

Original Article  
Preventive & Social Medicine



# Influencing Factors of Transportation Costs Regarding Healthcare Service Utilization in Korea

Su Yeon Jang , Jeong Yeon Seon , and In-Hwan Oh

Department of Preventive Medicine, School of Medicine, Kyung Hee University, Seoul, Korea



Received: Apr 17, 2020

Accepted: Jul 16, 2020

**Address for Correspondence:**

In-Hwan Oh, MD, MPH, PhD

Department of Preventive Medicine, Kyung Hee University School of Medicine, 26 Kyungheedae-ro, Dongdaemun-gu, Seoul 02447, Korea.

E-mail: parenchyme@gmail.com

© 2020 The Korean Academy of Medical Sciences.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

**ORCID iDs**

Su Yeon Jang

<https://orcid.org/0000-0001-7545-3168>

Jeong Yeon Seon

<https://orcid.org/0000-0002-0080-168X>

In-Hwan Oh

<https://orcid.org/0000-0002-5450-9887>

**Funding**

This study was supported by a grant from the Korean Health Technology R&D Project through the Korean Health Industry Development Institute (KHIDI), funded by the Ministry of Health and Welfare, Republic of Korea (grant No. H118C0446).

**Disclosure**

The authors have no potential conflicts of interest to disclose.

## ABSTRACT

**Background:** Transportation costs can be a barrier to healthcare services, especially for low-income, disabled, elderly, and geographically isolated populations. This study aimed to estimate the transportation costs of healthcare service utilization and related influencing factors in Korea in 2016.

**Methods:** Transportation costs were calculated using data from the 2016 Korea Health Panel Study. A total of 14,845 participants were included (males, 45.07%; females, 54.93%), among which 2,148 participants used inpatient and 14,787 used outpatient care services. Transportation costs were estimated by healthcare types, transportation modes, and all disease and injury groups that caused healthcare service utilization. The influencing factors of higher transportation costs were analyzed using multivariable regression analysis.

**Results:** In 2016, the average transportation costs were United States dollars (USD) 43.70 (purchasing power parity [PPP], USD 32.35) per year and USD 27.67 (PPP, USD 20.48) per visit for inpatient care; for outpatient case, costs were USD 41.43 (PPP, USD 30.67) per year and USD 2.09 (PPP, USD 1.55) per visit. Among disease and injury groups, those with neoplasms incurred the highest transportation costs of USD 9.73 (PPP, USD 7.20). Both inpatient and outpatient annual transportation costs were higher among severely disabled individuals (inpatient, +USD 44.71; outpatient, +USD 23.73) and rural residents (inpatient, +USD 20.40; outpatient, +USD 28.66). Transportation costs per healthcare visit were influenced by healthcare coverage and residential area. Sex, age, and income were influencing factors of higher transportation costs for outpatient care.

**Conclusion:** Transportation cost burden was especially high among those with major non-communicable diseases (e.g., cancer) or living in rural areas, as well as elderly, severely disabled, and low-income populations. Thus, there is a need to address the socioeconomic disparities related to healthcare transportation costs in Korea by implementing targeted interventions in populations with restricted access to healthcare.

**Keywords:** Healthcare Costs; Transportation of Patients; Korea Health Panel Study; Economic Burden of Disease; Healthcare Disparities; Health Services for Persons with Disabilities

**Author Contributions**

Conceptualization: Jang SY, Oh IH.  
Methodology: Oh IH. Formal analysis: Jang SY, Seon JY, Oh IH. Data curation: Jang SY.  
Software: Jang SY. Validation: Jang SY, Seon JY, Oh IH. Investigation: Jang SY, Seon JY, Oh IH. Writing - original draft: Jang SY. Writing - review & editing: Seon JY, Oh IH.

**INTRODUCTION**

When patients try to access healthcare services, time, distance, and cost constraints related to transportation usage lead to a lack of healthcare access.<sup>1</sup> Transportation barriers are especially prevalent among poorer, older, disabled, and rural populations, who are disadvantaged in transport utilization, owing to geographical inconveniences (regarding access to healthcare), inability to drive, lack of private cars, and financial difficulties in paying for public transportation.<sup>2</sup> Lack of access to healthcare transportation results in more substantial burden of diseases among the transport-disadvantaged population, hence leading to lower life expectancy and quality of life than the transport-advantaged.<sup>3</sup>

The Korean healthcare system is facing several challenges owing to geographic gaps in healthcare access and a high burden of diseases among the elderly.<sup>4</sup> According to the Health Insurance Review & Assessment Service and the National Health Insurance Service of Korea, 24% of the total healthcare providers and 31% of all tertiary hospitals are in Seoul—the national capital.<sup>5</sup> Other than regional inequalities, the Korean healthcare system is confronting ever-enlarging medical expenditure issues owing to rapid aging; in the next 50 years, elderly people aged 65 or above are expected to account for more than 45% of the national population.<sup>6</sup>

Given the aforementioned associations between traveling burden and access to healthcare among disadvantaged populations (e.g., rural residents or elderly people), there is a need to estimate transportation costs regarding healthcare service utilization as a part of the socioeconomic costs of illness. Owing to transportation inconveniences, a significant number of Korean rural elderly people have unmet healthcare needs, more than 35% of which were due to a lack of transportation.<sup>7</sup> Another study on access to medical services among people with unmet healthcare needs in Korea reported that 20.9% of the population experienced barriers to receiving necessary medical services due to a lack of transportation access.<sup>8</sup> Similarly, several studies reported a lack of access to healthcare among rural, elderly, and disabled populations, indicating a prevalence of physical barriers in primary care settings among vulnerable populations in Korea.<sup>9-11</sup> Previous studies have determined the economic burden of diseases in Korea by measuring the direct medical costs of inpatient and outpatient care, pharmaceuticals, direct non-medical costs (e.g., transportation costs and caregiver expenses), and indirect costs owing to productivity loss regarding morbidity and mortality.<sup>12-17</sup> Notwithstanding, despite the aforementioned importance of transportation in healthcare utilization, no previous Korean study has independently investigated transportation cost burden.

Conversely, several studies in the United States of America and Europe have investigated transportation cost burden in patients who are required to visit healthcare services regularly owing to medical conditions—such as type 2 diabetes, end-stage renal disease, rheumatoid arthritis, or various types of cancers (i.e., colorectal, cervical, and breast cancer).<sup>18-23</sup> However, the abovementioned past literature from other countries on the size of transportation cost burden regarding healthcare utilization generally focused on a single disease or specific treatment groups. Regarding this gap, a past study highlighted that studies on the cost of disease could benefit from a methodological approach that allows for measuring the overall economic burden in different disease groups, as this may help to enable the distribution of restricted healthcare resources.<sup>24</sup> For corroboration, we believe that investigating transportation costs regarding healthcare service utilization among different

disease groups at the national level is warranted, and this study may come to support policymakers in their decision-making process related to resource allocation.

