Original article

Association between multimorbidity and utilization of medical and long-term care among older adults in a rural mountainous area in Japan

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Abstract

Objective: With the accelerated population aging, multimorbidity has become an important healthcare issue. However, few studies have examined multimorbidity and its impact on the use of medical and long-term care services in Japan. Therefore, this study aimed to examine the association between multimorbidity and the use of medical and long-term care services among older adults living in the depopulated mountainous areas of Japan.

Patients and Methods: A cross-sectional study was conducted using insurance claims data from late-stage medical insurance and long-term care insurance (April 2017 to March 2018) for older adults ≥75 years residing in a mountainous area in the Tottori prefecture. In addition to the descriptive analysis, multiple generalized linear regressions with family gamma and log-link functions were used to examine the association between the number of morbidities and total annual medical and long-term care expenditures.

Results: A total of 970 participants ≥75 years were included in the analysis. Participants who had two or more morbidities constituted 86.5% of the total sample. Furthermore, participants with mental disorders were found to have more comorbidities. The number of comorbidities is associated with higher medical and long-term care expenditures.

Conclusion: Multimorbidity was dominant among late-stage older adults living in depopulated mountainous areas of Japan, and the number of morbidities was associated with higher economic costs of medical and long-term care services. Mitigating the impact of multimorbidity among older adults in depopulated regions of Japan is an urgent challenge. Future research should investigate the degree and effectiveness of social protections for vulnerable older adults living in remote areas.

Key words: multimorbidity, medical expenditure, long-term care, older adults, health service utilization

Introduction

Multimorbidity, or the co-occurrence of two or more comorbid chronic conditions in an individual, increases with

population aging and is associated with reduced physical function and quality of life[1]. With accelerated population aging, multimorbidity is a growing global challenge in patient care[2, 3].

The prevalence of multimorbidity has been investigated in various target populations[4] and existing studies have extensively examined the impact of multimorbidity on the use of healthcare services and costs[5–7]. However, evidence from Japan regarding the same is scarce[8–10]. Specifically, the impact of multimorbidity on the economic costs of healthcare and long-term care (LTC) for later-stage older adults residing in remote mountainous areas of Japan has not been verified.

As the prevalence of multimorbidity is higher in socially deprived groups[11], the impact of economic inequality on multimorbidity deserves special attention. Previous studies have identified that relative poverty rates in Japan are higher

in depopulated areas than in urban areas, and that income inequality is particularly wider among older adults[12, 13]. Poverty and deprivation are important determinants of health[14]. In particular, relative poverty has been shown to have a negative impact on health[15, 16]. Furthermore, previous studies conducted in Japan have also confirmed the negative impact of relative poverty on health[17, 18].

Japan has had a universal health insurance system since 1961. Since 2008, all individuals aged ≥75 years, excluding public assistance recipients, have been eligible for the late-stage medical care system for older adults, which replaces medical insurance for persons under 75 years[19, 20]. Late-stage medical insurance covers services provided by health professionals, diagnostic tests, prescriptions, surgery, and anesthesia. Moreover, Japan developed a mandatory LTC insurance system in 2000 that covers LTC services for older adults aged ≥65 years and for those between 40 and 64 years with illnesses. Both institutional care and home-based services are provided under the LTC insurance system[21, 22]. One study has examined Japan's medical and LTC insurance systems and their claims data in detail[23]. However, to the best of our knowledge, no study has examined the relationship between income inequality and multimorbidity among older adults in Japan.

To bridge this gap in the existing literature, the current study aimed to examine the association between multimorbidity and the use of medical and LTC services and the corresponding medical and LTC expenditures among late-stage older adults aged ≥75 years living in a depopulated mountainous area in Japan. We hypothesized that a higher number of comorbid chronic conditions would be associated with higher medical and LTC expenditures.

