.64	1.32	.657	0.91	0.63	1.30	.591	0.91	0.64	1.31	.617
Individual social capital: Civic participation^c																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					0.34	0.23	0.51	<.001	0.35	0.24	0.53	<.001	0.34	0.23	0.52	<.001	0.34	0.23	0.51	<.001	0.35	0.24	0.53	<.001
2					0.45	0.26	0.79	.006	0.47	0.27	0.82	.008	0.46	0.26	0.80	.006	0.45	0.26	0.79	.006	0.47	0.27	0.83	.009
≥3					0.25	0.09	0.68	.007	0.26	0.10	0.71	.009	0.25	0.09	0.69	.007	0.25	0.09	0.68	.007	0.26	0.10	0.71	.009
Individual social capital: Social cohesion^d																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					0.66	0.46	0.96	.030	0.66	0.46	0.96	.030	0.67	0.46	0.97	.034	0.66	0.46	0.96	.031	0.67	0.46	0.97	.033
2					0.68	0.48	0.96	.029	0.67	0.48	0.95	.025	0.68	0.48	0.96	.029	0.68	0.48	0.96	.030	0.68	0.48	0.95	.025
3					0.51	0.37	0.70	<.001	0.51	0.37	0.69	<.001	0.50	0.37	0.69	<.001	0.51	0.37	0.70	<.001	0.50	0.36	0.68	<.001
Individual social capital: Reciprocity^e					Ref.				Ref.				Ref.				Ref.				Ref.			
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					1.11	0.40	3.11	.836	1.12	0.40	3.11	.831	1.10	0.39	3.08	.851	1.11	0.40	3.11	.836	1.11	0.40	3.09	.840
2					0.97	0.38	2.45	.943	0.95	0.37	2.39	.907	0.94	0.37	2.38	.897	0.97	0.38	2.45	.943	0.92	0.37	2.33	.867
3					0.74	0.30	1.80	.503	0.73	0.30	1.78	.487	0.72	0.29	1.75	.463	0.74	0.30	1.80	.501	0.71	0.29	1.74	.459
Community social capital indices																								
Civic participation									0.67	0.51	0.88	.004									0.68	0.52	0.89	.006
Social cohesion													0.74	0.54	1.01	.056					0.75	0.56	1.00	.050
Reciprocity																	1.02	0.79	1.31	.890	0.94	0.73	1.21	.620
Community-level variance (SE)	0.149	(0.065)			0.021	(0.040)			7.7×10^{-29}	(4.6×10^{-15})			0.025	(0.047)			0.021	(0.041)			2.1×10^{-28}	(1.1×10^{-14})		
PCV^b, %					86.0				14.0				-2.7				0.1				14.0			

^a Chi-square test.
^b proportional change in variance
^c Groups in which subjects participated more than once/month

[d] Items with a positive response

[e] Items with a response other than "no one"

Table 3b. Result of multilevel logistic regression analysis to examine the association between community level SC and homebound status in urban areas

