

Original Article



Accessibility for Rehabilitation Therapy According to Socioeconomic Status in Patients With Stroke: A Population-Based Retrospective Cohort Study

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HIGHLIGHTS

- Rural area and medical aid were associated with low use of rehabilitation therapy.
- Rehabilitation therapy utilization was less affected by income level.
- Age, male, and comorbidities were associated with low use of rehabilitation therapy.

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Accessibility for Rehabilitation Therapy According to Socioeconomic Status in Patients With Stroke: A Population-Based Retrospective Cohort Study

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ABSTRACT

This study aimed to investigate accessibility for rehabilitation therapy according to socioeconomic status (SES) after stroke using nationwide population-based cohort data. We selected patients with a diagnosis with stroke (International Classification of Diseases, 10th Revision code: I60-64) and SES including residential area, income level, and insurance type were also assessed. Receiving continuous rehabilitation therapy was defined as accumulation of “Rehabilitative developmental therapy for disorder of central nervous system (claim code: MM105)” more than 41 times. Logistic regression analyses were performed to investigate the association between SES and rehabilitation therapy using odds ratios (ORs) and 95% confidence intervals (CIs). A total of 18,842 patients with stroke were enrolled. Rural area (OR, 0.745; 95% CI, 0.664–0.836) and medical aid (OR, 0.605; 95% CI, 0.494–0.741) were associated with lower rate of receiving rehabilitation therapy. As for income level, when lowest income group was used as a reference group, low-middle group showed an increased rate of receiving rehabilitation therapy (OR, 1.206; 95% CI, 1.020–1.426). Although rehabilitation therapy after stroke is covered with national health insurance program in Korea, there still existed disparities of accessibility for rehabilitation therapy according to SES. Our results would suggest helpful information for health policy in patients with stroke.

Keywords: Stroke; Rehabilitation; Socioeconomic factors; Income; Residence characteristics

INTRODUCTION

Stroke is a leading cause of death and disability worldwide [1]. Advances in medicine have reduced mortality after stroke, however, more individuals have acquired stroke-related disability [2,3]. In patients with stroke, impairments of motor control and strength, sensory deficit, language disorder, swallowing difficulty, and cognitive impairment would occur [4,5]. To reduce these impairment and related disability, rehabilitation therapy is recommended, which has shown the association with functional improvement and reduced complications [6-9]. Clinical Guidelines for Stroke Management in Australia have

Conflict of Interest

The corresponding author of this manuscript is an editor of Brain & NeuroRehabilitation. The corresponding author did not engage in any part of the review and decision-making process for this manuscript. The other authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Yoon SY; Data curation: Yoon SY, Park JM; Formal analysis: Yoon SY; Funding acquisition: Yoon SY; Investigation: Yoon SY, Park JM; Methodology: Kim YW; Project administration: Kim YW; Supervision: Yang SN; Writing - original draft: Yoon SY; Writing - review & editing: Kim YW, Yang SN.

recommended early rehabilitation and performing rehabilitation therapies including physical therapy and occupational therapy as much as possible [10]. Also, Canadian Stroke Best Practice Recommendation suggested that rehabilitation program with interdisciplinary team approach should be delivered to reduce the risk of complication and optimize recovery [11].

Despite of the importance of rehabilitation therapy for the recovery after stroke, there have been only a few studies on the association between socioeconomic status (SES) and the utilization of rehabilitation therapy [12-14]. Older age, lower SES, and multiple comorbidities have been suggested as negative predictive factors for the probability of receiving inpatient rehabilitation in Taiwan [12]. A recent prospective observational study in New Zealand suggested that nonurban stroke patients received less physical therapy and community rehabilitation than those living in urban area [14]. Medical and healthcare systems differ across the counties, which might influence the utilization pattern of rehabilitation therapy in patients with stroke. In Korea, rehabilitation programs, including physical therapy and occupational therapy, for stroke patients are insured by National Health Insurance System, and stroke patients with severe disability can use transportation support system. There has been no attempt to investigate accessibility for rehabilitation therapy according to SES after stroke in Korea. Therefore, this study aimed to investigate the association between SES and rehabilitation therapy utilization in Korea using nationwide population-based cohort data.