Patients and Methods

Data, research setting, and study participants

The current research was a cross-sectional study that employed insurance claim data from the late-stage medical insurance for older adults and LTC insurance data from a town (hereafter referred to as Town "A") in the Tottori prefecture. Town "A" had a population of 3,150 (1,441 males and 1,709 females) and comprised 1,248 households according to 2017 demographic statistics. The results of the 2015 census indicated that the employment rate of Town "A" was 53.3% (27.1% of older adults); 19.7% were employed in the primary sector, 20.3% in the secondary sector, and 60.0% in the tertiary sector. Town "A" has one 99-bed public secondary hospital in the center of the town. Public transport is scarce, and it takes approximately one hour for private cars to reach surrounding cities that have tertiary emergency hospitals.

The study sample included individuals aged ≥75 years who were registered for late-stage medical insurance in Town "A" during the one-year study period from April 2017 to March 2018. The collected data did not contain any personally identifiable information about the participants. Dummy ID codes common to medical and LTC insurance were assigned to each participant. Medical and LTC claims data for those aged ≥75 years were combined using dummy ID codes, followed by data analysis. Because medical claims data for welfare recipients from the town were not available, they were excluded from the analysis.

Measurements

Medical expenditures of the participants were obtained from their medical insurance claims data. The data included outpatient and inpatient medical claims, pharmaceutical dispensing claims, and dental claims. Furthermore, the International Classification of Diseases-10 (ICD-10) for the medical claims data was used to determine the presence of chronic diseases. Although there is no clear definition of multimorbidity, individuals with more than two of the 12 chronic conditions listed as follows were used to identify and categorize patients with multimorbidity: diabetes, hypertension, dyslipidemia, musculoskeletal diseases, heart diseases, cerebrovascular diseases, renal diseases, chronic obstructive pulmonary disease (COPD), other conditions related to functional decline, cancer, dementia, and depression. A list of ICD-10 codes corresponding to each chronic disease is presented in Supplementary material 1. For LTC expenditures, the expenditure for each month was added to obtain the annual claim amount. Expenditure on medical and LTC claims included both reimbursed and co-payment amounts for covered services. Expenditures are presented as both Japanese yen (¥) and US dollars ($). The mean exchange rate between April 2017 and March 2018 was ¥113 per US dollar.

Participants' demographic data were obtained from a list of insurance registries. We categorized household income levels into three groups based on the LTC insurance premiums. The level of LTC required, the number of medical institutions providing medical services, and the number of months of insurance claims for inpatient/outpatient medical services were obtained from the insurance claims dataset.

However, information on whether each individual was living in Town "A" in April 2017 during the study period or whether they had moved elsewhere could not be obtained. Reliable information regarding the deaths that occurred during the study period was not available.

Statistical analysis

First, participants' descriptive characteristics were tabulated. The mean number of comorbidities was tabulated for sex, age, household income level, LTC level, number of medical institutions, and number of insurance claims for inpatient/outpatient medical services. Differences in the pro-

portion of participants with more than two chronic conditions and those with comorbid physical and mental illnesses (depression and/or dementia) were tabulated for each variable. Second, we compared the average annual expenditures on medical and LTC services according to the number of comorbidities. Likewise, the average annual expenditure was examined based on the participants' income levels. Finally, multiple generalized linear regressions with family gamma and log-link functions were conducted to examine the association between the number of comorbidities and total annual expenditures on medical and LTC services. We adjusted for sex, age, household income level, level of LTC required, and number of claims for inpatient/outpatient services. Similarly, the association between the number of comorbidities and expenditures on annual medical services was examined using a multiple generalized linear regression model. The independent variables were selected after internal discussions among the researchers, considering model fitting and multicollinearity. In both regression models, the analyses were conducted after excluding those who did not incur any medical and/or LTC costs. SPSS version 25.0 (IBM Corp., New York, NY, USA) and STATA version 16 (Stata Corp. LP, College Station, TX, USA) were used for data analysis.

Ethical considerations

This study was reviewed and approved by the Faculty of Medicine, Tottori University Ethical Review Committee. The data were anonymized prior to analysis. Considering the retrospective nature of this study, the Ethics Committee waived the need for informed consent from participants. Information regarding the purpose and methods of the study can be found on the webpage of the University Hospital for potential subjects. Instructions for individuals who did not wish to participate are also available on the webpage, which state that the participants were free to refuse participation for any reason.