	Urban																							
	Model 1				Model 2				Model 3				Model 4				Model 5				Model 6			
	n= 5,605				n= 3,634				n= 3,634				n= 3,634				n= 3,634				n= 3,634			
	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a
Sex																								
Men					Ref.				Ref.				Ref.				Ref.				Ref.			
Women					1.41	0.94	2.13	.098	1.43	0.95	2.15	.090	1.41	0.94	2.12	.101	1.43	0.95	2.15	.089	1.43	0.95	2.16	.087
Age																								
65-69					Ref.				Ref.				Ref.				Ref.				Ref.			
70-74					0.58	0.29	1.16	.124	0.59	0.30	1.17	.129	0.58	0.29	1.16	.124	0.58	0.29	1.16	.123	0.58	0.29	1.16	.125
75-79					1.37	0.75	2.48	.304	1.39	0.77	2.52	.277	1.37	0.75	2.48	.302	1.37	0.76	2.48	.299	1.40	0.77	2.53	.271
80-84					2.28	1.25	4.16	.007	2.36	1.29	4.30	.005	2.27	1.24	4.13	.008	2.29	1.26	4.17	.007	2.30	1.26	4.21	.007
≥85					4.49	2.39	8.43	<.001	4.65	2.47	8.77	<.001	4.50	2.40	8.45	<.001	4.50	2.39	8.45	<.001	4.66	2.47	8.80	<.001
Household																								
Living with others					Ref.				Ref.				Ref.				Ref.				Ref.			
Living alone					1.25	0.72	2.17	.423	1.26	0.72	2.18	.418	1.25	0.72	2.17	.423	1.25	0.72	2.17	.422	1.26	0.72	2.18	.416
Marital status																								
Married					Ref.				Ref.				Ref.				Ref.				Ref.			
Widowed, unmarried, other					0.98	0.61	1.56	.923	0.97	0.61	1.55	.897	0.98	0.61	1.57	.936	0.98	0.61	1.56	.918	0.98	0.61	1.57	.940
Educational attainment (in years)																								
≤9					Ref.				Ref.				Ref.				Ref.				Ref.			
≥10					1.11	0.74	1.66	.620	1.14	0.76	1.71	.533	1.10	0.73	1.65	.657	1.13	0.75	1.70	.562	1.12	0.74	1.69	.583
Equivalized annual household income (in million yen)																								
<1					Ref.				Ref.				Ref.				Ref.				Ref.			
1-3.99					1.08	0.72	1.63	.707	1.09	0.72	1.64	.697	1.08	0.72	1.63	.708	1.08	0.72	1.63	.708	1.08	0.72	1.64	.703
≥4					1.32	0.74	2.36	.348	1.30	0.73	2.33	.377	1.32	0.74	2.37	.344	1.32	0.74	2.36	.350	1.32	0.73	2.36	.358
Geriatric depression scale-15 score																								
0-4					Ref.				Ref.				Ref.				Ref.				Ref.			
5-9					1.44	0.94	2.20	.091	1.43	0.94	2.19	.095	1.44	0.94	2.21	.090	1.43	0.94	2.19	.096	1.43	0.94	2.19	.097
≥10					1.52	0.82	2.78	.180	1.52	0.83	2.80	.174	1.53	0.83	2.81	.174	1.50	0.82	2.75	.193	1.54	0.84	2.83	.167
Instrumental activities of daily living																								
0-4					Ref.				Ref.				Ref.				Ref.				Ref.			
5					5.79	3.86	8.69	<.001	5.78	3.86	8.67	<.001	5.82	3.88	8.73	<.001	5.79	3.86	8.68	<.001	5.87	3.91	8.81	<.001