MATERIALS AND METHODS

Data source

This study used the Korean National Health Insurance Service (NHIS) – National Sample Cohort (NSC) data, which includes information of approximately 1 million patients. NHIS is a compulsory insurance program that covers most of the healthcare services conducted in Korea. Approximately 97% of the total population has been covered by the NHIS, and the remaining 3% of the population are covered by the Medical Assistance Program, but their outpatient and inpatient claims are reviewed by the NHIS. The data includes a unique anonymous number for each patient and summarizes demographic characteristics such as age, sex, and type of insurance, a list of diagnoses according to the International Classification of Diseases, 10th Revision (ICD-10), medical costs claimed, and drug prescriptions. This study was approved by the Institutional Review Board (IRB) of Korea University Guro Hospital, which waived the need for informed consent (IRB No. 2022GR0140).

Study population

We selected new-onset stroke patients based on ICD-10 code (I60-I64) from 2003 to 2019. We only included patients admitted to the hospital with a diagnosis of stroke by brain imaging evaluation such as magnetic resonance image or computed tomography. After that, we excluded patients 1) with combined diagnosis of transient ischemic attack and 2) who had already been registered in the national disability registration (NDR) system from brain impairment before the diagnosis with stroke. Finally, 18,842 patients with new-onset stroke were enrolled and analyzed for the accessibility of rehabilitation therapy according to SES (**Fig. 1**).

Rehabilitation therapy

In Korea, various rehabilitation treatments such as physical therapy, occupational therapy, dysphagia therapy, cognitive therapy, and speech therapy are implemented for recovery of the impairment after stroke. In this study, among these various rehabilitation treatments,

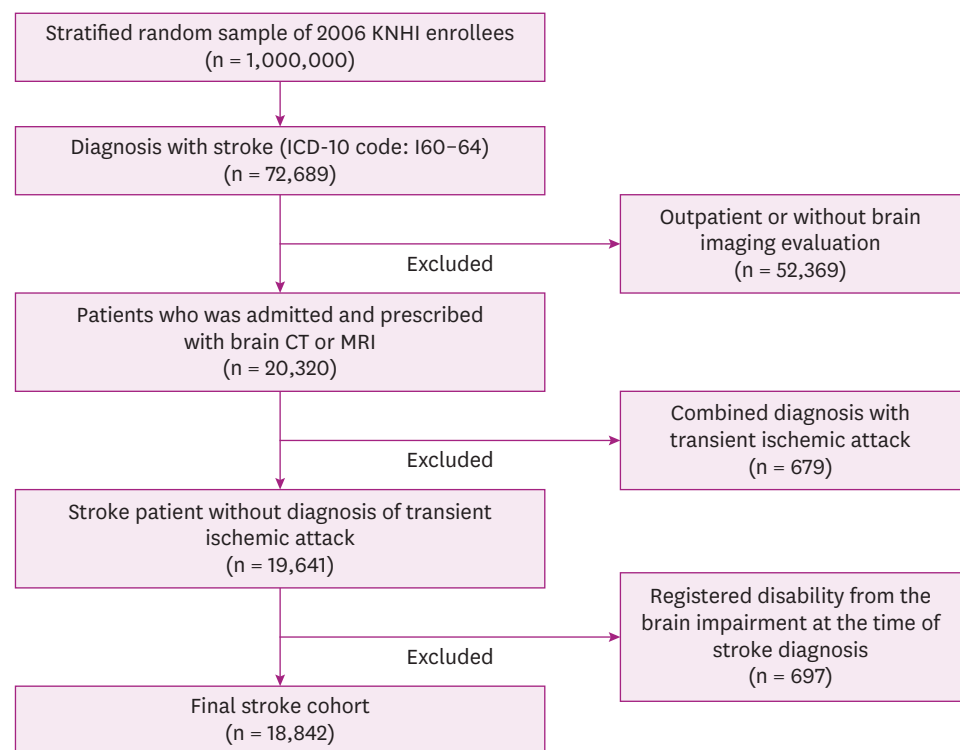


Fig. 1. Flowchart for participant selection.
ICD-10, International Classification of Diseases, 10th Revision.