Results

A flowchart of the participants included in the study is shown in Supplementary material 2. A total of 981 individuals were registered in the Late-Stage Medical Care System for the Elderly in Town "A" in 2017. Based on the exclusion criteria, we included 970 individuals who were aged ≥75 years for the analysis.

Participants' characteristics are presented in Table 1. The proportion of women in the study sample was 63.5%. Furthermore, 64.5% of the participants did not use LTC services, 94.5% visited at least one medical institution, and 86.5% had two or more comorbidities. The mean number of morbidities among participants was 4.2. The number of morbidities and the proportion of those with multimorbidity increased with age, number of medical institutions used,

number of outpatient claims, and number of inpatient claims. However, the differences in the number of morbidities according to income level are not clear. Regarding physical and mental illness-related comorbidities, 8.5% had physical-depression comorbidity, 14.6% had physical-dementia comorbidity, and 21.1% had physical morbidity with dementia and/or depression. The prevalence of physical-depression comorbidity was higher in groups with the lowest income, a higher number of medical institutions, higher utilization of outpatient/inpatient services, and a higher number of morbidities. The proportion of physical-dementia comorbidity was likely to increase with age, lower income level, higher level of LTC required, and a higher number of inpatient claims. Likewise, physical-depression and/or dementia comorbidity tended to increase with age, lower income, higher level of LTC required, higher number of inpatient claims, and higher number of morbidities.

Figure 1 demonstrates the relationship between the number of morbidities and the total mean annual medical and LTC expenditures. An increasing trend in the mean annual expenditure was observed as the number of morbidities increased. The increase in medical expenditures for inpatient care was especially noticeable among participants with more comorbidities. The relationship between household income levels and total mean annual medical and LTC expenditures is presented in Figure 2. The total annual expenditures on medical and LTC was highest in the lowest-income group. Conversely, annual expenditure on medical care increased slightly for higher-income groups.

The results of multiple generalized linear regression analysis indicated that a higher number of comorbidities was associated with higher annual medical and LTC expenditures (Table 2; n=941). The mean expenditure for older adults with three chronic conditions was significantly higher at ¥319,531 ($2,828) (95% CI [¥63,345, ¥575,717] or 95% CI [$561, $5,095]; P=0.02), compared with that of the group with none or only one morbidity. As the number of morbidities increased, the mean annual expenditure increased significantly. Furthermore, the multiple generalized linear models, with annual expenditures for medical services as the objective variable, indicated a significant association between the number of morbidities and annual medical expenditures (Table 3; n=924). Compared with the individuals with none or just one morbidity, individuals with more than two conditions were significantly associated with a ¥251,687 ($2,227) increase in annual medical expenditures (95% CI [¥128,575, ¥374,798] or 95% CI [$1,138, $3,317]; P<0.01). The difference in medical expenditures between the reference group and the group with six or more morbidities was a ¥714,019 ($6,319) increase (95% CI [¥595,674, ¥832,363] or 95% CI [$5,271, $7,366]; P<0.01) in the latter group.

Table 1 Descriptive characteristics, multimorbidity, and physical-mental health comorbidities