Therefore, this study aimed to determine the characteristics of transportation costs regarding healthcare service visits in Korea using secondary data from a nationally representative sample of the Korea Health Panel Study (KHPS). Specifically, we estimated transportation costs in travels to inpatient and outpatient care units in 2016 by transport mode and all categories of diseases that cause people to utilize healthcare services (i.e., 238 disease and 19 injury groups). Afterward, we analyzed the estimated transportation costs to determine the sociodemographic predictors of high economic burden related to healthcare transportation.

## METHODS

### Data collection and participants

This study utilized data retrieved from the KHPS version 1.5 database. The KHPS is an official statistical database of Korea; since 2008, the study has been conducted annually by the Korea Institute for Health and Social Affairs and the National Health Insurance Service. It provides baseline data on healthcare service utilization, medical expenditures, and healthcare coverage in a nationally representative sample of Korea.<sup>25</sup>

Specifically, this study used the eleventh-year panel data of the KHPS version 1.5 database (collected in 2016). It had a total sample of 17,424 subjects; this study included only samples of individuals who had experience in healthcare service utilization: 2,216 participants in inpatient and 14,990 in outpatient care. After this initial selection, we excluded subjects with any type of missing data on their sociodemographic characteristics or transportation utilization. In total, 14,845 individuals (6,281 households) were included in our study. Within our final sample, 2,148 had experiences with inpatient and 14,787 with outpatient care. As there were individuals who used healthcare services several times during the study period, the number of healthcare service visits exceeded that of the included samples, with 3,392 inpatient and 292,765 outpatient care visits.

### Transportation costs and related variables

In this study, transportation costs were defined as the round-trip costs of using transportation when traveling to utilize a healthcare service. It included inpatient and outpatient transportation costs. In the KHPS survey, participants self-reported their transportation costs for all healthcare travel they made from January to December 2016, except when they traveled by private vehicle (e.g., car or motorcycles).<sup>25</sup> In our study, these missing values regarding transportation costs when using private vehicles were filled with the mean value for transportation costs using transit modes other than private vehicles, except in cases where travel cost was free, which were excluded from the calculations. The calculated average transportation costs of using non-private transit modes for inpatient and outpatient care were USD (United States of America dollars) 32.19 and USD 3.93, respectively, which replaced the missing values of transportation costs in private vehicle users.

The estimated transportation costs were computed by healthcare service types (inpatient and outpatient care), transportation modes (private car, taxi, public transportation, train or airplane, walking or biking, ambulance, emergency room hospitalization, and others [including motorcycle or tractor]), and by disease and injury groups (i.e., the major illnesses

inducing transportation costs). The latter variable included 238 disease and 19 injury groups, which were categorized under three main clusters: communicable, maternal, neonatal, and nutritional conditions (CMNNs); non-communicable diseases (NCDs); and injuries. We defined the disease and injury groups according to major illness diagnoses from the KHPS database; diagnoses were coded according to the Korean Classification of Diseases (KCD), which is a classification system based on the International Classification of Diseases (ICD). Thereafter, we classified the 238 disease groups based on the hierarchies defined by a previous Korean study on the burden of disease.<sup>26</sup> Nevertheless, for the injury groups, while the KHPS database provides information on injury types with S- and T-codes, this aforementioned Korean study clustered injury groups by cause of injury through V-, X-, and Y-codes.<sup>26</sup> Thus, the definitions of the 19 injury groups followed the classification of 298 disease groups by KCD codes, as the KCD system provides disease classification from codes for injury type (S-code and T-code).<sup>27</sup> In the secondary data we analyzed, transportation costs were calculated exclusively for disease and injury groups that had 30 or more healthcare visits. A selection criterion of a minimum of 30 cases was decided as a compromise between accuracy and the restricted number of samples available in the KHPS database.

### Demographic variables

We also collected demographic and socioeconomic factors of the sample, which included: sex (male and female), age (below 20, 20-44, 45-64, 65-74, and 75 or above), healthcare coverage (employee health insurance, self-employed health insurance, and medical-aid beneficiary), household income level in 5-quantiles, disability status (not disabled, mildly disabled, and severely disabled), and residential area (capital, urban, and rural). In the panel data, household income was estimated during the reference period of the previous year, from January to December 2015.<sup>25</sup> To reduce any potential bias caused by changes in household members and family size when determining household income levels, we used household population-based weights in the estimation, rather than raw values. This study included data from the following Korean administrative districts: one special metropolitan city (Seoul), six metropolitan cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), one metropolitan autonomous city (Sejong), eight provinces of “Do” (Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, and Gyeongnam), and one special self-governing province (Jeju).<sup>28</sup> In this study, we used three categories for residential areas: capital (for those residing in the special metropolitan city), urban (for those residing in either the metropolitan cities or the metropolitan autonomous city), and rural (for those residing in other provinces or the special self-governing province).

### Statistical analysis

We utilized descriptive statistics to determine participants' socioeconomic and demographic characteristics, healthcare service types, and outcomes associated with transportation costs. Participants' baseline characteristics and transportation costs were compared between-group for the two types of healthcare services utilized (inpatient and outpatient care recipients); we conducted Pearson's  $\chi^2$  test for categorical variables and Student's *t*-test for continuous variables. Transportation costs among participants who traveled by private car, walked, or biked showed identical values: either imputed values to replace missing variables or zero. Therefore, we excluded participants who utilized the aforementioned transit modes to visit healthcare services from the comparative analysis of transportation costs between inpatient and outpatient care recipients by mode.

Multivariable regressions were performed to analyze the influencing factors of higher transportation costs among both groups, and for both the total annual transportation costs and the average cost per visit made to utilize a healthcare service. In the multivariable regression models, the explanatory variables were sex, age, healthcare coverage, household income, disability status, and residential area. These variables are common socioeconomic and demographic factors. Furthermore, multivariable logistic regressions were performed to analyze the influencing factors of higher transportation costs. We defined transportation costs to be at a higher level if they were in the upper 25% of average costs per visit (inpatient, USD 32.19; outpatient, USD 3.60) or per year (inpatient, USD 32.19; outpatient, USD 47.12).