we focused on “Rehabilitative developmental therapy for disorder of central nervous system (claim code: MM105)” which is the most important for functional recovery in patients with stroke. This therapy can be claimed when a qualified rehabilitation specialist or physical therapist has performed 1:1 professional rehabilitation therapy for patients with injuries to the central nervous system for more than 30 minutes. It can be performed twice in a day for the first 2 years after stroke onset and then only once a day thereafter. In Korea, after acute management of stroke, patients with functional impairment are usually transferred to rehabilitation department, and received intensive rehabilitation therapy for about one month. The discharge locations vary, including other hospitals for continuous rehabilitation or home, depending on various factors including functional limitations and SES. In this study, we tried to evaluate the effects of SES on continuous rehabilitation treatment, therefore, claim code of MM105 more than 41 times were considered as “receiving continuous rehabilitation treatment.”

SES

Residential areas were categorized into capital, urban, and rural areas. In Korea, there are 6 metropolitan cities with the total populations exceeding 1 million people: Busan, Incheon, Daejeon, Daegu, Gwangju, and Ulsan. Patients living in these cities were categorized as living in a “urban” area. Patients living in areas other than Seoul, the capital of Korea, and the urban areas mentioned above were classified as living in “rural” areas.

Regarding income levels, the National Health Insurance (NHI) premium was used as a proxy measure of precise income because it is proportional to monthly income, including earnings and capital gains. In Korea, the type of health insurance is classified as NHI or medical

aid. People who have NHI based on employment must pay a monthly insurance premium according to their annual salary, and people who are self-employed pay for their premium based on the value of their property. The income deciles of enrolled subjects were categorized into four categories (Q1: all medical aid enrollees + 0–20 percentiles of NHI enrollees, Q2: 21–50 percentile of NHI enrollees, Q3: 51–80 percentile of NHI enrollees, Q4: 81–100 percentile of NHI enrollees).

Covariates

Ages were categorized into four groups: < 60 years, 60–69 years, 70–79 years, and ≥80 years. Comorbidity was defined using a Charlson Comorbidity Index (CCI). Diseases included in the CCI are congestive heart failure, myocardial infarction, cerebrovascular disease, peripheral vascular disease, connective tissue disease, chronic lung disease, ulcer, chronic liver disease, severe liver disease, dementia, diabetes, hemiplegia, moderate or severe kidney disease, tumor, leukemia, lymphoma, moderate or metastatic solid tumor, and acquired immunodeficiency syndrome. In this study, we excluded cerebrovascular disease and hemiplegia for the calculation of the CCI score, because these two diagnoses are too closely related with stroke, which may increase the CCI score. NDR from brain impairment at least 6 months after stroke onset was extracted and used as a proxy for disease severity. The Korean government classifies NDR from brain impairment to six grades according to activities of daily living based on Modified Barthel Index (MBI). We classified NDR grades to following three categories: none ($97 \leq \text{MBI}$), mild to moderate (NDR 4–6 grades, $70 \leq \text{MBI} \leq 96$), and severe (NDR 1–3 grades, $\text{MBI} < 70$).

Statistical analyses

Baseline categorical variables were expressed as numbers and percentages according to the utilization of rehabilitation therapy. The χ^2 test was used to compare distributions of the baseline characteristics between stroke patients with and without rehabilitation therapy. We estimated the odds ratio (OR) and 95% confidence interval (CI) for the relationships between the covariates including SES and receiving rehabilitation therapy by applying univariate and multivariate logistic regression models. All statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA) with a statistical significance level of 0.05.

RESULTS

Baseline characteristics of the study population

Table 1 presents the demographic and medical characteristics of stroke patients according to receiving continuous rehabilitation therapy. There was a significant difference in age between the groups. As age increased, stroke patients tended to receive less rehabilitation therapy. Regarding SES, stroke patients living in rural area, with lowest income level, or medical aid significantly less received rehabilitation therapy. Stroke patients who received rehabilitation therapy have more been registered in NDR from brain impairment than those who did not receive rehabilitation therapy.

