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ORIGINAL ARTICLE

Factors affecting regional variations in hospitalization expenditures of elderly residents in Japan

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Abstract
Aim The aim of this study was to examine the possible effects of healthcare resource factors, socioeconomic factors, and sociodemographic factors on variations in hospitalization expenditures of elderly patients in Japan at different levels of urbanization.
Subject and methods A secondary analysis was conducted using data obtained from a regional health care cost report and the Portal Site of Official Statistics of Japan. The regional unit of analysis used was the secondary medical care area. We divided these areas into three groups based on their levels of urbanization (low, middle, and high urbanization), indicated by their respective population densities of inhabitable areas. Multiple linear regression models were used to analyze the candidate factors affecting per capita hospitalization expenditures of elderly residents.
Results The significance and magnitude of associations were observed to vary according to different levels of urbanization. Our findings showed that medical resource factors and sociodemographic factors were more influential in areas of low urbanization, whereas the number of hospital beds and socioeconomic factors appeared more influential in high urbanization areas.
Conclusion Policies designed to contain healthcare expenditures should take regional characteristics and levels of urbanization into account in order to support the development and implementation of region-specific improvements that ensure affordable healthcare for the elderly.

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Introduction

Healthcare spending has steadily risen in most developed countries, with a substantial portion of expenses incurred by the elderly. Among the member countries of the Organisation for Economic Co-operation and Development (OECD), Japan has the highest proportion of residents aged over 65 years (OECD 2013). Understanding the underlying factors that influence the healthcare expenditure of elderly people in an aging society such as Japan can support the identification of possible targets for cost containment, as well as provide a reference for other countries that will invariably face similar issues in the near future.

In Japan, the Act on Assurance of Medical Care for Elderly People was enacted in 1982 to (1) ensure the preservation and improvement of the quality of daily life for elderly people, (2) ensure no excessive increases in healthcare expenditures, and (3) gradually reduce the medium- and long-term rates of increases in healthcare expenditures. However, spending has continued to increase annually, particularly for patients aged 70 years and above. In 2002, healthcare expenditures incurred by elderly people constituted 37.7 % of Japan's national health expenditure (Ministry of Health, Labour and Welfare 2010). When compared with younger people, the average expenditure of elderly people was 6.7 times more for hospitalization and four times more for outpatient services (Cabinet Office, Government of Japan 2005). In addition, the existence of substantial regional variations in medical expenditures of elderly residents in Japan has been reported (Fujiwara and Hoshi 1998; Fujiwara et al. 2000; Innami 1997; Une 1996).

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The impact of urbanization on regional differences in healthcare utilization and expenditure has been previously demonstrated. A study found that wealthier urban provinces in Canada had greater healthcare utilization (Jiménez-Rubio et al. 2008), whereas US state-level data demonstrated a negative relationship between the proportion of the population living in urban areas and healthcare utilization (Wang 2009). Furthermore, it has also been shown that rural areas in the US are less likely to receive prompt and appropriate primary care (Laditka et al. 2009), and have lower health statuses in community ratings (Greiner et al. 2004). Higher-volume users of healthcare in rural areas have shown greater risk in the long-term recovery process (Young et al. 2009), and stroke patients in rural areas are less likely to receive rehabilitation therapy than those in urban areas (Jia et al. 2012). In China, elderly people living in more urbanized areas have shown a positive association with chronic conditions (Pudrovska and Anishkin 2013). Local Health Departments located in rural areas in the US have less funding and staffing, which may increase health disparities (Beatty et al. 2010).

In addition to the level of urbanization, previous reports have indicated that the number of hospital beds is a major contributing factor of regional differences in healthcare expenditures (Crivelli et al. 2006; Hay 2003; Innami 1997; Thornton and Rice 2008; Wang 2009). In Japan, the Medical Expenditure Control Plan—based on the Act on Assurance of Medical Care for Elderly People—was introduced in 2008 and established targets for reducing the number of beds for long-term care. Under this plan, beds for long-term nursing care were to be abolished by the end of 2012, and a portion of beds for long-term medical care was to be diverted to healthcare facilities for elderly patients. However, an interim evaluation in 2011 reported that the reorganization plan was unrealistic, and the active reduction in the target number of long-term care beds was temporarily halted (MHLW 2011). Furthermore, the Medical Care Act in Japan stipulates the number of hospital beds at the prefectural level (analogous to the states of the US), and individual hospitals are unable to unilaterally determine bed numbers. By controlling the number of hospital beds, policymakers sought to correct regional imbalances and assure a standardized level of medical care at the national level. With this substantial involvement of both the national and regional governments, the number of hospital beds is evidently a major focus of health policy in Japan.

