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Seasonal effects on healthcare costs: Using panel data from medical and long-term care claim records of the elderly in Hokkaido

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Objectives: Most developed countries share a growing concern about care services and increasing healthcare expenditures. In this regard, many studies have identified the impact of seasons effects on health, but have not clarified the relationship between seasons and healthcare services and costs. The aim of this study was to examine the impact of seasons on the healthcare expenditures; we used a longitudinal cohort of older persons for healthcare utilization and costs.

Methods: This paper describes the results of a longitudinal retrospective study conducted in City A, Hokkaido, with a panel survey of medical care (MC) and/or LTC utilization and costs. The subjects were community-based elderly residents aged 65 years and above (n = 1,793) who are classified as requiring Support Levels 1 or 2, or Care Needs Levels 1 to 5, in accordance with the LTC insurance system. The study used data from July and December of the years 2007 to 2009 (i.e., a total of six survey points). The data were collected from MC insurance claim records, LTC insurance claim records, and questionnaires used to evaluate the cognitive and physical status of each subject in order to ascertain his or her nursing care needs in terms of the LTC insurance system.

Results: In 2007, the mean age of the subjects was 84 years, 71% of them were female, most had cognitive impairment and/or functional disability, and most were on low incomes. There were no significant various in the seasonal and yearly data for the MC and LTC costs. Probit analysis was conducted to determine factors that are associated with the coefficients of healthcare behaviors per month. Winter season was a negative determinant of the utilization of outpatient care and positive determinant of the use of facility care. Furthermore, we used a Tobit model to analyze the determinants of the coefficients of healthcare costs per month. Winter season was found to be a negative determinant of outpatient costs, but had no impact on other costs. Of the population variables, severe cognitive impairments and functional disabilities were associated with greater hospital and/or facility care costs.

Conclusion: Seasonal variations influence the use of healthcare services in the elderly who are in need of support or care. The population of elderly is growing and the MC and LTC costs are rising as the baby-boomer generation is aging; thus, healthcare policymakers should pay attention to the relationship between seasonal variations and healthcare utilization and costs.

keywords: Healthcare services, medical care cost, long-term care cost, seasonal effect, elderly.

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I. Introduction

As the baby-boomer generation ages over the next three decades, demand for healthcare services are expected to rise steeply [1]. This is particularly relevant in Japan,

which is experiencing the highest rate of aging of the society in the world. Japan's healthcare policy includes medical care (MC) and long-term care (LTC) insurance systems. With regard to the former, the country has had a national health insurance (NHI) system that supports

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MC for all citizens since 1961. In 2008, this NHI system was revised to include a new medical insurance system for those aged 75 years and over. LTC insurance, a social insurance system that supports LTC for the elderly, was established in 2000 [2,3]. In 2010, the total costs for MC insurance reached US\$400 billion (US\$1 = 93.5 yen in 2009). Of this, US\$222 billion represented the costs for the elderly. Further, total LTC costs have grown from US\$42 billion in 2000 to US\$85 billion in 2010. Such runaway healthcare costs make the sustainability of the MC and LTC insurance systems doubtful. In order to reduce the increasing healthcare service costs, it is necessary to investigate the determinants of the inflated expenditures for the elderly. The costs of facilities such as nursing homes have been suggested as being one of the factors for the increasing healthcare costs [4]. Thus, policy makers must focus on ways to reduce the costs of healthcare facilities and minimize admission of the elderly to such facilities.

Studies have identified seasonal impacts on health. For example, seasonal variations have been reported on the number of hospital admissions in the fields of general medicine and orthopedics [5]. During the winter, increased mortality has been reported in intensive care units [6]. In particular, the elderly are vulnerable to very hot or cold weather; for example, the incidence of hip joint fractures is higher in the winter than in the spring season [7]. Rolden et al. used the data of elderly Dutch health insurance clients and reported that institutionalization rates peak in the winter [8]. Healthcare costs for the elderly in Japan has paid by the MC and LTC insurance systems. The status of individuals can then be considered by using the data that contain time-series observations and blending the inter-individual differences with intra-individual dynamics [9]. However, in Japan it is generally difficult to combine the claim records for MC and LTC; indeed, there are many reports using MC records or LTC records, there is few studies have analyzed the data both MC records and LTC records. Consequently, a systematic analysis of the relationship between the seasons and healthcare costs has not been conducted in Japan.