In this study, we chose to present transportation costs based on USD; for this intent, we used the 2016 average currency exchange rate of Korean Won/USD (USD 1 = 1,160.41 KRW).<sup>29</sup> To ensure that the estimation of transportation costs during the 2016 study period is comparable to those in other years, key findings are also reported in purchasing power parity dollars (PPP USD). In 2016, the PPP exchange rate was 858.99 KRW/PPP USD.<sup>30</sup> All statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY, USA), and statistical significance was set at  $P = 0.05$ .

### Ethics statement

The protocol of this study was reviewed and approved by the Institutional Review Board of Kyung Hee University (approval No. KHSIRB-19-354[EA]). Because this study used public data from the KHPS, which is de-identified, the Review Board deemed that the need for collecting informed consent was not applicable.

## RESULTS

**Table 1** shows the sociodemographic characteristics of the 2016 KHPS participants by healthcare service type. Among the inpatient care recipients, 57.96% were female, 28.35% were aged 45–64, 68.34% had employee health insurance, 22.11% were in the first (lowest) quintile for household income level, 90.18% were not disabled, and 61.59% were rural residents. Conversely, among outpatient care recipients, 54.93% were female, 30.54% were aged 45–64, 70.30% had employee health insurance, 22.95% were in the fourth quintile for household income level, 93.98% were not disabled, and 58.29% were rural residents.

**Table 2** shows the total and average costs of using transportation by healthcare service type. Total transportation costs for participants were USD 93,863 (PPP USD 69,483) for inpatient and USD 612,623 (PPP USD 453,493) for outpatient care. In 2016, the average annual transportation costs per patient were USD 43.70 (PPP USD 32.35) for inpatient and USD 41.43 (PPP USD 30.67) for outpatient care; there was no statistically significant difference. However, the average transportation costs per visit (made to a healthcare service) were USD 27.67 (PPP USD 20.48) for inpatient and USD 2.09 (PPP USD 1.55) for outpatient care; for this result, we found a statistically significantly higher cost for inpatient than for outpatient care.

**Fig. 1** shows the number of visits to inpatient and outpatient care by transportation mode. For inpatient care visits, participants traveled mostly by private car (1,851; 54.57%). For outpatient care visits, participants traveled mostly by walking and biking (130,710; 44.65%). According to average costs by transportation mode and healthcare service type, for both inpatient and outpatient care visits, traveling by train or airplane was the costliest (USD 142.25 for inpatient;

**Table 1.** Participants' sociodemographic characteristics

Characteristics	Inpatients	Outpatients	P value
Total	2,148	14,787	
Sex			0.008
Male	903 (42.04)	6,665 (45.07)	
Female	1,245 (57.96)	8,122 (54.93)	
Age, yr			< 0.001
0–19	267 (12.43)	3,051 (20.63)	
20–44	394 (18.34)	3,421 (23.14)	
45–64	609 (28.35)	4,516 (30.54)	
65–74	442 (20.58)	2,105 (14.24)	
≥ 75	436 (20.30)	1,694 (11.46)	
Healthcare coverage			< 0.001
Employee health insurance	1,468 (68.34)	10,396 (70.30)	
Self-employed health insurance	542 (25.23)	3,815 (25.80)	
Medical-aid beneficiary	138 (6.42)	576 (3.90)	
Household income			< 0.001
QU <sub>1</sub> (lowest)	475 (22.11)	2,074 (14.03)	
QU <sub>2</sub>	470 (21.88)	2,889 (19.54)	
QU <sub>3</sub>	432 (20.11)	3,229 (21.84)	
QU <sub>4</sub>	431 (20.07)	3,394 (22.95)	
QU <sub>5</sub> (highest)	340 (15.83)	3,201 (21.65)	
Disability status			< 0.001
Not disabled	1,937 (90.18)	13,897 (93.98)	
Mildly disabled	125 (5.82)	545 (3.69)	
Severely disabled	86 (4.00)	345 (2.33)	
Residential area			< 0.001
Capital	187 (8.71)	1,826 (12.35)	
Urban, not capital	638 (29.70)	4,342 (29.36)	
Rural	1,323 (61.59)	8,619 (58.29)	

Data are presented as number (%).  
QU = quintile.

**Table 2.** Participants' average transportation costs by characteristics and healthcare service type

Variables	Inpatients	Outpatients	P value
Average annual transportation cost per patient, USD	43.70 (101.20)	41.43 (95.72)	0.329
Average transportation cost per visit, USD	27.67 (39.89)	2.09 (5.27)	< 0.001
By taxi	13.33 (17.44)	8.88 (8.97)	< 0.001
By public transportation	12.27 (21.72)	2.86 (5.60)	< 0.001
By train/plane	142.25 (61.99)	64.85 (78.48)	< 0.001
By ambulance	102.95 (147.55)	-	-
Emergency room hospitalization	30.94 (99.58)	-	-
Total No. of patients	2,148	14,787	-
Total No. of visits	3,392	292,765	-
Total transportation cost, USD	93,863	612,623	-

Data are presented as number (%) mean ± standard deviation.  
USD = United States dollars.

USD 64.85 for outpatient care travels) (Table 2). Costs for travel by taxi, public transportation, and train or airplane were significantly higher among inpatient than outpatient care visits.

Fig. 2 shows the number of visits by healthcare service type for the three main disease groups—CMNNs, NCDs, and injuries—in 2016. For both inpatient and outpatient care visits, NCDs were the leading cause of healthcare service utilization (1,917 for inpatient; 177,542 for outpatient care).

Fig. 3 shows the top ten disease groups with the highest average transportation costs regarding healthcare visits. Participants with neoplasms incurred the highest transportation costs

