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## Original Study

# Trajectories of Long-Term Care Expenditure During the Last 5 Years of Life in Japan: A Nationwide Retrospective Cohort Study



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## A B S T R A C T

**Keywords:**

Long-term care expenditure  
end-of life  
trajectory  
cause of death  
older population

**Objectives:** Despite the significant utilization of long-term care (LTC) services at the end of life, evidence on the trajectory of LTC expenditure in later life is scarce. This study aims to identify distinct trajectories of LTC expenditure in the last 5 years of life and to examine whether these trajectories differ according to cause of death.

**Design:** A nationwide retrospective longitudinal cohort study based on linked data of National LTC Claims and the Japan's National Vital Statistic.

**Setting and Participants:** Participants comprised decedents aged 70 years or older and who died in 2017.

**Methods:** We assessed 5 years of monthly LTC expenditure among participants and applied group-based trajectory model to identify distinct trajectories of LTC expenditure. Subsequently multinomial logistic regression analysis was performed to investigate how these trajectories vary according to cause of death.

**Results:** Among 1,124,335 decedents, 4 distinct trajectories of LTC expenditure were identified: persistently low (58.5%), late increase (9.8%), progressive increase then late decrease (8.8%), and persistently high (22.9%). Approximately 80.7% of total LTC expenditure was spent by the persistently high group. After adjustment for age and sex; deaths due to age-related physical debility and dementia were associated with persistently high LTC expenditure.

**Conclusions and Implications:** Ongoing discussions of LTC policy and reducing LTC expenditure may be more effective when emphasizing persistently high spenders. In addition, budget allocation for LTC at the end of life should be combined with data for health conditions.

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The currently aging population continues to drive demand for long-term care (LTC) services. According to the Centers for Disease Control and Prevention, more than 80% of older adults have at least 1

chronic health condition and 1 in 3 older adults has limitations in activities such as preparing meals and housekeeping.<sup>1</sup> Consequently, the rapid increase in LTC expenditure has become a pressing issue for governments in most developed countries.<sup>2</sup> The use of care services is most intensive in the last phase of life,<sup>3,4</sup> which poses a great burden to both individuals and the government.

Japan, with the oldest population in the world, almost one-third of its population is older than 65,<sup>5</sup> introduced a long-term care insurance (LTCI) system in 2000 in response to society's concern about caring for its older population. This universal long-term care coverage system is one of the most comprehensive social care systems for older adults in the world, aimed to ensure support for citizens who require LTC.<sup>6</sup> Since then, the number of LTCI users has increased rapidly. The ratio

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of LTC expenditure to gross domestic product is rising steadily and projected to at least double in 2060 compared with 2006.<sup>7</sup> This soaring expenditure is threatening the financial sustainability of the LTCI system.<sup>8,9</sup> Given that LTC expenditure peaks at the end of life, classification of LTC expenditure to identify high spenders may assist policymakers aspiring to slow the growth of LTC expenditure. However, little was known about the patterns or trajectories of LTC expenditure at the end of life.

LTC can be broadly defined as paid care for people who need support in many facets of living over a prolonged period of time. LTC services include supports for activities of daily living and instrumental activities of daily living, which are mainly provided by caregivers, nurses, and rehabilitation therapists. LTC can be financed through a mix of financing arrangements, including government spending, compulsory social insurance as well as private insurance, and private funds. LTC systems across Organisation for Economic Co-operation and Development countries have been described in detail elsewhere.<sup>10</sup> Briefly, there is considerable diversity in LTC coverage schemes and only a few countries implemented universal coverage within a single system. Therefore, as most countries provide multiple coverage, acquiring LTC data for the entire population of older people is difficult.

Early evidence on health care expenditure patterns at the end of life indicates significant distinct cost trajectories according to causes of death.<sup>11</sup> Expenditure for sudden death was lowest compared with decedents dying from a terminal illness, organ failure, and frailty in Canada. The expenditure was very low and stable until 3 months before death, and increased markedly in the last 3 months of life.<sup>11</sup> However, these authors did not consider the effect of demographic factors; most older people pay for LTC at the end of life, which is strongly related to health care expenditure.<sup>12</sup> In the United States, Davis and colleagues<sup>13</sup> focused on older decedents and identified 4 health expenditure trajectories in the last year of life: high persistent, moderate persistent, progressive, and late rise. Among all Medicare decedents, 48.7% had high persistent spending; however, this research did not include LTC expenditure data, because Medicare does not pay for LTC.