The behavioral model of utilization, developed by Andersen, Aday and others, is one of the most frequently used frameworks for analyzing factors that are associated with patient utilization of healthcare services [10-12]. The framework of the model has broad applicability and enables analyses across age, country and various segments of society [13]. The model also includes four interacting variables: environment, population characteristics, health behavior, and outcomes. By 2025, when the baby-boomer generation reaches the later-stage elderly, Japan is supposed to build an integrated community care system

that takes regional realities into account. The environment may be one of the factors that affect the health behavior of elderly. If the effects of environmental factors on the healthcare behavior were investigated, it will be useful for construction of an integrated community system based on local circumstances.

In this present study, the factors that influence healthcare expenditures, especially the variables from Andersen's model related to the environment and population characteristics, were examined. The subjects of the study were elderly enrollees in the Japanese LTC insurance system, who are responsible for a part of the MC and LTC expenditures in local City A, Hokkaido, Japan. To determine the seasonal effects on healthcare expenditures, we used a longitudinal cohort of older persons for healthcare utilization and costs.

II. Methodology

1. Study setting

The present study was conducted in City A of Hokkaido prefecture, Japan, after the city extended its cooperation for the research. City A is approximately in the center of Hokkaido and has an inland climate. The average temperature is 5.5 °C, the mean annual rainfall is 960 mm, and the mean snowfall is 884 cm (data from 1980 to 2010) [14]. During the summer season of 2009 (around July), the highest temperature was 30.6 °C and the lowest was 9.6 °C. In contrast, during the winter season of 2009 (around December), the highest temperature was 3.4 °C and the lowest was -19.7°C [14]. The city A has a population of 31,000. In Japan, local cities, towns and villages with a populations of under 50,000 account for more than two-thirds of all municipalities. In 2009, elderly people aged over 65 years old accounted for 25.0% of the total population in City A, a figure higher than the national average of 22.7%. However, the per-capita MC and LTC costs for the elderly were almost equal to the national rates.

City A has four hospitals and 10 clinics. In addition, it has one LTC health facility, two welfare facilities, and one LTC medical facility. The proportion of LTC beds per 100,000 people is higher than the national average. The MC and LTC services provided by City A are considered to be comparatively satisfactory.

2. Population

We conducted a survey of City A residents who were over 65 years old and who were classified as requiring Support Levels of 1 or 2, or Care Needs Levels of 1 to 5, in accordance with the LTC insurance system. The survey subjects were also insured by the NHI system and/or MC

insurance system for elderly people aged over 65 years old. We analyzed the data ($n = 1,793$) for the months of July and December of each year from 2007 to 2009 (i.e., a total of six survey points).

In the Japanese LTC insurance system, eligibility is classified into seven levels depending upon an individual's current cognitive/physical status and severity of their medical condition(s). Individuals classified as requiring Support Level 1 or 2 do not require help for daily living activities; however, they could be potentially assigned in the near future to a Care Needs Level. Such individuals sometimes require some help, not care, for physical functions in order to retain their independence during their daily lives. Individuals classified into Care Needs Level 1 require partial care, whereas those classified into Care Needs Level 5 cannot undertake any activities of daily living without extensive assistance. A Care Needs Certification Review questionnaire must be completed to determine the level that a person should be assigned to. A representative from the city's administrative office or agent of home-care providers commissioned by the city interviews the applicant and his or her family to determine the applicant's cognitive and physical status and the severity of his/her medical conditions. The questionnaire contains 74–82 items and two scales, namely, to determine the degree of independent living in elderly people with cognitive impairments and the degree of independent living in elderly people with physical disabilities. Then, a committee comprising medical and other professionals reviews the results and assigns each person to the appropriate Support Level or Care Needs Level in accordance with the LTC insurance system [2]. Support and Care Needs Levels are classified according to the number of services provided and the fee for each service.

3. Data

A longitudinal design was applied to the analysis of the MC and LTC insurance data. The MC insurance data were obtained from the NHI and/or MC insurance systems for the elderly aged over 65 years old for the months of July and December of 2007, 2008 and 2009 (i.e., a total of six survey points). The LTC insurance data were obtained from the LTC insurance system and collected for the same periods as the MC survey points.