SES and other factors associated with receiving rehabilitation therapy

Table 2 displays the OR for receiving rehabilitation therapy using univariate and multivariate logistic regression models. After adjusting covariables, when using the lowest income level as a reference group, stroke patients in low-middle income level received significantly more rehabilitation therapy (OR, 1.206; 95% CI, 1.020–1.426), however, middle-high or highest

Table 1. Characteristics of patients with stroke according to receiving rehabilitation therapy

Variables	Rehabilitation therapy		p value
	Yes (n = 3,078)	No (n = 15,764)	
Age (yr)			< 0.001
< 60	395 (12.8)	1,569 (10.0)	
60–69	586 (19.0)	2,353 (14.9)	
70–79	559 (18.2)	2,571 (16.3)	
≥ 80	1,538 (50.0)	9,271 (58.8)	
Sex			0.885
Men	1,600 (52.0)	8,172 (51.8)	
Women	1,478 (48.0)	7,592 (48.2)	
Income levels			< 0.001
Lowest	522 (17.0)	3,150 (20.0)	
Low-middle	624 (20.3)	2,750 (17.4)	
Middle-high	730 (23.7)	3,667 (23.3)	
Highest	1,202 (39.1)	6,197 (39.3)	
Residential area			< 0.001
Capital	567 (18.4)	2,506 (15.9)	
Urban	788 (25.6)	3,463 (22.0)	
Rural	1,723 (56.0)	9,795 (62.1)	
Insurance type			< 0.001
National health insurance	2,843 (92.4)	14,218 (90.2)	
Medical aid	235 (7.6)	1,546 (9.8)	
CCI	7.18 ± 3.73	7.33 ± 3.81	< 0.001
Other co-morbidities*			
Hypertension	2,778 (90.3)	13,866 (88.0)	< 0.001
Dyslipidemia	2,741 (89.1)	13,575 (86.1)	< 0.001
Pneumonia	1,794 (58.3)	8,499 (53.9)	< 0.001
Urinary tract infection	1,850 (60.1)	6,903 (43.8)	< 0.001
Disability†			< 0.001
None	978 (31.8)	11,886 (75.4)	
Mild to moderate	924 (30.0)	2,276 (14.4)	
Severe	1,176 (38.2)	1,602 (10.2)	

Values are presented as mean ± standard deviation or number (%).

CCI, Charlson Comorbidity Index.

*Other co-morbidities not included in CCI.

†Disability from brain disorder at least six months after stroke onset.

income level was not associated with receiving rehabilitation therapy. Stroke patients living in rural areas received less rehabilitation therapy than those living in capital (OR, 0.745; 95% CI, 0.664–0.836). Medical aid group showed lower utilization of rehabilitation therapy than NHI group (OR, 0.745; 95% CI, 0.664–0.836). Age, male sex, and comorbidities were associated with reduced use of rehabilitation therapy, whereas disability severity was associated with increased use of rehabilitation therapy in patients with stroke.

Subgroup analysis

The results of the subgroup analyses of stroke type, sex, age, disability grades, and onset duration for the association between SES and rehabilitation therapy are presented in **Supplementary Tables 1–3** and **Tables 3** and **4**, respectively. Overall, the association between SES and utilization of rehabilitation therapy showed similar patterns with main analysis. Somewhat different results of subgroup analyses are as follows.

As for stroke type, patients with ischemic stroke showed more significant association between income level and rehabilitation therapy than hemorrhagic stroke (**Supplementary Table 1**). In stroke patients aged ≥ 80 years, there was no significant difference in receiving rehabilitation therapy according to insurance type (**Supplementary Table 3**). In stroke patients with mild to moderate disability, the association between income level and rehabilitation therapy

