

Age-Dependent Reversal of Sex Differences in Severe Long-Term Care Dependency: A Six-Year Analysis of Integrated Healthcare and Long-Term Care Data

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Population aging has increased the burden of chronic diseases and long-term care needs worldwide. We conducted a repeated cross-sectional study using integrated medical claims and long-term care certification data from approximately 400,000 adults aged ≥ 65 years in Kobe City, Japan, between fiscal years 2017 and 2022. Temporal changes in population structure, disease burden, and long-term care demand were evaluated, and associations between age, sex, and severe care dependency (Care Need Level ≥ 2) were assessed using logistic regression analysis. Although the overall study population remained stable, the proportion of individuals aged ≥ 85 years, particularly women, increased over time. The most prevalent disease categories were digestive, endocrine/metabolic, musculoskeletal, circulatory, neurological, and ophthalmological disorders. While many disease categories showed a transient decline during the COVID-19 pandemic, circulatory and endocrine/metabolic diseases continued to increase. Both the number and prevalence of long-term care certifications increased throughout the study period and were consistently higher among women. Severe care dependency increased markedly among individuals aged ≥ 85 years, especially women. Logistic regression analysis demonstrated a nonlinear increase in severe care dependency with advancing age. Women aged ≥ 85 years exhibited substantially elevated odds of severe care dependency (OR ≈ 46) compared with women aged 65–69 years. Significant age-by-sex interactions were observed, and the pattern of severe care dependency shifted from male predominance among younger-old adults (aged 65–74 years) to female predominance among older-old adults (aged ≥ 80 years), indicating that long-term care needs are increasingly concentrated among the oldest-old women.

INTRODUCTION

Rapid population aging in Japan has emerged as a major public health challenge, accompanied by increasing disease burden from chronic conditions and a growing number of older adults requiring long-term care (1). In older populations, the accumulation of multiple chronic diseases has been shown to be closely associated with declining health status and functional impairment and is recognized as a major determinant of quality of life and healthy life expectancy in many developed countries (2, 3). As population aging progresses, the proportion of women among older adults continues to increase. Sex differences in health status, disability, and long-term care dependency have therefore attracted increasing attention (4, 5). Recent studies have suggested that long-term care demand may become disproportionately concentrated among very old women and that the sex-specific pattern of care dependency risk may change with advancing age (6–8).

In this context, a comprehensive understanding of population structure, disease burden, and long-term care demand among older adults is essential for the development of regional healthcare and long-term care policies. However, because medical and long-term care data are often fragmented owing to institutional and technical barriers, only a limited number of studies have quantitatively examined age-dependent changes in long-term care demand and its concentration among the oldest-old women (aged ≥ 85 years), using large-scale real-world data integrating medical claims and long-term care certification records. Furthermore, the possibility that care dependency increases with advancing age in a nonlinear rather than a simple linear manner has not been adequately investigated, nor have sex differences in this pattern. Comprehensive quantitative evaluations of temporal trends

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in disease burden and long-term care demand among the oldest-old population are also lacking. Because population aging is reflected not only by changes in demographic structure but also by changes in disease burden and long-term care demand, describing these components together provides a comprehensive understanding of the healthcare needs of older adults. Moreover, although age and sex are non-modifiable characteristics, characterizing age- and sex-specific patterns of long-term care dependency is essential for healthcare planning, long-term care resource allocation, and future demand forecasting in rapidly aging societies.

Kobe City, a major designated city in Japan, has established the Kobe City Healthcare Data Integration System (9), which integrates a wide range of administrative datasets, including medical claims and long-term care certification records. This infrastructure enables population-based analyses using large-scale real-world data. In the present study, we analyzed an anonymized individual-level database integrating medical claims and long-term care certification records for approximately 400,000 residents aged 65 years and older who were enrolled in the National Health Insurance or Late-Stage Elderly Healthcare Insurance systems in Kobe City. Using repeated cross-sectional analyses covering fiscal years 2017 through 2022, we examined temporal changes in population structure, disease burden, and long-term care certification status.

The aim of this study was to comprehensively characterize the dynamics of population structure, disease burden, and long-term care demand among older adults. In addition, we sought to quantitatively elucidate the age-dependent patterns of long-term care demand according to care severity and to evaluate the interaction between age and sex in the risk of loss of healthy life expectancy. The present analyses were performed as exploratory and descriptive analyses to assess the quality, population characteristics, and suitability of the dataset for AI model development.

Furthermore, considering the unique characteristics of this integrated database, we examined its potential utility as a foundation for developing machine learning models to predict health deterioration and long-term care dependency among older adults. Rather than estimating the independent causal effects of age or sex, we sought to quantitatively elucidate and discussed its value as a data resource for advancing data-driven community-based integrated care.

MATERIALS AND METHODS

Study population

The study population comprised residents of Kobe City aged 65 years and older who were enrolled in either the National Health Insurance (NHI) program or the Late-Stage Elderly Healthcare Insurance System. Analyses were conducted using anonymized individual-level data integrating medical claims records and long-term care certification records from April 2017 through March 2023. These data were provided by the Kobe City Health Bureau through the Kobe City Healthcare Data Integration System.

