



Brief Communication

High Population Density Areas in Japan are More Likely to be Influenced by COVID-19 Pandemic-Associated Frailty

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SUMMARY

We investigated the regional characteristics of COVID-19 pandemic-associated frailty. This three-year repeated cross-sectional study compares data from 2019 before the pandemic with information from 2020–2021 during the pandemic. Out of the 5,552 individuals targeted, a total of 3,168 people were included in the analysis after applying the exclusion criteria. In each study year, we used the Kihon Checklist (KCL) to assess the frailty status of all older individuals aged 70 and 75 years living in a city in Tochigi Prefecture. The KCL categorized individual participants' status as robust, pre-frailty, or frailty. Participants were also classified into three groups based on population density: urban, suburban, and rural. The chi-square test was employed for all statistical analyses. The frailty and pre-frailty groups grew significantly in urban and suburban areas, while rural areas showed no such increase. Examining specific KCL question items, we observed a significant increase in No. 4 (visiting friends) only in urban and suburban areas, whereas No. 17 (going out less) showed a significant increase across all three areas. This research shows that high population density areas were more susceptible to COVID-19 pandemic-associated frailty, while rural areas were less susceptible.

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1. Introduction

Lifestyle changes brought about by the coronavirus disease 2019 (COVID-19) pandemic have significantly influenced frailty.^{1,2} COVID-19 prevention measures in Japan involve basic infection control steps, such as washing hands and mask mandate, as well as avoiding crowded places, close contact, and closed spaces that pose a high risk of infection.³ In day-to-day life, more densely populated areas have more people, leading to higher chances of crowding and close contact. Therefore, during the COVID-19 pandemic, people in more densely populated areas refrained from activities of daily life to avoid infection risk, which is hypothesized to influence the progression of frailty. Thus, we investigated the changes in the three-year frailty prevalence before and during the COVID-19 pandemic according to population density in one city to clarify the regional characteristics of COVID-19 pandemic-associated frailty.

2. Methods

We performed a repeated cross-sectional and secondary analysis of a previously reported 3-year dataset from May 2019 (before the onset of the COVID-19 pandemic), as well as May 2020 and May

2021 (during the ongoing COVID-19 pandemic).¹ This survey is conducted annually and targets all older adults aged 70 and 75 years in each study year living in a city in Tochigi Prefecture. The Kihon Checklist (KCL) was mailed to the participants in each study year, and responses were used to classify individuals as robust, pre-frailty, and frailty.^{4,5} The KCL questionnaire consists of 25 items, and each question is answered with a “Yes” or “No” response. Each question is rated on a scale of unimpaired (0) to impaired (1), and the cumulative deficit score is calculated by adding up the scores for all 25 questions. A higher score indicates a worse function, with scores ranging from 0 to 25 points. Total scores of 0–3, 4–7, and ≥ 8 points correspond to robust, pre-frailty, and frailty states, respectively.^{4,5} Of the 5,552 targeted individuals (1,772 in 2019, 1771 in 2020, and 2,009 in 2021), those who did not return the survey, declined the survey, or had missing data were excluded. Thus, 3,168 eligible participants (1,010 in 2019, 999 in 2020, and 1,159 in 2021) were included in the analysis. Responses rates ranged from 74.2% to 76.3%, and analyzed valid responses rates ranged from 56.4% to 57.7% across the survey. Participants were divided into three groups, calculated from the eight population density quantiles in 1,740 municipalities nationwide: areas with 473.3 people/km² or more were classified as urban, areas with 91.5 people/km² or more and less than 473.3 people/km² were classified as suburban, and areas with less than 91.5 people/km² were classified as rural. All statistical analyses were performed using the chi-square test (Pearson chi-squared/linear-by-linear association), with a significance level of 5%.

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3. Results

The number of participants in urban areas was 416 in 2019, 378 in 2020, and 388 in 2021. The number of participants in suburban areas was 484 in 2019, 499 in 2020, and 638 in 2021. Finally, the number of participants in rural areas was 110 in 2019, 122 in 2020, and 133 in 2021. Table 1 shows the basic attributes of study participants and KCL points. Figure 1 shows frailty changes in each area

Table 1

Basic attributes of study participants and KCL points.