Other factors that possibly influence regional differences in healthcare expenditures and services have been addressed in various countries. These have included medical resource factors such as the numbers of hospitals, numbers of physicians, and progress in medical technology (Angulo et al. 2011; Brown et al. 2001; Crivelli et al. 2006; Hay 2003; Innami 1997; Martín et al. 2011). Also, socioeconomic factors (Kagamimori et al. 2009; Ross et al. 2000; Thornton and Rice 2008; Wagstaff and Van Doorslaer 2000) and sociodemographic factors (Angulo et al. 2011; Goetghebeur et al. 2003; Jiménez-Rubio et al. 2008; Kroneman and Siegers 2004; Martín et al. 2011; Wang 2009; Zweifel et al. 2009) have been reported to influence healthcare expenditures.

The factors associated with regional variations in healthcare expenditures for elderly people in Japan have yet to be investigated at the national level. Although Japan possesses efficient and extensive distribution systems, the existing differences in urbanization may affect expenditures. Additionally, Japan's aging population and reduced birth rate may have increased the variations in demographics and resource availability at the prefectural and sub-prefectural levels. Elucidating the underlying factors of variations in healthcare expenditures that incorporate urbanization levels is an important step in the formulation and implementation of regionally appropriate cost-containment measures. The objective of this study was to investigate the factors associated with regional variations in healthcare expenditures for hospitalization of elderly residents at different levels of urbanization.

Methods

Secondary medical care area

The regional unit of analysis used in this study was the "secondary medical care area". These areas are defined in the Medical Care Act as sub-prefectural regions where comprehensive inpatient primary care is provided, and demand for healthcare in each region can essentially be met with the available supply. We selected secondary medical care areas as the unit of analysis because health policies in Japan are frequently developed and implemented at this level. During the study period, there were 363 designated secondary medical care areas within Japan's 47 prefectures, and these secondary medical care areas encompass all areas of the nation. Another sub-prefectural regional classification is the municipality, but these vary greatly in size and population density. Also, in contrast to secondary medical care areas, municipalities are not designated based on any particular functional criteria.

Despite the possible existence of regional variations in healthcare expenditures among the secondary medical care areas, these variations may be diluted in analyses carried out at the prefectural level due to the dispersion of various intra-prefectural factors. Analyses at the municipality levels also present their own limitations for investigations on healthcare expenditures such as their varying sizes and lack of hospitals in some municipalities. We therefore selected the secondary medical care area as the most appropriate unit of analysis for this study.

Data sources

National-level data from March 2001 to February 2002 of per capita hospitalization expenditures of residents aged 70 years and above were obtained from a regional health care cost report (Shakai hoken kenkyuu sho 2004). In this study, elderly residents were defined as those aged 70 years and above because our data were from the Health Insurance for the Aged component of Japan's National Health Insurance system, and its beneficiaries are defined as such. In addition, disabled individuals aged between 65 and 69 years were also included as beneficiaries in the Health Insurance for the Aged system, and could not be distinguished from those aged 70 years and above within the available data. However, data from 2008 (from an Annual Report of the Latter-Stage Elderly Health Care System) showed that the proportion of disabled beneficiaries accounted for only 4 % of all beneficiaries of elderly health insurance. This suggests that the presence of these disabled beneficiaries would have little influence on the results. Data of the various independent variables were obtained from the following publically available reports, with the majority of data for this analysis obtained from the Portal Site of Official Statistics of Japan (e-Stat). Data of populations, households, and inhabitable areas were obtained from the Japanese National Population Census in 2000 (Statistics Bureau 2000). The numbers of hospital beds, hospitals, clinics, physicians, and other medical resources were obtained from a survey of medical institutions in 2002, conducted by the Ministry of Health, Labour and Welfare (2002). The list of institutions identified as academic medical centers was provided by the Ministry of Education, Culture, Sports, Science and Technology (2006). This list included the current addresses of academic medical centers; however, if an academic medical center was found to have moved after 2002, we utilized the address correct at 2002. Regions were identified as having no academic medical centers, one academic medical center, or two or more academic medical centers.

Regional differences in consumer price indices were calculated from the regional difference index of prices in ten major groups (prefectural average=100), which were obtained from a National Survey of Prices in 2002 (Statistics Bureau 2002b). Price of land was obtained from the Statistical Observations of Municipalities, also provided by the Statistics Bureau (2002). In this study, per capita income refers to per capita taxable income, and was also obtained at the municipality level (Statistics Bureau 2002a) before aggregation at the secondary medical care area level.