Self-rated health																								
fair					Ref.				Ref.				Ref.				Ref.				Ref.	.		
poor					1.77	1.16	2.71	.009	1.77	1.15	2.70	.009	1.77	1.16	2.72	.008	1.76	1.15	2.70	.009	1.78	1.16	2.73	.008
Number of medical diseases under care or sequelae																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					1.18	0.65	2.14	.583	1.17	0.65	2.13	.595	1.18	0.65	2.14	.580	1.18	0.65	2.14	.588	1.17	0.65	2.13	.598
2					1.30	0.70	2.40	.411	1.30	0.70	2.42	.399	1.29	0.70	2.40	.415	1.30	0.70	2.41	.404	1.30	0.70	2.40	.412
≥3					1.12	0.57	2.19	.743	1.13	0.58	2.21	.722	1.11	0.57	2.18	.760	1.13	0.57	2.21	.728	1.11	0.56	2.17	.768
Individual social capital: Civic participation[c]																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					0.25	0.12	0.53	<.001	0.26	0.12	0.54	<.001	0.25	0.12	0.53	<.001	0.25	0.12	0.53	<.001	0.25	0.12	0.54	<.001
2					0.49	0.22	1.09	.080	0.50	0.22	1.11	.089	0.49	0.22	1.09	.081	0.49	0.22	1.10	.082	0.50	0.23	1.13	.095
≥3					0.12	0.02	0.89	.038	0.12	0.02	0.91	.040	0.12	0.02	0.89	.038	0.12	0.02	0.89	.038	0.13	0.02	0.92	.041
Individual social capital: Social cohesion[d]																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					1.51	0.74	3.12	.260	1.52	0.74	3.13	.256	1.52	0.74	3.13	.257	1.51	0.73	3.10	.265	1.53	0.74	3.15	.251
2					1.59	0.80	3.17	.189	1.54	0.77	3.09	.221	1.61	0.80	3.21	.181	1.55	0.78	3.10	.215	1.55	0.77	3.11	.217
3					1.75	0.94	3.25	.077	1.72	0.92	3.19	.088	1.78	0.95	3.31	.071	1.70	0.91	3.16	.095	1.74	0.93	3.25	.082
Individual social capital: Reciprocity[e]																								
0					Ref.				Ref.				Ref.				Ref.				Ref.			
1					0.53	0.09	3.22	.491	0.51	0.08	3.09	.463	0.53	0.09	3.20	.487	0.51	0.09	3.11	.469	0.48	0.08	2.90	.424
2					0.88	0.17	4.52	.876	0.86	0.17	4.41	.855	0.87	0.17	4.50	.871	0.85	0.17	4.36	.846	0.81	0.16	4.13	.799
3					0.49	0.10	2.38	.377	0.48	0.10	2.31	.359	0.49	0.10	2.38	.378	0.47	0.10	2.27	.348	0.45	0.09	2.18	.322
Community social capital indices																								
Civic participation									0.79	0.54	1.17	.241									0.83	0.55	1.24	.360
Social cohesion													1.09	0.73	1.62	.675					1.33	0.83	2.13	.231
Reciprocity																	1.25	0.81	1.94	.315	1.38	0.81	2.37	.236
Community-level variance (SE)	$4.7×10^{-27}$	$(8.0×10^{-15})$			$1.0×10^{-32}$	$(2.0×10^{-17})$			$3.7×10^{-37}$	$(1.8×10^{-19})$			$1.3×10^{-31}$	$(1.2×10^{-16})$			$2.4×10^{-31}$	$(2.0×10^{-16})$			$5.0×10^{-36}$	$(2.2×10^{-18})$		
PCV[b], %					100.0				0.0002				-0.0025				-0.0049				0.0002			

