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ORIGINAL RESEARCH

Understanding the Utilization of Tertiary Hospitals by Mild Disease Patients: Travel Cost Method Analysis

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Purpose: Tertiary hospital utilization for patients with mild diseases creates inefficiencies in medical utilization for medical consumers and providers, collapses the healthcare delivery system, and has negative consequences for the public health system. This study aims to identify the factors that lead to the selection of tertiary hospitals and the medical needs of patients with mild diseases. We evaluate the value of using medical institutions by comparing and analyzing regional and individual patient characteristics.

Methods: The travel cost method based on the travel cost incurred according to the consumer's temporal choice, was used to evaluate the medical use. We considered data from Ajou University Hospital from 2017 to 2022. The variables used for travel costs are travel costs, time costs, and medical costs. The Quantum Geographic Information System(QGIS) network analysis was used to calculate travel costs and time costs, and independent sample *t*-tests and analysis of variance (ANOVA) were used to compare the evaluated values between groups.

Results: The analysis revealed that travel costs were the highest for patients with diabetes. Regarding personal characteristics, men exhibited higher rates than women, and individuals under 65 years of age and those receiving type 2 medical benefits demonstrated higher travel costs. Travel costs and outpatient visit rates for mild diseases exhibited a direct proportional relationship. We compared the total economic value assessed for each type of mild disease and found the highest value for diabetes patients with the highest number of outpatient visits.

Conclusion: These findings highlight the importance of incorporating patient segmentation into policy formulation to alleviate the overcrowding of patients with mild diseases in tertiary care hospitals. Furthermore, they advocate adopting a primary care-centered approach to enhance the healthcare delivery system and address imbalances in community healthcare resources.

Keywords: tertiary hospitals, healthcare delivery system, healthcare utilization value, Travel cost method, experience demand curve

Introduction

The demand for medical care has been increasing gradually because of rapid advances in medical technology and the extension of the human lifespan. As the tendency to prefer tertiary hospitals that guarantee high-quality medical services based on the latest medical equipment and expertise has strengthened, the phenomenon of patient concentration has worsened, where patients with mild diseases or of the simple-treatment disease group (C-Group) are excessively concentrated in tertiary hospitals located in metropolitan areas.[1,2] Medical institutions with a high concentration of patients may have a prolonged medical waiting time or shortened contact clinic time because of their excessive capacity, leading to a decline in the quality of medical services.[3,4] Additionally, the outflow of patients from local communities causes financial difficulties in primary and secondary medical institutions, worsening the local community's medical

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safety net and increasing medical inequality between regions.[5] Particularly, using tertiary hospitals for patients with mild diseases aggravates the financial soundness of the national health insurance system by wasting time owing to unnecessary travel and increasing medical costs caused by overtreatment.[6] Thus, the patient concentration phenomenon induces inefficiencies in medical use for medical consumers and providers and collapses the healthcare delivery system, resulting in negative consequences for the public health system.

Providing community-centered medical services improves individual health and reduces medical costs. Accordingly, the government intended to reduce the medical gap between regions by establishing a community-centered medical delivery system.[7,8] To regulate the utilization of tertiary hospitals by patients with mild diseases and to promote the use of primary medical institutions, the government has implemented a series of policy measures. In 2009, outpatient copayment rates for mild and chronic disease patients using tertiary hospitals were increased to encourage a focus on severe cases. In 2011, a sliding scale for copayments on medicine costs for mild diseases was introduced to further differentiate financial burdens based on the type of healthcare utilization. In 2015, an evaluation system was established to assess the proportion of primary care-centered outpatient disease groups within tertiary hospitals, ensuring that these institutions adhered to their designated roles within the healthcare system. Consequently, the outpatient usage of tertiary hospitals by patients with mild diseases decreased by 1.3% in 2019 compared with 2008, while the share of medical costs for patients with mild diseases decreased by 2.8%. However, the outpatient usage of primary care-level medical institutions by patients with mild diseases also decreased by 1.5%, increasing the necessity to supplement the system.[9–12]

To resolve this phenomenon of patient concentration in tertiary hospitals, it is necessary to understand the characteristics of medical institutions from the perspective of patients with mild diseases. Regarding the general demand for medical use, the higher the users' socioeconomic status, the greater their preference for medical services offered by medical staff with excellent medical equipment and high-level expertise. As such, "consumer value" influences the behavior of individuals and is defined more comprehensively than concepts such as opinions, beliefs, attitudes, and interests.[13] Values are constant in the short term, serve as an internal standard for behavioral selection, and play a role in justifying the behavior, accordingly which has an organic relationship with consumers' actual behavior.[14,15] If the value system is similar, the results of the behavior will also be similar; therefore, understanding consumer values can help predict consumer behavior.[16] In other words, to understand the selection factors for tertiary hospitals for patients with mild diseases and their medical care demands, it is necessary to understand the values and environmental factors of patients with mild diseases to understand their behavior.