Because the data for hospitalization expenditures were from 2002, the data for the candidate independent variables in 2002 were analyzed. In addition, we obtained population data of residents aged 70 years and older at 2002 from the Basic Residents Register (Statistics Bureau 2011).

Population densities of inhabitable areas

Population density has been used as a proxy to indicate levels of urbanization in regions (Crivelli et al. 2006). In this study, we further modified this variable by taking the geographical characteristics of Japan into account: Japan has vast uninhabitable areas consisting of mountains and forests, with relatively low availability of inhabitable flat areas. These inhabitable areas are clearly demarcated (Statistics Bureau 2000), and we used the population densities of inhabitable areas to indicate the levels of urbanization. The population density of inhabitable areas in each secondary medical care area was calculated as the population divided by the inhabitable land area in that region (excluding mountainous areas, forested areas, and water bodies).

The secondary medical care areas were then divided into three groups based on their levels of urbanization. These three groups consisted of regions in the bottom 25 %, the middle 50 %, and the top 25 % of population densities; and were designated the low, middle, and high urbanization subgroups, respectively. The high urbanization subgroup consisted mainly of core cities such as the Tokyo metropolitan area and Osaka City, whereas the low subgroup included more rural villages and remote islands.

Outcome measure

The main outcome measure used in this study was per capita hospitalization expenditure of elderly residents. We analyzed the hospitalization expenditure data of beneficiaries of the National Health Insurance system who were aged 70 years and older, which also included disabled beneficiaries aged between 65 and 69 years.

Independent variables

Independent variables were selected from those that have previously shown statistically significant associations with hospital expenditures of elderly residents (Angulo et al. 2011; Brown et al. 2001; Crivelli et al. 2006; Fujiwara and Hoshi 1998; Goetghebeur et al. 2003; Hay 2003; Innami 1997; Jiménez-Rubio et al. 2008; Kroneman and Siegers 2004; Martín et al. 2011; Ross et al. 2000; Thornton and Rice 2008; Wagstaff and Van Doorslaer 2000; Wang 2009; Zweifel et al. 2009). The variables used in this study are listed in Table 1, and include a combination of medical resource factors, socioeconomic factors, and sociodemographic factors. All independent variables were calculated at the secondary medical care area level.

Medical resource factors included the number of hospital beds per 1,000 elderly residents, number of hospitals per 1,000 elderly residents, and number of hospitals per

Table 1 Independent variables used in regression analysis of per capita hospitalization expenditure of elderly residents

Independent variables
Healthcare resource factors
Beds per 1,000 elderly residents:
Number of hospital beds per 1,000 residents aged 70 and older
Hospitals 1,000 elderly residents:
Number of hospitals per 1,000 residents aged 70 and older
Academic medical centers:
Number of academic medical centers
0: None
1: One
2: Two or more
Hospitals per area:
Number of hospitals per inhabitable area
Socioeconomic factors
Regional difference index of prices:
Regional difference index of prices by ten major categories (prefectural average=100)
Price of land:
Price of residential land
Per capita income:
Per capita taxable income
Sociodemographic factors
Elderly-only households:
Ratio of one-person or aged-couple households among people aged 65 and older
Proportion of residents aged 75 and older among elderly residents:
Proportion of residents aged 75 and older among residents aged 70 and older

All variables were calculated at the secondary medical care area level

inhabitable area. These variables were used to indicate the availability and ease of access to medical resources. Also, the number of academic medical centers per secondary medical care area was used as an indicator of a region's availability of advanced medical technology. The numbers of clinics, physicians, and nurses relative to the number of elderly residents were also considered as candidate variables. However, these were not included in the final analysis due to their high correlation with the number of hospital beds per 1,000 elderly residents, which would give rise to possible multicollinearity issues in the ensuing regression analyses. Socioeconomic factors were included to show the economic strength of each region, and included regional differences in price indices, price of land, and per capita income. Sociodemographic factors included the proportion of residents aged 75 years and older out of elderly residents (aged 70 years and older), as well as the proportion of elderly-only households (elderly residents living alone or with their spouse).

Statistical analysis

Correlations between per capita hospitalization expenditure of elderly residents and the various independent variables were calculated using Pearson's product-moment correlation coefficients. We used multiple linear regression analyses to compare the linear contributions of the various independent variables by observing the changes in the adjusted coefficients of determination (R^2) when independent variables were added. The appending order of independent variables was as follows—model 1: the number of hospital beds per 1,000 elderly residents; model 2: the number of hospital beds and medical resource factors; model 3: all variables in model 2 and socioeconomic factors; and model 4: all variables in model 3 and sociodemographic factors.