Because LTC is typically used long before death, longer years of follow-up may be required to assess the peak period of LTC spending. French and colleagues<sup>14</sup> reported that the percentage spent for LTC out of total health care expenditure (ie, medical and LTC expenditure) was higher in the last 3 years of life (Denmark: 54.2%, Germany: 36.6%, Japan: 44.86%, and the United States: 44.9%) than during the final year of life (Denmark: 21.7%, Germany: 14.9%, Japan: 22.1%, and the United States: 18.2%). Older age, female sex, and living alone are associated with higher LTC expenditure at the end of life.<sup>12</sup> Nursing home care is expensive, and accordingly is strongly correlated with increased LTC expenditure.<sup>15,16</sup> In addition, “cause of death,” which identifies the main needs for health care displays heterogeneity in end-of-life spending; expenditure is lowest in sudden deaths and most costly in decedents with organ failure.<sup>11,16</sup>

Our study used national data by linking Vital Statistics and LTCI claims that cover the entire population of citizens aged  $\geq 70$  who died in 2017. The aim of this study was to identify distinct trajectories of LTC expenditure in the last 5 years of life and to examine whether these distinct trajectories vary according to cause of death.

## Methods

### Data and Study Population

The death certificate data from a survey of vital statistics in Japan were used to obtain data for decedents who had died in 2017. To ensure that all decedents were eligible for LTC coverage during the 5 years of the follow-up period (ie,  $\geq 65$  years in 2012), decedents who

were aged  $\geq 70$  years at death were included, as LTCI services are offered in Japan to those aged 65 and older. Among decedents, we identified LTC beneficiaries by probabilistically linking with LTCI claims using a set of identifiers: sex, birth month/year, date of death (ineligibility date in LTC claims), and the municipality of residence. Notably, the claims cover all LTC beneficiaries in Japan and provide detailed information on types of LTC services, the amount of care granted, and the associated payments. Finally, 1,124,335 decedents who were aged  $\geq 70$  years and had died in 2017 were included in data analyses (Supplementary Figure 1). Our study was approved by the ethics committee (Approval number: 1324).

### LTC Insurance System in Japan

The LTC insurance system provides formal care services including both in-home services and in-facility services. Citizens aged  $\geq 65$  years are eligible to receive LTC services on receipt of a certificate of care-need level.<sup>17</sup> Eligibility for LTC insurance services is determined by municipalities according to nationally standardized assessments strictly based on the extent of a physical or mental disability. Care-need level certificate consists of 7 categories, starting with support level 1 or 2, care-need level 1 (less disabled) to care-need level 5 (most disabled). The upper limit of the cost of service covered by the LTCI differs depending on care-need level certificates. LTC facility services include LTC welfare facilities (ie, a living facility for those who are in stable condition), LTC health facilities (ie, intermediary facilities that aim to discharge individuals who need care and rehabilitation to home), and LTC medical facilities (ie, medical-based facilities for individuals who need substantial care and long-term treatment).<sup>18</sup>

### Outcome

Monthly LTC expenditure for decedents who satisfied the inclusion criteria was expressed in Japanese thousand yen (equivalent to 9.5 US dollars on July 30, 2020).<sup>19</sup>

### Leading Causes of Death

The leading cause of death was obtained from the death certificate data based on the underlying cause of death and was defined according to the International Classification of Disease, 10th edition (ICD-10): cancer C00–C97; heart disease I01–I02, I05–I09, I20–I25, I27, I30–I35; cerebrovascular disease I60–I69, pneumonia J12–18, age-related physical debility R54.<sup>20,21</sup> These selected diseases are listed as the top 5 leading causes of death among older people in Japan, according to the Ministry of Health, Labour and Welfare, Japan.<sup>21</sup> We added dementia and Alzheimer disease (ICD-10 code: F01–F03, G30), given that Alzheimer disease has been a leading causes of death in the United Kingdom<sup>22</sup> and among top 6 of leading causes in the United States since 2015.<sup>20</sup>

### Socioeconomic Variables

Social-economic characteristics of spousal relationships and copayment were examined. Three categories of copayments in the last year of death were included: 0% (livelihood protection recipients), 10% (general), and 20% (when household income is above a certain level). Under the LTCI system, general insured persons are required to pay 10% copayments, and those with higher income levels [ie, total income of 1.6 million Japanese yen (JPY) or more for 1 person and 3.46 million JPY or more for a household of 2 or more persons] are required to pay 20% copayments. For livelihood protection recipients (ie, who are unable to maintain a minimum standard of living due to poverty), the 10% copayment is paid by governments under the support of the Public Assistance Act.<sup>23</sup>