[a] Chi-square test.

[b] proportional change in variance

[c] Groups in which subjects participated more than once/month

[d] Items with a positive response

Table 4a. Result of multilevel logistic regression analysis to examine the association between neighborhood built environment and homebound status in rural areas

									Rural								
	Model 1 (n=7,536)				Model 2 (n=7,536)				Model 3 (n=7,536)				Model 4 (n=7,536)			
	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a
Sex																
Men	Ref.				Ref.				Ref.				Ref.			
Women	1.48	1.18	1.85	.001	1.47	1.17	1.84	.001	1.48	1.18	1.84	.001	1.48	1.18	1.84	.001
Age																
65-69	Ref.				Ref.				Ref.				Ref.			
70-74	1.09	0.76	1.57	.650	1.09	0.76	1.57	.647	1.09	0.76	1.57	.646	1.09	0.76	1.57	.643
75-79	1.41	0.99	2.00	.057	1.40	0.98	1.99	.061	1.41	0.99	2.00	.055	1.40	0.99	2.00	.058
80-84	2.22	1.56	3.16	<.001	2.23	1.57	3.17	<.001	2.24	1.58	3.19	<.001	2.22	1.56	3.15	<.001
≥85	4.11	2.86	5.91	<.001	4.11	2.85	5.91	<.001	4.13	2.87	5.94	<.001	4.11	2.85	5.91	<.001
Household																
Living with others	Ref.				Ref.				Ref.				Ref.			
Living alone	0.93	0.69	1.26	.640	0.92	0.68	1.24	.584	0.92	0.68	1.25	.603	0.92	0.68	1.25	.610
Marital status																
Married	Ref.				Ref.				Ref.				Ref.			
Widowed, unmarried, other	1.48	1.15	1.89	.002	1.49	1.17	1.91	.001	1.49	1.17	1.91	.001	1.48	1.16	1.90	.002
Educational attainment (in years)																
≤9	Ref.				Ref.				Ref.				Ref.			
≥10	0.85	0.67	1.09	.199	0.84	0.66	1.07	.165	0.85	0.66	1.08	.184	0.85	0.67	1.09	.200
Equivalized annual household income (in million yen)																
<1	Ref.				Ref.				Ref.				Ref.			
1-3.99	0.61	0.48	0.78	<.001	0.61	0.47	0.77	<.001	0.60	0.47	0.77	<.001	0.61	0.48	0.78	<.001
≥4	0.65	0.42	1.00	.052	0.65	0.42	1.01	.053	0.64	0.41	1.00	.048	0.65	0.42	1.01	.056
Geriatric depression scale-15 score																
0-4	Ref.				Ref.				Ref.				Ref.			
5-9	1.60	1.27	2.03	<.001	1.61	1.27	2.04	<.001	1.60	1.27	2.03	<.001	1.61	1.27	2.04	<.001
≥10	1.50	1.07	2.12	.020	1.50	1.06	2.11	.021	1.49	1.06	2.11	.021	1.51	1.07	2.12	.019
Instrumental activities of daily living																
0-4	Ref.				Ref.				Ref.				Ref.			
5	3.15	2.52	3.94	<.001	3.15	2.52	3.94	<.001	3.14	2.51	3.92	<.001	3.14	2.51	3.93	<.001
Self-rated health																
Fair	Ref.				Ref.				Ref.				Ref.			
Poor	2.02	1.59	2.58	<.001	2.03	1.60	2.59	<.001	2.03	1.60	2.58	<.001	2.03	1.59	2.58	<.001
Number of medical diseases under care or sequelae																
0	Ref.				Ref.				Ref.				Ref.			
1	1.04	0.76	1.41	.817	1.03	0.76	1.41	.834	1.03	0.76	1.41	.832	1.03	0.76	1.41	.831
2	0.99	0.71	1.38	.961	0.98	0.70	1.37	.923	0.99	0.71	1.38	.930	0.99	0.71	1.39	.970
≥3	0.92	0.64	1.31	.635	0.91	0.63	1.30	.587	0.91	0.63	1.30	.592	0.92	0.64	1.31	.634
Individual social capital: Civic participation [c]																
0	Ref.				Ref.				Ref.				Ref.			
1	0.34	0.23	0.52	<.001	0.34	0.23	0.52	<.001	0.34	0.23	0.51	<.001	0.34	0.23	0.52	<.001
2	0.46	0.26	0.80	.006	0.46	0.26	0.80	.006	0.46	0.26	0.80	.006	0.46	0.26	0.81	.007
≥3	0.25	0.09	0.69	.007	0.25	0.09	0.69	.007	0.25	0.09	0.68	.007	0.25	0.09	0.69	.008
Individual social capital: Social cohesion [d]																
0	Ref.				Ref.				Ref.				Ref.			
1	0.67	0.46	0.97	.033	0.67	0.46	0.97	.033	0.67	0.46	0.97	.032	0.67	0.46	0.98	.037
2	0.68	0.48	0.96	.027	0.68	0.48	0.96	.029	0.69	0.49	0.97	.032	0.68	0.48	0.96	.028
3	0.51	0.37	0.69	<.001	0.51	0.37	0.70	<.001	0.51	0.37	0.70	<.001	0.51	0.37	0.69	<.001
Individual social capital: Reciprocity [e]																
0	Ref.				Ref.				Ref.				Ref.			
1	1.13	0.41	3.17	.810	1.11	0.40	3.10	.847	1.10	0.40	3.08	.849	1.12	0.40	3.14	.827
2	0.96	0.38	2.43	.930	0.96	0.38	2.44	.931	0.96	0.38	2.43	.934	0.95	0.37	2.42	.915
3	0.73	0.30	1.79	.493	0.73	0.30	1.79	.494	0.73	0.30	1.78	.486	0.72	0.29	1.77	.477
Built environment																
Suitable parks or pavements for walking and exercising	0.72	0.52	1.01	.060									0.72	0.51	1.02	.066
Possible dangerous places or intersections that evoke risk of traffic accidents					0.88	0.65	1.19	.403					0.90	0.67	1.21	.490
Grocery or mobile shops in which you can get fresh food									0.87	0.65	1.16	.328	0.91	0.67	1.22	.523
Community-level variance (SE)	0.018	(0.042)			0.033	(0.045)			0.022	(0.044)			0.028	(0.046)		
PCV [b], %	2.2				-8.3				-1.0				-4.4			