Statistical significance was set at $P < 0.05$, and analyses were conducted using SPSS software, version 19.0 J for Windows (SPSS Inc., Chicago, IL, USA).

Results

Figure 1 shows the per capita healthcare expenditures of Japan's 47 prefectures according to their north–south geographical location, with the northernmost prefecture of Hokkaido on the leftmost position of the x-axis. Each square and diamond in the figure represents mean medical expenditure per elderly person and non-elderly person, respectively, within a secondary medical care area. The figure shows that there are substantial variations in per capita healthcare expenditures of elderly people even within the same prefecture.

Table 2 shows the descriptive statistics of the independent variables used in this analysis in the low, middle, and high subgroups of urbanization. In the low urbanization subgroup, per capita hospitalization expenditures of elderly residents showed substantial variations. An analysis of the inter-subgroup differences using multiple comparison tests showed that areas in the high urbanization subgroup generally had more available medical resources, higher per capita income, and a greater proportion of elderly-only households.

The correlations between per capita hospitalization expenditure of elderly residents and the various independent variables are shown in Table 3. The numbers of beds and hospitals per 1,000 elderly residents were both correlated with per capita hospitalization expenditure of elderly residents in all subgroups. Moreover, the low urbanization subgroup showed significant correlations between elderly-only households and per capita hospitalization expenditure of elderly residents.

Table 4 shows the results of a sensitivity analysis using the bootstrap method with 1,000 replicates of multiple linear regressions with per capita hospitalization expenditures of elderly residents as the dependent variable. The 95 and 99 % confidence intervals were generated using the bootstrap

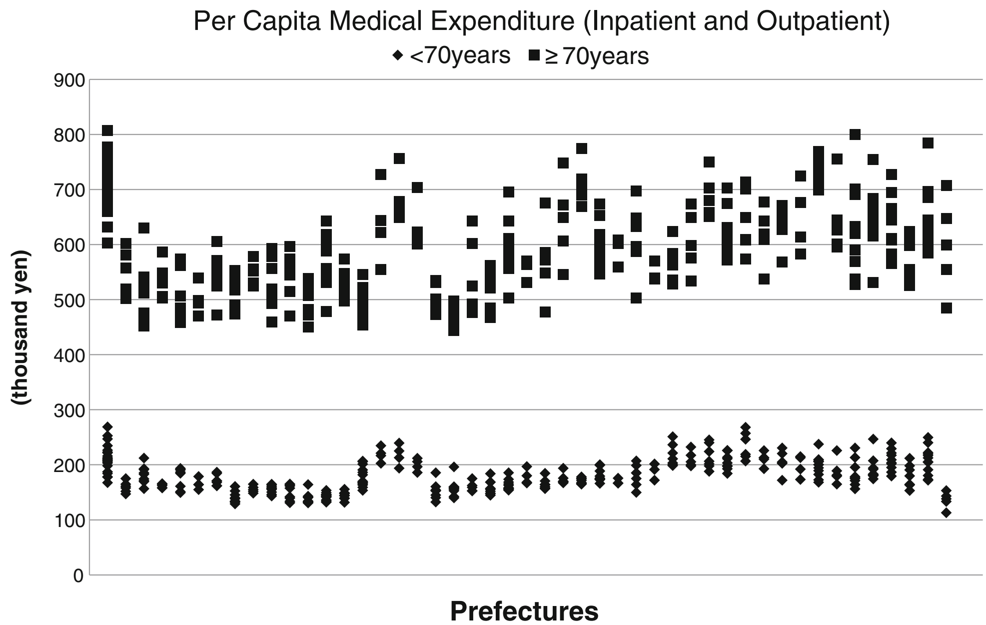

Fig. 1 Regional differences in medical expenditures in Japan in 2002 at the prefectural level. Each *square* and *diamond* represents the mean medical expenditure per elderly person and non-elderly person, respectively, for a single secondary medical care area within each prefecture. Prefectures are arranged according to their north–south geographical location, with the northernmost prefecture of Hokkaido on the *left* of the x-axis

analysis, and the coefficients from the original regression model were confirmed to be within these confidence intervals. The regression models showed relatively good fit, with adjusted R^2 values at more than 0.726 in the high and low urbanization subgroups, and 0.604 in the middle urbanization subgroup.