A panel for each subject was constructed with the data obtained from his/her MC and LTC insurance records. The MC records contain information on the age and sex of the patient, and monthly information on hospital and/or outpatient care service use, and the costs for such use. The LTC records contain information on the age and sex of the patient, and monthly information on the Support or Care

Needs level assigned to, home and/or facility care services used, and the costs for such services. The LTC records also contained information about the level of the LTC premiums and the filled-in Care Needs Certification Review questionnaire.

Subjects are requested to pay their LTC premiums along with their local residence tax. The insurance premium for LTC is proportionate to an individual's income; thus, if individuals with higher incomes pay a higher LTC premium. The premium ranges from levels 1 to 6 in the LTC insurance system of City A. Subjects who receive welfare or an old-age welfare pension, and those who are not required to pay the local residence tax, are assigned to Level 1 or 2. Subjects who are members of households that are exempt from municipal taxation are assigned to Level 3 or 4. Subjects who pay municipal taxes, but whose total annual income is less than 2,500,000 yen are assigned to Level 5. Subjects who pay municipal taxes and whose total annual income is 2,500,000 yen or more are assigned to Level 6. The scales in the Care Needs Certification Review questionnaire are used to determine the degree of independent living in elderly people with cognitive impairments and the degree of independent living in elderly people with physical disabilities (functional disabilities). Cognitive impairment is ranked as follows: Independent, Rank I (mild cognitive disorder), Rank II, Rank III, Rank IV, and Rank M (severe cognitive disorder). Functional disability is ranked as follows: Independent, Rank J (requires partial care), Rank A, Rank B, and Rank C (bedridden and unable to undertake any activities of daily living without extensive assistance). The Care Needs Certification Review questionnaire contains the question, "What kind of medical care did you receive during the past 14 days?"; we used the response to this question to judge the severity of the subject's medical condition(s). The data for each subject at each of the six survey points were combined.

4. Analytical approach

We included the following variables: environment, namely, the season (summer or winter); population characteristics, namely, the age, sex, and income level (Levels 1–6); cognitive impairment (Independent–Rank M); functional disability (Independent–Rank C); medical condition (receiving/not receiving medical treatment); MC services; MC costs; LTC services; LTC costs.

We selected variables that were considered to be potentially associated with healthcare costs on the basis of prior research. Most studies conducted outside Japan have used units of data with individual panel data or cross-sectional data. The results of these studies revealed that the population status, sex [15], cognitive impairment [15,16],

functional disability [15,17], and medical condition [18], are associated with the healthcare costs. It should also be noted that Japan's social security system for the elderly differs from those in other countries. For example, in the United States, Medicare is part of MC, whereas the LTC costs in Japan are part of the social security system. However, few prior studies have used individual panel data on the health and seasons in Japan.

Both Izumida and Akiyama et al. used the information on the LTC premium as a surrogate parameter of the income level in their studies [19,20]. The authors revealed that a low socioeconomic status influences the admission of elderly to care facilities [20]. Izumida used the variable of income status, with Level 2 as low-income status and Level 3 or more as high-income status. His study indicated that the number of elderly people with low incomes and assigned to high Care Needs Levels that are admitted to LTC facilities is increasing [19]. In addition, Akiyama et al. used the LTC premium as a surrogate marker of the income. In their study, they classified Levels 1 and 2 into the low-income level, Levels 3 and 4 into the middle-income level, and Levels 5 and 6 into the high-income level [20]. We found that the number of assigned subjects for income status was unbalanced. Thus, we combined the income status levels 1–6 and divided the income level into three ranks, namely, high, middle and low, in line with prior reports [19,20]. We also used information on the LTC premium as a surrogate marker of the income level. Using individual cross-sectional data, Akiyama et al. reported the existence of a strong association between the LTC costs and the Care Needs Levels and LTC costs are strongly associated [21]. Care Needs Levels are determined by the amount of time for which the insured person needs care from other people. The levels are not determined by the individuals' assigned severe Care Needs Levels, the severity of cognitive impairments, and/or the degree of functional disabilities. Studies about the elderly who have Care Needs certification have used the degree of independent living of the elderly and disabled as a surrogate parameters of cognitive and functional disabilities [22,23]. We also used the two scales and the response to the aforementioned question in the Care Needs Certification Review questionnaire as surrogate parameters of cognitive/functional and medical status. The number of subjects with cognitive impairment classified into Ranks IV and M was small; thus, we divided cognitive impairment into five ranks, Independent, Rank I, Rank II, Rank III, and Rank IV/M, in line with prior reports [22,23]. Most of the subjects did not have medical conditions that required insulin injections, tube-feeding, etc.