	n (%)	Mean number of morbidities (SD)	Percentage with multimorbidity	Percentage with any physical-depression comorbidity	Percentage with any physical-dementia comorbidity	Percentage with any physical-depression and/or dementia comorbidity
Total	970 (100.0%)	4.2 (2.2)	86.5%	8.5%	14.6%	21.1%
Sex						
Men	354 (36.5%)	4.3 (2.3)	85.9%	5.4%	11.3%	15.5%
Women	616 (63.5%)	4.1 (2.1)	86.9%	10.2%	16.6%	24.4%
Age						
75–79	261 (26.9%)	3.4 (2.2)	77.0%	6.1%	3.4%	9.6%
80–84	273 (28.1%)	4.2 (2.1)	89.7%	10.3%	13.9%	22.3%
85–89	254 (26.2%)	4.5 (2.2)	90.6%	9.4%	20.1%	25.6%
90–94	134 (13.8%)	4.6 (2.0)	91.0%	7.5%	21.6%	27.6%
≥95	48 (4.9%)	4.4 (2.5)	85.4%	8.3%	31.3%	35.4%
Household income level						
Middle-to-high income group	522 (53.8%)	4.1 (2.2)	86.2%	8.0%	12.1%	18.4%
Low-income group	327 (33.7%)	4.2 (2.3)	86.2%	7.3%	15.0%	21.4%
Very low-income group	121 (12.5%)	4.1 (2.1)	88.4%	13.2%	24.8%	32.2%
Level of long-term care required						
Not required	626 (64.5%)	3.8 (2.0)	84.7%	7.0%	4.5%	1.0%
Support levels 1–2	87 (9.0%)	5.2 (2.1)	94.3%	12.6%	11.5%	24.1%
Care levels 1–2	124 (12.8%)	4.7 (2.4)	87.1%	12.9%	42.7%	46.8%
Care levels 3–5	133 (13.7%)	4.9 (2.3)	89.5%	8.3%	38.3%	42.9%
Number of medical institutions to receive service in 2017						
None	53 (5.5%)	NA	NA	NA	NA	NA
1	493 (50.8%)	4.3 (2.1)	90.7%	8.5%	19.5%	25.4%
2	251 (25.9%)	4.5 (2.1)	90.8%	6.8%	12.7%	18.7%
3	98 (10.1%)	4.4 (1.8)	95.9%	14.3%	11.2%	23.5%
≥4	75 (7.7%)	4.6 (1.8)	93.3%	12.0%	4.0%	13.3%
Number of months of insurance claims for outpatient medical services in 2017						
0–4	227 (23.4%)	2.7 (2.5)	59.0%	4.8%	18.9%	21.1%
5–7	225 (23.2%)	4.0 (2.0)	88.9%	4.9%	12.0%	15.1%
8–10	258 (26.6%)	4.7 (1.9)	96.5%	9.7%	14.3%	22.5%
11–12	260 (26.8%)	5.0 (1.7)	98.5%	13.5%	13.5%	25.0%
Number of months of insurance claims for inpatient medical services in 2017						
0	677 (69.8%)	3.7 (2.1)	82.1%	7.5%	11.8%	18.0%
1–2	189 (19.5%)	5.0 (2.1)	95.8%	9.0%	16.4%	23.8%
3–5	81 (8.4%)	5.5 (1.8)	97.5%	13.6%	25.9%	33.3%
≥6	23 (2.4%)	5.7 (1.6)	100.0%	13.0%	43.5%	47.8%
Number of disorders						
0	78 (8.0%)	NA	NA	NA	NA	NA
1	53 (5.5%)	NA	NA	NA	NA	NA
2	77 (7.9%)	NA	NA	5.2%	14.3%	19.5%
3	159 (16.4%)	NA	NA	6.3%	8.8%	15.1%
4	169 (17.4%)	NA	NA	7.1%	14.8%	20.7%
5	153 (15.8%)	NA	NA	7.2%	11.8%	17.6%
≥6	281 (29.0%)	NA	NA	16.0%	26.3%	37.0%

SD: standard deviation.

Discussion

Multimorbidity or two or more chronic conditions were observed in 86.5% of older adults investigated in this study. This result is slightly higher than the figures reported in a previous study using data from medical records in the UK[11] but is comparable to a study that used insurance claims data from Japan and Switzerland[5, 9]. However, no consensus has been reached on the definition of multimorbidity in the existing literature. Our findings indicate that most older adults living in mountainous areas of Japan have multimorbidity.