Accordingly, this study evaluates the value of transportation costs, time costs, and medical costs for patients with mild diseases using tertiary hospitals and compares them based on disease characteristics. To this end first, the value of travel costs are compared according to regional distance and demographic characteristics to understand the medical use characteristics of patients with mild diseases who visit tertiary hospitals. Second, the characteristics of medical use are analyzed by deriving a demand curve for visiting medical institutions according to distance and cost increases. Third, the value of medical services for tertiary hospitals in accordance with disease type is compared to identify preferences by type for tertiary hospitals. Thus, we suggest indicators from a new perspective to alleviate the patient concentration phenomenon, seeking to prepare policy measures to establish a medical delivery system in which tertiary hospitals can perform their original functions.

Literature Review

Valuation of Healthcare Utilization

Typically, consumers choose to use goods or services positively only when the perceived benefits are higher than the costs. Zeithaml (1988) defined the value for medical service use as the customer's desire to obtain what he or she wants from the quality obtained in return for the price paid. Gooding (1995) defined it as the difference between the quality of medical services as perceived by patients and their efforts to obtain those services. Porter (2010) defined this as health outcomes generated through the costs invested in using medical services.[17–19]

There is information asymmetry between providers and consumers of medical services. Providers have a great influence on diagnosis or treatment; however, in Korea's medical system, where utilizing and having access to medical

institutions is facilitated, the choice of consumers (patients) plays an important role. Therefore, understanding consumer value in using medical services must precede the dimension of medical policy development or hospital management, which is essential for improving the health promotion of population groups.[20–22] Examining previous related studies, Park et al (2023) believed that differences exist between doctors and patients in terms of selection factors for medical institutions, and that expertise acts as an important factor in building trust between doctors and patients.[23] Mulyanto et al (2019) noted that urban areas usually provide higher-quality medical services than rural areas and that to resolve medical inequality, the improvement of health insurance is important, but it is also necessary to address medical infrastructure and geographical factors.[24] Godøy and Huitfeldt (2020) argued that as geographic differences cause inefficiencies in supplying medical care services and a higher visiting count to primary medical institutions in the region would have a positive effect on the treatment improvement, including mortality, primary medical institutions can complement the expertise of tertiary hospitals.[25]

Patients seem to visit tertiary hospitals that provide specialized treatment to receive better medical services. However, previous studies did not comprehend the selection factors for tertiary hospitals that must provide medical services focused on severe diseases because they not consider the severity of the disease. Treatment at primary medical institutions seems to improve the health condition of patients, which could complement the expertise of tertiary hospitals. Accordingly, by focusing on patients with mild diseases who select tertiary hospitals and comparing the value they place on medical institutions, it would be possible to identify disease groups that can be prioritized for referral to primary medical institutions based on disease severity.

Travel Cost Method

The travel cost method, proposed by Hotelling in 1947, evaluates consumer value based on the use of medical services. It estimates the economic benefits of visiting areas, assuming that the consumer's benefits from visiting areas are higher than the travel costs for the visit. It is mostly used as a valuation method for parks, recreational forests, cultural assets, and medical institutions, and allows visitors to be admitted without any admission fees or requires only minimal costs with respect to the environment.[26]

Some of the previous studies applied the travel cost method to medical resources. Deyak and Smith (1976) identified the demand for abortion services by utilizing travel distance and regional abortion costs.[27] Jeuland et al (2010) measured individual demand for the cholera vaccine using time and transportation expenses.[28] Wang'ombe (1984) conducted an economic evaluation of the healthcare project of local communities by using time costs, medication costs, project participation expenses, and consumer surplus expenses.[29] Clarke (1998) performed an economic evaluation for portable mammography screening devices by utilizing the cost for travel distance, transportation, and medical care.[30]

The travel cost method evaluates value based on the consumer's explicit choice, which facilitates the interpretation of the results. However, because the definition of travel cost may differ depending on the study, care must be taken when selecting the factors considered in the valuation. According to the healthcare economic evaluation guidelines of the National Evidence-based Healthcare Collaborating Agency (NECA), non-market goods factors include transportation, nursing, and time costs. Transportation costs refer to all expenses incurred by patients visiting medical institutions. Time costs implies amount of time loss to patients for utilizing medical institutions or pharmacies. Nursing expenses refer to the time- or wage-loss costs spent nursing a patient.[31] The participants of this study were outpatients, who only utilized transportation and time costs, excluding nursing expenses; to identify the cost according to their use of medical institutions, medical costs were added and measured.

Materials and Methods

The Study Area

As of 2023, there are 45 tertiary hospitals in Korea: 14 in Seoul, eight in the metropolitan area, and 23 in other regions. The Ajou University Hospital, the subject of this study, has approximately 1,200 beds and is the largest tertiary hospital in the southern region of Gyeonggi. Ajou University Hospital has maintained its status as a tertiary hospital for four consecutive years since 2011. Moreover, it has been designated as a regional emergency medical center and regional

trauma center in southern Gyeonggi Province, serving as a core medical institution to save lives in eight regions, namely, Suwon, Ansan, Osan, Hwaseong, Anyang, Gwacheon, Gunpo, and Uiwang.