We divided season, which was an independent variable,

into summer and winter. The data for summer were from the observation points of July 2007, July 2008 and July 2009, while those for the winter were from December 2007, December 2008 and December 2009.

Subjects were classified as MC service users if they had MC insurance claims. In order to survey the trend of use of MC services, we divided MC insurance claims into two: hospital use and outpatient use. With regard to LTC services, we divided LTC insurance claims into two types: home care and facility services. In 2008, the Japanese MC insurance system was revised and the total remuneration for MC costs decreased by 0.82%. In 2009, the LTC insurance system was also revised and the total remuneration for LTC costs increased by 3%. Considering the effects of these changes to the MC and/or LTC insurance remunerations, we multiplied the MC cost in 2007 by -0.82% and the LTC costs in 2007 and 2008 by +3% for 2009.

Data were analyzed using the t-test, the Wilcoxon signed-rank test, and the median test to compare the characteristics and costs between summer and winter across the years 2007, 2008 and 2009. The Probit model was used when the dependent variable was a binary variable, like healthcare utilization, and the Tobit model was used when the dependent variable was represented by truncated data, like healthcare costs. We assigned the summer values as the reference values for the seasonal variables. In addition, we assigned female as the reference value of sex. In this study, high-income level (Levels 1 and 2) was set as the reference, and middle-income level (Levels 3 and 4) as one level lower, and low-income level (Levels 5 and 6) as two levels lower. Using independent as the reference in the classification of cognitive impairment, we ranked the other levels in descending order of severity as follows (Rank I = 1, Rank II = 2, Rank III = 3, Rank IV/M = 4). Similarly, the number of subjects classified according to the degree of functional disability as Independent and into Rank J was so small that we divided functional disability into four ranks: Independent/Rank J, Rank A, Rank B, and Rank C. Independent/Rank J was used as the reference value, and we assigned the patients in order from slight functional disability to severe functional disability as follows: Rank A = 1, Rank B = 2, and Rank C = 3. Persons who did not need medical care were assigned the rank of zero, and those who needed one or more kinds of medical care were assigned the group I or higher. We assigned the zero group as the reference group.

A random-effects Probit model was used to investigate the effect of season on healthcare. Since data on all the variables were not available all points in time, we selected random-effect which is the individual-specific effect, instead

of the fixed effect. The analysis was performed using healthcare services as the dependent variable and season, age, sex, income status, cognitive impairment, functional disability, medical condition, and year (2007, 2008, and 2009) as the independent variables. The distributions of the MC and LTC costs were censored at zero for a large portion of the sample. In order to examine the seasonal effects, we used a Tobit (1958) model for estimating a regression function with a censored dependent variable [24]. In the Tobit model, data are disconnected at a level of 0 dollar of healthcare cost. The analysis was performed with healthcare cost as the dependent variable, and season, age, sex, income status, cognitive impairment, functional disability, medical condition, and year as the independent variables. Costs and age were treated as continuous variables, while healthcare, sex, medical condition, year, use/no use of services, and costs were categorical variables. Income status, cognitive impairment, and functional disability were treated as ordinary variables. As in the Probit model, the Tobit model also handles the reference variables the same way.

The statistical analyses shown in Table 1 and Table 2 were performed using the JMP Statistical Software, version 9.0 (SAS Institute Inc., CA, USA), and the time-series analyses shown in Table 3 and Table 4 of were performed using Stata, version 11.0 (Light Stone Inc., TX, USA). $P \leq 0.05$ was considered as denoting statistical significance in all the analyses. This study was conducted with the approval of the Ethics Committee of the University of Tokyo. It was a joint study between city A and the researchers. We obtained

comprehensive agreement from the residents for the study. In order to preserve the anonymity of the participants, the staff of city A deleted all their personal information before handing it over to the researchers.

III. Results

1. Subjects' characteristics and monthly healthcare costs

The extracted data set consisted of 1,793 subjects, of which information for all six survey points were obtained for 733. In the remaining 1,060 subjects, information from fewer survey points were obtained because of death, departure from City A, or the non-assignment of Care Needs or Support levels for certain survey points. We excluded seven subjects because of missing data for the independent variables. Overall, we used a data set consisting of 1,786 subjects and 7,291 observations.

