Hierarchical Structure Analysis on Health Determinants of Living Environment Defining Social Capital

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Abstract. In Japan, healthcare and nursing care expenses for the elderly are increasing year by year, and extending healthy life expectancy is therefore desirable. Social capital (SC) is a measure of the degree of social interaction and has been gaining attention as a health-related indicator. Previous studies have shown that few people have poor subjective health in areas with good SC scores. Thus, a living environment that fosters SC might facilitate the improvement and maintenance of health status. The purpose of this study was to clarify the effects of living environment, such as facilities and community outreach efforts, on nursing care risk as mediated by SC. A questionnaire survey was carried out for 3 weeks from September to October 2018. Participants were adults in three elementary school districts in Niihama City, Ehime Prefecture. The survey contents included SC, neighborhood environment, residential environment, and health status. A total of 7,220 questionnaires were distributed, and 2,053 were correctly completed (valid response rate = 28.4%). Of respondents over 65 years of age, 26.8% were at high risk of needing long-term care. Logistic regression analysis was performed to clarify the relationship between SC and the risk of requiring long-term care or support and the relationship between SC and living environment. The analysis model considered factors including age, sex, educational attainment, and length of residence in the area. The odds ratio (OR) of requiring long-term care for low SC compared with high SC was 1.91 (p < 0.01), and the OR of requiring long-term care for living environment factors ranged from 1.6 to 2.0 (p < 0.01). Finally, path analysis was performed. The determination coefficient for the risk of long-term care was 0.19. In summary, it became clear that among the factors of the living environment, the place of residence of the facility affects the SC, either directly or through community components.

1. Introduction

In recent years, Japan’s population has been decreasing, whereas the rate of aging has been increasing due to the increase in life expectancy along with advancements in medical technology. In 2065, one in four people in Japan are expected to be over the age of 75 years [1]. In addition, the benefit costs of health-care and long-term care expenses for the elderly are increasing year after year [1] (Fig. 1). Therefore, it is desirable to extend healthy life expectancy. Considering these circumstances, Health Japan 21 [2] was implemented with a focus on extending not only average life expectancy but also healthy life expectancy. This measure is written as “through development of a good social environment which supports healthy life at every life stage, we reduce health disparities (gap in health status between the groups, created by difference in community or socioeconomic status)” [2]. Thus, it is important to improve the living environment to extend healthy life expectancy. Social capital (SC), which indicates degree of social interaction, is a health-related indicator, and is the focus of the present study. Studies [3] have shown that in areas with good SC scores, few people have poor subjective health. Therefore, health status could be maintained or even raised depending on the living environment, which fosters SC.
In this report, we propose a hypothetical model (Fig. 2) based on logistic regression analysis, with the aim of elucidating the hierarchical structure of living environments that contribute to risk of needing long-term care, which is a focus for evaluating health conditions.

2. Research Approach

2.1 Research purpose and analysis method

Overview of survey

The focus of this study was living environment as a factor for preventing the need for long-term care. We conducted a questionnaire survey to assess the living environment and health condition of adults (age, 20 years and older) in the target area. We examined the relationship between SC and the independence of the elderly (65 years and older), and verified this relationship by multivariate analysis. Then, path analysis was performed to verify that the structure of the hypothetical model (Fig. 2) exists. All statistical analyses were performed using SPSS version 25.0 software (IBM, Armonk, New York). Mann–Whitney U test was performed to verify the impact of SC on risk of needing long-term care. Logistic regression analysis was performed using participant attributes such as sex and household composition as moderator effects. The aim was to clarify the effects of living environment such as facilities and community outreach on the risk of needing long-term care via SC. The variable selection method used was the forced entry method.
2.2. Target area
The target area comprised three elementary school districts in Niihama, Ehime, Japan (Fig. 3). T school district is located in a coastal area, I school district is located in an urban area, and O school district is located in a mountainous area. At the time of the study, about 19,000 people were living in these three areas, which consists mainly of detached houses. In addition, the aging rate—defined as the proportion of the population aged 65 years or older—of Niihama was 31.5%, which was higher than that of Japan as a whole in 2016 (23.7%).

2.3. Outline of questionnaire survey implementation
The questionnaire survey was aimed at adults living in the target area and was conducted by indirect distribution via a self-governing association. It asked about health condition, living environment including housing environment and neighborhood environment, SC, and lifestyle (Table 1). The risk of needing long-term care was judged based on a care prevention checklist[4][5]. The cut-off score for the care prevention checklist was set at 3/4 so that we could focus on participants genuinely in need of long-term care[4][5]. SC questionnaire items were cited from the Comprehensive Assessment System for Built Environment Efficiency (CASBEE) Community Health Checklist[6]. Housing environment and neighborhood environment questionnaire items were from the CASBEE Community Housing Health Checklist[7] and the CASBEE Community Health Checklist[6], respectively. The neighborhood environment section comprised items that fell under the categories “Facilities,” “Activity participation,” and “Communication.” The questionnaire survey was distributed to 7,220 adults in the target area and 2,693 completed questionnaires were collected (collection rate, 37.3%). Of these, 2,053 were regarded as valid samples, after excluding questionnaires that were missing response items related to age and sex and/or variables required for multivariate analysis.