[a] Chi-square test.

[b] proportional change in variance

[c] Groups in which subjects participated more than once/month

[d] Items with a positive response

[e] Items with a response other than "no one"

Table 4b   Result of multilevel logistic regression analysis to examine the association between neighborhood built environment and homebound status in urban areas

	Urban											
	Model 1 (n=3,634)			Model 2 (n=3,634)			Model 3 (n=3,634)			Model 4 (n=3,634)		
	OR	95% CI	P^a	OR	95% CI	P^a	OR	95% CI	P^a	OR	95% CI	P^a
Sex												
Men	Ref.			Ref.			Ref.			Ref.		
Women	1.41	0.94 2.12	.100	1.42	0.94 2.13	.096	1.41	0.94 2.13	.098	1.41	0.94 2.13	.098
Age												
65-69	Ref.			Ref.			Ref.			Ref.		
70-74	0.59	0.29 1.16	.126	0.59	0.29 1.16	.127	0.58	0.29 1.16	.125	0.59	0.30 1.17	.128
75-79	1.38	0.76 2.50	.291	1.37	0.76 2.48	.301	1.37	0.75 2.48	.303	1.38	0.76 2.49	.293
80-84	2.29	1.26 4.18	.007	2.34	1.28 4.27	.006	2.28	1.25 4.16	.007	2.33	1.27 4.26	.006
≥85	4.53	2.41 8.52	<.001	4.56	2.43 8.57	<.001	4.49	2.39 8.43	<.001	4.56	2.42 8.58	<.001
Household												
Living with others	Ref.			Ref.			Ref.			Ref.		
Living alone	1.26	0.73 2.19	.405	1.26	0.73 2.19	.410	1.25	0.72 2.17	.425	1.26	0.73 2.19	.407
Marital status												
Married	Ref.			Ref.			Ref.			Ref.		
Widowed, unmarried, other	0.97	0.61 1.56	.912	0.97	0.60 1.54	.885	0.98	0.61 1.56	.925	0.97	0.60 1.55	.891
Educational attainment (in years)												
≤9	Ref.			Ref.			Ref.			Ref.		
≥10	1.10	0.73 1.65	.645	1.13	0.75 1.70	.563	1.11	0.74 1.66	.624	1.12	0.74 1.68	.597
Equivalized annual household income (in million yen)												
<1	Ref.			Ref.			Ref.			Ref.		
1-3.99	1.09	0.72 1.65	.687	1.08	0.72 1.63	.714	1.08	0.72 1.64	.707	1.08	0.72 1.64	.699
≥4	1.32	0.74 2.36	.353	1.30	0.73 2.34	.371	1.32	0.74 2.36	.348	1.31	0.73 2.34	.368
Geriatric depression scale-15 score												
0-4	Ref.			Ref.			Ref.			Ref.		
5-9	1.44	0.94 2.20	.094	1.44	0.94 2.20	.093	1.44	0.94 2.20	.092	1.44	0.94 2.20	.095
≥10	1.54	0.84 2.83	.165	1.53	0.83 2.82	.169	1.51	0.82 2.78	.182	1.54	0.84 2.84	.165
Instrumental activities of daily living												
0-4	Ref.			Ref.			Ref.			Ref.		
5	5.82	3.88 8.73	<.001	5.75	3.83 8.63	<.001	5.79	3.86 8.70	<.001	5.78	3.85 8.67	<.001