## Statistical Analysis

A group-based trajectory model was used to categorize distinct trajectories of LTC expenditure in the last 5 years of life.<sup>24,25</sup> Because LTC expenditure data were highly skewed, we used a natural logarithm to normalize expenditure data.<sup>13</sup> The Bayesian information criterion and average posterior probability value were used to select the number of trajectory group and the functional form of trajectory models (linear, quadratic, or cubic). Each trajectory group was required to include at least 5% of participants. Subsequently, we conducted a descriptive analysis to review the distribution of decedents' characteristics by distinct trajectories. We further used multinomial logistic regression to investigate if spending trajectories vary by causes of death. Data management and analyses were performed using STATA, Version 15 (StataCorp, College Station, TX).

## Results

### LTC Expenditure Trajectories Among LTC Services Users

Among 1,124,335 decedents, 4 distinct trajectories of LTC expenditure in the last 5 years of life were identified: persistently low, late increase, progressive increase then late decrease, and persistently high (Figure 1). More than half of decedents (58.5%) had a persistently low expenditure over the last 5 years of life. Approximately 9.8% of decedents showed a late increase trajectory where LTC expenditure was very low up to 2 years before death and then increased dramatically. The progressive increase then late decrease trajectory (8.8% of decedents) exhibited a steady increase of LTC expenditure with a peak at 1.5 years before death and a decrease until the end of life. Last, 22.9% of decedents had a persistently high LTC expenditure throughout the entire 5 years before death.

There was a considerable difference in total LTC expenditure in the last 5 years of life across the distinct trajectories (Figure 2). The mean total expenditure was highest among decedents in the persistent high trajectory group (11,286 thousand yen), followed by progressive increase then late decrease spenders (5070 thousand yen). For late increase spenders, the LTC expenditure increased rapidly in the last 2 years of life, the total expenditure (1663 thousand yen) was 7.1% of persistently high spenders. More than half of persistently low spenders did not use LTC services (median expenditure is 0).

### Characteristics of Decedents

As summarized in Table 1, the mean age of total decedents was 85.8 years old and 48.5% were men. Social-demographics and functional status of decedents at death significantly differed among the distinct trajectories. Overall, decedents with persistently high trajectory (mean age of 89.7 years) were older than decedents in the other remaining trajectories. The late increase trajectory group included a higher proportion of men than women (55.6%) compared with only 29.9% in the persistently high group. The percentage of decedents with care-need level 5 (care-need level 5 represents a serious condition such as bedridden life) were significantly higher in persistently low (13.2%) group than remaining groups (5.4%–9.3%).

### Place of Death and Length of Facility Stay

There was substantial variation in terms of the place of death in the percentage of decedents in each trajectory group. More decedents in the persistently high group (24.3%) died in LTC facilities compared with those in the other trajectory groups (6.6% to 14.2%). Similarly, among the 4 trajectory groups, length of stay in LTC insurance facilities was longest (9.5 months on average) in the persistently high spenders.

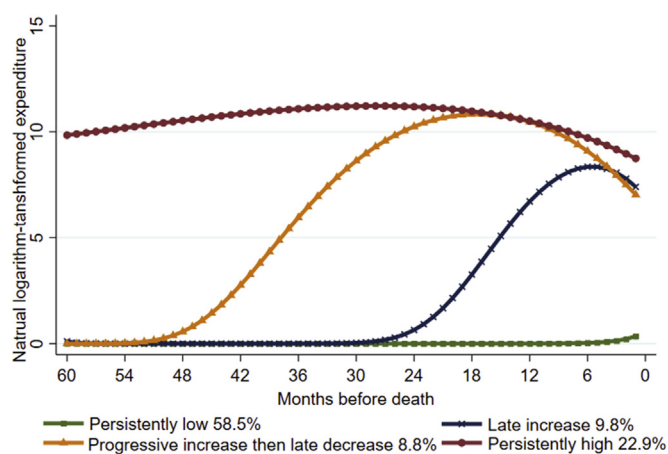


Fig. 1. Trajectories of LTC expenditure in the last 5 years of life.

### Socioeconomic Characteristics

Decedents who experienced spousal bereavement accounted for a high proportion (67.6%) of the persistently high group. The proportion of livelihood protection recipients was highest (5.5%) in the persistently high group compared with the other groups (0.4%–4.9%). In contrast, for those with a high income (20% copayments), the highest proportion was found in the late increase groups.