| Table 1. Overview of questionnaire survey |
|-----------------------------------------|
| **Survey period** | September 18 to October 14, 2018 (28 days) |
| **Targets** | Adults residing in three elementary school districts, Niihama, Ehime, Japan |
| **Number of participants** | Distribution: 7,220 participants |
| | Included for analysis: 2,053 participants (28.4%) |
| **Distribution and collection** | The questionnaire survey was distributed and collected by local community associations. |
| **Survey contents** | Health condition: needing long-term care risk, depression, etc. |
| | Housing environment: thermal insulation performance, age of house, etc. |
| | Neighborhood environment: flower bed, hedge, bench, walking route, etc. |
| | Individual attributes: sex, age, body mass index, living alone or with others, education level, etc. |
| | Lifestyle: drinking habits, smoking habits, exercise habits, disease, etc. |
3. Results of relationship between SC and risk of needing long-term care

3.1. Fundamental results of personal attributes
Basic aggregation results revealed that 56.4% of the participants were women, 56% of the participants were aged 65 years or older, and the mean age was 64.7 (± 14.4) years (Table 2).

| Table 2. Participant attributes | Sample that answered the questionnaire |
|---------------------------------|----------------------------------------|
|                                 | Overall (n = 2,053) | Men (n = 895) | Women (n = 1,158) |
| Age, years                      |                         |               |                   |
| <44 years                       | 374                     | 18.2          | 136               | 15.2          | 237               | 20.5          |
| 45-64 years                     | 540                     | 26.3          | 239               | 26.8          | 301               | 25.9          |
| >65-74 years                    | 648                     | 31.6          | 316               | 35.3          | 332               | 28.7          |
| >75 years                       | 491                     | 23.9          | 204               | 22.8          | 288               | 24.9          |
| Living arrangement              |                         |               |                   |               |                   |               |
| Alone                           | 1653                    | 80.5          | 776               | 86.7          | 877               | 75.7          |
| With others                     | 235                     | 11.5          | 64                | 7.2           | 171               | 14.8          |
| Unknown                         | 165                     | 8.1           | 55                | 6.1           | 110               | 9.6           |
| Years lived in the target area |                         |               |                   |               |                   |               |
| <20 years                       | 714                     | 34.8          | 308               | 34.4          | 406               | 35.1          |
| 21–40 years                     | 815                     | 39.7          | 371               | 41.4          | 445               | 38.4          |
| >41 years                       | 431                     | 21.0          | 179               | 20.0          | 252               | 21.8          |
| Unknown                         | 93                      | 4.5           | 37                | 4.2           | 55                | 4.7           |
| Certifies for long-term care    |                         |               |                   |               |                   |               |
| Independent                     | 1913                    | 93.2          | 845               | 94.4          | 1069              | 92.3          |
| Needs long-term care            | 119                     | 5.8           | 28                | 3.1           | 81                | 7.0           |
| Unknown                         | 21                      | 1.0           | 12                | 1.5           | 8                 | 0.7           |

3.2. Calculation of risk of needing long-term care
The distribution of scores of elderly not certified for long-term care according to the care prevention checklist revealed that 26.8% were at high risk of needing long-term care (Fig. 4). Thus, many of the elderly were likely eligible for long-term care but did not receive it.

3.3. SC calculation
SC scores calculated from points participants assigned in response to three questions (Table 3). The total possible score was 9 points, and participants with scores of 5 points or less were considered to have a low score whereas those with 6 points or more to have a high score, based on the total average score of all of their points. The distribution of the SC scores were plotted (Fig. 5), with a higher score indicating a better SC. In other words, a higher score implied that the participant was not isolated.
3.4. Average SC scores

The average SC scores of those at high vs low risk of needing long-term care were compared for 1,001 elderly who did not certify for long-term care and responded to all SC items (Fig. 6). Those who were at high risk of needing long-term care had a lower SC score than those who were at low risk of needing long-term care (p<0.001).

Table 3. SC evaluation method

| Question Item                                                                 | Score calculation |
|------------------------------------------------------------------------------|-------------------|
| 1. How much interaction do you have with your neighbors?                    | 3 points × 3 questions = 9 points |
| (1 = none, 2 = some, or 3 = a lot)                                          |                   |
| 2. How many people are there in your neighborhood?                          |                   |
| (1 = none, 2 = some, or 3 = a lot)                                          |                   |
| 3. Do you generally feel that you can trust your neighborhood?              |                   |
| (1 = not at all, 2 = some, or 3 = a lot)                                    |                   |

Fig. 5. Distribution of score of SC (n=2,282)