The variables included in the analyses were age, sex, disease classification codes based on the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10), and long-term care certification levels. Age was categorized into five groups at 5-year intervals: 65–69, 70–74, 75–79, 80–84, and ≥85 years. Disease categories were classified according to the Major Diagnostic Categories (MDCs) of the Japanese Diagnosis Procedure Combination (DPC) system. ICD-10 diagnoses from both inpatient and outpatient medical claims were mapped to the corresponding MDCs. Repeated claims for the same diagnosis within an individual were counted only once, whereas different diagnoses for the same individual were counted separately. Consequently, a single individual could contribute to multiple disease categories. The number of patients was then aggregated for each diagnostic category. With respect to long-term care certification status, Care Need Level 2 certification is widely used in Japan as a surrogate indicator of the end of healthy life expectancy. Accordingly, individuals certified as Support Need Levels 1–2 or Care Need Level 1 were classified as having mild care dependency, whereas those certified as Care Need Levels 2–5 were classified as having severe care dependency in the present study.

Statistical analysis

Odds ratios (ORs) for severe care dependency were estimated using the 65–69-year age group as the reference category. Logistic regression analysis was performed to evaluate the association between age group (65–69, 70–74, 75–79, 80–84, and ≥85 years) and severe care dependency. The outcome variable was the presence or absence of severe care dependency (Care Need Level ≥2). Additional logistic regression analyses were performed including age group, sex, and an age-by-sex interaction term. The 65–69-year age group and male sex were used as the reference categories. No additional covariates were included because the objective of this analysis was to quantify age- and sex-specific differences in severe care dependency and to evaluate the age-by-sex interaction, rather than to estimate adjusted associations or develop a prediction model.

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Results are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The statistical significance of the age-by-sex interaction was assessed using the regression coefficients of the interaction terms. Furthermore, female-to-male odds ratios were derived from the interaction model for each age group to characterize the age-dependent nature of sex differences in severe care dependency.

All statistical analyses were performed using Python version 3.8.10 (<https://www.python.org>) and Stata version 17 (StataCorp LLC, College Station, TX, USA). A two-sided p value < 0.05 was considered statistically significant.

Ethical considerations

The data used in this study consisted of linked anonymized records provided by the Kobe City Health Bureau. The study was conducted with the approval of the Ethics Committee of Kobe University Graduate School of Medicine (Approval Number: B200234; September 19, 2020) and the Research Ethics Review Committee for Health Programs of Kobe City (March 22, 2021).

This study was conducted using an opt-out approach, and individual informed consent was waived. To protect personal privacy, disease categories corresponding to ICD-10 codes with 10 or fewer patients were excluded from the analyses.

To ensure the security and confidentiality of the data, all analyses were conducted within a secure data analysis environment at Kobe University. Access to the integrated dataset was strictly restricted to authorized researchers within this secure facility.

RESULTS

Temporal changes in the age structure of the study population

Table I presents the annual trends in the number and proportion of study participants by sex between 2017 and 2022. The total study population remained relatively stable at approximately 400,000 individuals throughout the study period, with no substantial fluctuations observed. When stratified by sex, the number of female participants was consistently approximately 1.5 times greater than that of male participants and showed a gradual increase over time. In contrast, the number of male participants peaked in 2019 and subsequently exhibited a modest declining trend. When expressed as a proportion of the total study population in each fiscal year, the proportion of women demonstrated a gradual but consistent increase, whereas the proportion of men showed a corresponding gradual decline.

Table I. Annual characteristics of the study population, fiscal years 2017–2022

Fiscal year	Study Population				
	Total	Male		Female	
	N	N	Proportion (%)	N	Proportion (%)
2017	395,018	165,327	(41.9)	229,691	(58.1)
2018	399,534	166,716	(41.7)	232,818	(58.3)
2019	402,212	167,091	(41.5)	235,121	(58.5)
2020	403,304	166,686	(41.3)	236,618	(58.7)
2021	403,698	165,639	(41.0)	238,059	(59.0)
2022	402,337	163,639	(40.7)	238,698	(59.3)
Change (2017→2022)	+7,319 (+1.9%)	−1,688 (−1.0%)		+9,007 (+3.9%)	

Proportion (%) indicates the percentage of each sex within the total study population for the corresponding fiscal year. Change (2017→2022) represents the absolute and percentage change between fiscal years 2017 and 2022.

Fiscal year refers to the Japanese fiscal year (April–March).

When examined by age group, the proportion of individuals aged 65–69 years decreased steadily in both sexes, whereas the proportion of those aged ≥ 85 years increased consistently throughout the observation period (Figure 1). This increase in the oldest-old population was particularly pronounced among women.