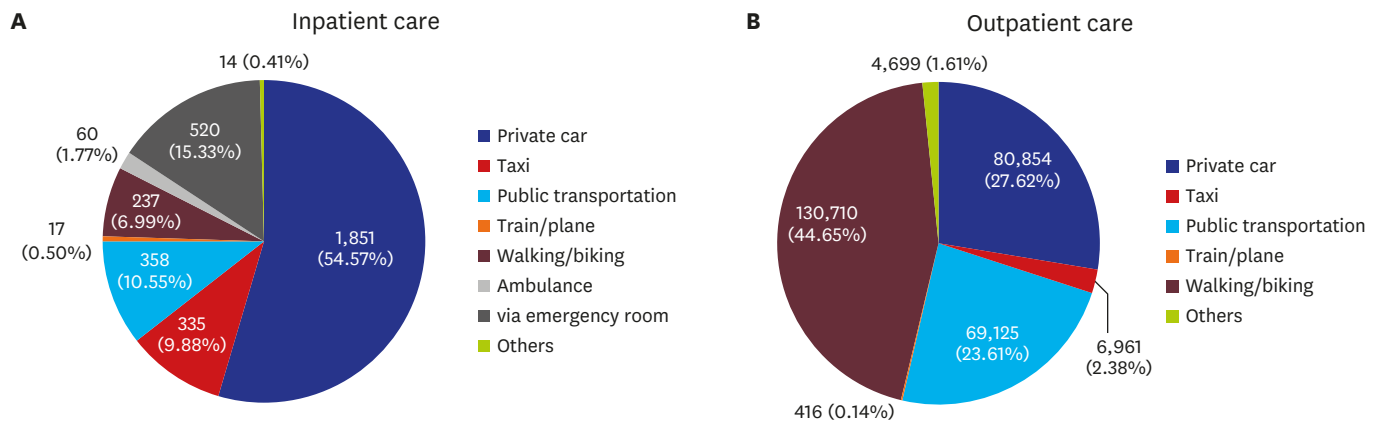


Fig. 1. Number of visits to healthcare services by transportation mode. (A) Number of inpatient care visits by transportation mode. (B) Number of outpatient care visits by transportation mode.

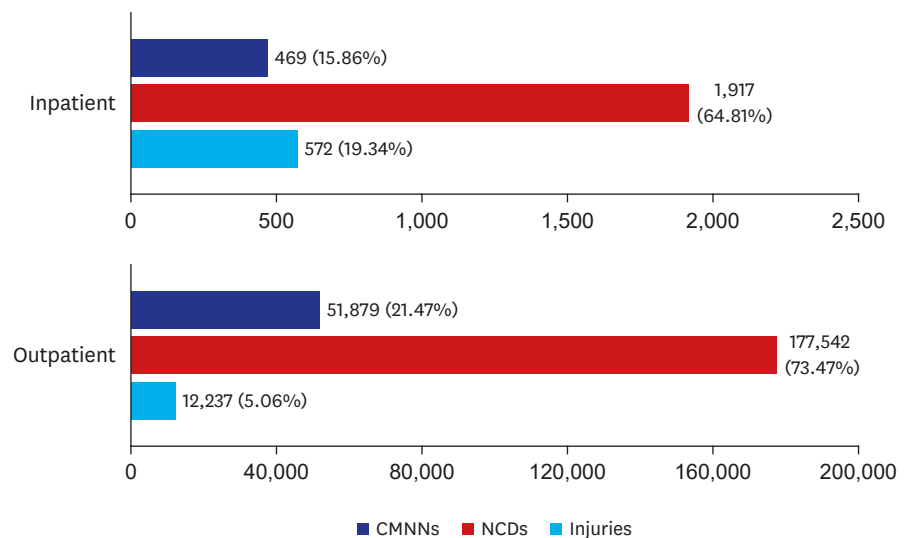
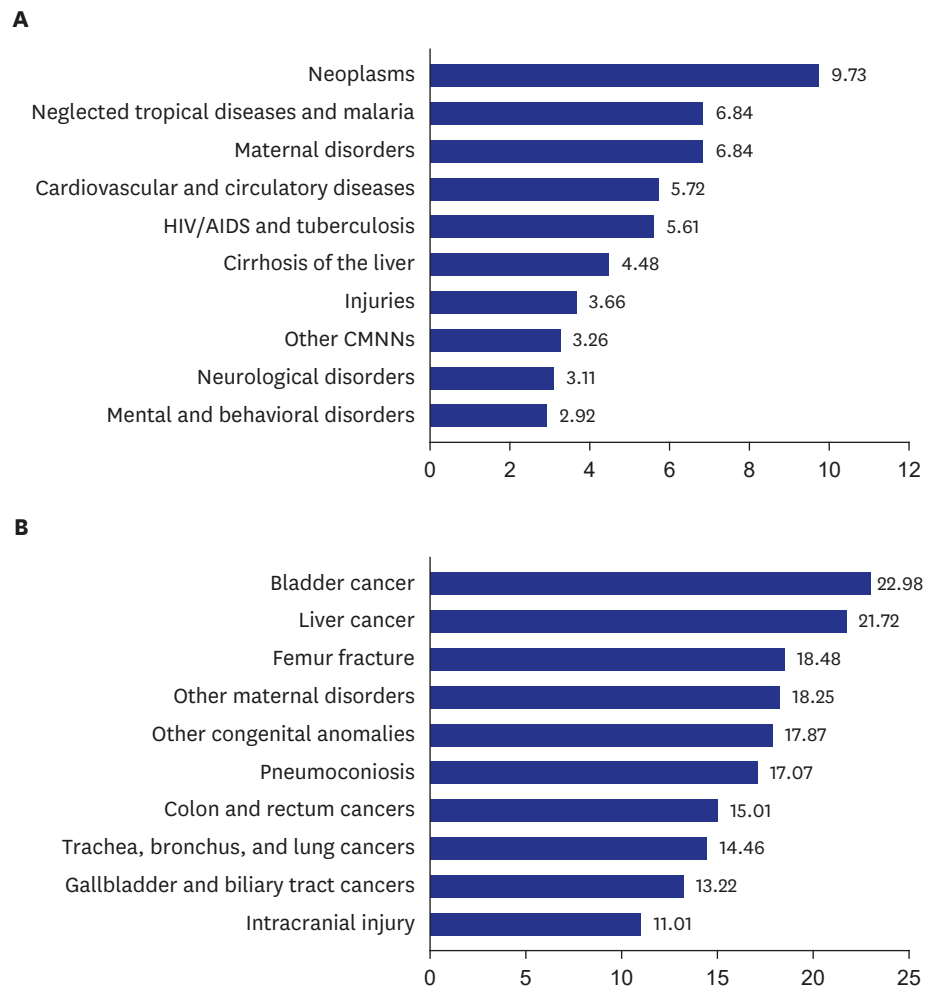


Fig. 2. Number of visits to healthcare services by disease groups in 2016. CMNN = communicable, maternal, neonatal, and nutritional condition, NCD = non-communicable disease.

(average of USD 9.73 per visit). Among the smaller groups, participants with bladder cancer (defined by ICD code C67) incurred the highest transportation cost (average of USD 22.98 per visit), followed by those with liver cancer (ICD code C22; average of USD 21.72), and those with femur fractures (ICD code S72; average of USD 18.48). Particularly, for inpatient care, femur fractures resulted in the highest costs per visit (average of USD 71.31); for outpatient care, liver cancer resulted in the highest costs per visit (average of USD 18.86) (Table 3).