The regression analyses showed that two variables—beds per 1,000 elderly residents and elderly-only households—were significantly and positively associated with per capita hospitalization expenditures of elderly residents in all subgroups. The number of hospitals per 1,000 elderly residents and number of hospitals per secondary medical care area were significantly associated with per capita hospitalization expenditures in the low urbanization subgroup, whereas the presence of an academic medical center was significant only in the high urbanization subgroup. Per capita income was significantly associated with per capita hospitalization expenditures in both the high and middle urbanization subgroups.

Table 2 Descriptive statistics of secondary medical care areas in the low, middle and high subgroups of population densities of inhabitable areas

	Low subgroup (91 secondary medical care areas)				Middle subgroup (182 secondary medical care areas)				High subgroup (90 secondary medical care areas)				*P*-value[a]
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	
Per capita hospitalization expenditure for elderly residents [1,000 Yen]	327.5	71.9	211.5	498.9	318.9	59.7	215.0	462.9	325.0	58.3	243.9	520.6	
Beds per 1,000 elderly residents	79.77	28.94	4.60	160.83	91.50	29.45	22.72	180.28	114.61	35.33	26.95	203.25	<0.001[b]
Hospitals per 1,000 elderly residents	0.53	0.23	0.09	1.07	0.56	0.21	0.16	1.27	0.59	0.21	0.19	1.61	
Academic medical centers	0.01	0.10	0.00	1.00	0.14	0.36	0.00	2.00	0.54	0.67	0.00	2.00	<0.001
Hospitals per area	0.03	0.02	0.00	0.08	0.07	0.03	0.02	0.23	0.26	0.20	0.05	0.99	<0.001
Regional difference index of prices	96.43	3.01	89.58	103.09	97.00	2.63	90.62	104.71	102.15	4.53	89.90	111.42	<0.001[b]
Price of land	1.45	0.70	0.33	3.94	1.82	1.17	0.14	9.30	1.36	1.09	0.08	7.03	
Per capita income	1.13	0.18	0.66	1.63	1.28	0.19	0.87	1.69	1.68	0.28	0.81	2.81	<0.001
Elderly-only households	0.44	0.14	0.21	0.74	0.42	0.11	0.21	0.70	0.50	0.09	0.33	0.65	<0.01
Proportion of residents aged 75 and older among elderly residents	0.63	0.02	0.59	0.68	0.63	0.02	0.58	0.68	0.60	0.02	0.57	0.65	<0.001[b]

All variables were calculated at the secondary medical care area level

SD standard deviation

[a] *P*-values were calculated using Bonferroni multiple comparisons tests

[b] Indicates statistically significant differences observed only in the high subgroup relative to the other groups. Other *P*-values indicated statistically significant differences among all the three subgroups

Table 3 Correlation analysis between per capital hospitalization expenditure for elderly residents and various independent variables

	Per capita hospitalization expenditure for elderly residents [Yen] (log)	Beds per 1,000 elderly residents	Hospitals per 1,000 elderly residents	Academic medical centers	Hospitals per area	Regional difference index of prices	Price of land	Per capita income	Elderly-only households
Low subgroup (91 secondary medical care areas)									
Beds per 1,000 elderly residents	0.663[a]	1							
Hospitals per 1,000 elderly residents	0.762[a]	0.690[a]	1						
Academic medical centers	0.141	0.238[b]	0.136	1					
Hospitals per area	0.200	0.197	0.489[a]	0.084	1				
Regional difference index of prices	0.150	0.149	0.199	0.062	−0.139	1			
Price of land	−0.322[a]	−0.376[a]	−0.300[a]	−0.170	0.070	−0.085	1		
Per capita income	−0.146	−0.091	−0.111	0.073	−0.341[a]	0.453[a]	0.127	1	
Elderly-only households	0.674[a]	0.338[a]	0.528[a]	0.130	0.206[b]	0.230[b]	−0.171	−0.222[b]	1
Proportion of residents aged 75 and older among elderly residents	−0.070	−0.207[b]	−0.103	−0.124	0.311[a]	−0.117	0.430[a]	−0.191	0.11
Middle subgroup (182 secondary medical care areas)									
Beds per 1,000 elderly residents	0.682[a]	1							
Hospitals per 1,000 elderly residents	0.676[a]	0.698[a]	1						
Academic medical centers	0.176[b]	0.378[a]	0.201[a]	1					
Hospitals per area	0.614[a]	0.650[a]	0.831[a]	0.229[a]	1				
Regional difference index of prices	−0.111	0.021	−0.154[b]	0.379[a]	−0.029	1			
Price of land	−0.215[a]	−0.413[a]	−0.192[a]	−0.245[a]	−0.178[b]	−0.051	1		
Per capita income	−0.350[a]	−0.058	−0.267[a]	0.231[a]	−0.092	0.405[a]	−0.100	1	
Elderly-only households	0.412[a]	0.203[a]	0.325[a]	−0.078	0.394[a]	−0.052	0.046	−0.414[a]	1
Proportion of residents aged 75 and older among elderly residents	0.056	−0.153[b]	−0.013	−0.194[a]	0.021	−0.107	0.326[a]	−0.222[a]	0.178[b]
High subgroup (90 secondary medical care areas)									
Beds per 1,000 elderly residents	0.699[a]	1							
Hospitals per 1,000 elderly residents	0.747[a]	0.804[a]	1						
Academic medical centers	0.417[a]	0.359[a]	0.227[b]	1					
Hospitals per area	0.186	0.097	0.134	0.378[a]	1				
Regional difference index of prices	−0.211[b]	−0.263[b]	−0.238[b]	0.260[b]	0.693[a]	1			
Price of land	−0.208[b]	−0.099	−0.183	−0.125	0.036	0.008	1		
Per capita income	−0.476[a]	−0.309[a]	−0.428[a]	0.103	0.445[a]	0.722[a]	0.319[a]	1	
Elderly-only households	0.335[a]	0.102	0.203	0.377[a]	0.653[a]	0.594[a]	−0.135	0.312[a]	1
Proportion of residents aged 75 and older among elderly residents	0.266[b]	0.192	0.233[b]	0.182	−0.016	−0.164	0.117	−0.193	−0.050