Self-rated health												
Fair	Ref.			Ref.			Ref.			Ref.		
Poor	1.78	1.16 2.73	.008	1.77	1.16 2.71	.009	1.77	1.15 2.71	.009	1.78	1.16 2.72	.008
Number of medical diseases under care or sequelae												
0	Ref.			Ref.			Ref.			Ref.		
1	1.17	0.65 2.13	.598	1.17	0.65 2.13	.600	1.18	0.65 2.14	.583	1.17	0.65 2.12	.605
2	1.29	0.69 2.39	.422	1.29	0.70 2.40	.413	1.30	0.70 2.40	.410	1.29	0.70 2.39	.419
≥3	1.10	0.56 2.16	.776	1.12	0.57 2.20	.733	1.12	0.57 2.19	.743	1.11	0.57 2.18	.755
Individual social capital: Civic participation [c]												
0	Ref.			Ref.			Ref.			Ref.		
1	0.25	0.12 0.53	<.001	0.25	0.12 0.54	<.001	0.25	0.12 0.53	<.001	0.25	0.12 0.53	<.001
2	0.49	0.22 1.10	.083	0.49	0.22 1.10	.085	0.49	0.22 1.09	.080	0.49	0.22 1.10	.085
≥3	0.12	0.02 0.90	.039	0.12	0.02 0.90	.039	0.12	0.02 0.89	.038	0.12	0.02 0.90	.039
Individual social capital: Social cohesion [d]												
0	Ref.			Ref.			Ref.			Ref.		
1	1.50	0.73 3.09	.274	1.52	0.74 3.14	.256	1.51	0.73 3.12	.261	1.51	0.73 3.11	.266
2	1.57	0.79 3.14	.202	1.57	0.78 3.14	.203	1.59	0.80 3.17	.189	1.56	0.78 3.13	.206
3	1.75	0.94 3.25	.077	1.74	0.94 3.24	.079	1.75	0.94 3.25	.077	1.74	0.94 3.24	.078
Individual social capital: Reciprocity [e]												
0	Ref.			Ref.			Ref.			Ref.		
1	0.52	0.09 3.19	.482	0.51	0.08 3.10	.467	0.53	0.09 3.22	.491	0.51	0.08 3.11	.467
2	0.89	0.17 4.59	.887	0.86	0.17 4.44	.862	0.88	0.17 4.52	.876	0.87	0.17 4.50	.872
3	0.50	0.10 2.44	.392	0.49	0.10 2.36	.371	0.49	0.10 2.38	.377	0.49	0.10 2.40	.382
Built environment												
Suitable parks or pavements for walking and exercising	1.17	0.81 1.71	.400							1.10	0.71 1.71	.670
Possible dangerous places or intersections that evoke risk of traffic accidents				0.83	0.57 1.22	.350				0.87	0.56 1.36	.552
Grocery or mobile shops in which you can get fresh food							1.02	0.41 2.54	.967	1.03	0.40 2.64	.949
Community-level variance (SE)	$2.0× 10^{-33}$	$(1.0× 10^{-17})$		$3.0× 10^{-33}$	$(3.0× 10^{-17})$		$6.0× 10^{-31}$	$(5.0× 10^{-16})$		$2.0× 10^{-34}$	$(2.0× 10^{-18})$	
PCV [b], %	0.0002			0.0002			-0.01			0.0002		

Table 5. Result of multilevel logistic regression models combining all community level factors (i.e., SC and neighborhood built environment) by rural and urban areas