Table 1 shows the characteristics of the 1,786 subjects. In 2007, the mean age of the subjects was 84 years and 71% of the subjects were female. In addition, most of the subjects had low incomes, Rank II cognitive impairment, and Rank A functional disability. Cognitive impairment and functional disability were widespread: nearly 80% of the subjects needed help. Most of the subjects were assigned a value of zero because they had medical conditions. We found no significant differences in the subjects' characteristics between the seasons by years. Although we have not shown the distribution of the LTC Levels in the table, the distribution was as follows: Support Level 1/2, 30%; Care

Table 1 A comparison of subjects' characteristics between seasons by years

			Year 2007		P_value	Year 2008		P_value	Year 2009		P_value
			Summer n = 1,166	Winter n = 1,209		Summer n = 1,250	Winter n = 1,208		Summer n = 1,242	Winter n = 1,216	
Age ^a		mean $\pm$ SD	83.9 $\pm$ 7.7	83.9 $\pm$ 7.6	0.887	84.2 $\pm$ 7.7	84.1 $\pm$ 7.7	0.652	83.8 $\pm$ 7.5	83.8 $\pm$ 7.4	0.905
Sex ^b	Female	n (%)	825 (70.8)	852 (70.6)	0.893	873 (69.8)	846 (70.0)	0.930	874 (70.4)	855 (70.3)	1.000
	Male	n (%)	341 (29.2)	357 (29.5)		377 (30.2)	362 (30.0)		368 (29.6)	361 (29.7)	
Income status ^c	High	n (%)	142 (12.2)	143 (11.8)	0.502	161 (12.9)	165 (13.7)	0.641	169 (13.6)	172 (14.1)	0.701
	Middle	n (%)	493 (42.3)	538 (44.5)		520 (41.6)	501 (41.5)		517 (41.6)	507 (41.7)	
	Low	n (%)	531 (45.5)	528 (43.7)		569 (45.5)	542 (44.9)		556 (44.8)	537 (44.2)	
Cognitive impairment ^c	Independent	n (%)	229 (19.6)	217 (17.9)	0.468	220 (17.6)	205 (17.0)	0.944	219 (17.6)	213 (17.5)	0.629
	Rank I	n (%)	302 (25.9)	331 (27.4)		321 (25.7)	313 (25.9)		301 (24.2)	281 (23.1)	
	Rank II	n (%)	398 (34.1)	394 (32.6)		426 (34.1)	427 (35.3)		450 (36.2)	451 (37.1)	
	Rank III	n (%)	154 (13.2)	185 (15.3)		206 (16.5)	184 (15.2)		193 (15.5)	189 (15.5)	
	Rank IV/M	n (%)	83 (7.1)	82 (6.8)		77 (6.2)	79 (6.5)		79 (6.4)	82 (6.7)	
Functional disability ^c	Independent/Rank J	n (%)	263 (22.6)	289 (23.9)	0.845	309 (24.7)	313 (25.9)	0.353	341 (27.5)	340 (28.0)	0.509
	Rank A	n (%)	513 (44.0)	509 (42.1)		513 (41.0)	502 (41.6)		533 (42.9)	534 (43.9)	
	Rank B	n (%)	247 (21.2)	259 (21.4)		289 (23.0)	264 (21.9)		256 (20.6)	238 (19.6)	
	Rank C	n (%)	143 (12.3)	152 (12.6)		140 (11.2)	129 (10.7)		112 (9.0)	104 (8.6)	
Medical condition ^b	Zero	n (%)	1031 (88.4)	1073 (88.8)	0.847	1132 (90.6)	1092 (90.4)	0.891	1132 (91.1)	1117 (91.9)	0.563
	One or more	n (%)	135 (11.6)	136 (11.2)		118 (9.4)	116 (9.6)		110 (8.9)	99 (8.1)	

^at-test; ^bFisher's exact test; ^cWilcoxon signed-rank test.