	2019 (n = 1,010)	2020 (n = 999)	2021 (n = 1,159)
Age			
70 years old	593 (58.7%)	687 (68.8%)	622 (53.7%)
75 years old	417 (41.3%)	312 (31.2%)	537 (46.3%)
Sex			
Men	483 (47.8%)	484 (48.4%)	543 (46.9%)
Women	527 (52.2%)	515 (51.6%)	616 (53.1%)
KCL total points	3.5 ± 3.6	3.9 ± 3.7	4.3 ± 4.0

Values are presented as n (%)/mean ± standard deviation. KCL, Kihon Checklist.

over the three years. Frailty and pre-frailty groups increased significantly in urban and suburban areas but not in rural areas. Over three years, the frailty and pre-frailty prevalence in rural areas was significantly higher than in the other areas in 2019 ($p = 0.035$); however, no significant differences were observed between the areas in 2020 ($p = 0.602$) and 2021 ($p = 0.124$). Figure 2 shows changes in the “visiting friends” and “going out less” items that were affected by crowded areas and close contact avoidance: No. 4 “Do you sometimes visit your friends?” and No. 17 “Do you go out less frequently compared to last year?” No. 4 significantly increased only for urban and suburban areas, while No. 17 significantly increased for all three areas.

4. Discussion

Three insights based on our results are presented below. First, when focusing on frailty prevalence before the COVID-19 pandemic, frailty values were higher in rural areas with a relatively lower population density than in urban and suburban areas with relatively higher population densities. Reports published before the COVID-19 pandemic have shown similar results.⁶⁻⁸ A systematic review and

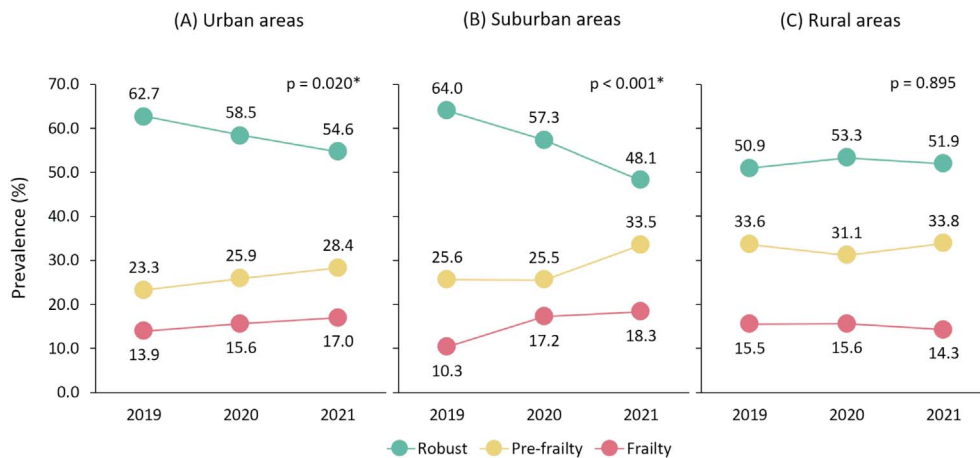


Figure 1. Changes in frailty prevalence over the three-year study period in each area. The number of individuals in the frailty and pre-frailty stages significantly increased in urban and suburban areas with high population densities, while no significant changes were observed in rural areas with low population densities.