	Rural				Urban			
	n=7,536				n=3,634			
	OR	95% CI		P^a	OR	95% CI		P^a
Sex								
Men	Ref.				Ref.			
Women	1.46	1.17	1.82	.001	1.43	0.95	2.15	.090
Age								
65-69	Ref.				Ref.			
70-74	1.08	0.75	1.56	.666	0.58	0.29	1.16	.125
75-79	1.41	0.99	2.00	.054	1.38	0.76	2.51	.285
80-84	2.21	1.56	3.15	<.001	2.30	1.26	4.22	.007
≥ 85	4.10	2.85	5.90	<.001	4.62	2.44	8.72	<.001
Household								
Living with others	Ref.				Ref.			
Living alone	0.94	0.69	1.26	.671	1.27	0.73	2.21	.398
Marital status								
Married	Ref.				Ref.			
Widowed, unmarried, other	1.47	1.15	1.88	.002	0.98	0.61	1.57	.921
Education (in years)								
≤ 9	Ref.				Ref.			
≥ 10	0.86	0.67	1.09	.211	1.12	0.74	1.69	.604
Equivalized annual household income (in million yen)								
< 1	Ref.				Ref.			
1-3.99	0.61	0.48	0.78	<.001	1.08	0.71	1.63	.717
≥ 4	0.66	0.42	1.02	.060	1.32	0.73	2.36	.358
Missing data								
Geriatric depression scale-15 score								
0-4	Ref.				Ref.			
5-9	1.62	1.28	2.05	<.001	1.43	0.93	2.19	.101
≥ 10	1.51	1.07	2.13	.019	1.55	0.84	2.86	.157
Instrumental activities of daily living								
0-4	Ref.				Ref.			
5	3.13	2.50	3.91	<.001	5.86	3.90	8.80	<.001
Self-rated health								
Fair	Ref.				Ref.			
Poor	2.03	1.60	2.59	<.001	1.79	1.17	2.74	.008
Number of medical diseases under care or sequelae								
0	Ref.				Ref.	Ref.		
1	1.03	0.76	1.40	.847	1.16	0.64	2.11	.617
2	1.00	0.72	1.40	.997	1.28	0.69	2.38	.432
≥3	0.91	0.64	1.31	.625	1.09	0.56	2.15	.796
Individual social capital: Civic participation [c]								
0	Ref.				Ref.			
1	0.35	0.23	0.53	<.001	0.25	0.12	0.53	<.001
2	0.47	0.27	0.83	.009	0.50	0.23	1.13	.094
≥ 3	0.26	0.10	0.71	.009	0.13	0.02	0.92	.041
Individual social capital: Social cohesion [d]								
0	Ref.				Ref.			
1	0.67	0.46	0.97	.035	1.52	0.74	3.15	.257
2	0.68	0.48	0.95	.026	1.55	0.77	3.11	.219
3	0.50	0.36	0.68	<.001	1.76	0.94	3.29	.078
Individual social capital: Reciprocity [e]								
0	Ref.				Ref.			
1	1.11	0.40	3.10	.839	0.46	0.08	2.78	.399
2	0.92	0.36	2.33	.863	0.80	0.16	4.05	.784
3	0.71	0.29	1.73	.452	0.45	0.09	2.17	.322
Built environment								
Suitable parks or pavements for walking and exercising	0.89	0.62	1.29	.539	1.07	0.60	1.90	.817
Possible dangerous places or intersections that evoke risk of traffic accidents	0.99	0.79	1.24	.909	0.74	0.39	1.42	.368
Grocery or mobile shops in which you can get fresh food	0.93	0.71	1.22	.608	1.09	0.42	2.82	.859
Community social capital indices								
Civic participation	0.70	0.52	0.93	.015	1.09	0.54	2.20	.806
Social cohesion	0.79	0.57	1.08	.135	1.45	0.82	2.57	.196
Reciprocity	0.93	0.72	1.21	.603	1.64	0.86	3.12	.130
Community-level variance (SE)	1.2×10^{-30}	(5.8×10^{-16})			3.6×10^{-33}	(9.4×10^{-18})		
PCV [b], %	14.1				0.0001			

[a] Chi-square test.