Suwon-si in Gyeonggi-do, where Ajou University Hospital is located, has four administrative districts: The GyeongGi-Do Provincial Government Office, 44 administrative dongs, and 56 legal dongs. It is the largest local government in the country with an area of 121.03 km^2 and a population of approximately 1.2 million. Additionally, as the Korean metropolitan area developed, centered on the triangular belt of Seoul-Incheon-Suwon, it served as the central city of society, culture, economy, and administration in Gyeonggi-do. Particularly, Suwon is evaluated as a transportation hub because it serves as the central axis of the metropolitan transportation system based on the Gwangmyeong Korea train express (KTX) and southeastern Hwaseong Super Rapid Train (SRT) in southern Gyeonggi Province.[32,33]

Suwon-si in Gyeonggi-do, which has the southernmost tertiary hospital among the tertiary hospitals in Seoul and the metropolitan area, has the characteristic of showing the highest out-of-jurisdiction medical utilization in the country. Suwon-si shows high accessibility to medical care services, with 2,280 cares and hospitals, including one tertiary hospital, five secondary hospitals, 33 primary hospitals, and 803 primary cares. However, Noh Yun-ho (2013) compared the number of annual out-of-jurisdiction hospitalization-visit days for health insurance patients and found that the highest frequency appeared in Suwon-si among 299 cities, counties, and gus nationwide, indicating that it was influenced by the KTX.[34] Additionally, according to the Status of Out-of-Jurisdiction Medical Treatment Results by City, County, and Gu, published by the National Health Insurance Corporation (2022), it can be found that the frequency of out-of-jurisdiction hospitalization days appears highest in Suwon-si among the cities, counties, and gus in Seoul, Incheon, Gyeonggi-do, and Gangwon-do. Thus, the out-of-jurisdiction medical utilization (regions other than Suwon-si) of those living in Suwon-si is shown, and simultaneously, there is a lot of medical utilization flowing into Suwon-si from other regions.

Data Sources and Study Population

The analysis utilized data from outpatients who visited Ajou University Hospital between January 1, 2017, and February 28, 2022. The study population was selected based on policies aimed at regulating the use of tertiary hospitals and directing patients to primary medical institutions, defining patients with mild diseases as those diagnosed with diabetes (E10, E11, E13, E14), hypertension (I10, I11), cerebrovascular disease (I60, I61, I62, I63, I64), and dementia (F00, F01, F02, F03). Among these, patients with two or more comorbid conditions were excluded, and only those with a single disease were selected, resulting in a final study population of 27,988 individuals. Of these, 27,360 people were selected as study participants, excluding 164 without medical cost information and 464 living in island areas surrounded by the sea on four sides (eg, Jeju and Ulleungdo Islands). To analyze travel costs using geographic information, QGIS3.2.3 was utilized. To compare the evaluated values between groups, independent sample *t*-tests and ANOVA were conducted using StataSE 17.

Definition of Variable

Sociodemographic characteristics used in this study include gender, age, and insurance type. Gender was divided into male and female, and age was divided into non-elderly people under the age of 65 years and elderly people aged 65 years or older. Insurance types were divided into health insurance, commonly subscribed to in Korea, and medical types 1 and 2, which were provided to the low-income bracket (Table 1).

Transportation, time and medical costs were utilized to evaluate the value of medical service use through the travel cost method. Transportation costs were defined as travel time costs incurred according to the travel distance traveled to visit a medical institution. To calculate this, the travel distance was first measured using the domestic traffic network geographic information system (2022) from the Korea Transport Database (KTDB) and network analysis within the QGIS. The means of transportation to visit medical institutions were limited to passenger cars. Next, the shortest distance from the locality of the patient's address to the medical institution was calculated, and the free-passing speed for each link on the road was reflected, which was then returned as the travel time. Finally, the transformed travel time was converted into monetary units to derive the travel cost. The final transportation cost was calculated by applying the non-business travel time value (12,485 won/hour) of passenger cars provided by the Korea Transport Institute (2020) and the weight of closed toll roads.[35]

Table 1 Definition of Variables

Variable		Definition
Demographics	Gender	Male
		Female
	Age	Under 65
		65 years or older
	Insurance type	Health Insurance
		Medical Aid type1
		Medical Aid type2
Travel costs	Transportation costs	Transportation time costs incurred depending on travel distance
	Time costs	Waiting time and clinic time
	Medical costs	Copayments and medicine costs

Time costs were defined as the waiting and clinic times for outpatient treatment incurred when the patient visited a medical institution. According to the Korea Institute for Health and Social Affairs (2021), in Korea, the average waiting time to receive outpatient treatment is 14.6 minutes, and the average clinic time is 6.5 minutes.[36] The final time cost was calculated by applying the hourly wage by gender or age provided by the Ministry of Employment and Labor (2021) and the employment rate by gender or age offered by the National Statistical Office (2022) to convert the time taken into monetary units.[37] Medical costs were defined as the sum of copayments and medicine costs incurred while the patient used a medical institution, which were directly borne by the patient.