Table 4 shows the multivariable regression analysis results on the influencing factors of average transportation costs for healthcare services, per year and visit, by service type. Among inpatient care visits, the annual transportation costs were higher by USD 22.32 among those with employee health insurance compared to those who were medical-aid beneficiaries ( $P = 0.023$ ); by USD 44.71 among those severely disabled compared to those who were not disabled ( $P < 0.001$ ); and by USD 20.40 among rural compared to capital residents ( $P = 0.010$ ).



**Fig. 3.** Ranking of average transportation costs by disease group (USD). **(A)** Top 10 leading causes in level 2 disease groups. **(B)** Top 10 leading causes in level 3 and 4 disease groups. HIV/AIDS = Human immunodeficiency virus infection and acquired immune deficiency syndrome, CMNN = communicable, maternal, neonatal, and nutritional condition, USD = United States dollars.

**Table 3.** Ranking of average transportation cost by disease group and healthcare service type

Rank	Inpatients	Costs, USD	Outpatients	Costs, USD
1	Femur fracture	71.31	Liver cancer	18.86
2	Intracranial injury	57.94	Bladder cancer	18.62
3	Liver cancer	43.99	Other congenital anomalies	17.46
4	Colon and rectum cancers	43.09	Trachea, bronchus, and lung cancers	13.35
5	Fracture of neck, thorax, or pelvis	35.74	Pneumoconiosis	12.60
6	Hemorrhagic and other non-ischemic strokes	34.57	Colon and rectum cancers	11.13
7	Ischemic stroke	34.52	Prostate cancer	10.24
8	Gall bladder and bile duct diseases	32.83	Atrial fibrillation and flutter	9.21
9	Stomach cancer	31.47	Pancreatitis	8.33
10	Alzheimer's disease and other dementias	31.25	Decubitus ulcer	7.65

USD = United States dollars.

Among outpatient care visits, compared to those aged below 20, annual transportation costs were lower by USD 7.91 among those aged 20-44 ( $P = 0.001$ ) and higher by USD 10.73 ( $P < 0.001$ ), USD 30.70 ( $P < 0.001$ ), and USD 37.43 ( $P < 0.001$ ) among those aged 45-64,



**Table 4.** Multivariable regression analysis on the influencing factors of transportation costs of healthcare service visits by service type

Variables	Per visit				Per year			
	Inpatients		Outpatients		Inpatients		Outpatients	
	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value	Coefficient (95% CI)	P value
Total, No.	2,148		14,787		2,148		14,787	
Sex	Reference		Reference		Reference		Reference	
Male	Reference		Reference		Reference		Reference	
Female	-0.90 (-3.31, 1.51)	0.470	-0.32 (-0.43, -0.21)	< 0.001	-6.57 (-15.28, 2.15)	0.140	0.96 (-2.09, 4.0)	0.539
Age, yr	Reference		Reference		Reference		Reference	
0-19	Reference		Reference		Reference		Reference	
20-44	0.79 (-3.59, 5.18)	0.720	0.35 (0.19, 0.52)	< 0.001	-12.09 (-27.96, 3.77)	0.130	-7.91 (-12.50, -3.33)	0.001
45-64	-1.74 (-5.80, 2.32)	0.400	0.41 (0.26, 0.57)	< 0.001	-9.82 (-24.50, 4.86)	0.190	10.73 (6.41, 15.06)	< 0.001
65-74	-4.05 (-8.49, 0.39)	0.070	0.28 (0.09, 0.48)	< 0.001	-12.98 (-29.04, 3.08)	0.110	30.70 (25.22, 36.19)	< 0.001
≥ 75	1.81 (-2.83, 6.44)	0.440	0.40 (0.17, 0.62)	< 0.001	-3.24 (-20.01, 13.53)	0.700	37.43 (31.21, 43.65)	< 0.001
Healthcare coverage	Reference		Reference		Reference		Reference	
Medical-aid beneficiary	Reference		Reference		Reference		Reference	
Employee health insurance	7.67 (2.35, 12.99)	< 0.001	0.13 (-0.17, 0.44)	0.390	22.32 (3.08, 41.56)	0.020	-8.24 (-16.72, 0.24)	0.057
Self-employed health insurance	9.27 (3.66, 14.89)	< 0.001	0.34 (0.03, 0.65)	0.030	17.59 (-2.72, 37.89)	0.090	-8.21 (-16.94, 0.52)	0.065
Household income	Reference		Reference		Reference		Reference	
QU <sub>1</sub> (lowest)	Reference		Reference		Reference		Reference	
QU <sub>2</sub>	-2.39 (-6.20, 1.42)	0.220	0.05 (-0.16, 0.25)	0.640	0.62 (-13.17, 14.40)	0.930	-3.32 (-9.05, 2.40)	0.256
QU <sub>3</sub>	1.97 (-2.19, 6.14)	0.350	0.14 (-0.07, 0.35)	0.200	-0.43 (-15.50, 14.64)	0.960	-3.20 (-9.18, 2.78)	0.294
QU <sub>4</sub>	3.01 (-1.28, 7.30)	0.170	0.30 (0.09, 0.52)	0.010	0.29 (-15.23, 15.80)	0.970	-3.58 (-9.69, 2.52)	0.250
QU <sub>5</sub> (highest)	1.48 (-3.13, 6.08)	0.530	0.41 (0.18, 0.63)	< 0.001	-6.24 (-22.91, 10.43)	0.460	-2.88 (-9.10, 3.34)	0.364
Disability status	Reference		Reference		Reference		Reference	
Not disabled	Reference		Reference		Reference		Reference	
Mildly disabled	2.58 (-2.58, 7.74)	0.330	0.32 (0.02, 0.61)	0.040	12.24 (-6.42, 30.89)	0.200	14.28 (6.06, 22.50)	0.001
Severely disabled	0.70 (-5.47, 6.87)	0.820	0.61 (0.24, 0.98)	< 0.001	44.71 (22.39, 67.04)	< 0.001	23.73 (13.50, 33.96)	< 0.001
Residential area	Reference		Reference		Reference		Reference	
Capital	Reference		Reference		Reference		Reference	
Urban, not capital	4.86 (0.28, 9.43)	0.040	0.82 (0.63, 1.0)	< 0.001	12.68 (-3.87, 29.23)	0.130	14.35 (9.22, 19.48)	< 0.001
Rural	9.41 (5.09, 13.73)	< 0.001	1.41 (1.24, 1.58)	< 0.001	20.40 (4.78, 36.02)	0.010	28.66 (23.90, 33.41)	< 0.001

CI = confidence interval, QU = quintile.