Table 2. Unadjusted and adjusted OR for rehabilitation therapy after stroke

Variables	Unadjusted		Adjusted*	
	OR (95% CI)	p value	OR (95% CI)	p value
Age (yr)				
< 60	1.000		1.000	
60–69	0.989 (0.858–1.141)	0.882	0.902 (0.77–1.059)	0.208
70–79	0.864 (0.748–0.997)	0.045	0.683 (0.58–0.803)	< 0.001
≥ 80	0.659 (0.583–0.745)	< 0.001	0.533 (0.46–0.618)	< 0.001
Sex				
Men	1.000		1.000	
Women	0.994 (0.92–1.074)	0.885	1.165 (1.067–1.272)	< 0.001
Income level				
Lowest	1.000		1.000	
Low-middle	1.369 (1.206–1.555)	< 0.001	1.206 (1.020–1.426)	0.029
Middle-high	1.201 (1.063–1.357)	0.003	1.042 (0.886–1.225)	0.623
Highest	1.170 (1.047–1.308)	0.006	1.113 (0.955–1.297)	0.171
Residential area				
Capital	1.000		1.000	
Urban	1.006 (0.892–1.133)	0.926	0.973 (0.853–1.109)	0.679
Rural	0.777 (0.700–0.863)	< 0.001	0.745 (0.664–0.836)	< 0.001
Insurance type				
National health insurance	1.000		1.000	
Medical aid	0.760 (0.659–0.877)	< 0.001	0.605 (0.494–0.741)	< 0.001
Disability				
None	1.000		1.000	
Mild to moderate	4.934 (4.462–5.455)	< 0.001	5.281 (4.760–5.860)	< 0.001
Severe	8.922 (8.076–9.855)	< 0.001	9.116 (8.211–10.121)	< 0.001
CCI	0.990 (0.980–1.000)	0.047	0.942 (0.929–0.955)	< 0.001

OR, odds ratio; CI, confidence interval; CCI, Charlson Comorbidity Index.

*Adjusted for age, sex, socioeconomic status, comorbidities, disability grades, and lifestyle factors (smoking, alcohol consumption, and physical activity).

Table 3. Adjusted OR between socioeconomic status and rehabilitation therapy after stroke according to severity of disability

Variables	None		Mild to moderate		Severe	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Age (yr)						
> 60	1.000		1.000		1.000	
60–69	1.022 (0.777–1.344)	0.875	0.721 (0.522–0.995)	0.047	0.776 (0.561–1.073)	0.125
70–79	0.829 (0.623–1.104)	0.200	0.424 (0.309–0.581)	> 0.001	0.574 (0.415–0.792)	> 0.001
≥ 80	1.075 (0.839–1.378)	0.566	0.202 (0.150–0.273)	> 0.001	0.341 (0.253–0.459)	> 0.001
Sex						
Men	1.000		1.000		1.000	
Women	1.087 (0.949–1.245)	0.230	1.268 (1.066–1.508)	0.007	1.314 (1.110–1.555)	0.002
Residential area						
Capital	1.000		1.000		1.000	
Urban	1.156 (0.945–1.413)	0.158	0.844 (0.649–1.097)	0.205	0.881 (0.680–1.141)	0.337
Rural	0.820 (0.686–0.981)	0.030	0.694 (0.551–0.874)	0.002	0.674 (0.538–0.843)	> 0.001
Income level						
Lowest	1.000		1.000		1.000	
Low-middle	1.054 (0.813–1.366)	0.693	1.586 (1.134–2.217)	0.007	1.152 (0.843–1.576)	0.374
Middle-high	1.001 (0.781–1.284)	0.992	1.364 (0.989–1.881)	0.059	0.899 (0.664–1.216)	0.488
Highest	1.018 (0.808–1.282)	0.881	1.511 (1.112–2.054)	0.008	1.071 (0.805–1.425)	0.636
Insurance type						
National health insurance	1.000		1.000		1.000	
Medical aid	1.123 (0.834–1.512)	0.446	0.573 (0.394–0.833)	0.004	0.326 (0.222–0.478)	> 0.001
CCI	0.972 (0.952–0.994)	0.011	0.952 (0.927–0.977)	> 0.001	0.891 (0.868–0.915)	> 0.001

OR, odds ratio; CI, confidence interval; CCI, Charlson Comorbidity Index.

utilization was more significant than those with severe disability (**Table 3**). In the subgroup analyses according to onset duration, there were some interesting results in residential area (**Table 4**). In stroke patients with an onset duration < 6 months, there was no significant

Table 4. Adjusted OR between socioeconomic status and rehabilitation therapy after stroke according to onset duration