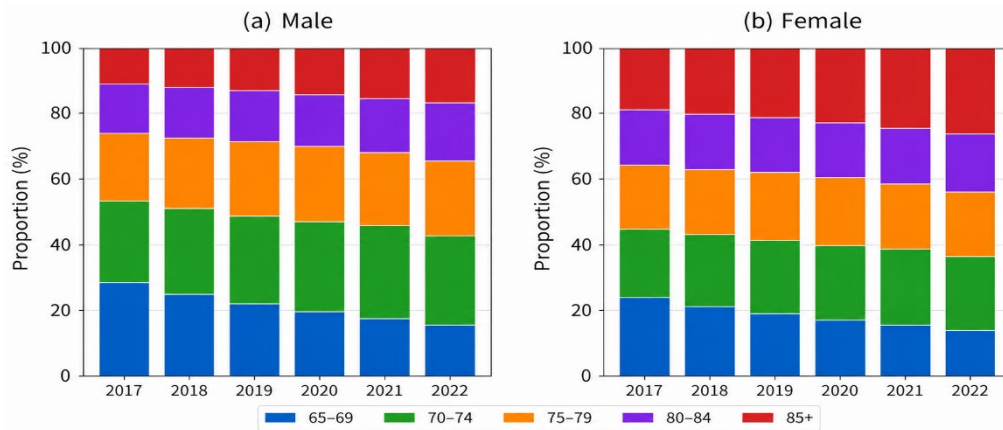


Figure 1. Annual trends in the number of subjects by age group, fiscal years 2017–2022

Temporal trends in the number of patients by major diagnostic category

Annual trends in the number of patients by Major Diagnostic Category (MDC) are presented in Appendix 1. The six most prevalent disease categories were disorders of the digestive system, endocrine and metabolic disorders, musculoskeletal disorders, circulatory diseases, neurological disorders, and ophthalmological diseases (Figure 2).

The number of patients in most disease categories generally increased between 2017 and 2019. However, a transient decline was observed across many categories in 2020, coinciding with the onset of the COVID-19 pandemic. This reduction was particularly pronounced for respiratory diseases and otorhinolaryngological disorders. In contrast, the number of patients with circulatory diseases continued to increase consistently throughout the pandemic period. Similarly, endocrine and metabolic disorders exhibited only a modest decline in 2020, followed by a subsequent increase in the following years.

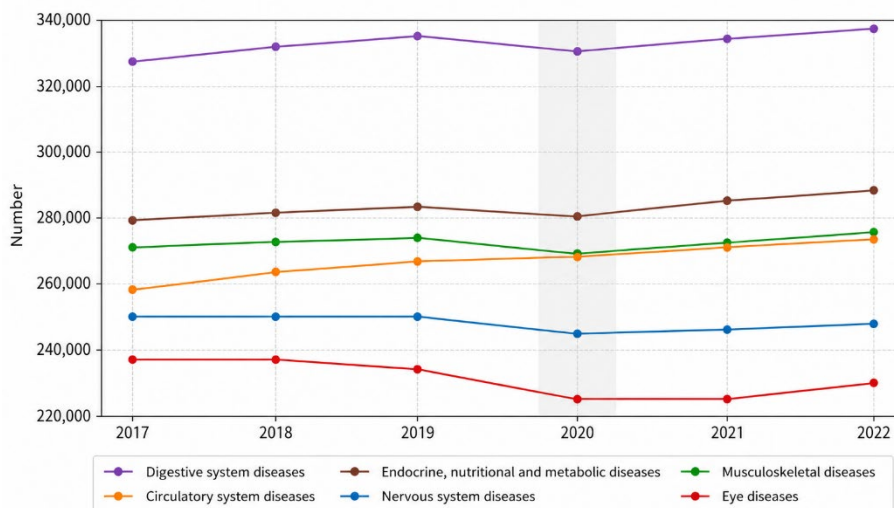


Figure 2. Annual trends in the number of subjects by major diagnostic category (top six categories), fiscal years 2017–2022

Temporal trends in long-term care certification status

Across the overall study population, the proportion of individuals without long-term care certification decreased from 76.7% in 2017 to 73.4% in 2022, whereas the proportion of certified individuals increased from 23.3% to 26.6% during the same period.

Figure 3 illustrates the annual trends in the number and proportion of long-term care certification recipients by sex between fiscal years 2017 and 2022. Throughout the observation period, the number of certified individuals was consistently more than twice as high among women as among men. When stratified by care severity, both the number and proportion of individuals in the mild care dependency group remained generally stable in both sexes

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until approximately 2020, followed by a modest decline after 2021. In contrast, both the number and proportion of individuals in the severe care dependency group (Care Need Level ≥ 2) increased steadily throughout the study period in both sexes. The rate of increase was greater among women than among men, resulting in a progressively widening sex difference over time. By 2022, the prevalence of severe care dependency had reached approximately 18% among women and 13% among men.