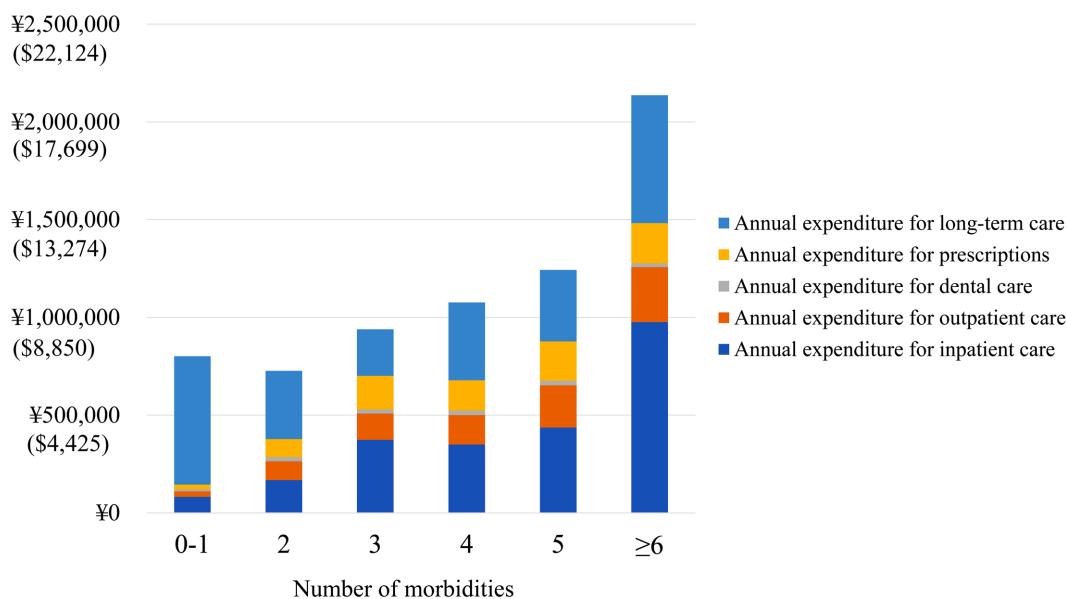The mean number of morbidities and proportion of mul-

Figure 1 Mean of the total annual medical and long-term care expenditures by number of morbidities.
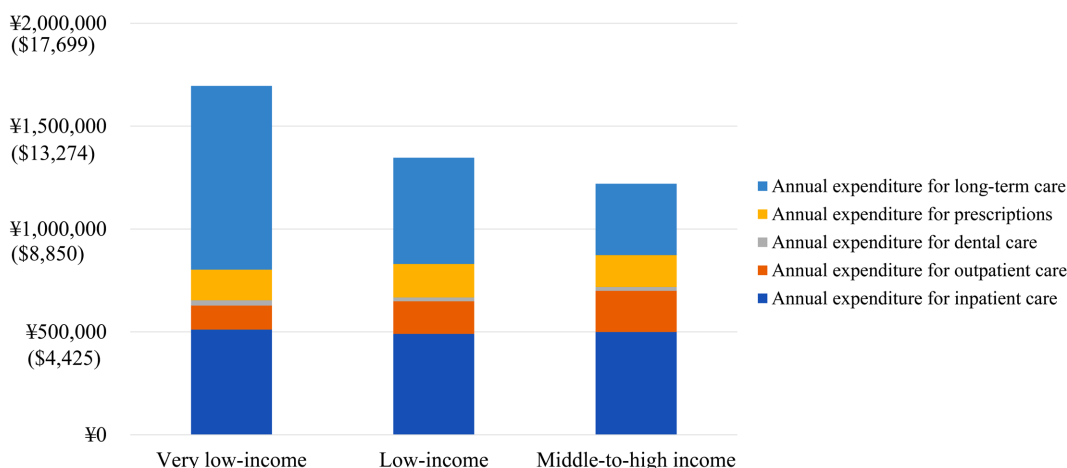

Figure 2 Mean of the annual total medical and long-term care expenditures by household income level.

timorbidities increased in the group with experience of visiting more medical institutions and with more outpatient/inpatient medical service utilization. These findings are consistent with the results of previous studies[6, 24, 25]. Furthermore, our results replicate the findings of previous studies, which reported that individuals with a higher number of morbidities tended to indicate a higher proportion of mental illnesses such as depression and dementia[26, 27]. Furthermore, lower income groups had higher proportions of multimorbidity related to mental illness, as also concluded in a previous study[11]. Although it was difficult to ascertain causality between poverty and mental illness in the present cross-sectional study, our findings indicate that managing complex care for deprived older adults with physical-mental comorbidities is a crucial challenge for rural medicine.