### LTC Expenditure Trajectories According to the Leading Causes of Death

Figure 3 presents the average predicted probability of classification in each of the distinct trajectories according to the leading causes of death. A predominant trajectory was observed for cancer decedents, whose average probability of persistently low (68.6%) was higher than those who died due to other diseases (47.0%–59.8%). Individuals who died due to age-related physical debility and dementia were more likely to have a persistently high LTC expenditure.

## Discussion

In this nationwide longitudinal study, we identified 4 distinct trajectories of LTC expenditure in the last 5 years of life and demonstrated that these trajectories varied according to leading causes of death. More than 80% of total LTC expenditure in the last 5 years of life was spent by decedents with a persistently high LTC expenditure trajectory (22.9% of decedents). Moreover, deaths due to dementia and age-related physical debility were associated with the persistently high spenders.

Our findings indicate that a 5-year follow-up is more appropriate for assessment of the peak period of LTC expenditure compared with the last 12 months of life. Given that it is well-known that health expenditure skyrockets during the year of death, LTC expenditure in only the last year of life was analyzed as a part of health care expenditure in previous studies.<sup>12–14</sup> However, we observed that the peak period of LTC expenditure differed across the 4 distinct trajectories and approximately 31.7% of decedents (ie, persistently high spender and progressive increase then late decrease spenders) exhibited steadily decreased LTC expenditure in the last year of life. Furthermore, we identified that LTC expenditure begins to increase at approximately 4.5 years before death for progressive increase then late decrease spenders. Hence, when allocating budgetary resources for LTC, a long-term view of 5 years is more appropriate than shorter timelines.

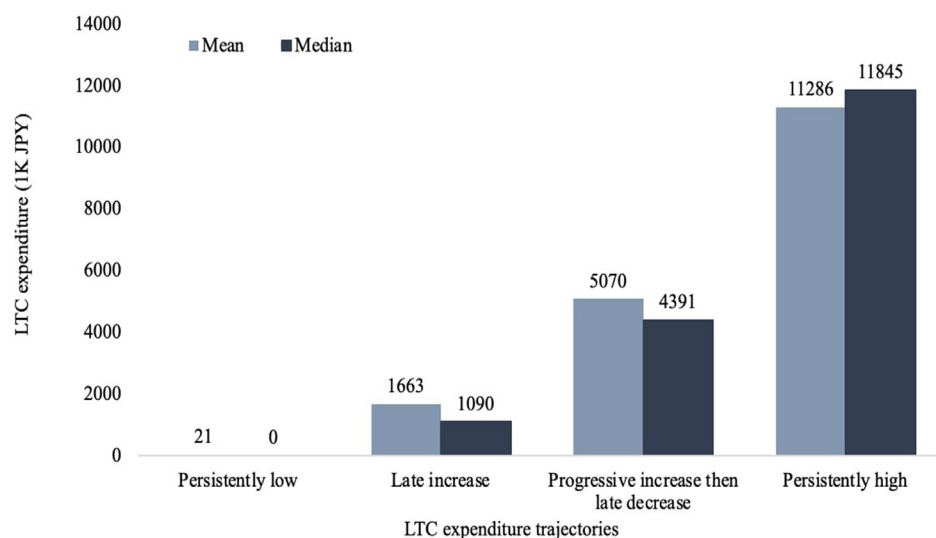
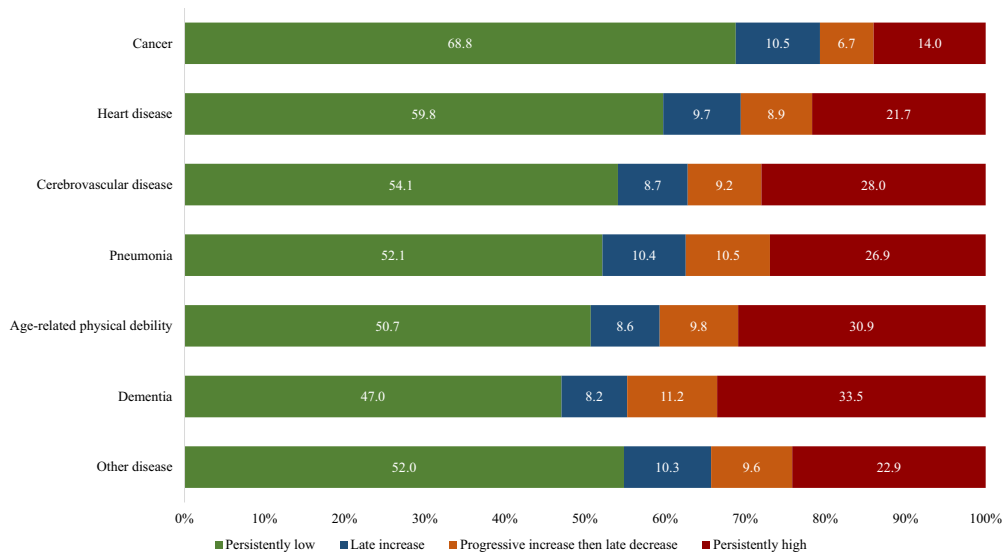