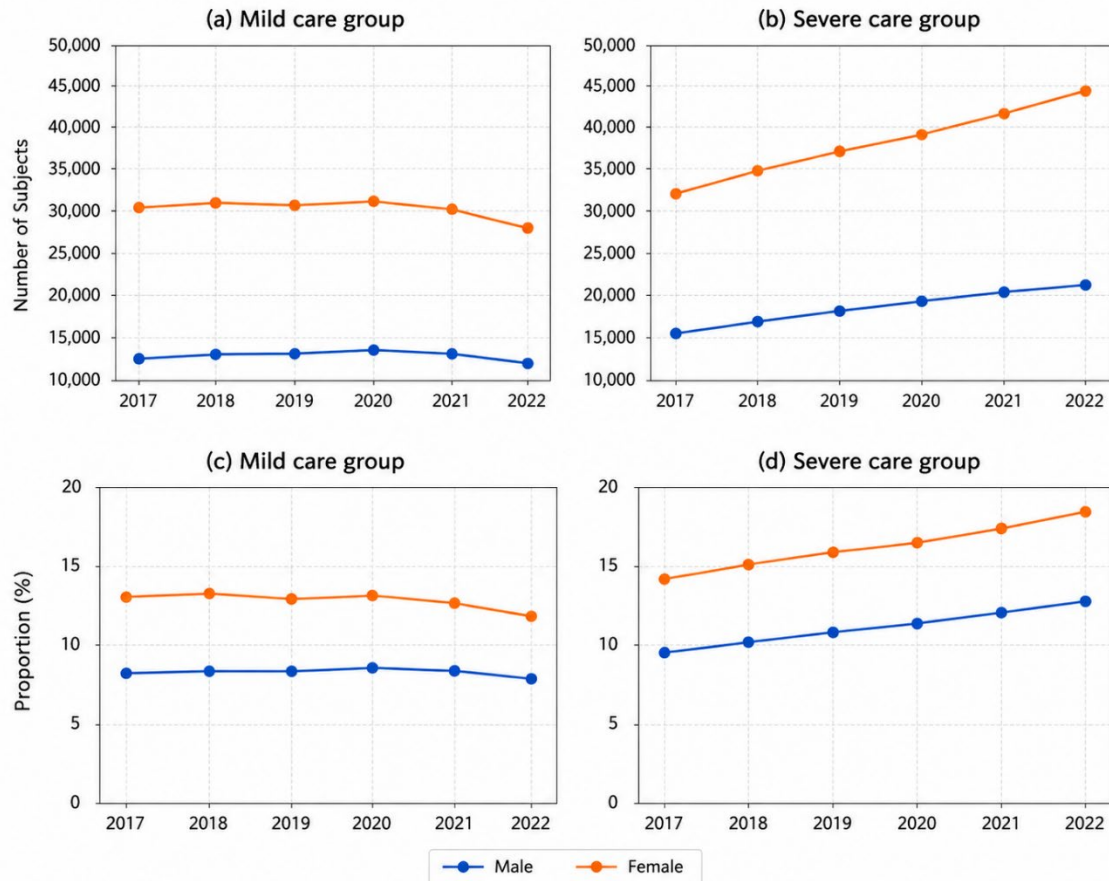


Figure 3. Annual trends in the number and proportion of subjects with long-term care certification by sex and care severity, fiscal years 2017–2022

Panels (a) and (b) show the annual number of subjects in the mild care group and severe care group, respectively, whereas panels (c) and (d) show the corresponding proportions. The proportion was calculated as the percentage of certified subjects among all subjects of the same sex in each fiscal year. The mild care group included Support Levels 1 and 2 and Care Level 1, whereas the severe care group included Care Levels 2–5.

When examined by age group, annual changes in the number of individuals with long-term care certification were relatively small among both men and women aged ≤ 84 years between fiscal years 2017 and 2022, with no substantial temporal fluctuations observed overall. In contrast, among individuals aged ≥ 85 years, the number of certified individuals increased consistently throughout the study period in both the mild and severe care dependency groups and in both sexes. Over the six-year observation period, the number of certified individuals in this age group increased by approximately 1.5-fold.

With respect to sex-specific patterns, no marked sex differences were observed among individuals aged 65–69 years in the mild care dependency group (Figures 4A and 4C). However, among those aged ≥ 70 years, the number of certified women tended to exceed that of men. In contrast, in the severe care dependency group (Figures 4B and 4D), the number of certified men exceeded that of women among individuals aged ≤ 74 years. This difference narrowed in the 75–79-year age group, whereas among those aged ≥ 80 years, the number of certified women surpassed that of men.