Table 2 A comparison of the utilization of healthcare services and costs between seasons by years

			Year 2007			Year 2008			Year 2009		
			Summer	Winter	P_value	Summer	Winter	P_value	Summer	Winter	P_value
			n = 1,166	n = 1,209		n = 1,250	n = 1,208		n = 1,242	n = 1,216	
The utilization of healthcare services											
Medical care services use ^a	Hospital	n (%)	189 (16.2)	186 (15.4)	0.779	210 (16.8)	163 (13.5)	0.021	140 (11.3)	154 (12.7)	0.291
	Outpatient	n (%)	826 (70.8)	810 (67.0)	0.039	905 (72.4)	828 (68.5)	0.034	863 (69.5)	892 (73.4)	0.036
Long-term care services use ^a	Home care	n (%)	565 (48.5)	578 (47.8)	0.626	607 (48.6)	605 (50.1)	0.444	637 (51.3)	624 (51.3)	1.000
	Facility care	n (%)	257 (22.0)	262 (21.7)	0.883	272 (21.8)	269 (22.3)	0.770	263 (21.2)	279 (22.9)	0.307
Healthcare costs											
Monthly medical care costs ^b	Hospital	Median	0.0	0.0	0.582	0.0	0.0	0.022	0.0	0.0	0.288
	Outpatient	Median	60.5	41.9	0.002	54.7	50.8	0.747	56.5	59.5	0.420
Monthly long-term care costs ^b	Home care cost	Median	0.0	0.0	0.853	0.0	31.8	0.497	43.0	36.8	0.936
	Facility care cost	Median	0.0	0.0	0.794	0.0	0.0	0.716	0.0	0.0	0.812

^aFisher's exact test; ^bMedian test.

Needs Level 1, 20%; Level 2, 17%; Level 3, 14%; Level 4, 9%; and Level 5, 10%. The observed ratios of Support Levels and Care Needs Levels were the same as the national levels in the winter of 2007 [25].

Table 2 presents a comparison of the subjects' healthcare services and costs. Approximately 70% of the subjects were outpatients who used MC services. Furthermore, 50% of the subjects used home care services within the LTC insurance system. The medians of the hospital costs in the MC insurance system and facility costs in the LTC insurance system were both US\$0 across the survey points. However, the medians of the outpatient costs and some of the home care costs were \$42–\$61 and \$32–\$43, respectively. There were no significant various in the seasonal and yearly data for the MC and LTC costs.

2. Probit analysis: Impact of season on the utilization of healthcare services

Table 3 summarizes the results of the Probit analysis. This analysis was conducted to determine the factors

associated with the coefficients of healthcare behaviors per month. Season was found to be a negative determinant of the utilization of outpatient care and positive determinant of facility care. In the Probit model, the likelihood of outpatient care use decreasing during winter as compared to the summer. Conversely, the likelihood of facility care use increased during winter as compared to the summer.

The results of the relationship between the subjects' characteristics and healthcare service use showed that increasing dependence among those with cognitive impairments and functional disabilities are risk factors for increased use of hospital and facility care in the study cohort. Moreover, decreasing dependence among subjects with cognitive impairments and functional disabilities was a significant factor contributing to decreased use of outpatient and home care. Severity of the medical condition was a significantly positive determinant of hospital use. In contrast, it was negatively associated with outpatient, home care, and facility care. Low-income status was strongly and positively associated with the utilization of facility care and

Table 3 Probit model; Analysis of seasonal effect impacts on the utilization of healthcare service among the elderly
n = 1,786

	Medical care services				Long-term care services			
	Hospital		Outpatient		Home care		Facility care	
	Coef.	P_value	Coef.	P_value	Coef.	P_value	Coef.	P_value
Seasonal effect (ref. = summer)	-0.313	0.534	-0.084	0.042	-0.056	0.273	0.215	0.003
Age	0.003	0.590	0.031	<0.001	-0.005	0.630	0.080	<0.001
Sex (ref. = female)	0.043	0.685	0.023	0.812	0.149	0.376	-0.175	0.414
Income status (ref. = high income)	-0.203	0.002	0.039	0.495	-0.168	0.049	0.800	<0.001
Cognitive impairment (ref. = Independent)	0.103	0.007	-0.157	<0.001	-0.331	<0.001	0.616	<0.001
Functional disability (ref. = Independent/Rank J)	0.623	<0.001	-0.477	<0.001	-0.925	<0.001	1.128	<0.001
Medical condition (ref. = zero)	0.551	<0.001	-0.306	0.006	-0.610	<0.001	-0.421	0.033

Notes: Coef. is coefficient. Ref. is reference value.

P_values were calculated using a random-effect Probit model.

The Probit model was adjusted for the dummy variables of the appropriate year of the study.

Costs are US\$/month; US\$1 = 93.5 yen in 2009.

was a contributory factor to increased LTC insurance. The pattern of the Probit analysis results reveals that those with severe dependency because of cognitive impairments and/or functional disabilities had a large coefficient for the use of hospitals and/or facility care services. Moreover, those who used hospitals required some medical care, and those who used facility care services had low incomes.