Variables	< 6 months		6–24 months		≥ 24 months	
	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Age (yr)						
< 60	1.000		1.000		1.000	
60–69	1.320 (0.962–1.811)	0.086	0.737 (0.581–0.936)	0.012	0.831 (0.661–1.045)	0.113
70–79	0.877 (0.626–1.229)	0.445	0.721 (0.570–0.911)	0.006	0.509 (0.401–0.647)	< 0.001
≥ 80	0.874 (0.647–1.181)	0.381	0.513 (0.413–0.636)	< 0.001	0.350 (0.282–0.435)	< 0.001
Sex						
Men	1.000		1.000		1.000	
Women	1.283 (1.086–1.516)	0.003	1.070 (0.941–1.216)	0.300	1.212 (1.062–1.383)	0.004
Income level						
Lowest	1.000		1.000		1.000	
Low-middle	1.247 (0.900–1.730)	0.185	1.244 (0.974–1.589)	0.081	1.194 (0.930–1.533)	0.164
Middle-high	1.199 (0.877–1.641)	0.256	1.091 (0.861–1.382)	0.470	0.927 (0.726–1.184)	0.544
Highest	1.164 (0.864–1.568)	0.319	1.144 (0.915–1.432)	0.238	1.097 (0.873–1.379)	0.428
Residential area						
Capital	1.000		1.000		1.000	
Urban	1.303 (1.004–1.690)	0.047	0.966 (0.800–1.168)	0.723	0.815 (0.670–0.992)	0.041
Rural	1.002 (0.792–1.267)	0.990	0.712 (0.603–0.841)	< 0.001	0.659 (0.556–0.780)	< 0.001
Insurance type						
National health insurance	1.000		1.000		1.000	
Medical aid	0.906 (0.617–1.329)	0.613	0.527 (0.388–0.715)	< 0.001	0.477 (0.352–0.646)	< 0.001
Disability						
None	1.000		1.000		1.000	
Mild	2.605 (2.146–3.162)	< 0.001	5.373 (4.599–6.277)	< 0.001	9.990 (8.402–11.877)	< 0.001
Moderate	2.248 (1.776–2.847)	< 0.001	9.995 (8.587–11.635)	< 0.001	19.810 (16.763–23.411)	< 0.001
CCI	0.940 (0.915–0.966)	< 0.001	0.929 (0.910–0.948)	< 0.001	0.949 (0.930–0.969)	< 0.001

OR, odds ratio; CI, confidence interval; CCI, Charlson Comorbidity Index.

difference in the rehabilitation therapy utilization between living in capital and living in rural areas (OR, 1.002; 95% CI, 0.792–1.267). In the periods of onset duration from 6 months to 24 months, living in rural area revealed association with less rehabilitation therapy utilization (OR, 0.712; 95% CI, 0.603–0.841). Furthermore, in the periods of onset duration ≥ 24 months, both living in urban areas (OR, 0.815; 95% CI, 0.670–0.992) and rural areas (OR, 0.659; 95% CI, 0.556–0.780) were associated with reduced rehabilitation therapy utilization than living in capital.

DISCUSSION

Among 18,842 patients with stroke, 3,087 (16%) patients received continuous rehabilitation therapy. Overall, rural area and medical aid were associated with low utilization of rehabilitation therapy. As for income level, when lowest income group was used as a reference group, low-middle group showed an increased rate of receiving rehabilitation therapy, whereas income level of middle-high and highest group showed no significant association with rehabilitation therapy utilization. In the subgroup analysis according to onset duration, as onset duration got longer, disparities in rehabilitation therapy according to residential area got worse. Age, male sex, and comorbidities were associated with reduced use of rehabilitation therapy, whereas disability severity was associated with increased use of rehabilitation therapy in patients with stroke.

Stroke is a major public health problem as the population is ageing worldwide. There have been several studies to investigate the association between SES and stroke incidence and related-mortality, which suggested that incidence and mortality of stroke was increased in

individuals with socioeconomic deprivation [15-18]. In addition, functional recovery after stroke has shown the relationship with socioeconomic deprivation [19,20]. In patients with stroke, several neurologic impairments could remain, and early and intensive rehabilitation is recommended in many guidelines to optimize functional recovery [10,11]. However, there have been only few studies on the accessibility for rehabilitation treatment according to SES [12-14]. A previous study in Taiwan, authors investigated predictive factors of receiving inpatients rehabilitation during 7 to 10 months after stroke, and presented that older age, lower SES, and multiple comorbidities were negative predictive factors [12]. A recent prospective multicenter observational study in New Zealand investigated the association between geographic disparities and various factor related with stroke including acute care, functional recovery, rehabilitation, and secondary prevention. The results showed that nonurban stroke patients experienced poorer outcomes and reduced access to stroke management across the entire care continuum including rehabilitation therapy [14]. Uninsured patients have shown to be more likely to die than the privately insured, and among survivals were less likely to receive inpatient rehabilitation [13].