65-74, and 75 or above, respectively. Disability status also had a significant association with annual transportation costs for healthcare services: compared to participants who were not disabled, costs were higher by USD 14.27 among those mildly disabled ( $P = 0.001$ ) and by USD 23.73 among those severely disabled ( $P < 0.001$ ). Residential area had a significant association with higher annual transportation costs for outpatient visits: compared to capital residents, costs were higher by USD 14.35 among urban residents ( $P < 0.001$ ) and by USD 28.66 among rural residents ( $P < 0.001$ ).

Compared to medical-aid beneficiaries, average transportation costs per inpatient care visit were higher by USD 7.67 among those with employee health insurance ( $P = 0.005$ ) and by USD 9.27 among those with self-employed health insurance ( $P = 0.001$ ). Residential area also had a significant association with average transportation costs per inpatient visit: costs were higher by USD 4.86 among non-capital urban residents ( $P = 0.038$ ) and by USD 9.41 among rural residents, compared to capital residents ( $P < 0.001$ ).

Among outpatient care recipients, average transportation costs per visit were lower by USD 0.32 among female compared to male participants ( $P < 0.001$ ). Age groups were all statistically significantly associated with higher mean transportation costs per visit, with those aged 20-44, 45-64, 65-74, and 75 or above had mean transportation costs that were USD 0.35 ( $P < 0.001$ ), USD 0.41 ( $P < 0.001$ ), USD 0.28 ( $P = 0.005$ ), and USD 0.40 higher ( $P < 0.001$ ) per visit, respectively, compared to those aged below 20. Moreover, among

outpatient care recipients, average transportation costs per visit were higher by USD 0.34 among those with self-employed health insurance ( $P = 0.032$ ) than those who were medical-aid beneficiaries ( $P = 0.032$ ). Compared to those in the first quintile for household income level, costs were higher by USD 0.30 among those in the fourth quintile ( $P = 0.006$ ) and by USD 0.41 among those in the fifth ( $P < 0.001$ ). Compared to those who were not disabled, costs were higher by USD 0.32 among those who were mildly disabled ( $P = 0.035$ ) and by USD 0.61 among those who were severely disabled ( $P = 0.001$ ). Compared to capital residents, costs were higher by USD 0.82 among non-capital urban residents ( $P < 0.001$ ) and by USD 1.41 among rural residents ( $P < 0.001$ ). Results from the logistic regression analyses for average transportation costs per year and visit also generally presented similar trends (Supplementary Table 1).

## DISCUSSION

In 2016, based on KHPS data, average annual transportation costs per patient were USD 43.70 and USD 41.43 for inpatient and outpatient care, respectively. For each visit made to receive healthcare services, average transportation costs per visit were USD 27.67 for inpatient care and USD 2.09 for outpatient care. A report on the 2016 KHPS estimated transportation costs to be approximately 1.3% of overall household medical expenses and 19.17% of non-medical costs.<sup>31</sup> According to Lee et al.,<sup>16</sup> the total socioeconomic burden of disease in Korea was USD 133.7 billion in 2015, of which USD 65.5 billion were attributable to direct costs and USD 68.2 billion to indirect costs. However, also regarding socioeconomic disease burden, a previous Korean study did not mention the amount of transportation costs, or non-medical expenses including both transportation and caregiving costs. Conversely, the current study focused on the transportation aspect of disease burden. Our findings suggest that inpatient care poses a great economic burden in using transportation to utilize healthcare services, and thus needs to be managed.

Our results showed that, for inpatient care visits, the most popular mode of transportation was private cars (55% of the total cases); among outpatient care visits, most walked or biked (45% of the total cases). In the UK, car ownership is one of the primary factors affecting healthcare usage, mainly because the public transportation system may not be prevalent in disadvantaged areas (e.g., rural locations).<sup>32</sup> Moreover, according to the transit performance monitoring system in the US, in small-sized transportation systems for population groups under 500,000, walking is a major alternative to make up for the lack of public transportation.<sup>33</sup> Nevertheless, Korea is a country with developed and urbanized transportation systems. In 2016, Korea devoted 9.4% of its total government expenditure on transportation and social overhead capital, all to stimulate regional development.<sup>34</sup> Owing to the high investment allocated to urban transport infrastructure, the Korean average for the modal share of public transport was 42.8 in 2016.<sup>35</sup> However, despite the high investment in and well-established infrastructure of public transportation, our results from a nationally representative Korean sample showed similarities to those of other countries: higher usage of private cars in an inpatient care context, with walking or biking being more widely utilized for outpatient care visits. The similarities in patterns of transportation utilization between Korea and other countries may be due to differences in public transportation infrastructure in rural areas with low population density. For example, the subway system is built only in five metropolitan areas of Korea: Seoul, Busan/Ulsan, Daegu, Gwangju, and Daejeon.<sup>36</sup> Therefore, stronger public transportation systems should be established in non-metropolitan areas.

Overall, there was a high burden of transportation costs related to cancer, representing two of the top three diseases that incurred the highest transportation costs (i.e., bladder cancer, liver cancer, and femur fracture). This corroborated a previous study showing diseases that necessitate regular medical follow-ups (e.g., different types of cancer) require patients to spend considerable amounts of time and money on their treatments.<sup>37</sup> Furthermore, outpatient transportation costs were the highest among patients with liver cancer (USD 18.86). In Korean healthcare system, patients can choose between different healthcare providers for their treatment, including tertiary hospitals.<sup>4</sup> Although the Korean government has encouraged its population to utilize local clinics before approaching a higher level of healthcare, the freedom to choose any type of healthcare service leads patients with diseases such as cancer to seek and receive medical care mostly from tertiary hospitals—not only for inpatient but also outpatient care.<sup>38,39</sup> Results from this study showed a high burden of transportation costs among patients with cancer diagnoses. The study also reflected the inclination of major NCD patients to prefer tertiary hospitals over local clinics, thus underscoring a need to strengthen the primary healthcare system in Korea.

In this study, the influencing factors of higher annual inpatient transportation costs were healthcare coverage, disability status, and residential area. Moreover, those influencing higher annual outpatient transportation costs were age, disability status, and residential area. According to Wallace et al.,<sup>2</sup> age, geographical location, and disabilities were considered disadvantages for transportation utilization related to healthcare services. Moreover, these results were partly investigated in previous Korean studies that have determined among those who are disabled, the elderly, or rural residents, there is a lower probability of using health screening or medical services when faced with minor symptoms. Furthermore, this behavior was shown to be associated with increased severity in overall health outcomes.<sup>7,40,41</sup> Specifically, our results showed age to be a strong influencing factor for transportation costs associated with healthcare services, with those aged over 75 years spending up to USD 37.43 more annually on medical-related travel compared to the younger population. Higher transportation costs among elderly people may be due to the low proportion of individuals in this population who can drive themselves or find a driver among family members.<sup>7</sup> Due to the lower availability of personal transportation for older individuals, previous studies have reported higher rates of facing barriers to healthcare access for this population.<sup>7,41</sup>

Although we pointed out positive results for research and practice, this study still had limitations. First, we estimated transportation costs based on KHPS secondary data, which were collected through self-report questionnaires; hence, there may have been under or overestimations owing to participants' facing difficulties in recollecting such information. Second, transportation costs for private vehicles (e.g., cars or motorcycles) were calculated using a substitute; the average transportation costs of other transit modes was used. Thus, our results regarding this transportation mode may be different from actual costs.