3. Tobit analysis: Seasonal impacts on healthcare costs

We used a Tobit model to analyze the determinants of the coefficients of healthcare costs. Table 4 shows the factors that are related to the healthcare costs per month. The winter season was a negative determinant of outpatient costs, but was not associated with other costs. In the Tobit model, outpatient costs were lower by 19 dollars per month during the winter as compared to the summer.

Among the variables in the research population, severe cognitive impairments and functional disabilities generated greater hospital and/or facility care costs. The negative parameter estimated for the variables of the income status indicated that the hospital costs were lower for subjects with low incomes than for those with high incomes, for whom the facility care costs were higher.

IV. Discussion

The primary aim of this retrospective longitudinal cohort study was to examine the seasonal effects on the healthcare expenditures of older persons. When considering factors that influence healthcare costs paid by the MC and LTC insurance systems, it is necessary to collect and combine various data from both sets of claim records for each person. However, only a few studies have simultaneously

analyzed the data from both MC and LTC claim records. The reason is that the insurers of MC and LTC differ in their approaches; thus, it is generally difficult to combine MC and LTC claim records. In this study, we were fortunate to obtain the permission of City A to collect various data in a single panel for each subject from both types of claim records. We were able to collect various data in a single panel for each subject from both claim records.

Three major findings of this study should be emphasized. First, seasons exert an influence on the level of use of outpatient and facility care services and consequently outpatient costs. With regard to outpatients, the utilization rate and costs in the winter were lower than those in the summer. In the area examined in this study, the impact of climate, such as heavy snowfall and geography (e.g., long distances between houses), makes the provision of care to the elderly living at home a challenge. Furthermore, the total amount of physical activity is influenced by meteorological factors, particularly snow precipitation and the mean ambient temperature [26]. It is possible that new health problems arise because of not being able to receive the necessary MC. Therefore, when considering an integrated community system of the elderly, it is necessary to pay attention to the influence of weather conditions on MC and LTC. In this study, we did not consider the influence of the difference in the number of business days of the hospital between July and December. The smaller number of business days in December could have contributed to the decrease in the use of outpatient services and outpatient costs in the winter.

Second, we found that the use of facilities increased in the winter as compared to the summer. A prior study also reported that institutionalization rates are significantly higher in the winter [5]. During the winter, the elderly

Table 4 Tobit model; Analysis of seasonal effect impacts on healthcare costs among the elderly

n = 1,786

	Medical care costs				Long-term care costs			
	Hospital		Outpatient		Home care		Facility care	
	Coef.	P_value	Coef.	P_value	Coef.	P_value	Coef.	P_value
Seasonal effect (ref. = summer)	-167.8	0.480	-18.6	0.013	-17.7	0.088	27.3	0.457
Age	-4.4	0.875	1.7	0.268	-9.9	0.006	80.8	<0.001
Sex (ref. = female)	57.9	0.906	31.1	0.218	106.7	0.086	-379.4	0.021
Income status (ref. = high income)	-1005.7	0.001	-4.6	0.726	-30.8	0.166	212.0	0.004
Cognitive impairment (ref. = Independent)	422.7	0.018	-34.7	<0.001	-26.6	0.029	217.4	<0.001
Functional disability (ref. = Independent/Rank J)	2533.2	<0.001	-95.9	<0.001	-181.7	<0.001	870.1	<0.001
Medical condition (ref. = zero)	2090.6	<0.001	127.4	<0.001	-71.0	0.073	-202.6	0.073

Notes: Coef. is coefficient. Ref. is reference value.

P_values were calculated using a random-effect Tobit model.

The Tobit model was adjusted for the dummy variables of the appropriate year of the study.

Costs are US\$/month; US\$1 = 93.5 yen in 2009.

cannot stay at home alone if they have severe disabilities. They should be admitted to facilities temporarily, such as in short LTC health facilities. Problems such as snow and low temperatures during the winter make it difficult for the elderly living at home to go out. It has been reported that severe cognitive impairment and functional disability are associated with a decrease in the outpatient and home care service use and costs, and conversely, with increased hospital and facility care service use and costs. This is in line with the findings of this research which revealed that the level of cognitive impairment and functional disability were determinants of healthcare expenditures [15,17]. In addition, according to the staff of an LTC health facility, some elderly people living alone find it difficult to stay at home during the winter and choose to be admitted to an LTC facility. Consequently, our findings revealed the impact of seasons on the health behaviors of functionally disabled elderly. There is a possibility of seasonal effects being particularly strong in persons with severe cognitive impairment and functional disability, although this remains to be examined in a future study.