[a] Indicates statistical significance at the 1 % level
[b] Indicates statistical significance at the 5 % level

When conducting multiple linear regression analyses, there are generally six assumptions that should be fulfilled (Greene 2002). These are (1) linearity, (2) full rank (identification condition), (3) exogeneity of the independent variable, (4) homoscedasticity and non-autocorrelation, (5) exogenously generated data, and (6) normal distribution. Assumptions 1,

Table 4 Regression analysis results of per capita healthcare expenditure of elderly residents

Independent variables	Low subgroup		Middle subgroup		High subgroup	
	Coefficient	99 % CI[c]	Coefficient	99 % CI[c]	Coefficient	99 % CI[c]
Constant	12.412[a]	[10.844–14.163]	11.934[a]	[10.371–13.374]	12.565[a]	[11.203–14.013]
Beds per 1,000 elderly residents	0.002[b]	[−0.000–0.004]	0.003[a]	[0.002–0.004]	0.001[b]	[−0.000–0.003]
Hospitals per 1,000 elderly residents	0.486[a]	[0.223–0.772]	0.161	[−0.074–0.397]	0.169	[−0.044–0.434]
Academic medical centers	−0.023	[−0.154–0.138]	0.006	[−0.050–0.066]	0.043[b]	[−0.001–0.088]
Hospitals per area	−2.673[b]	[−5.206–−0.129]	0.468	[−0.731–1.951]	0.082	[−0.101–0.350]
Regional difference index of prices	−0.007	[−0.026–0.007]	0.000	[−0.011–0.011]	−0.004	[−0.015–0.005]
Price of land	−0.011	[−0.091–0.061]	−0.003	[−0.025–0.029]	0.006	[−0.021–0.033]
Per capita income	0.014	[−0.270–0.266]	−0.201[a]	[−0.352 to −0.056]	−0.227[a]	[−0.410 to −0.038]
Elderly-only households	0.572[a]	[0.331–0.824]	0.233[b]	[−0.025–0.484]	0.632[a]	[0.286–1.037]
Proportion of residents aged 75 and older among elderly residents	0.652	[−1.075–2.261]	0.795	[−0.715–2.551]	0.498	[−1.399–2.310]
Adjusted R^2	0.726		0.604		0.735	

[a] Indicates statistical significance at the 1 % level
[b] Indicates statistical significance at the 5 % level
[c] Calculated using a bootstrap analysis of 1,000 replicates

2, 4 and 6 were examined, as the remaining two assumptions did not apply to our data. Linearity of the relationships between the independent and dependent variables was confirmed using scatterplot analysis. Although there were some deviations among the subgroups, the plots demonstrated overall linearity. Next, full rank (or the lack of multicollinearity) was analyzed using calculations of variance inflation factor (VIF). The VIF values for almost all factors was approximately 2.0 or below. In the middle subgroup, the factors of hospitals per 1,000 elderly residents and number of hospitals per secondary medical care area had slightly higher VIF values at 4.5 and 4, respectively. However, the results were similar to those of the other subgroups, and with no contradictions in correlation directionalities, we determined that there were no multicollinearity issues. Homoscedasticity and non-autocorrelation were confirmed using scatterplots of the standardized residuals and the predicted values. Finally, with regard to normality of the data, statistical tests of normality, histograms, and Q-Q plots all indicated that the residuals were normally distributed.