Fig. 2. Mean and median total LTC expenditure in the last 5 years of life according to distinct trajectories.

**Table 1**  
Characteristics of the Decedents in the Last 5 Years Before Death According to Distinct LTC Expenditure Trajectories

	Total N (%)	Persistently Low n (%)	Late Increase n (%)	Progressive Increase Then Late Decrease n (%)	Persistently High n (%)	P Value
	N = 1,124,335	n = 657,952	n = 109,685	n = 98,89	n = 257,803	
Proportion of total LTC expenditure (%)	100	0.4	5.1	13.9	80.7	
Age, mean y (SD)	85.8 (7.4)	84.7 (7.4)	85.3 (6.7)	87.1 (6.5)	89.7 (6.8)	*
Sex						*
Male	545,143 (48.5)	360,032 (54.7)	60,955 (55.6)	47,062 (47.6)	77,094 (29.9)	
Female	579,192 (51.5)	297,920 (45.3)	48,730 (44.4)	51,833 (52.4)	180,709 (70.1)	
Spousal relationship						*
Married	464,911 (41.4)	312,267 (47.5)	52,898 (48.3)	38,914 (39.4)	60,832 (23.6)	
Not married	55,933 (5)	38,032 (5.8)	3723 (3.4)	3372 (3.4)	10,806 (4.2)	
Bereavement	537,053 (47.8)	262,736 (40)	47,894 (43.7)	52,261 (52.9)	174,162 (67.6)	
Divorce	65,526 (5.8)	44,253 (6.7)	5119 (4.7)	4291 (4.3)	11,863 (4.6)	
Copayments (%)						*
High income (20%)	65,463 (5.8)	11,589 (1.8)	16,873 (15.4)	13,364 (13.5)	23,637 (9.2)	
General (10%)	444,017 (39.5)	55,824 (8.5)	87,527 (79.8)	80,666 (81.6)	220,000 (85.3)	
Livelihood protection recipients (10%)	26,990 (2.4)	2674 (0.4)	5285 (4.8)	4865 (4.9)	14,166 (5.5)	
Care-need level						*
None	588,134 (52.3)	588,134 (89.4)	0 (0)	0 (0)	0 (0)	
Support level 1	55,169 (4.9)	5377 (0.8)	13,775 (12.6)	14,468 (14.6)	21,549 (8.4)	
Support level 2	57,314 (5.1)	4844 (0.7)	11,891 (10.8)	12,619 (12.8)	27,960 (10.9)	
Care level 1	122,049 (10.9)	14,301 (2.2)	26,456 (24.1)	26,908 (27.2)	54,384 (21.1)	
Care level 2	105,923 (9.4)	14,224 (2.2)	20,379 (18.6)	17,486 (17.7)	53,834 (20.9)	
Care level 3	77,938 (6.9)	10,173 (1.6)	14,396 (13.1)	11,636 (11.8)	41,733 (16.2)	
Care level 4	70,582 (6.3)	11,676 (1.8)	14,229 (13)	10,420 (10.5)	34,257 (13.3)	
Care level 5	47,226 (4.2)	9223 (1.4)	8559 (7.8)	5358 (5.4)	24,086 (9.3)	
Place of death						*
Hospital	843,269 (75)	517,594 (78.7)	83,383 (76)	73,330 (74.2)	168,962 (65.5)	
LTC facility	130,679 (11.6)	43,448 (6.6)	10,425 (9.5)	14,052 (14.2)	62,754 (24.3)	
Home	133,514 (11.9)	88,189 (13.4)	14,377 (13.1)	9967 (10.1)	20,981 (8.1)	
Other	16,873 (1.5)	8721 (1.3)	1500 (1.4)	1546 (1.6)	5106 (2)	
Length of stay in LTC facilities [Mean months (SD)]	2.8 (7.6)	0.02 (0.2)	2 (4.7)	4.9 (9)	9.5 (12)	
Conditions leading to death						*
Cancer	282,602 (25.1)	208,307 (31.7)	28,810 (26.3)	16,690 (16.9)	28,795 (11.2)	
Heart disease	179,519 (16)	103,753 (15.8)	17,219 (15.7)	16,287 (16.5)	42,260 (16.4)	
Cerebrovascular disease	94,720 (8.4)	50,581 (7.7)	8205 (7.5)	8788 (8.9)	27,146 (10.5)	
Pneumonia	92,203 (8.2)	45,557 (6.9)	9846 (9)	10,267 (10.4)	26,533 (10.3)	
Age-related physical debility	100,824 (9)	37,698 (5.7)	7780 (7.1)	10,538 (10.7)	44,808 (17.4)	
Dementia	35,995 (3.2)	14,624 (2.2)	2802 (2.6)	4146 (4.2)	14,423 (5.6)	
Other diseases	338,472 (30.1)	197,432 (30)	35,023 (31.9)	32,179 (32.5)	73,838 (28.6)	