Our findings suggest that a higher number of comorbid chronic conditions are associated with higher medical and LTC expenditures. A similar trend was observed in previous studies conducted in other countries[5–7]. Although direct comparisons could not be made because of differences in the settings and cost components, the healthcare costs obtained in the present study were intermediate between those in Europe and the USA[6]. Our findings are especially robust since the study employed data based on actual insurance claims and LTC expenditures.

Our results suggest that the impact of inpatient care expenditure on the incremental total healthcare expenditure was significant because of an increase in the number of comorbidities among older adults (Figure 1). This finding differs from those of studies conducted in other countries[5, 28],

Table 2 Association of annual medical and LTC expenditures with the number of morbidities using generalized linear regressions (n=941)

	Coefficient	P-value	95% CI	Estimated difference from reference group	P-value	95% CI
Number of disorders						
0–1	Reference					
2	0.03	0.84	−0.22, 0.27	¥27,492 ($243)	0.84	−¥235,442, ¥290,426 (−$2,084, $2,570)
3	0.27	0.02	0.05, 0.48	¥319,531 ($2,828)	0.02	¥63,345, ¥575,717 ($561, $5,095)
4	0.31	<0.01	0.10, 0.52	¥380,061 ($3,363)	<0.01	¥125,818, ¥634,304 ($1,113, $5,613)
5	0.45	<0.01	0.24, 0.67	¥591,966 ($5,239)	<0.01	¥305,920, ¥878,012 ($2,707, $7,770)
≥6	0.56	<0.01	0.36, 0.75	¥777,868 ($6,884)	<0.01	¥522,697, ¥1,033,039 ($4,626, $9,142)
Sex						
Men	Reference					
Women	−0.01	0.80	−0.13, 0.10	−¥23,390 (−$207)	0.80	−¥202,982, ¥156,201 (−$1,796, $1,382)
Age						
75–79	Reference					
80–84	0.20	0.01	0.06, 0.34	¥328,567 ($2,908)	0.01	¥94,120, ¥563,015 ($833, $4,982)
85–89	0.06	0.43	−0.09, 0.21	¥91,904 ($813)	0.43	−¥134,013, ¥317,821 (−$1,186, $2,813)
≥90	0.01	0.93	−0.17, 0.19	¥12,566 ($111)	0.93	−¥252,582, ¥277,713 (−$2,235, $2,458)
Household income level						
Middle-to-high income group	Reference					
Low-income group	−0.04	0.46	−0.16, 0.07	−¥68,174 (−$603)	0.46	−¥249,918, ¥113,571 (−$2,212, $1,005)
Very low-income group	0.08	0.39	−0.10, 0.25	¥127,089 ($1,125)	0.40	−¥167,704, ¥421,882 (−$1,484, $3,733)
Level of long-term care required						
Not required	Reference					
Support levels 1–2	0.65	<0.01	0.46, 0.85	¥581,543 ($5,146)	<0.01	¥359,207, ¥803,879 ($3,179, $7,114)
Care levels 1–2	1.49	<0.01	1.32, 1.67	¥2,170,799 ($19,211)	<0.01	¥1,729,350, ¥2,612,249 ($15,304, $23,117)
Care levels 3–5	1.66	<0.01	1.49, 1.84	¥2,701,860 ($23,910)	<0.01	¥2,195,070, ¥3,208,651 ($19,425, $28,395)
Number of months of insurance claims for inpatient medical services in 2017						
0	Reference					
1–2	0.98	<0.01	0.85, 1.12	¥1,387,675 ($12,280)	<0.01	¥1,108,812, ¥1,666,538 ($9,812, $14,748)
3–5	1.21	<0.01	1.01, 1.40	¥1,949,333 ($17,251)	<0.01	¥1,441,127, ¥2,457,538 ($12,753, $21,748)
≥6	1.34	<0.01	0.99, 1.70	¥2,358,948 ($20,876)	<0.01	¥1,277,232, ¥3,440,663 ($11,303, $30,448)

Generalized linear regressions were adjusted for the number of diseases, sex, age, household income level, level of long-term care required, and number of months of insurance claims for inpatient medical services in 2017.

Participants who claimed neither medical nor long-term care service insurance in 2017 were excluded.