Despite these limitations, this is, to the best of our knowledge, the first Korean study to investigate transportation costs of all disease groups among those receiving Korean healthcare services. To emphasize previously cited studies in the Introduction, cost or geographical location constraints to transportation usage when trying to visit healthcare services lead to lower healthcare accessibility.<sup>1-3</sup> Previous studies in Korea determined the association between transportation inconveniences and the unmet healthcare needs of vulnerable populations (e.g., elderly people or rural residents)<sup>7,41</sup>; nevertheless, these same studies acknowledged the lack of detailed research on specific transportation aspects (e.g.,

costs or transportation modes) that limit people's accessibility to healthcare services.<sup>7</sup> To close this research gap, we used a nationally representative dataset of individuals and households in Korea,<sup>25</sup> and analyzed transportation costs of healthcare travel for both inpatient and outpatient care.

In summary, our results showed that the average annual transportation costs were USD 43.70 for inpatient and USD 41.43 for outpatient care. Moreover, the average transportation costs per visit made to a healthcare service were USD 27.67 for inpatient and USD 2.09 for outpatient care. Regarding transportation modes, for inpatient care visits, most used private vehicles; for outpatient care visits, most walked or biked. These results suggested differences in transport utilization related to accessible transportation modes that differ according to levels of public transport infrastructure.

Additionally, transportation costs were estimated by cause of travel (including all 238 disease groups and 19 injuries we found in the KHPS data). Particularly, outpatient care users experienced high transportation costs when they had cancer diagnoses. Furthermore, the influencing factors of transportation costs were age, healthcare coverage, household income, disability status, and residential area. We believe our study provides evidence that transportation cost burden is higher among older, low-income, disabled, or geographically isolated (i.e., rural residents) populations; specifically, it seems to be high among major NCD groups with severe symptoms (e.g., cancer), which often require regular follow-up. Hence, despite the well-structured public transportation system in Korea, transportation costs can still be burdensome to vulnerable populations, especially among those without private vehicles.

In response, we believe there is a need for future investigations on transportation cost disparities in disadvantaged groups (e.g., elderly, low-income, or disabled individuals, and those in rural areas, with major NCD diagnoses, or without private vehicles), and for the targeted implementation of policies to reduce transportation cost burden among these populations.

## SUPPLEMENTARY MATERIAL

### Supplementary Table 1

Logistic regression analyses on the influencing factors of transportation costs for healthcare service visits by service type

[Click here to view](#)

## REFERENCES

1. Syed ST, Gerber BS, Sharp LK. Traveling towards disease: transportation barriers to health care access. *J Community Health* 2013;38(5):976-93.  
[PUBMED](#) | [CROSSREF](#)
2. Wallace R, Hughes-Cromwick P, Mull H, Khasnabis S. Access to health care and nonemergency medical transportation - two missing links. *Transp Res Rec* 2005;1924(1):76-84.  
[CROSSREF](#)
3. Wallace R, Hughes-Cromwick P, Mull H. Cost-effectiveness of access to nonemergency medical transportation: comparison of transportation and health care costs and benefits. *Transp Res Rec* 2006;1956(1):86-93.  
[CROSSREF](#)

4. Song YJ. The South Korean health care system. *Japan Med Assoc J* 2009;52(3):206-9.
5. National Health Insurance Service. *2018 National Health Insurance Statistical Yearbook*. Wonju: National Health Insurance Service; 2019, 40-1.
6. Korean Statistical Information Service. Projected population by age (Korea). [http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT\\_1BPA001&conn\\_path=I2&language=en](http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1BPA001&conn_path=I2&language=en). Updated 2019. Accessed April 16, 2020.
7. Choi Y, Nam K, Kim CY. Association between convenience of transportation and unmet healthcare needs of rural elderly in Korea. *J Prev Med Public Health* 2019;52(6):355-65.  
[PUBMED](#) | [CROSSREF](#)
8. Kim JR, Jeong B, Park KS, Kang YS. Associations of generalized trust and social participation at the individual level with unmet healthcare needs in communities with high mortality. *J Korean Med Sci* 2018;33(11):e84.  
[PUBMED](#) | [CROSSREF](#)
9. Park JH, Lee JS, Lee JY, Hong JY, Kim SY, Kim SO, et al. Factors affecting national health insurance mass screening participation in the disabled. *J Prev Med Public Health* 2006;39(6):511-9.  
[PUBMED](#)
10. Yoon C, Ju YS, Kim CY. Disparities in health care utilization among urban homeless in South Korea: a cross-sectional study. *J Prev Med Public Health* 2011;44(6):267-74.  
[PUBMED](#) | [CROSSREF](#)
11. Hwang B, Chun SM, Park JH, Shin HI. Unmet healthcare needs in people with disabilities: comparison with the general population in Korea. *Ann Rehabil Med* 2011;35(5):627-35.  
[PUBMED](#) | [CROSSREF](#)
12. Kim YA, Oh IH, Yoon SJ, Kim HJ, Seo HY, Kim EJ, et al. The economic burden of breast cancer in Korea from 2007–2010. *Cancer Res Treat* 2015;47(4):583-90.  
[PUBMED](#) | [CROSSREF](#)
13. Kim YE, Lee YR, Park SY, Lee KS, Oh IH. The economic burden of otitis media in Korea, 2012: a nationally representative cross-sectional study. *BioMed Res Int* 2016;2016:3596261.  
[PUBMED](#) | [CROSSREF](#)
14. Lee KS, Chang HS, Lee SM, Park EC. Economic burden of cancer in Korea during 2000-2010. *Cancer Res Treat* 2015;47(3):387-98.  
[PUBMED](#) | [CROSSREF](#)
15. Lee YH, Yoon SJ, Kim EJ, Kim YA, Seo HY, Oh IH. Economic burden of asthma in Korea. *Allergy Asthma Proc* 2011;32(6):35-40.  
[PUBMED](#) | [CROSSREF](#)
16. Lee YR, Cho B, Jo MW, Ock M, Lee D, Lee D, et al. Measuring the economic burden of disease and injury in Korea, 2015. *J Korean Med Sci* 2019;34 Suppl 1:e80.  
[PUBMED](#) | [CROSSREF](#)
17. Shon C, Choi HY, Shim JJ, Park SY, Lee KS, Yoon SJ, et al. The economic burden of hepatitis A, B, and C in South Korea. *Jpn J Infect Dis* 2016;69(1):18-27.  
[PUBMED](#) | [CROSSREF](#)
18. Hanly P, Céilleachair AÓ, Skally M, O'Leary E, Kapur K, Fitzpatrick P, et al. How much does it cost to care for survivors of colorectal cancer? Caregiver's time, travel and out-of-pocket costs. *Support Care Cancer* 2013;21(9):2583-92.  
[PUBMED](#) | [CROSSREF](#)
19. Leminen A, Tykkyläinen M, Laatikainen T. Self-monitoring induced savings on type 2 diabetes patients' travel and healthcare costs. *Int J Med Inform* 2018;115:120-7.  
[PUBMED](#) | [CROSSREF](#)
20. Secker-Walker RH, Vacek PM, Hooper GJ, Plante DA, Detsky AS. Screening for breast cancer: time, travel, and out-of-pocket expenses. *J Natl Cancer Inst* 1999;91(8):702-8.  
[PUBMED](#) | [CROSSREF](#)
21. Sørensen J, Linde L, Hetland ML. Contact frequency, travel time, and travel costs for patients with rheumatoid arthritis. *Int J Rheumatol* 2014;2014:285951.  
[PUBMED](#) | [CROSSREF](#)
22. Stephens JM, Brotherton S, Dunning SC, Emerson LC, Gilbertson DT, Gitlin M, et al. High cost of dialysis transportation in the United States: exploring approaches to a more cost-effective delivery system. *J Health Econ Outcomes Res* 2013;1(2):134-50.  
[CROSSREF](#)
23. Woolley C, Philips Z, Whynes DK, Cotton SC, Gray NM, Sharp L, et al. United Kingdom cervical cancer screening and the costs of time and travel. *Int J Technol Assess Health Care* 2007;23(2):232-9.  
[PUBMED](#) | [CROSSREF](#)