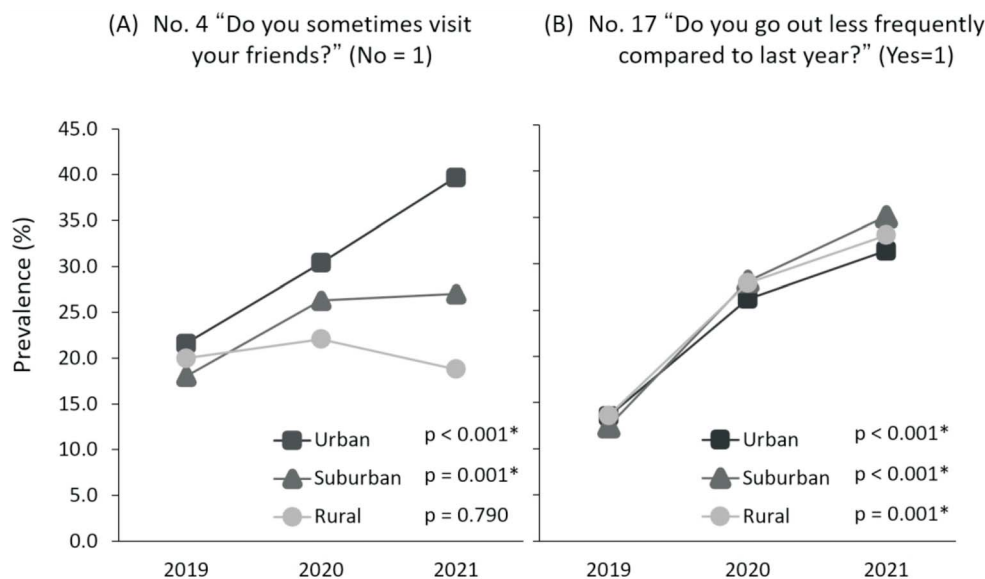


Figure 2. Changes in Kihon Checklist question items No. 4 and No. 17 over the three-year study period in each area. The proportion of participants who scored 1 point on Item No. 4 was 21.6/30.4/39.7 for urban, 18.0/26.3/27.0 for suburban, and 20.0/22.1/18.8 for rural areas, respectively, 2019, 2020 and 2021. Item No.4 significantly increased in urban and suburban areas with high population densities during the COVID-19 pandemic. No significant changes were observed in rural areas with low population densities. The proportion of participants who scored 1 point on Item No. 17 was 13.5/26.2/31.4 for urban, 12.4/28.1/35.1 for suburban, and 13.6/27.9/33.1 for rural areas, respectively, 2019, 2020 and 2021. Item No. 17 increased significantly in all three areas. The survey in the year 2019 was conducted before the COVID-19 pandemic. Surveys for the years 2020 and 2021 were conducted during the COVID-19 pandemic. * p value set to 0.05.

meta-analysis identified the following reasons for the higher prevalence of frailty in rural areas as follow: (i) lower socioeconomic status among residents living in rural communities, (ii) limited accessibility of healthcare services and resources, and (iii) relatively unhealthy lifestyle and limited healthcare awareness.^{8–10} Furthermore, poor access to recreational facilities and lack of aesthetically pleasing places were associated with physical frailty in rural areas.⁶ Second, frailty prevalence reversed during the COVID-19 pandemic, as frailty increased in areas of high population density and did not change in areas of low population density. Previous research supporting these findings includes a study indicating decreased physical activity and the number of steps in older adults, especially those living in the capital city and its suburbs with large populations, during the COVID-19 pandemic.^{11,12} Third, we analyzed KCL question items related to this study. Specifically, during the COVID-19 pandemic, opportunities to go out progressively decreased each year similarly in all three areas. However, the number of visits to friends' homes, which was the same in all three areas before the COVID-19 pandemic, decreased in urban and suburban areas but not in rural areas. As per our hypothesis, this decrease was particularly prominent in urban areas, suggesting that older people in densely populated areas avoided interacting with others during the pandemic. Consequently, individuals living in urban areas were more susceptible to COVID-19 pandemic-associated frailty, and they should incorporate more indoor physical activity in their daily routine or contact with families/friends by phone or social networking services alternatively.

A key limitation of this study was that it was limited to one city in Japan. Information propagation speed and the fear of infection from crowded areas may differ within and outside the study area. Although there is a possibility of volunteer effects, the study had a very low bias, as this was a complete survey in a city, and the response rate and valid response rate were nearly identical over the three years.

5. Conclusion

The above results showed that high population density areas were more susceptible to COVID-19 pandemic-associated frailty, while rural areas were less susceptible.

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Declarations of interest

The authors declare that there is no conflict of interest.

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