Table 5 shows changes in the R^2 values in the three urbanization subgroups. The number of hospital beds alone could account for more than 40 % of variance in per capita hospitalization expenditures of elderly residents. After adjusting for the number of hospital beds, medical resource factors had higher R^2 value changes in the low and high urbanization subgroups. Socioeconomic factors had a greater impact on the middle and high urbanization subgroups, but the incremental values were low. The effect of sociodemographic factors in the low urbanization subgroup was observed to be relatively high.

Discussion

In this study, we analyzed the regional variations in per capita healthcare expenditures in elderly residents in Japan at the level of secondary medical care areas, and investigated the factors associated with these variations at different levels of urbanization.

The regression models used in this study were able to explain a large part of the observed variances in per capita hospitalization expenditures of elderly residents, particularly in areas of low and high urbanization. The adjusted R^2 was 0.726 in the low urbanization subgroup and 0.735 in the high urbanization subgroup. The predictive power was less pronounced in the regression model that used data from the middle urbanization subgroup (R^2=0.604), with no particular trend observed in the independent variables.

Table 5 Changes in adjusted R^2 values of regression results among the various urbanization subgroups

Regression models	Low subgroup		Middle subgroup		High subgroup	
	R^2	ΔR^2	R^2	ΔR^2	R^2	ΔR^2
Model 1	0.433		0.463		0.483	
Model 2	0.625	0.192	0.539	0.076	0.614	0.131
Model 3	0.628	0.003	0.592	0.053	0.688	0.074
Model 4	0.726	0.098	0.604	0.012	0.735	0.047

All R^2 values refer to adjusted R^2 values
Model 1: number of hospital beds
Model 2: model 1+healthcare resource factors
Model 3: model 2+socioeconomic factors
Model 4: model 3+sociodemographic factors

When comparing the changes in adjusted R^2 in the regression models with incremental additions of independent variables, the findings showed that the number of hospital beds had a substantial impact on per capita healthcare expenditures in elderly residents. This was especially apparent in the high urbanization subgroup, where hospital beds were able to explain almost half of the observed variance in expenditures. The results also suggested that the number of hospitals (per 1,000 elderly residents and per area) was able to explain a large amount of variance in the low urbanization subgroup. Medical resource factors and sociodemographic factors were more influential in the low urbanization subgroup, whereas the number of hospital beds and socioeconomic factors appeared more influential in the high urbanization subgroup.

Medical resource factors that showed significant association with spending included the numbers of hospital beds and hospitals per 1,000 elderly residents. Previous studies have reported positive correlations between the number of beds and per capita hospitalization expenditure, indicating a possible induced demand for medical services, otherwise known as supplier-induced demand (Shain and Roemer 1959; Thornton and Rice 2008; Wang 2009). In the context of supplier-induced demand, Thornton and Rice (2008) noted that there is “no reason to believe that causation runs from healthcare spending to physician availability”. Although our study design does not allow determination of causality, it is possible that our findings also indicate a degree of supplier-induced demand in areas with abundant medical resources, with the high number of hospital beds in the high urbanization subgroup pointing to an excess of medical resources. In contrast, there are fewer medical resources available in areas of low urbanization, and therefore less leeway to generate supplier-induced demand. If the medical resources in such areas were increased to meet demand, it is possible that per capita hospitalization expenditure of elderly residents may also increase. The number of hospitals per area is an indicator of the ease of access to a healthcare provider for residents in that area. In all three subgroups of urbanization, the number of hospitals per 1,000 elderly residents was positively correlated with per capita hospitalization expenditures. The low urbanization subgroup had the lowest number of hospitals per 1,000 elderly residents, and an increase of one hospital may therefore induce a relatively substantial increase on per capita expenditures.