95% CI: 95% confidence interval.

which found that the influence of multimorbidity was more significant on outpatient expenditures than on inpatient expenditures. Multimorbidity has also been reported to be associated with an increased frequency of hospital admissions and longer hospital stays[29]. Our results may reflect the impact of Japan's inadequate accessibility to inpatient care with no clear gatekeepers, free access to secondary medical institutions, and a high number of beds per unit population. Strengthening primary care functions is a global imperative[30]; it is important to examine whether the increased availability of primary care reduces secondary care utilisation[6]. Previous literature indicates that care coordination with efficient collaboration between primary care and specialist physicians aimed at reducing preventable hospital admissions and hospital-acquired complications and curbing the increase in individual chronic diseases is important to mitigate the impact of multimorbidity[25, 31].

Moreover, significant differences in the number of morbidities and expenditures were observed, even after adjusting for the level of LTC required and the number of hospital admission claims, which can substitute for the increased frequency of hospital admissions and longer hospital stays. This finding indicates that the severity and urgency of admission, increased in-hospital complications, and the reimbursement assessment system of the secondary hospitals to which the patient is admitted may be associated with incremental costs owing to increased levels of multimorbidity. However, further studies are required to confirm this association.

Notably, although multimorbidity is more prevalent among the more deprived groups in the UK[11], there were no clear differences in the number of comorbidities or healthcare expenditures based on income levels in the current study. A systematic review indicated that in addition to multimorbidity, older women with lower education, lower income, and inappropriate healthcare insurance were likely to have limited access to adequate healthcare services and the burden of large out-of-pocket payments[32]. Hence, the 10%

Table 3 Association of annual medical expenditures with the number of morbidities using generalized linear regressions (n=924)

	Coefficient	P-value	95% CI	Estimated difference from reference group	P-value	95% CI
Number of disorders						
0–1	Reference					
2	0.49	<0.01	0.27, 0.72	¥251,687 ($2,227)	<0.01	¥128,575, ¥374,798 ($1,138, $3,317)
3	0.74	<0.01	0.54, 0.93	¥431,851 ($3,822)	<0.01	¥317,376, ¥546,326 ($2,809, $4,835)
4	0.76	<0.01	0.56, 0.95	¥446,817 ($3,954)	<0.01	¥330,929, ¥562,705 ($2,929, $4,980)
5	0.90	<0.01	0.70, 1.10	¥576,831 ($5,105)	<0.01	¥443,441, ¥710,221 ($3,924, $6,285)
≥6	1.03	<0.01	0.84, 1.22	¥714,019 ($6,319)	<0.01	¥595,674, ¥832,363 ($5,271, $7,366)
Sex						
Men	Reference					
Women	−0.02	0.70	−0.12, 0.08	−¥19,432 (−$172)	0.70	−¥116,481, ¥77,618 (−$1,031, $687)
Age						
75–79	Reference					
80–84	0.08	0.23	−0.05, 0.21	¥80,251 ($710)	0.22	−¥48,999, ¥209,500 (−$434, $1,854)
85–89	−0.01	0.86	−0.15, 0.12	−¥12,033 (−$106)	0.86	−¥142,917, ¥118,852 (−$1,265, $1,052)
≥90	−0.14	0.10	−0.30, 0.03	−¥124,450 (−$1,101)	0.10	−¥273,459, ¥24,559 (−$2,420, $217)
Household income level						
Middle-to-high income group	Reference					
Low-income group	0.03	0.54	−0.07, 0.14	¥32,152 ($285)	0.54	−¥70,332, ¥134,635 (−$622, $1,191)
Very low-income group	−0.06	0.46	−0.22, 0.10	−¥55,521 (−$491)	0.45	−¥198,455, ¥87,412 (−$1,756, $774)
Level of long-term care required						
Not required	Reference					
Support levels 1–2	0.11	0.21	−0.06, 0.29	¥108,222 ($958)	0.23	−¥66,864, ¥283,307 (−$592, $2,507)
Care levels 1–2	−0.04	0.60	−0.20, 0.11	−¥37,208 (−$329)	0.60	−¥174,355, ¥99,938 (−$1,543, $884)
Care levels 3–5	0.14	0.11	−0.03, 0.31	¥134,618 ($1,191)	0.12	−¥35,543, ¥304,780 (−$315, $2,697)
Number of months of insurance claims for inpatient medical services in 2017						
0	Reference					
1–2	1.33	<0.01	0.85, 1.45	¥943,579 ($8,350)	<0.01	¥806,295, ¥1,080,862 ($7,135, $9,565)
3–5	2.30	<0.01	1.01, 2.49	¥3,033,864 ($26,848)	<0.01	¥2,446,694, ¥3,621,035 ($21,652, $32,045)
≥6	3.20	<0.01	0.99, 3.53	¥7,957,212 ($70,418)	<0.01	¥5,287,464, ¥10,600,000 ($46,792, $93,805)
Number of months of insurance claims for outpatient medical services in 2017						
0–4	Reference					
5–7	0.39	<0.01	0.24, 0.55	¥276,192 ($2,444)	<0.01	¥159,858, ¥392,525 ($1,415, $3,474)
8–10	0.69	<0.01	0.53, 0.85	¥566,761 ($5,016)	<0.01	¥417,678, ¥715,843 ($3,696, $6,335)
11–12	0.98	<0.01	0.82, 1.15	¥955,862 ($8,459)	<0.01	¥752,573, ¥1,159,151 ($6,660, $10,258)