24. Jo C. Cost-of-illness studies: concepts, scopes, and methods. *Clin Mol Hepatol* 2014;20(4):327-37.  
[PUBMED](#) | [CROSSREF](#)
25. Korea Health Panel Study. <https://www.khp.re.kr:444/eng/main.do>. Updated 2016. Accessed March 23, 2020.
26. Kim YE, Park H, Jo MW, Oh IH, Go DS, Jung J, et al. Trends and patterns of burden of disease and injuries in Korea using disability-adjusted life years. *J Korean Med Sci* 2019;34 Suppl 1:e75.  
[PUBMED](#) | [CROSSREF](#)
27. Health Insurance Review & Assessment Service, National Health Insurance Service. *Classification of 298 Diseases. 2018 National Health Insurance Statistical Yearbook*. Wonju: National Health Insurance Service; 2019, 428-38.
28. Ministry of the Interior and Safety. Administrative districts of local governments. In: Information and Statistics Division, editor. *Statistical Yearbook of MOIS (Volume 21)*. Sejong: Ministry of the Interior and Safety; 2019.
29. Bank of Korea Economic Statistics System. Exchange rate of Won against US Dollar, China Yuan Renminbi, and Japan Yen, longer frequency. <http://ecos.bok.or.kr/>. Updated 2020. Accessed April 8, 2020.
30. Organization for Economic Cooperation and Development. Stat. 4. PPPs and exchange rates. [https://stats.oecd.org/Index.aspx?DatasetCode=SNA\\_TABLE1](https://stats.oecd.org/Index.aspx?DatasetCode=SNA_TABLE1). Updated 2020. Accessed July 3, 2020.
31. Kim N, Seo J, Jung Y, Lee J, Lee N, Bae J, et al. *A Report on the Korea Health Panel Survey of 2016: Chronic Disease, Morbidity, Health Behaviour and Health Status*. Sejong: Korea Institute for Health and Social Affairs; 2018.
32. Wang C. The impact of car ownership and public transport usage on cancer screening coverage: empirical evidence using a spatial analysis in England. *J Transp Geogr* 2016;56:15-22.  
[PUBMED](#) | [CROSSREF](#)
33. Godavarthy RP, Mattson J, Ndembe E. Cost-benefit analysis of rural and small urban transit in the United States. *Transp Res Rec* 2015;2533(1):141-8.  
[CROSSREF](#)
34. The Korea Transport Institute. *Transport-SOC related Government Expense. National Transportation Statistics 2018*. Sejong: The Korea Transport Institute; 2019.
35. Organization for Economic Cooperation and Development. *Urban Transport Governance and Inclusive Development in Korea*. Paris: OECD Publishing; 2017.
36. The Korea Transport Institute. *Passenger Journeys and Total Distance Travelled on Rail/Subway/Airport Rail/Light Rail. National Transportation Statistics 2018*. Sejong: The Korea Transport Institute; 2019.
37. Jowett S, Bryan S, Mahé I, Brieger D, Carlsson J, Kartman B, et al. A multinational investigation of time and traveling costs in attending anticoagulation clinics. *Value Health* 2008;11(2):207-12.  
[PUBMED](#) | [CROSSREF](#)
38. Lee JY, Jo MW, Yoo WS, Kim HJ, Eun SJ. Evidence of a broken healthcare delivery system in Korea: unnecessary hospital outpatient utilization among patients with a single chronic disease without complications. *J Korean Med Sci* 2014;29(12):1590-6.  
[PUBMED](#) | [CROSSREF](#)
39. Yoon TH, Lee SY, Kim CW, Kim SY, Jeong BG, Park HK. Inequalities in medical care utilization by South Korean cancer patients according to income: a retrospective cohort study. *Int J Health Serv* 2011;41(1):51-66.  
[PUBMED](#) | [CROSSREF](#)
40. Jeon B, Kwon S, Kim H. Health care utilization by people with disabilities: A longitudinal analysis of the Korea Welfare Panel Study (KoWePS). *Disabil Health J* 2015;8(3):353-62.  
[PUBMED](#) | [CROSSREF](#)
41. Kim YS, Lee J, Moon Y, Kim KJ, Lee K, Choi J, et al. Unmet healthcare needs of elderly people in Korea. *BMC Geriatr* 2018;18(1):98.  
[PUBMED](#) | [CROSSREF](#)