\*P value < .001 across spending trajectories, analysis of variance used to compare means and  $\chi^2$  test to compare proportions.



**Fig. 3.** Average predicted probability of classification in distinct trajectories according to leading causes of death. The multinomial logistic regression model was additionally adjusted by age and sex. We estimated the average predicted probabilities of specific disease belonging to each trajectory by using predictive margins.

The LTC expenditure in the last 5 years of life differed considerably among the 4 distinct trajectories. Although only 22.9% of decedents had a presently high LTC expenditure trajectory, 80.7% of the total LTC expenditure was spent by this group. To be specific, the average LTC expenditure of persistently high spenders was more than twice the progressive increase than late decrease spenders and 14 times higher than late increase spenders. An indicator of the financial protection named catastrophic health expenditure, represents that out-of-pocket payments on health during the past 12 months were more than 10% of their total income.<sup>26</sup> The persistently high spenders are more likely to experience a high burden of LTC cost because the percentage of the out-of-pocket payment for LTC in income was approximately 15.1%. This was calculated by dividing average annual out-of-pocket payment (sum of copayments and premium) on LTC for persistently high spenders by average annual income per household member with persons aged  $\geq 65$  years in 2016 (ie, (11286 thousand JPY/5 years\*10% copayment+66 thousand JPY)/1928 thousand JPY<sup>27</sup>).

Combined with the fact that the largest proportion of decedents was persistently high spenders, it may be more effective to focus on persistently high spenders than other trajectory groups when policymakers seek to reduce LTC expenditure.

Previous studies suggested that there may be a difference in the way decedents use LTC services by copayments and spousal relationships.<sup>6,9</sup> To test whether spending trajectories differ by these social-economic characteristics, we performed a multinomial logistic regression (Supplementary Table 1) As a result, lower copayments were associated with persistently high LTC expenditure. This finding is consistent with previous studies, which indicates that the lowest income group may fully use LTC services under the policy of 100% financial support for low-income individuals.<sup>6</sup> In addition, Fu and colleagues<sup>9</sup> provided evidence that moral hazard in LTC insurance exists; that is, individuals, on average, use more health care services when they are required to pay less out of pocket. Decedents who have never been married were associated with persistently high LTC expenditure. One possible interpretation of this is that older people who have never been married are more likely to reside in LTC facilities because family care or informal support is commonly unavailable to them in later life.<sup>28</sup>

The trajectory of LTC expenditure was associated with the leading causes of death. Deaths due to dementia and age-related physical debility were significantly associated with persistent high LTC expenditure in the last 5 years of life. For decedents with dementia,

the increased length of stay in nursing homes compared with decedents with other medical diseases may contribute to persistently high expenditure. Eventual nursing home admission and care until death is almost inevitable for older people with dementia unless a caregiver can provide full-time skilled medical care.<sup>29</sup> Previous studies have reported that older people with dementia incur greater care costs than those without dementia because they primarily all require a higher degree of care due to dementia.<sup>29</sup> Similar to dementia, the length of nursing home stay is much longer for decedents who die due to age-related physical debility. They are more likely to require consistent long-term care because several medical conditions such as cancer, pneumonia, and cerebrovascular disease may lead to hospitalization or an earlier death.<sup>30</sup> Therefore, a care program aiming at resuming home life for age-related physical debility may reduce length of stay in nursing homes.