Generalized linear regressions were adjusted for the number of diseases, sex, age, household income level, level of long-term care required, number, number of months of insurance claims for inpatient medical services in 2017, and number of months of insurance claims for outpatient medical services in 2017.

Participants who claimed no medical care service insurance in 2017 were excluded.

95% CI: 95% confidence interval.

(30% for high income groups) co-payment burden in Japan's universal health insurance system, which differs markedly from the universal free health service in the UK, may lead to the underuse of medical services[33]. Regarding the total health care burden including LTC expenditures, the average amount tended to be higher in the lower income group. As the income levels of the participants in this study were categorized by household income, this result may indicate that older adults with fewer family members have a greater need for LTC services. Here, we could not verify the actual amount of participants' out-of-pocket payments because the study did not consider welfare or disability pension recipients. However, the burden of copayment for both medical and LTC services can affect the adequate healthcare service utilization of older adults. Future research is required to determine whether social protection functions appropriately to support the health and wellbeing of older adults in Japan, considering income inequalities and regional differences.

Although the present study revealed important findings, it has several limitations. The first was the validity of the criteria for determining the 12 chronic conditions used in this study. Although we aimed to minimize errors in disease identification using the ICD-10 codes, which are based on a document of therapeutic actions according to a physician's diagnosis, the individual diagnoses in the claims data were not clinically validated by specialists. However, we believe that subjective measurements based on self-administered questionnaires are suboptimal measures for the older popu-

lation, including those with cognitive decline and complex medical care; hence, we employ ICD-10 codes. Second, we may not have adequately adjusted for potential confounding variables such as individual severity of illness in examining the relationship between the number of morbidities and healthcare expenditures. Although the available variables were limited to insurance claims data, combining secondary data may enable future studies to develop the current analysis further. Third, the level of LTC required and expenditure may be significantly influenced by family structure. However, this study did not consider individual family structures. Furthermore, we did not examine the impact of the cost of informal care provided by the participants' families. Fourth, generalizability is limited because our study only included older adults living in the mountainous areas of Japan. However, to the best of our knowledge, this is the first study to examine the financial challenges of multimorbidity in the mountainous areas of Japan. Future studies should expand their geographical scope to include larger populations. Finally, our cross-sectional study was unable to ascertain a causal relationship between the number of comorbidities and the financial costs of medical and LTC services.

Conclusion

This study found that multimorbidity was dominant among late-stage older adults living in depopulated mountainous areas of Japan, and an increase in the number of morbidities was associated with higher economic costs for medical and LTC services. Comprehensive care coordination is an urgent healthcare challenge for older adults living in mountainous regions of Japan. Future research should investigate the degree and effectiveness of social protection for vulnerable older adults living in remote areas to discuss the equity of accessibility to care.

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