Analysis of the Travel Cost Model

This study employed the travel cost method to measure the economic value of patients who had hypertension, diabetes, dementia, and cerebrovascular disease and visited the Ajou University Hospital, the travel, time, and medical costs of medical institutions. The calculation method for travel costs on the total (N) obtained by totaling the travel costs for an individual patient (i) is shown in Equation (1).

$$\sum_{i=1}^{N} Travel\ Costs_i = \sum_{i=1}^{N} Transportation\ Costs_i + \sum_{i=1}^{N} Time\ Costs_i + \sum_{i=1}^{N} Medical\ costs_i \tag{1}$$

Estimating the Experience Demand Function

In the travel cost method, if travel costs are used as the concept of *costs according to travel distance*, the regression equation of the Gravity Model, which exhibits an inverse relationship between distance and demand, can be adopted. If the distance from the address locality of the patient visiting the medical institution to the relevant medical institution is $D_i$and the population size of the locality of the patient's address is P_i, the medical institution visit rate (Q_i) in each region is shown in Equation (2). Therefore, it can be assumed that the medical institution visit rate has an inverse relationship with travel distance, but a proportional relationship with the patient's local population. Here, α and βrefer to the parameters to be estimated.

$$Q_i = \frac{\alpha P_i}{D_i^{\beta}} \tag{2}$$

If Equation (2) is modified to take logarithms on both sides, it can be expressed as Equation (3). Here, $\frac{Q_i}{P_i}$on the left side is defined as the per capita visit rate in the locality of the patient's address and is expressed as a distance function. Accordingly, Equation (3) is estimated to be the field experience demand curve obtained from the patient's travel costs, and the change in the quantity demanded can be identified according to additional increments in travel distance or travel costs in a specific region (i).

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$$\ln \frac{Q_i}{P_i} = \ln \alpha - \beta \ln D_i \tag{3}$$

Results

General Characteristics of Outpatients

The general characteristics of the outpatients at Ajou University Hospital are presented in Table 2. As for the frequency of outpatient visits by residential district, Gyeonggi-do, where the hospital is located, was the highest, with 24,426 people, followed by Chungcheongnam-do (738) and Seoul Metropolitan City (511). When examining the frequency of outpatient visits by disease, patients with diabetes, cerebrovascular disease, dementia, and hypertension had the highest frequency. The frequency of visits by patients with diabetes was the highest in all regions except Jeollanam-do.

Result of Travel Cost Analysis

The travel costs for outpatients at Ajou University Hospital in a residential district are listed in Table 3. Transportation costs incurred by visiting medical institutions were the highest in Busan Metropolitan City ($142.16), followed by Ulsan Metropolitan City ($138.45), and Jeollanam-do ($118.39). However, time costs were the highest in Gwangju Metropolitan City with $5.56, followed by Incheon Metropolitan City ($4.93) and Seoul Metropolitan City ($4.83). In terms of medical costs, Daejeon Metropolitan City had the highest with $495.76, followed by Jeollanam-do ($469.59) and Gyeonggi-do ($463.06). Overall, the travel cost, containing transportation costs, time costs, and medical costs, was the highest in Jeollanam-do with $591.54, followed by Daejeon Metropolitan City ($548.22), and Busan Metropolitan City ($530.14).

Next, a comparative analysis was conducted on travel costs according to outpatient disease and demographic characteristics (Table 4). To measure the economic benefits of non-market goods, the travel cost method can be used to measure the value of objects for which the usage fee is not paid. Owing to the nature of medical services, health service accessibility and the time required for services play major roles in measuring patient value. However, in the case of medical costs, differences in expenditure may arise depending on the severity of mild diseases, and this impact can alter the perceived value of a medical institution at the time the patient decides to visit. Therefore, the value of visiting a medical institution should be distinguished from the value that includes the decision to utilize medical services.

A comparative analysis of travel costs by factor, including medical costs, indicated that none were statistically significant. The travel cost per trip by disease was the highest for hypertension with $491.78, followed by diabetes

Table 2 Status of Outpatient Visits by Region

	Frequency of Visits (n)				
	Diabetes	**Dementia**	**Hypertension**	**Cerebrovascular**	**Total**
Gyeonggi	15,684	1,944	193	6,605	24,426
Chungnam	394	86	5	253	738
Seoul	322	58	4	127	511
Chungbuk	182	33	0	107	322
Gyeongbuk	140	35	0	95	270
Gangwon	138	28	1	70	237
Jeonnam	87	26	1	99	213
Jeonbuk	101	38	2	61	202
Incheon	67	16	3	41	127
Gyeongnam	57	12	1	36	106
Busan	31	9	0	11	51
Daegu	21	6	0	16	43
Daejeon	27	1	0	15	43
Gwangju	22	1	0	6	29
Sejong	13	3	0	7	23
Ulsan	13	2	0	4	19