Korea has maintained a nationwide health insurance system since 1963 under the Korean NHIS, and nearly all citizens of Korea are required to join the NHIS. Access to medical and healthcare services in Korea has been considered relatively easily accessible compared to other countries. There has been a previous study to investigate the accessibility of physical therapy and occupational therapy according to geographic regions in patients with central nervous system injury, which suggested that those therapies were concentrated in the capital area and other large urban areas [21]. However, to our knowledge, there has been no attempt to investigate the accessibility of rehabilitation therapy after stroke in Korea. Neurologic impairment after stroke such as gait disturbance and related mobility restriction would make stroke patients difficult to use medical services including rehabilitation therapy. Therefore, this study investigated the association between SES and utilization of rehabilitation therapy. In our results, overall, urban areas and medical aid insurance type were related with lower utilization of rehabilitation therapy. On the other hand, income level showed somewhat different results. Although low-middle income group received more rehabilitation therapy than lowest income group, upper-half income group did not receive more rehabilitation therapy than lowest income group. Based on these results, we thought that disparities in income level was relatively not significant for stroke patients in Korea. In the subgroup analysis, overall, results remained similar with main analyses. However, in the subgroup analysis by disease duration, we found that geographical disparities in rehabilitation therapy utilization got more significant as disease duration got longer. In stroke patients with onset duration more than two years, stroke patients in both urban and rural area less received rehabilitation therapy than those living in capital. Previous studies on the association between SES and stroke mostly focused on inpatient rehabilitation or the outcome until disease duration 1 year [12-14]. Our results presented different patterns of rehabilitation utilization according to disease duration, which needs clinical attention and relevant future research.

Besides SES, there are other predictive factors for receiving rehabilitation therapy in our results. Older age, especially aged > 70 years, showed significant association with reduced use of rehabilitation therapy. This is in line with a previous study [12]. It seems that medical condition such as sarcopenia or frailty related with ageing and comorbidities would influence the neurologic recovery after stroke, which made these older patients less likely to receive rehabilitation therapy. Male sex also showed the relationship with lower probability of receiving rehabilitation. Previous research has shown that there are sex differences in the utilization of

health care services and that women have a higher utilization rate than men [22,23]. Increased number of comorbidities was associated with less utilization of rehabilitation therapy, which is in line with previous study. This study used claim-based data, thus, stroke severity could not be obtained. Instead, NDR grades was used as a proxy for disease severity. NDR severity and probability of rehabilitation utilization showed positive association.

This study has several limitations. First, we focused on the “Rehabilitative developmental therapy for disorder of central nervous system (claim code: MM105)” among various rehabilitation treatments. Although it is the most important physical therapy for functional recovery in patients with stroke, it could bias our results. We tried to evaluate the effects of SES on continuous rehabilitation therapy utilization, thus, it was difficult to consider and include various kinds of rehabilitation therapy for the analysis. In this study, we defined “continuous rehabilitation therapy” as claim code of MM105 more than 41 times to evaluate impact of SES on rehabilitation therapy utilization. Second, this is a nationwide database-based study, and we could not obtain information about stroke severity. Instead, we used NDR grades as a proxy for disease severity. Finally, we only used residential area, insurance type, and income level to represent SES. More information such as education level and occupation could draw more profound interpretations for the effects of SES on rehabilitation therapy utilization. The results of present study should raise awareness in clinicians and healthcare professionals about the inequality of accessibility for rehabilitation therapy in stroke patients with low SES.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Adjusted OR between socioeconomic status and rehabilitation therapy after stroke according to stroke type

[Click here to view](#)

Supplementary Table 2

Adjusted OR between socioeconomic status and rehabilitation therapy after stroke according to sex

[Click here to view](#)

Supplementary Table 3

Adjusted OR between socioeconomic status and rehabilitation therapy after stroke according to age groups

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