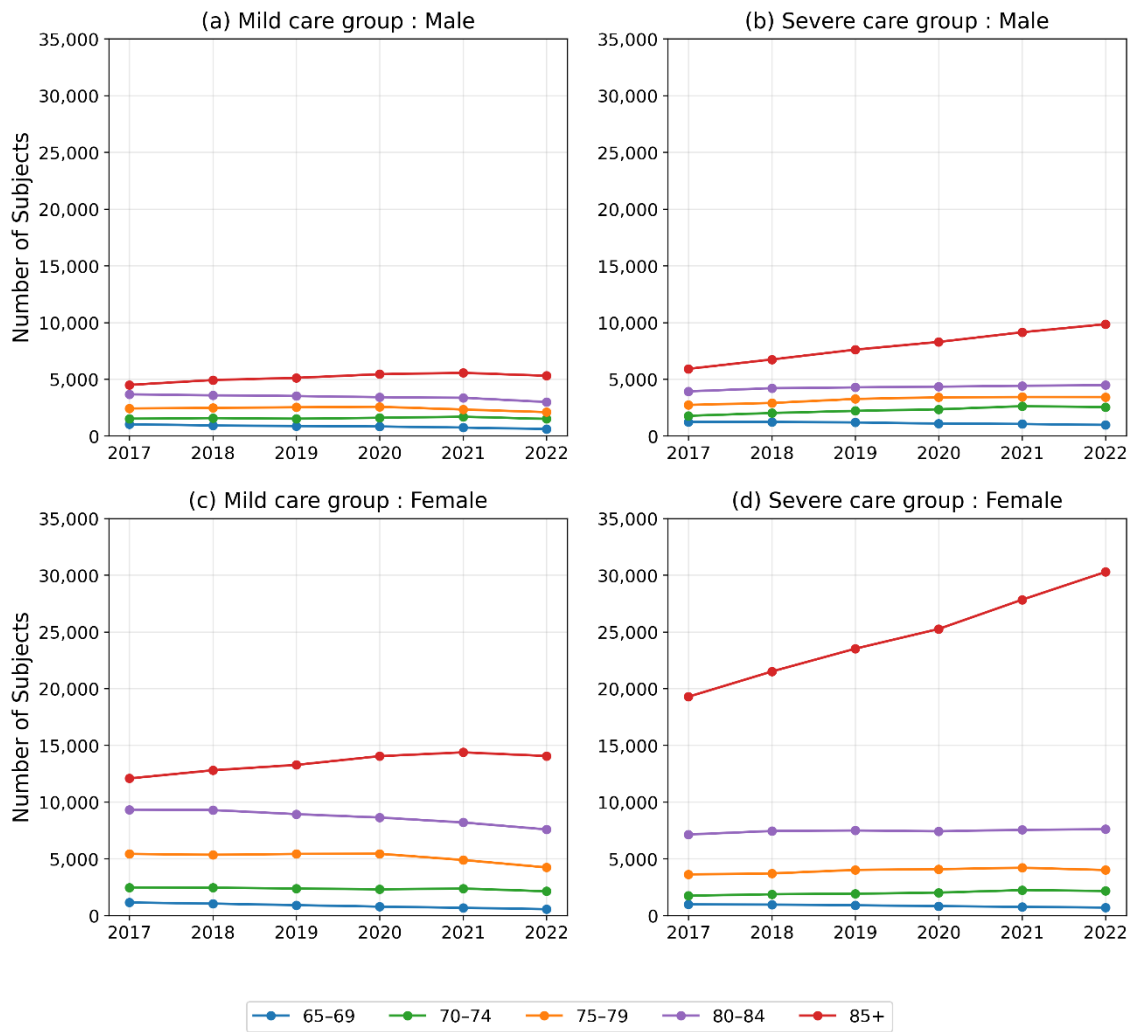


Figure 4. Annual trends in the number of subjects with long-term care certification by age group, sex, and care severity, fiscal years 2017–2022

Panels (a) and (b) show the annual number of male subjects in the mild care group and severe care group, respectively, whereas panels (c) and (d) show the corresponding numbers for female subjects. The mild care group included Support Levels 1 and 2 and Care Level 1, whereas the severe care group included Care Levels 2–5.

When certification prevalence was examined, a consistent decline was observed in the mild care dependency group among both men and women aged ≥ 75 years between fiscal years 2017 and 2022 (Figures 5A and 5C). In contrast, the prevalence of severe care dependency increased steadily among individuals aged ≥ 85 years in both sexes, reaching approximately 50% among women and 36% among men in 2022 (Figures 5B and 5D).

Furthermore, the sex-specific pattern of severe care dependency prevalence varied across age groups. Among individuals aged ≤ 74 years, prevalence was higher in men than in women; however, this difference largely disappeared in the 75–79-year age group. Among those aged ≥ 80 years, prevalence was higher in women than in men.