Table 3 Average Travel Costs by Region

	Transportation Costs (A)	Time Costs (B)	Medical Costs (C)	Travel Costs (A+B+C)
Gyeonggi	6.80	4.79	463.06	474.65
Chungnam	38.82	3.90	415.90	458.62
Seoul	15.64	4.83	422.42	442.89
Chungbuk	40.83	4.23	446.01	491.07
Gyeongbuk	75.66	3.35	435.57	514.58
Gangwon	61.73	3.80	395.94	461.47
Jeonnam	118.39	3.56	469.59	591.54
Jeonbuk	70.13	3.36	390.08	463.58
Incheon	21.54	4.93	427.08	453.55
Gyeongnam	114.60	3.79	411.75	530.14
Busan	142.16	4.21	372.35	518.72
Daegu	85.64	3.88	424.17	513.69
Daejeon	48.04	4.42	495.76	548.22
Gwangju	102.43	5.56	347.74	455.72
Sejong	39.01	4.37	411.28	454.66
Ulsan	138.45	4.53	371.02	514.00

Note: Unit: $.

Table 4 Topic Analysis 2017–2021

	Transportation Costs (A)	Time Costs (B)	Medical Costs (C)	Travel Costs (A+B+C)	P	Travel Costs (A+B)	P
Diseases							
Diabetes	11.90	5.46	459.51	476.87	0.911	17.36	0.000
Dementia	13.59	2.68	460.23	476.49		16.26	
Hypertension	7.62	3.93	480.23	491.78		11.55	
Cerebrovascular	11.41	3.62	455.84	470.87		15.03	
Gender							
Female	12.62	2.66	456.81	472.09	0.414	15.28	0.000
Male	11.33	6.18	460.08	477.59		17.51	
Age							
Under 65	10.66	6.31	456.1	473.07	0.459	16.97	0.005
65 years or older	13.09	3.09	461.36	477.54		16.18	
Insurance type							
Health Insurance	11.75	4.73	460.56	477.04	0.671	16.48	0.000
Medical Aid Type1	13.27	4.32	439.42	457.01		17.59	
Medical Aid Type2	13.90	5.21	355.28	374.40		19.12	

Note: Unit: $.

($476.87), and dementia ($476.49). For gender, travel costs were similar for both men and women, while age was also similar for patients under and over 65 years of age. In terms of insurance type, travel costs for health insurance subscribers were the highest at $477.04.

However, a comparative analysis of travel costs by factor excluding medical costs, indicated statistically significant differences. For the travel cost per trip by disease, diabetes was the highest at $17.36, followed by dementia ($16.26), and hypertension ($11.55) ($P<0.001$). In the event of gender, the travel cost per trip was higher for men ($17.51) than women ($15.28) ($P<0.001$). For age, the travel cost per trip was higher ($16.97) for patients under 65 years of age than those 65

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years or older ($16.18), (P<0.005). In terms of insurance types, the travel cost per trip was highest at $19.12 for medical aid type 2, followed by $17.59 for medical aid type 2 and $16.48 for health insurance (P<0.001).

Result of Estimating the Experience Demand Function

A field-experience demand function was used to identify the relationship between visit rates and travel costs for outpatients. Utilizing the outpatient visit rate by residential district (i) for metropolitan cities and provinces as the dependent variable and travel costs excluding medical costs as the independent variable, a regression analysis was conducted to derive Equation (4). The modified Adj R-squared of the field-experience demand function regression equation was 0.4239, while travel costs had a statistically significant negative (-) effect on the outpatient visit rate at the significance level of 1%.

$$\ln \frac{Q_i}{P_i} = \ln(28124.04) - 1.145D_i \quad \left(R^2 = 0.4239\right) \tag{4}$$

The outpatient visit rates in all regions were estimated using Equation (4) for the field-experience demand function. In accordance with the theoretical analysis of travel costs, the results of increasing travel costs until the number of outpatients in all regions fell below 100 are presented in Table 5. The analysis showed that when the travel cost increased from $38.54 to $77.07, the number of outpatients in all regions reduced to below 1,000, and when the travel cost exceeded $462.43, the number of outpatients in all regions declined to below 100.

Economic Valuation of Outpatient Visits by Chronic Diseases

As the travel cost method starts with the assumption that consumers' expected benefits for visiting areas will be higher than the travel cost for the visit, the calculated travel cost is interpreted as the consumer's minimum expected benefit. The economic value of outpatient medical care at Ajou University Hospital is presented in Table 6. Examining the minimum expected benefit for one outpatient by disease, hypertension was appraised as the highest at $491.78, followed by diabetes ($476.87), dementia ($476.49), and cerebrovascular disease ($470.87). Based on this, the annual average value of outpatients who visited Ajou University Hospital was used to appraise the total economic benefit of each disease in the use of medical care services at Ajou University Hospital. Diabetes was the highest, with $21,261,128.71, followed by cerebrovascular disease with $8,248,394.68, hypertension with $2,716,620.26, and dementia with $2,535,984.11.