[b] proportional change in variance

[c] Groups in which subjects participated more than once/month

[d] Items with a positive response

[e] Items with a response other than "no one"

Supplementary Table 1a. Result of the multi-level logistic regression analysis to examine the association between community level SC and homebound status stratified by rural/urban areas and sex

| | Rural | | | | | | | | Urban | | | | | | | |
| | Male (n=3,919) | | | | Female (n=3,617) | | | | Male (n=1,865) | | | | Female (n=1,587) | | | |
	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a
Community social capital indices																
Civic participation	0.82	0.52	1.29	.381	0.54	0.33	0.88	.013	0.71	0.40	1.26	.239	0.95	0.52	1.74	.859
Social cohesion	0.72	0.44	1.17	.182	0.66	0.41	1.08	.098	1.19	0.64	2.23	.584	1.53	0.73	3.23	.264
Reciprocity	0.80	0.52	1.23	.314	1.05	0.70	1.56	.829	1.01	0.48	2.12	.979	1.79	0.79	4.05	.162
Community-level variance (SE)	0.08	(0.17)			0.10	(0.09)			2.0×10^{-33}	(3.4×10^{-17})			3.0×10^{-32}	(1.6×10^{-16})		
PCV[b], %	34.2				0.002				-2.2				-0.003			

[a] Community-level variance

[b] Proportional change in variance

Age, household, marital status, educational attainment, equivalized annual household income, geriatric depression scale-15 score, instrumental activities of daily living, self-rated heath, number of medical diseases under care, individual social capital (civic participation, social cohesion, and reciprocity) were adjusted in all models.

Supplementary Table 1b Result of the multi-level logistic regression analysis to examine the association between community level neighborhood built environment and homebound status stratified by rural/urban areas and sex

| | Rural | | | | | | | | Urban | | | | | | | |
| | Male (n=3,919) | | | | Female (n=3,617) | | | | Male (n=1,865) | | | | Female (n=1,587) | | | |
	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a	OR	95% CI		P^a
Built environment																
Suitable parks or pavements for walking and exercising	0.79	0.48	1.31	.367	0.65	0.39	1.07	.092	0.93	0.50	1.74	.828	1.43	0.74	2.76	.288
Possible dangerous places or intersections that evoke risk of traffic accidents	0.81	0.54	1.21	.299	0.91	0.58	1.43	.682	0.75	0.40	1.41	.373	1.05	0.54	2.02	.895
Grocery or mobile shops in which you can get fresh food	0.63	0.39	1.03	.065	1.16	0.74	1.82	.508	0.78	0.21	2.82	.699	1.53	0.38	6.14	.548
Community-level variance (SE)	0.04	0.12			0.10	0.09			(6.8×10^{-32})	(7.0×10^{-17})			(2.4×10^{-33})	(1.1×10^{-17})		
PCV[b], %	93.8				-10.2				-0.017				0.0005			

[a] Community-level variance

[b] proportional change in variance

Age, household, marital status, education, equivalized annual household income, geriatric depression scale-15 score, instrumental activities of daily living, self-rated heath, number of medical diseases under care, individual social capital (civic participation, social cohesion, and reciprocity) were adjusted in all models.

Supplementary Table 2. Types of civic participation by rural and urban areas

	Rural (n = 56)	Urban (n = 32)	P-value [a]
	Mean ± SD	Mean ± SD	
Civic participation			
Local meetings or group activities:			
Hobbies	19.1 ± 7.9	28.4 ± 7.8	< .001
Sports	12.9 ± 4.8	18.2 ± 4.6	< .001
Volunteers	9.8 ± 3.7	8.5 ± 3.4	.111
Learning and education	4.6 ± 2.3	6.9 ± 3.6	.002
The passing down of experience	3.2 ± 1.6	4.7 ± 2.3	.001

[a] Welch's *t* test was applied.