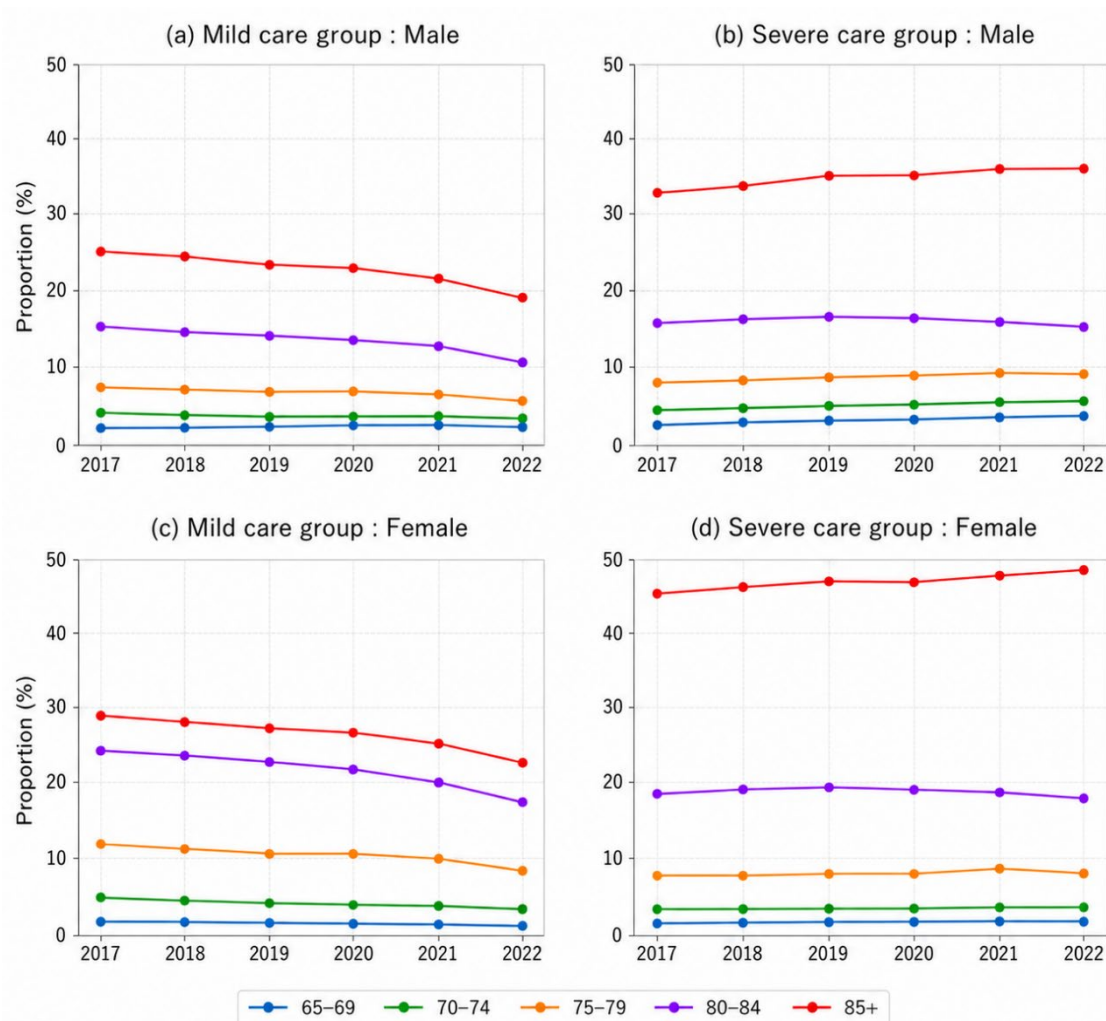


Figure 5. Annual trends in the proportion of subjects with long-term care certification by age group, sex, and care severity, fiscal years 2017–2022

Panels (a) and (b) show the annual proportion of male subjects in the mild care group and severe care group, respectively, whereas panels (c) and (d) show the corresponding proportions for female subjects. The proportion was calculated as the percentage of certified subjects within each age group and sex in each fiscal year. The mild care group included Support Levels 1 and 2 and Care Level 1, whereas the severe care group included Care Levels 2–5.

Logistic regression analysis

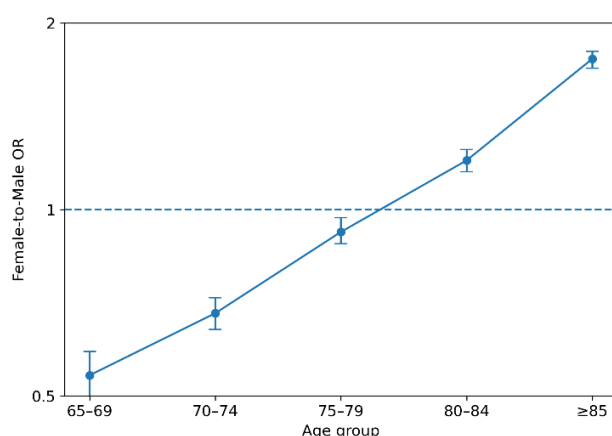
Logistic regression analyses were performed to evaluate the association between age group and severe care dependency (Care Need Level ≥ 2) in fiscal year 2022, using the 65–69-year age group as the reference category (Table II). The odds of severe care dependency increased progressively with advancing age in both men and women; however, the magnitude of this increase was substantially greater among women than among men.

The interaction between age and sex was statistically significant across all age groups ($P < 0.001$ for interaction), indicating that the effect of aging on severe care dependency was more pronounced in women. The interaction OR represents the extent to which the association between age and severe care dependency differs by sex. An interaction OR greater than 1.0 indicates a stronger age-related increase in severe care dependency among women than among men. Figure 6 presents the female-to-male odds ratios on a logarithmic scale to facilitate comparison across age groups. This ratio increased progressively with age and exceeded 1.0 at approximately 80 years of age. In contrast, the female-to-male OR represents the sex difference within the same age group. The interaction analysis confirmed that the association between age and severe care dependency was significantly stronger among women than among men.

Table II. Observed odds and odds ratios for severe long-term care dependency according to age group and sex

Age group (years)	Female		Male		Sex difference in age-related odds increase	Female-to-male comparison
	Observed Odds	Age-group OR (95% CI)	Observed Odds	Age-group OR (95% CI)	Interaction OR (95% CI)	Female-to-male OR within each age group (95% CI)
65–69	0.021	1.00 (reference)	0.040	1.00 (reference)	1.00	0.54 (0.49–0.59)
70–74	0.041	1.91 (1.78–2.04)	0.060	1.52 (1.43–1.61)	1.26 (1.17–1.36)*	0.68 (0.64–0.72)
75–79	0.094	4.42 (4.13–4.73)	0.102	2.56 (2.40–2.73)	1.72 (1.60–1.85)*	0.92 (0.88–0.97)
80–84	0.221	10.46 (9.78–11.18)	0.184	4.64 (4.34–4.96)	2.25 (2.09–2.42)*	1.20 (1.15–1.25)
≥85	0.986	46.43 (43.45–49.61)	0.565	14.31 (13.34–15.35)	3.24 (3.01–3.49)*	1.75 (1.69–1.80)

Observed odds were calculated directly from the observed numbers of individuals with and without severe long-term care dependency in each age–sex group. Female and male ORs compare each age group with the corresponding 65–69-year reference group within the same sex. Interaction OR represents the sex difference in the age-related increase in severe long-term care dependency. Female-to-male OR represents the sex difference within the same age group. OR, odds ratio; CI, confidence interval. * $P < 0.001$ for the age $\times$ sex interaction.