Finally, death due to cancer was strongly associated with persistently low or late increase in LTC expenditure. Previous research indicates that most cancer decedents had relatively good functional status early in their final year of life but experienced a sharp decline in the last 3 months before death.<sup>31</sup> Consequently, cancer decedents are more likely to use home care services and physician services than LTC facility services,<sup>15</sup> and this may be linked to persistently low or escalating cost of LTC expenditure late in the final year of life. Further, the special nature of terminal cancer may lead to difficulty in utilization of LTC services. One issue is that delays in obtaining the results of care-assessment may lead to a failure to accurately reflect their functional status in a timely manner. According to the Ministry of Health, Labour and Welfare, 20% of LTC beneficiaries with terminal cancer died before the acquisition of care-level certification.<sup>32</sup> To address this issue, the Japanese government implemented a policy to accelerate the care-level determination especially for patients with terminal cancer from 2011. Future studies that examine if the policy has enough effect on utilization of LTC services in patients with terminal cancer is needed. Another thing to consider is the variation in LTC expenditure trajectories by cancer types, as different cancers have different peak ages of onset and 5-year survival rates. Our sub-analysis showed that the proportion of individuals with persistently high LTC expenditure was highest in decedents with breast cancer (15.3%) and colorectal cancer (12.7%) than others (8.2%–9.9%; Supplementary Table 2).

When interpreting our findings, it is necessary to acknowledge the limitations of this study. First, we did not consider informal care because benefits for informal care are not captured in the Japanese

LTCI system.<sup>17</sup> Previous studies have reported that informal care cost during the last 3 months of life was particularly high in Canada,<sup>33</sup> and can even be higher than formal care costs in multiple countries (England, Ireland, and United States).<sup>34</sup> Kelley and colleagues<sup>35</sup> imputed the implicit cost of informal care by multiplying subjects' reported hours of informal care provided by the state-average costs of home care services. They found that the average informal care cost for decedents with dementia was more than double that of decedents without dementia over the last 5 years of life in the United States. A future study combining both formal and informal care could provide more comprehensive information regarding LTC. Second, "leading causes of death" were used as a proxy of the main health condition leading to LTC; however, this should be interpreted with caution, especially regarding dementia, given that when recording death certificates for decedents with multiple diseases, dementia is the last option relative to other diseases. For instance, although the rate of dementia in 2017 was 15% according to the Ministry of Health, Labour and Welfare, only 3.3% of deaths were identified as due to dementia.<sup>36</sup> Third, due to limited information in the datasets, we did not adjust for comorbidities, medications, length of stay, or surgeries even though it is a critical predictor of health care spending at the end of life.<sup>13</sup> The Japanese government has publicly released a nationwide linked database between medical and LTC claims from October 2020; future studies using this data are thus warranted.

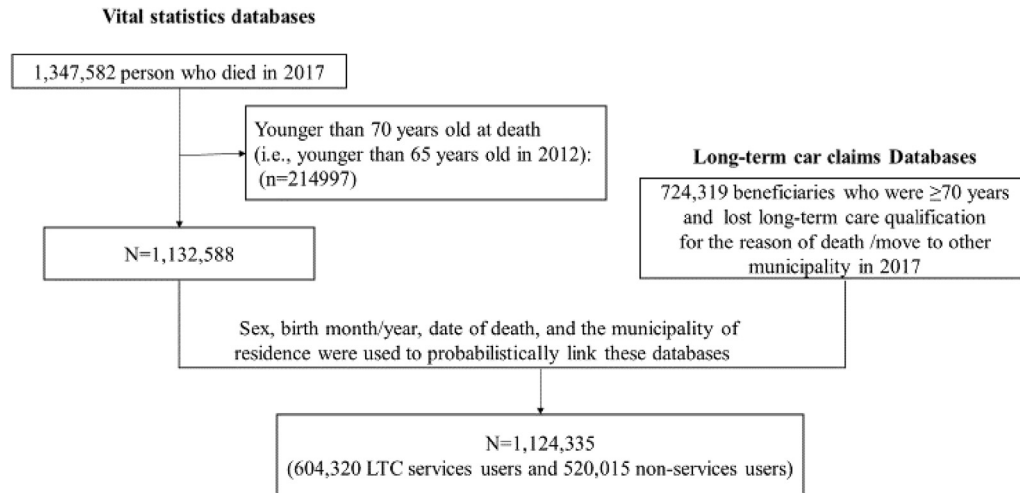
## Conclusion and Implication

This study identified 4 distinct LTC expenditure trajectories in the last 5 years of life among older people in Japan. More than 80% of LTC expenditure was spent by persistently high spenders (22.9% of total decedents). Ongoing discussions of budget allocation and reducing LTC expenditure should focus on persistently high spenders (ie, those with persistently high LTC expenditure throughout the last 5 years of life). Furthermore, age-related physical debility and dementia were drivers for persistently high LTC expenditure. Therefore, budget allocation for LTC at the end of life should be combined with data on health conditions.