Table 5 Variation in Outpatient Visits by Travel Costs

	Distance	Population	Travel Costs ($)								
			7.71	11.56	19.27	38.54	77.07	115.61	192.68	308.29	462.43
Gyeonggi	14	13,589	10,059	6,323	3,523	1,593	720	453	252	147	93
Seoul	34	9,428	6,979	4,387	2,444	1,105	500	314	175	102	64
Incheon	47	2,967	2,196	1,381	769	348	157	99	55	32	20
Chungnam	94	2,123	1,571	988	550	249	113	71	39	23	14
Sejong	98	384	284	178	99	45	20	13	7	4	3
Chungbuk	104	1,595	1,181	742	414	187	85	53	30	17	11
Daejeon	124	1,446	1,070	673	375	170	77	48	27	16	10
Gangwon	158	1,536	1,137	715	398	180	81	51	29	17	10
Jeonbuk	194	1,770	1,310	823	459	207	94	59	33	19	12
Gyeongbuk	200	2,600	1,925	1,210	674	305	138	87	48	28	18
Daegu	250	2,364	1,750	1,100	613	277	125	79	44	26	16
Gwangju	262	1,431	1,059	666	371	168	76	48	27	16	10
Gyeongnam	305	3,280	2,428	1,526	850	385	174	109	61	36	22
Jeonnam	311	1,818	1,345	846	471	213	96	61	34	20	12
Ulsan	325	1,111	822	517	288	130	59	37	21	12	8
Busan	353	3,318	2,456	1,544	860	389	176	111	62	36	23

Table 6 Economic Valuation of Outpatient Visits by Chronic Diseases

	Travel Costs	Average Annual Outpatient	Total Travel Costs
Diabetes	476.87	44,585	21,261,128.71
Dementia	476.49	5,322	2,535,984.11
Hypertension	491.78	5,524	2,716,620.26
Cerebrovascular	470.87	17,517	8,248,394.68

Abbreviations: QGIS, Quantum Geographic Information System; ANOVA, Analysis of variance; NECA, National Evidence-based Healthcare Collaborating Agency; KTX, Korea train express; SRT, Super Rapid Train; KTDB, Korea Transport Database.

Discussion

This study aimed to evaluate the value of medical care use according to travel costs for patients with mild diseases who visited tertiary hospitals to devise measures to alleviate patient concentration. This study aimed to evaluate the value of tertiary hospital use among patients with mild diseases and explore measures to alleviate patient concentration. Specifically, the study assessed the value of tertiary hospitals based on regional and sociodemographic characteristics, analyzed the impact of increased distance and costs on outpatient medical utilization, and compared the value of outpatient visits to tertiary hospitals according to disease type.

The analysis revealed that travel costs for patients with mild disease were higher in Jeollanam-do, Daejeon Metropolitan City, and Gyeongsangnam-do. Jeollanam-do and Gyeongsangnam-do, where travel costs appeared relatively high, are located in the southernmost regions of Korea, showing a similar context to the research results suggesting that transportation and medical costs would increase as the distance to visit a medical institution increases more.[38,39] However, Daejeon Metropolitan City showed high travel costs despite its relatively short distance. This implies that Ajou University Hospital, located at the southernmost point among the tertiary hospitals in the metropolitan area, is also attracting patients from Daejeon Metropolitan City who visit medical institutions to use multiple medical services. However, regions with high travel costs have one similarity, that is, a lack of medical institutions. Jeollanam-do has the largest number of medically vulnerable areas as 17 spots and is also in a situation where the medical departments of public medical institutions are being abolished owing to a shortage of medical personnel. Additionally, Daejeon Metropolitan City is experiencing a serious medical vacancy, as some specialists are not assigned by the locally responsible medical institution that is supposed to provide essential medical care services. In Gyeongsangnam-do, there is a shortage of public medical centers owing to incidents such as the abolition of the Jinju Medical Center, resulting in high utilization rates at tertiary hospitals in other regions. As such, the lack of medical institutions and manpower in the region may induce problems in medical equity, and continuous patient breakaway leads to difficulties in operating primary and secondary medical institutions in the region, making it a medically vulnerable area, which may be repeated in a vicious cycle.[40,41]

Examining the results of the comparative analysis of travel costs according to disease and demographic characteristics, no statistically significant differences were found in all variables when medical costs were included. This finding suggests that for patients with mild diseases, factors related to medical institution accessibility, such as transportation and time costs, may influence the choice of tertiary hospitals, whereas the medical costs incurred at the visited institution may offset these differences. The comparative analysis of travel costs, excluding medical costs, revealed statistically significant differences for all variables. Travel costs were the highest for diabetes, followed by dementia, cerebrovascular disease, and hypertension. This means that patients with diabetes, dementia, and cerebrovascular disease are more likely to visit tertiary hospitals in areas with greater access costs than patients with hypertension. This supports research that compares per capita chronic disease outpatient medical expenditures by region and finds that overall, diabetes and hyperlipidemia patients have higher medical expenditures than hypertension patients, that diabetes patients have a higher preference for tertiary hospitals than hypertension patients, and that diabetes patients are more likely to use tertiary hospitals once they have used them.[42,43] This may be because patients with hypertension, unlike patients with diabetes, dementia, and cerebrovascular disease, prefer to manage their disease by taking medication for a long period to visit a medical institution to receive medical treatment.