**Figure 6.**

Female-to-male odds ratios for severe long-term care certification by age group in FY 2020. Points indicate female-to-male odds ratios, and error bars indicate 95% confidence intervals. The y-axis is presented on a logarithmic scale. The dashed line indicates an odds ratio of 1.0, representing no sex difference. Female predominance was observed among individuals aged 80 years and older.

DISCUSSION

In the present study, we analyzed annual changes in population structure, disease burden, and long-term care certification status between 2017 and 2022 among residents of Kobe City aged ≥ 65 years who were enrolled in the National Health Insurance (NHI) system or the Late-Stage Elderly Medical Care System. Although employees' health insurance beneficiaries were not included among individuals aged 65–74 years, the study population covered almost all beneficiaries of the Late-Stage Elderly Medical Care System aged ≥ 75 years and can therefore be considered a large-scale real-world dataset with reasonable representativeness of the older adult population.

The number of study participants remained relatively stable at approximately 400,000 throughout the observation period. In contrast, the age distribution shifted toward older age groups, with a particularly marked increase in the proportion of women aged ≥ 85 years. This female predominance in the oldest-old has been widely reported in Japan and other developed countries (10, 11) and is consistent with future population projections for Japan (12). In contrast, both the number and proportion of younger older adults aged 65–69 years gradually declined over the study period. This trend may reflect not only the declining number of newly entering older adults due to a declining birth rate but also a reduced transition to the National Health Insurance system resulting from prolonged enrollment in employees' health insurance associated with extended working lives.

Analysis of the number of patients according to Major Diagnostic Categories (MDCs) demonstrated a continuous increase in disease burden in parallel with population aging. Although most diagnostic categories exhibited a transient decline in patient numbers in 2020, the first year of the COVID-19 pandemic, the overall trend during the observation period remained upward. In particular, cardiovascular diseases showed a consistent increase, whereas endocrine and metabolic diseases were only minimally affected by the pandemic. In contrast, respiratory and otorhinolaryngological diseases showed marked declines of approximately 12–15% in 2020 and

had not fully recovered by 2022. These findings are consistent with previous reports indicating that the COVID-19 pandemic affected healthcare access and healthcare-seeking behavior, whereas its long-term impact on chronic disease management was limited (13, 14).

Regarding long-term care certification, both the number of certified individuals and the certification prevalence increased between 2017 and 2022, indicating an overall expansion of long-term care demand. Throughout the study period, both the number and prevalence of certified individuals were consistently higher among women than among men, demonstrating a clear sex-specific pattern. When stratified according to care severity, the mild care dependency group showed a slight decline after 2021, whereas both the number and prevalence of individuals with severe care dependency continued to increase. In addition, the COVID-19 pandemic may have temporarily influenced long-term care certification during the early phase of the pandemic. Previous studies reported a transient decline in new applications for long-term care insurance certification in Japan, which has been attributed to reduced healthcare utilization, restrictions on certification procedures, and older adults' reluctance to seek public services during the pandemic (15, 16). Nevertheless, in the present study, the prevalence of severe care dependency continued to increase throughout the study period, suggesting that the long-term effects of population aging outweighed the temporary disruption associated with the COVID-19 pandemic.

One of the most important findings of the present study is that the increase in long-term care demand was not uniformly distributed across the older adult population but was concentrated among the oldest-old aged ≥ 85 years. In particular, both the number and prevalence of severe care dependency increased most markedly among women aged ≥ 85 years, indicating that long-term care demand is becoming increasingly concentrated among the oldest-old female population in parallel with the female-dominant demographic shift.

Logistic regression analysis using data from individuals certified as Care Need Level ≥ 2 in fiscal year 2022 demonstrated that the odds of certification increased with advancing age in both men and women. However, the increase became markedly steeper among individuals aged ≥ 85 years and was particularly pronounced among women. Among women, the odds ratio for certification in those aged ≥ 85 years was approximately 46-fold higher than that in the reference group of women aged 65–69 years. Furthermore, significant interactions between age and sex were observed across all age groups, statistically confirming that the impact of aging on the risk of certification was substantially greater among women than among men.

Previous studies have shown that women have a longer life expectancy than men but are also at higher risk of requiring long-term care and experience longer durations of care dependency, particularly among those aged ≥ 85 years (5, 6). In addition, frailty and the accumulation of health deficits increase nonlinearly with age and accelerate in the oldest-old, while women have a higher prevalence of frailty and diseases associated with functional decline, including osteoporosis and osteoarthritis, than men (17–20). Women are also known to have a higher prevalence of frailty and diseases related to functional decline while maintaining longer survival than men, a phenomenon widely recognized as the female–male health–survival paradox (21–24). Furthermore, a study based on the Comprehensive Survey of Living Conditions in Japan reported that, when all levels of long-term care certification, including Support Need Levels 1–2 and Care Need Levels 1–5, were analyzed, the interaction between age and sex was significantly associated with long-term care certification among individuals aged 85–89 years (7). In contrast, few studies have examined the interaction between age and sex using large-scale administrative data with severe care dependency (Care Need Level ≥ 2) as the outcome. The findings of the present study are consistent with these previous reports and further strengthen the existing evidence based on 6 years of real-world administrative data from approximately 400,000 community-dwelling older adults in an urban population.