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## Appendix



Supplementary Fig. 1. Flow chart of the study population.

Supplementary Table 1

Associations Between Socioeconomic Characteristics and LTC Expenditure Trajectories

	Late Increase RRR (95% CI)	Progressive Increase Then Late Decrease RRR (95% CI)	Persistently High RRR (95% CI)
Age	1.03 (1.02–1.03)	1.05 (1.05–1.05)	1.09 (1.09–1.09)
Sex (ref.: male)			
Female	1.05 (1.02–1.07)	1.24 (1.21–1.27)	1.91 (1.87–1.96)
Care-need level (ref.: support level 1)			
Support level 2	0.95 (0.91–1.0005)	0.95 (0.91–0.99)	1.35 (1.29–1.41)
Care level 1	0.71 (0.68–0.74)	0.66 (0.63–0.68)	0.84 (0.81–0.87)
Care level 2	0.57 (0.55–0.6)	0.45 (0.43–0.47)	0.87 (0.83–0.9)
Care level 3	0.53 (0.51–0.55)	0.38 (0.36–0.39)	0.80 (0.77–0.83)
Care level 4	0.44 (0.43–0.46)	0.28 (0.27–0.29)	0.52 (0.50–0.54)
Care level 5	0.32 (0.31–0.34)	0.17 (0.16–0.18)	0.43 (0.41–0.45)
Spousal relationships (ref.: have a spouse)			
Not married	1.20 (1.14–1.27)	1.35 (1.27–1.44)	2.05 (1.94–2.16)
Bereavement	1.10 (1.07–1.12)	1.23 (1.2–1.27)	1.62 (1.58–1.66)
Divorce	1.09 (1.04–1.15)	1.17 (1.11–1.23)	1.68 (1.6–1.76)
Copayments (%) (ref.: high income group [20%])			
General (10%)	1.04 (1.01–1.07)	1.11 (1.07–1.14)	1.18 (1.14–1.21)
Livelihood protection recipients (0%)	1.35 (1.27–1.42)	1.59 (1.5–1.69)	2.10 (1.99–2.22)
Place of death (ref.: hospital)			
LTC facility	2.27 (2.17–2.37)	3.08 (2.95–3.23)	4.41 (4.22–4.6)
Home	0.64 (0.63–0.66)	0.51 (0.5–0.53)	0.43 (0.42–0.44)
Other	1.22 (1.11–1.33)	1.29 (1.18–1.42)	1.56 (1.43–1.70)
Conditions leading to death (ref.: cancer)			
Heart disease	2.44 (2.36–2.52)	3.56 (3.44–3.69)	4.23 (4.1–4.37)
Cerebrovascular disease	3.2 (3.06–3.35)	5.93 (5.66–6.21)	8.64 (8.28–9.02)
Pneumonia	2.85 (2.73–2.97)	4.93 (4.72–5.15)	6.38 (6.14–6.64)
Age-related physical debility	2.57 (2.45–2.7)	4.84 (4.62–5.08)	6.70 (6.41–7.00)
Dementia	2.99 (2.78–3.23)	6.96 (6.47–7.50)	9.69 (9.04–10.38)
Other diseases	2.35 (2.3–2.41)	3.62 (3.52–3.72)	4.33 (4.23–4.44)

CI, confidence interval; RRR, relative risk ratio.

**Supplementary Table 2**

Descriptive Analysis of the 5 Most Common Cancers According to Distinct LTC Expenditure Trajectories

	Persistently Low	Late Increase	Progressive Increase Then Late Decrease	Persistently High
Types of cancer (ICD-10)	n (%)	n (%)	n (%)	n (%)
Lung cancer (C33–C34)	44,688 (76.6)	5770 (9.9)	3086 (5.3)	4801 (8.2)
Colorectal cancer (C18–C20)	26,469 (70.2)	3970 (10.5)	2480 (6.6)	4779 (12.7)
Stomach cancer (C16)	26,649 (75.7)	3145 (8.9)	1939 (5.5)	3493 (9.9)
Prostate cancer (C61)	7229 (66.5)	1750 (16.1)	877 (8.1)	1009 (9.3)
Breast cancer (C50)	4811 (67.1)	803 (11.2)	461 (6.4)	1094 (15.3)