Third, the variable of income level and medical condition was different directions associated with hospital and facility care use and costs. This points show that the people who expenditure hospital care has high income and medical care. Conversely, the people who expenditure facility care expenditure had low income and without being taking medical care. A previous study reported that people with low incomes tend to select facilities as their living quarters [19]. There is a possibility that elderly people choose their living quarters based on their income and/or medical care needs. It could also be dependent on the level of cognitive impairment and functional disability (independent or severely dependent). Thus, the income level, medical care needs and degrees of cognitive impairment, functional disability may be associated with the choice of an individual in respect of the living quarters, namely, care facility or home (persons who use both home care and outpatient care). From the research results of this study for the elderly conducted using individuals MC and LTC data, it became clear that the LTC need is related to the consumption of MC.

Our study had some limitations. First, we conducted our analyses in just one city; thus, caution should be exercised while generalizing the results to areas with larger populations. We did not use a randomized design, therefore, we cannot conclude a causal relationship. Second, prior studies have indicated the relationship between healthcare costs and variables such as illness, living arrangements, and marital status. However, these factors were not included in the present study because information pertaining to these

factors was not available in the claim records.

Despite these limitations, our findings indicate that environmental factors such as seasonal effects should be incorporated in the behavioral models of healthcare services for the elderly. Moreover, the results of the present study yield several findings that could inform recent discussions about ways in which more integrated community care for frail older adults should be designed in the years up to 2025. Healthcare policies for the elderly should focus on seasonal effects on outpatient and facility services expenditures.

V. Conclusion

Seasonal factors influence the use of healthcare services for those elderly who are in need of support or care. The elderly are growing in number and MC and LTC costs are rising as the baby-boomer generation ages; thus, healthcare policymakers should pay attention to the relationship between seasonal effects and healthcare utilization and costs.

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医療保険と介護保険のパネルデータを用いた ヘルスケアコストへの季節要因の影響

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抄録

目的：ベビーブーマー世代が後期高齢者を迎える2025年に向けて，我が国は地域で在住する高齢者に対する包括ケアの創設に苦慮している．本研究は要介護認定高齢者におけるヘルスケアサービスの受療行動に対する季節要因の影響を検討し，高齢者対策に向けた示唆を得ることである．

方法：本研究では研究協力の得られた北海道A市の医療保険と介護保険の後向きパネルデータを使用した．要支援1，要支援2，要介護1～5の認定を受けている65歳以上の要介護認定高齢者1793名を対象とした．データは2007～2009年の7月，12月の6調査時点の医療レセプトと介護レセプト，要介護認定調査の調査結果を収集し，個人毎に突合した．ヘルスケアサービスの利用率と季節要因の関連を調べるため，1ヶ月のヘルスケアサービス（入院医療／外来医療／居宅／介護施設サービス）の利用の有無を従属変数，個人属性（年齢・性別・所得・認知度・寝たきり度）を独立変数としたプロビット分析を行った．同様に，1ヶ月のヘルスケアサービス費（入院医療費／外来医療費／居宅サービス費／施設サービス費）を従属変数，個人属性を独立変数とするトービット分析を行った．

結果：対象者の2007年の年齢は84歳，71％は女性であった．対象者のほとんどは認知機能と身体機能に障害があり，収入は低かった．対象者の属性には季節と年度によって差はなかった．外来サービスの利用率は夏季に比べて冬季で減少し，介護保険施設サービスの利用率は夏季に比べて冬季に上昇することがプロビット分析で明らかになった．また，外来医療費は夏季に比べて冬季に減少することが明らかになった．属性とヘルスケアサービスの関係においては，重度な認知機能障害があるほど，身体機能障害があるほど，入院医療費や介護保険施設サービス費が有意に増加することがトービットモデルで明らかになった．

結論：本研究の結果から，要介護認定高齢者では季節によりヘルスケアサービスの利用に影響する可能性が示唆された．高齢者の地域包括ケアを考慮する際は，気象条件による医療・介護サービスへの影響を留意する必要がある．

キーワード：ヘルスケアサービス，医療費，介護費，季節要因，高齢者