It has also been suggested that because regions with more hospitals provide greater access to healthcare, this may in turn result in higher expenditures (Angulo et al. 2011; Innami 1997); the underlying rationale is that areas with more hospitals would increase the likelihood of a resident to live in close proximity to a hospital, thereby lowering the opportunity cost to seek healthcare. However, our study has established a negative association between the number of hospitals per area and expenditures per capita in elderly people, which is in contrast to previous findings. It has been postulated that although there are potentially many patients living in areas of low urbanization, the number of hospitals in these areas may be insufficient to satisfy the demand for healthcare (Innami 1997). Consequently, areas with extremely low population densities and low numbers of hospitals may have very low access to healthcare. Patients in these areas may seek healthcare only when their condition has severely deteriorated, resulting in overall higher per capita hospitalization expenditures. Furthermore, because of limited access to outpatient care after being discharged from hospitals in areas of low urbanization, the average period of hospitalization may be prolonged, which would in turn contribute to higher hospitalization expenditures. An example of this effect can be observed in the northernmost Japanese prefecture of Hokkaido, which is a large island with extensive unpopulated areas. The low number of hospitals per area could largely explain the high per capita hospitalization expenditures observed in our results. In Fig. 1, Hokkaido is represented by the leftmost prefecture on the x-axis, and has the highest per capita hospitalization expenditures among all the prefectures in Japan. Hokkaido has 21 secondary medical care areas, the vast majority of which are rural and belong to the low urbanization subgroup in this analysis. Furthermore, 14 of these areas are in the lowest 5 % with respect to population density of inhabitable areas, and nine are among the 20 secondary medical care areas with the lowest numbers of hospitals per area.

Academic medical centers represent a high concentration of medical resources (including beds, physicians, and other healthcare staff) and advanced technologies, which can result in higher expenditures (Hay 2003). In Japan, academic medical centers are further characterized by a surrounding cluster of satellite healthcare institutions. With this abundance in resources, areas with academic medical centers are particularly equipped to provide healthcare to patients with conditions that require a high level of resources. Although newer and more expensive technologies and medications may diffuse from academic medical centers to other areas, we were unable to address the effects of this diffusion as our analysis was conducted using data from a single year. It is, however, conceivable that the higher healthcare expenditure observed in the high urbanization subgroup was due to the increased use of newer technologies in these areas, which have more academic medical centers.

In the middle and high urbanization subgroups, per capita income (indicating socioeconomic status) had a significantly negative association with per capita hospitalization expenditures in elderly residents. A previous study has revealed that health is a concave function of individual income (Wagstaff and Van Doorslaer 2000). Income inequalities have shown strong association with health spending in the US but not in Canada, and policies aimed at reducing variations in income may also reduce inequalities in health (Ross et al. 2000).

Income and hospitalization expenditures at the regional level in Switzerland demonstrated a negative relationship (Crivelli et al. 2006) similar to our findings. The Swiss mandatory basic healthcare insurance system is similar to the Japanese National Health Insurance system in that there are no additional options (e.g., choice of physician or admission to a private room) covered under public health insurance, and this may have influenced the similar findings.

The factor of elderly-only households was a significant sociodemographic factor influencing per capita healthcare expenditures in all three subgroups. It has been suggested that patients from such households would be less likely to obtain in-home care due to a lack of caregivers, and therefore seek healthcare in hospitals (Innami 1997; Une 1996; Zweifel et al. 2009). Also, patients from these households may require types of care that can only be provided in hospitals, with in-home care insufficient for their conditions (Goetghebeur et al. 2003). This is further exacerbated in areas with limited access to hospitals, which would generally preclude outpatient care. In these cases, hospitalization becomes the only feasible option for obtaining healthcare, and this may explain the observation that the proportion of elderly-only households was most influential in the low urbanization subgroup.

This study had several limitations. First, the study design was a cross-sectional study, and as such, the directionality of associations between the independent and dependent variables could not be determined. However, it would be unintuitive to assume that an increase in per capital hospitalization expenditure of elderly residents would cause an increase in sociodemographic factors such as the number of elderly-only households. Similarly, fluctuations in hospital expenditures would unlikely have a causal effect on the socioeconomic factors or medical resource factors used in this study. Next, the data used in this analysis was from 2002. Although the use of more recent data would have been favorable, the implications of this study are still relevant to current medical resource allocation. Our findings on the differences between the low and high urbanization subgroups can support the improved distribution of medical resources according to sociodemographic and socioeconomic factors. Regional disparities in healthcare for the elderly continue to widen, and an analysis based on current data would likely reveal even more pronounced associations.

Conclusions

Our findings emphasize the importance of taking the level of urbanization into account when analyzing regional variations in hospitalization expenditures. Also, these variations were shown to be influenced by medical resource, socioeconomic, and sociodemographic factors. Policies designed to contain healthcare expenditures should take into account these regional characteristics in order to better implement region-specific improvements that ensure affordable healthcare in a rapidly aging society. The results of our study can inform the decision-making process in the development and implementation of these policies, and also provide a framework for future studies in other aging populations around the world.

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