Fig. 6. SC based on presence of risk of needing long-term care
3.5. Validation by logistic regression analysis
Logistic regression analysis was performed to verify that SC score indicates risk of needing long-term care. For the covariates, “high or low SC score” and participant attributes were input as adjustment variables. The adjusted odds ratio (AOR) was 1.91 (p<0.001). The results indicated that those who had a low SC score were 1.91 times as likely as those who had a high SC score to be at risk of needing long-term care (Table 4).

| Social capital | p-value | AOR | 95% CI   |
|----------------|---------|-----|----------|
| Low (Ref. Having) | <0.001  | 1.91 | 1.61–3.16 |
| Age, years |   |     |           |
| 65–74 (Ref. >75) | 0.019   | 1.51 | 1.07–2.14 |
| Living arrangement |   |     |           |
| Others (Ref. Alone) | 0.017   | 0.52 | 0.27–1.01 |
| Employment status |   |     |           |
| Employed (Ref. Not employed) | 0.330   | 1.32 | 1.02–1.70 |

4. Results of relationship between SC and living environment
4.1. Verification by logistic regression analysis
The possibility of SC affecting the risk of needing long-term care was confirmed, so the living environment factors that define SC were verified next.

4.1.1. relationship between SC and housing environment. Logistic regression analysis was performed under the same conditions as those in the previous section, with “SC” as the objective variable, “item related to the housing environment” as the covariate, and adjustment variables. The housing environment comprised “Facilities” and “Communication” items. The top three AOR items were judged to be significant at the 5% level (Tables 5 and 6). The AORs of the Communication items were 2.01 for “People gather,” 1.92 for “Invite a friend,” and 1.77 for “Guest accommodation” (all p<0.001). These results indicate, for example, that those who invite people to their home are 1.92 times as likely as those who do not invite people to their home to have a high SC score. Similarly, the AORs of the Facilities items were 2.02 for “Enough storage,” 1.83 for “Large table,” and 1.76 for “Large garden” (all p<0.001). In other words, the results suggest that not only people’s behavior but also the development of facilities are items necessary for improving SC.

| People gather | p-value | AOR | 95% CI   |
|---------------|---------|-----|----------|
|               | <0.001  | 2.01 | 1.59–2.52 |
| Invite a friend | <0.001  | 1.92 | 1.53–2.40 |
| Guest accommodation | <0.001  | 1.77 | 1.37–2.29 |

| Table 6. Logistic regression odds ratios for the relationship between social capital and Facilities items of housing environment questions

| Enough storage | p-value | AOR | 95% CI   |
|---------------|---------|-----|----------|
|               | <0.001  | 2.02 | 1.52–2.69 |
| Large table | <0.001  | 1.83 | 1.44–2.33 |
| Large garden | <0.001  | 1.76 | 1.17–2.65 |
4.1.2. relationship between SC and neighborhood environment

Logistic regression analysis was performed under the same conditions as those in the previous section, with “SC” as the objective variable, “item related to the neighborhood environment” as the covariate, and adjustment variables. The neighborhood environment comprised “Facilities” and “Activity participation” items. The top 3 AOR items were judged to be significant at the 5% level (Tables 7 and 8). The AORs of the activity participation items were 3.58 for “Participation in local activities,” 2.67 for “Use of public hall,” and 1.68 for “Walking” (all p<0.001). These results indicate, for example, that those who frequently participate in community activities are 3.58 times as likely as those who do not frequently participate in community activities to have a high SC score. Similarly, the AORs of the Facilities items were 2.02 for “Hedge maintenance,” 1.93 for “Bulletin board displaying local information,” and 1.76 for “Flower bed” (all p<0.001). In other words, the results suggest that not only people’s behavior but also the development of facilities are items necessary for improving SC. This is the same trend as that was observed for the analysis of the relationship between SC and the housing environment.

5. Path analysis

Logistic regression analysis was first used to demonstrate that the structure of the hypothetical model (Fig. 2) exists. Then, path analysis of the hypothetical model was performed (Fig. 7). In addition, an index for the housing and neighborhood environments was determined as the total score of the items that showed the relationships between SC and the housing and neighborhood environments, as analyzed previously. The results of the path analysis revealed that the facilities of the living environment affected SC directly or via the community items and finally affected the risk of needing long-term care. The determination coefficient for the risk of needing long-term care was 0.19.
6. Conclusion
In this study, we examined the relationship between SC and the risk of needing long-term care and the relationship between SC and the living environment based on the “Facilities,” “Activity participation,” or “Communication” items of a questionnaire survey. The results indicate that not only should people be encouraged to participate in the living environment, but also housing facilities should be enhanced and maintained so as to increase the number of places where people gather. This would increase the number of opportunities for people to interact with others. Furthermore, the living environment fosters SC and ultimately contributes to extending healthy life expectancy. A study limitation is that the results were based solely on data that covered one target area. In the future, we plan to conduct questionnaire surveys in other regions using statistical data and to analyze responses considering regional characteristics.
This study contributes to the Sustainable Development Goals “3. Good Health and Well-being” and “11. Sustainable Cities and Communities.”

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