In summary, transportation and time costs are taken into account in the use of tertiary hospitals by patients with mild diseases, and it can be said that patients with diabetes, who are relatively loyal to tertiary hospitals, bear more transportation and time costs than patients with dementia, cerebrovascular disease, and hypertension. For diabetes, like hypertension, early detection and proper management with medication can prevent complications from occurring, so it is important to focus on primary care centers in the community. However, unlike hypertension, which is relatively easy to screen and diagnose, diabetes, which is diverse and expensive, requires more detailed measures to support or manage it differently in primary healthcare chronic disease management projects.[44] Therefore, to encourage patients with mild diseases to switch from tertiary hospitals to primary care, positive discussions are essential to determine the priorities according to the type of mild disease.

Meanwhile, travel costs according to demographic characteristics were higher for men than for women. Further, travel costs were higher for those under 65 years of age than for those 65 years or older. This is consistent with the existing research results, suggesting that men tend to visit medical institutions in distant areas but spend relatively lower medical costs than older women.[45–47] Furthermore, in terms of insurance type, travel costs were higher in medical aid type 2, medical aid type 1, and health insurance subscribers. This indicates that the low-income bracket (medical beneficiaries) visit medical institutions located far from their residence, which is similar to existing research results suggesting that the lower the economic status, the lower the accessibility to medical care because of a lack of medical resources in the region.[48,49]

Overall, it can be concluded that among the patients with mild diseases who use tertiary hospitals, medical beneficiaries, who are socially vulnerable, incur more transportation and time costs than health insurance subscribers. Considering the previous finding that travel costs, including medical costs, were not significant, this can be interpreted as a net function of the Korean health insurance system providing equity in access to healthcare by easing the burden of medical costs on medical beneficiaries. However, given the skewing of patients with mild diseases to tertiary hospitals, it is necessary to provide incentives to encourage medical beneficiaries with high out-of-pocket expenditures to use community healthcare.[50,51]

Examining the field-experience demand function derived according to the increase or decrease in distance and travel costs, the increased travel costs resulted in a statistically significant decrease in the outpatient visit rate for patients with mild diseases. This is consistent with existing research suggesting that because distance is inversely proportional to visitation rates, the greater the distance, the more visitation rates decrease.[52,53] When visiting a medical institution, if the travel cost exceeded $77.07 (KRW 100,000), the number of patients in all regions declined below 1,000 people, and if it exceeded $462.43 (KRW 600,000), the number of patients in all regions declined below 100. This is probably because the development of transportation, including the KTX, has made it easier to travel between regions at a lower cost, making it possible to choose medical institutions outside the local community. Accordingly, to enable mild disease management within the local community, it is necessary to expand medical institutions that can provide a value of at least $77.07 and up to $462.43.

When comparing the economic value per capita assessed for each type of patient, hypertension, diabetes, dementia, and cerebrovascular disease are the highest, and hypertension and diabetes are more valuable to individuals than dementia and cerebrovascular disease. In addition, the total economic value of Ajou University Hospital by type of patient is higher for diabetes, cerebrovascular disease, hypertension, and dementia, in the same order as the number of visits by type. In sum, it was found that the value of using the tertiary hospital is higher for patients with hypertension and diabetes, which can be managed with medication in the community, than for cerebrovascular disease and dementia, which are more severe among chronic diseases. Furthermore, when comparing the total economic value of hypertensive and diabetic patients, the difference was 7.8 times that of hypertensive patients. This suggests that patients with diabetes or hypertension who can be managed in the community are more likely to prefer to use a tertiary hospital, which means that the core function of tertiary hospitals, medical care for severe diseases, is not adequately provided. In particular, in the case of diabetes, which has the highest total economic value, it is judged that it is due to various and expensive test methods compared to other mild diseases. In addition, the rate of diabetes-related tests and complication screenings in tertiary hospitals was 1.8 times higher than in primary care centers, indicating a higher amount of economic value compared to other mild diseases.

In conclusion, the high proportion of patients with less severe diseases utilizing tertiary hospitals indicates that the core function of tertiary hospitals, medical treatment of severe diseases, is not being adequately carried out, and

unnecessary medical expenditures are being incurred due to the use of advanced medical services. In particular, from the perspective that the higher the economic value of using a tertiary hospital, the higher the preference for using a tertiary hospital, the most preferred targets of tertiary hospitals are medical beneficiaries with diabetes among men under the age of 65 living in medical underdeveloped areas. Therefore, it is necessary to prepare policies that consider the characteristics of healthcare utilization by region, disease, and individual characteristics in order to induce healthcare utilization in the community and activate the healthcare delivery system leading to the primary, secondary, and tertiary levels.