Furthermore, the present study demonstrated that sex differences in the risk of certification for Care Need Level ≥ 2 changed with advancing age. Specifically, although the risk was higher among men during the younger-old stage, this relationship was reversed in the older-old stage, with women exhibiting a higher risk than men. Although a similar trend has been observed in administrative statistics, including the Survey of Long-Term Care Benefit Expenditures published by the Ministry of Health, Labour and Welfare of Japan (25), to our knowledge, no previous study has quantitatively demonstrated this age-dependent reversal in sex differences in the risk of long-term care certification across age strata using large-scale long-term care certification data. This age-dependent reversal in sex differences may be attributable to the combined effects of biological factors, including women's longer life expectancy and the accumulation of geriatric syndromes (20, 21), behavioral factors such as differences in healthcare-seeking behavior and long-term care insurance application behavior (26), and social factors including disparities in social support systems, such as living alone (27). However, because the present study was observational in nature, the relative contributions of these factors could not be directly evaluated. Further studies are therefore warranted to elucidate the mechanisms underlying this phenomenon.

Overall, between 2017 and 2022, Kobe City experienced parallel changes in population structure characterized by an expansion of the oldest-old population, together with increasing disease burden, predominantly driven by chronic diseases, and growing demand for long-term care. Furthermore, long-term care demand was concentrated primarily among individuals aged ≥ 85 years, and its increase progressed nonlinearly with advancing age. In

particular, severe long-term care demand was disproportionately concentrated among the oldest-old female population, indicating that the risk of loss of healthy life expectancy is becoming increasingly concentrated within this specific population subgroup. These findings provide important epidemiological evidence for understanding the structure of long-term care demand in aging societies and may contribute to risk stratification and the development of preventive strategies aimed at extending healthy life expectancy.

The present study has several limitations. First, this was a repeated cross-sectional observational study conducted over a 6-year period using administrative data. Therefore, the observed associations may have been influenced by healthcare-seeking behavior, reimbursement coding practices, long-term care certification criteria, and unmeasured confounding factors, and should not be interpreted as causal relationships. Second, because the analysis was based on data from a single urban municipality and did not include individuals aged 65–74 years who were covered by employees' health insurance, the generalizability of the findings may be limited. Nevertheless, the dataset used in the present study comprises a large-scale real-world database integrating medical claims and long-term care certification records at the individual level for approximately 400,000 older adults, enabling a comprehensive assessment of population structure, disease burden, and long-term care demand in an urban Japanese population. Furthermore, because the database contains approximately 6,000 ICD-10 diagnostic codes, it provides a valuable foundation for advanced analytical approaches, including explainable artificial intelligence and machine learning, to predict individual health and long-term care risks and to support the development of data-driven preventive strategies. The present analyses also served to characterize the dataset and to assess its quality and suitability for AI-based prediction model development, as demonstrated in our previous machine learning study using data derived from the same population-based healthcare data source (28).

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Appendix 1. Trends in the number of patients by Major Diagnostic Category (MDC) from fiscal years 2017 to 2022

Major diagnostic category	FY2017	FY2018	FY2019	FY2020	FY2021	FY2022
Diseases of the nervous system	249,966	250,033	249,980	244,426	246,011	247,939
Diseases of the eye	237,111	237,116	234,473	225,274	225,254	230,245
Diseases of the ear, nose, and throat	202,327	200,963	201,763	171,140	174,493	183,341
Diseases of the respiratory system	226,547	221,339	216,586	190,008	189,650	195,337
Diseases of the circulatory system	258,473	264,051	267,821	268,617	273,135	276,418
Diseases of the digestive system, liver, biliary tract, and pancreas	326,996	332,253	336,002	331,664	336,140	339,924
Diseases of the musculoskeletal system	271,814	273,642	274,629	269,320	273,795	276,829
Diseases of the skin and subcutaneous tissue	170,673	175,406	180,246	177,926	182,242	186,653
Diseases of the breast	150,119	139,801	132,934	123,096	120,572	120,306
Endocrine, nutritional, and metabolic diseases	278,183	281,369	283,442	280,470	284,698	287,896
Diseases of the kidney, urinary tract, and male reproductive system	206,492	202,577	200,770	194,298	196,364	199,416
Diseases of the female reproductive system and pregnancy-related disorders	12,858	13,315	13,605	12,706	13,215	13,836
Diseases of the blood, blood-forming organs, and	175,741	168,850	164,386	156,082	155,489	156,707
Neonatal diseases and congenital anomalies	147,039	136,539	129,662	119,442	116,872	116,680
Pediatric diseases	144,921	133,980	126,606	116,394	113,440	112,752
Trauma, burns, and poisoning	203,940	200,599	198,580	189,696	190,998	195,172
Mental disorders	185,284	179,055	174,962	167,001	166,376	167,128