This study has some limitations. First, in the disease analysis, patients with multiple chronic diseases could not be distinguished. Although it is necessary to classify severity according to the number of chronic diseases among patients with mild diseases, the analysis was limited to chronic diseases owing to limitations in the analysis data. Second, it did not include cases in regional tertiary hospitals. It is assumed that, even tertiary hospitals exhibit different characteristics in the capital and non-capital areas. If the travel costs for tertiary hospitals are analyzed according to the region in a future study, it enables the preparation of appropriate policy measures for the region. Third, health outcomes were not considered a measure of the value of medical use. Owing to the nature of the travel cost method, which only uses manifest data on the use of medical institutions, it is centered on valuation according to input cost consumption. In future studies, if health outcomes are also considered when evaluating the value of medical use, it enables a detailed understanding of patient demands as well as the value of medical institutions.

Conclusion

To the best of our knowledge, this study is the first to apply the travel cost method to evaluate the value of medical care for patients with mild diseases who use tertiary hospitals, and it presents the following three conclusions. First, the value of tertiary hospital utilization varies depending on regional healthcare accessibility and sociodemographic characteristics, with higher medical costs and travel costs in medically underserved areas influencing healthcare utilization patterns. Second, an increase in travel costs and distance leads to a decrease in outpatient medical utilization, and when travel costs exceed a certain threshold, changes in patients' choice of medical institutions become evident. Third, the value of outpatient utilization at tertiary hospitals differs by disease type, with diabetes patients demonstrating a stronger preference for tertiary hospitals despite higher travel and time costs. These findings highlight the need for policy interventions to improve the healthcare delivery system and emphasize the importance of region-based strategies to enhance medical accessibility tailored to patient characteristics.

The policy implications for resolving the concentration phenomenon in tertiary hospitals and providing incentives for primary care for patients with mild diseases are as follows. First, the problem of inequality in the medical resources of local communities must be addressed by expanding the number of medical institutions that can replace tertiary hospitals. Considering that medical costs do not significantly impact patient value, it is necessary to strengthen medical accessibility within residences and provide professional medical services to alleviate the concentration of patients with mild diseases in tertiary hospitals. Additionally, there is a need to improve negative perceptions of primary and secondary medical institutions to attract patients. If the medical infrastructure is expanded through medical institutions that have expertise, it alleviates the concentration phenomenon of patients and eliminates medical blind spots.

Second, incentives that reflect the segmented characteristics of patients with mild diseases who visit tertiary hospitals should be prepared. The government is enforcing policies such as strengthening coverage, abolishing elective treatment fees, and changing non-payment services to payment services for universal healthcare coverage. This can reduce co-payments and increase the number of patients visiting tertiary hospitals. Particularly, the low medical cost burden of the low-income group, as seen in our study, may reinforce the phenomenon of patient skewing to tertiary hospitals. Furthermore, different types of chronic diseases have different degrees of patient crowding out of tertiary hospitals. Complication screening, which is inexpensive and more aggressively implemented than primary and secondary care in the community, can increase patient satisfaction with healthcare, which in turn can increase loyalty to tertiary hospitals. Therefore, medical cost-relief policies should focus on severe diseases and offer prevention-oriented medical services by subdividing the characteristics of mild diseases. If community-centered health programs, such as community care and Healthy City projects, are expanded based on primary medical care, they ultimately enable the reduction of medical costs and efficient use of medical resources.

Third, the medical delivery system needs to be improved and centered on primary medical care. The policy currently enforced to alleviate the concentration phenomenon of patients is to suppress the treatment of patients with mild diseases and direct them to primary medical institutions by adjusting their copayments. However, as patients with mild diseases place greater value on transportation and time costs, it is judged that the policies emphasizing the medical cost aspect have limitations. In a general medical delivery system, primary and secondary medical institutions should manage mild diseases, including chronic ones, while tertiary medical institutions should manage severe diseases. However, the medical delivery system is currently insufficient, as medical institutions are classified according to the number of beds and the patient can utilize a tertiary medical institution regardless of the residential district if he or she has a medical treatment request form. The use of digital health services must be considered to reorganize medical delivery systems and efficiently utilize biased medical resources. Digital health is expanding, centering on home care and enabling health, and medication management, in daily life, and is thus being used for diseases in which self-management is important. To prevent and manage mild diseases, it is necessary to expand the application of digital health to chronic disease management pilot projects which are being implemented centered on primary medical institutions and community care projects that are being conducted for elderly patients with chronic diseases. This provides a medical system that allows patients with mild diseases to continuously manage their disease within the region, thereby resolving the concentration phenomenon in tertiary hospitals.

Data Sharing Statement

The data that support the findings of this study are available from the Ajou University of the Republic of Korea but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the corresponding author upon reasonable request and with permission of the Ajou University of the Republic of Korea.

Ethics Approval and Consent to Participate

The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki, as reflected in the a priori approval by the Institutional Review Board of the Ajou University Hospital (IRB No. AJIRB-SBR-MDB-22-110). Since this was a retrospective observational study using an anonymized dataset, there was no need to obtain participants' informed consent.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that they have no competing interests in this work.

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