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Causes and Trends of Disabilities in Community-Dwelling Stroke Survivors: A Population-Based Study

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HIGHLIGHTS

- One-third of community-dwelling stroke survivors have disabilities.
- Common causes of disabilities include musculoskeletal, sensory & medical problems.
- Disabilities have decreased from 2007–2009 to 2010–2012.

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ABSTRACT

Many stroke survivors live with disabilities in the community. This study aimed to investigate the causes and trends of disabilities among community-dwelling stroke survivors. A total of 1547 community-dwelling stroke survivors ≥ 19 years were identified using the Korea National Health and Nutrition Examination Survey (KNHANES) database from 2007 to 2018. We analyzed the causes and trends of disabilities in strokes survivors using complex-samples procedures. During 2007–2018, 38.0% of stroke survivors were found to have disabilities. Stroke itself was the most common cause of disabilities (21.3%). Musculoskeletal (back or neck problems, 7.0%; arthritis, 5.7%; and leg pain excluding arthritis, 2.3%), sensory (visual problems, 3.6%; and auditory problems, 1.4%), and medical problems (diabetes 2.6%; hypertension, 2.3%; heart disease, 1.5%) accounted for the rest of the other causes of disabilities. Upon analyzing the trends, we found that both the proportion of stroke survivors with disabilities and that of stroke survivors with stroke-related disabilities decreased from KNHANES IV (2007–2009) to V (2010–2012). After 2010–2012, the proportion of both groups stayed constant. The burden of disabilities in non-hospitalized stroke survivors has decreased but still remains high. Attention is warranted because many other problems than a stroke can cause disabilities in community-dwelling stroke survivors.

Keywords: Disability Evaluation; Disabled Persons; Epidemiology; Rehabilitation; Stroke

INTRODUCTION

Stroke is a leading cause of disability worldwide, despite continuous advances in treatment methods [1]. According to the International Classification of Functioning, Disability and Health (ICF), disability is a comprehensive biopsychosocial concept consisting of impairments, activity limitations, and participation restrictions [2]. Impairments are problems of body function or structure, activity limitations are related to an individual's difficulties in performing an activity, and participation restrictions are problems an individual may experience in participating in life situations. ICF also presents environmental factors that act reciprocally to all these components [3].

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.

Previous studies have suggested musculoskeletal problems, obesity, diabetes, hearing loss, and dementia as the causes of disability in stroke survivors [4-8]. However, the examined causes of disability were diverse across studies according to the design, region of study, and outcome measures. For instance, in a recent study, the leading causes for years lived with disability and injury in the perspective of heart disease and stroke were different between United States and the rest of the world [6]. Given that the causes of disabilities are complex and inconsistent across different populations and regions, studies on the causes of disabilities in non-institutionalized Korean stroke survivors are necessary so that informed decisions may be made to facilitate recovery in our patients.

There have been several longitudinal studies that reported the proportion of participants with disabilities after the onset of stroke [9-13]. The proportion of stroke survivors with disability has previously been reported to be 22-40% at the 6-month follow-up [10] and 29%–44% at the 10-year follow-up [9,13]. This inconsistency may arise from the wide variety of disability measures and whether the institutionalized patients were included. To our knowledge, however, nationwide studies on the temporal trends on the disabilities of community-dwelling post-stroke patients are scarce. The information on the long-term trends of disabilities in non-institutionalized stroke survivors can help identify populations in need of social interventions and help plan long-term policies.

The known causes and trends of disability in stroke survivors are diverse due to various disability measures. Many earlier studies have defined disability using the scales reflecting activities of daily living only [9,11,12]. However, considering the comprehensive concept of disability in real-world, the causes of disabilities that may have minimal effect on the activities of daily living should be examined. Therefore, we decided to define disability using a national survey where the community-dwelling stroke survivors could report the cause(s) of their disability. The present study aimed to analyze the self-reported causes of disabilities and to report the temporal trends of disabilities in non-hospitalized Korean stroke survivors.

MATERIALS AND METHODS

Data source and participants

This study utilized Korea National Health and Nutrition Examination Survey (KNHANES) data, which is composed of the four KNHANES survey cycles: KNHANES IV (2007–2009), KNHANES V (2010–2012), KNHANES VI (2013–2015), and KNHANES VII (2016–2018). The KNHANES database is a national health-related data resource designed by the two-stage stratified cluster sampling method. The KNHANES data provides information on health examinations, health survey, and nutritional survey of community-dwelling Koreans. A detailed data resource profile of KNHANES has been published previously [14].

In the current study, participants who responded “yes” to the question “Have you ever been diagnosed with stroke by a doctor?” were regarded as “stroke survivors”. Among the 75,428 adults aged 19 years or older, 1,547 stroke survivors (803 men and 744 women) were included. The prevalence of stroke survivors in Korean adults aged ≥ 19 years was defined as the number of stroke survivors aged ≥ 19 years divided by the total number of adults aged ≥ 19 years.

Variables

The presence of disabilities was defined by a question “Are your daily or social activities limited due to health problems or physical or mental disabilities?”. If a participant answered “yes” to the abovementioned question, that individual was instructed to choose the causes of disabilities among the examples. The sampled causes of disabilities included stroke, injuries, arthritis, heart disease, respiratory problems, diabetes, hypertension, back or neck problems, cancer, dental or oral problems, visual problems, auditory problems, dementia, psychiatric problems, dizziness, gastrointestinal problems, leg pain excluding arthritis, and headache. In addition, participants were able to write down the specific causes of disabilities in a narrative form, if the items mentioned in the list did not match their cause. The participants could report multiple causes as the reasons for their disabilities. The proportion of individuals with disabilities among stroke survivors was defined as the number of stroke survivors with disabilities divided by the total number of stroke survivors.

Body mass index (BMI) was calculated from the measured height and weight of the participants and categorized into $< 18.5 \text{ kg/m}^2$, $18.5\text{--}24.9 \text{ kg/m}^2$, and $\geq 25 \text{ kg/m}^2$. Excessive alcohol consumption was defined as daily alcohol drinking $> 10 \text{ g}$ for women and $> 20 \text{ g}$ for men [15]. Smoking was categorized as current, past, or never smoker. Data on education level (graduation of elementary school, middle school, high school, or college or university) and residence (urban or rural) were recorded.

Statistical analysis

The characteristics of stroke survivors and the disabilities of stroke survivors according to the survey rounds were examined by complex-sample analysis of variance for continuous variables and the χ^2 test for categorical variables. The causes of disabilities were analyzed using complex-sample descriptive statistics. In addition, stroke survivors were grouped based on presence of disabilities by a stroke. The causes of disabilities other than a stroke were compared between stroke survivors with disabilities due to stroke and those without disabilities by a stroke using a complex-sample χ^2 test. To test the trends from KNHANES cycles from IV to VII, we used complex-sample logistic regression analyses with adjustment for potential confounders. To reflect the sample survey with the complex sampling method, complex-sample procedures incorporating sampling weights were used in all statistical analyses. The data were presented as weighted means \pm standard errors (SEs) or weighted percentage (standard errors of percentage), as appropriate. We used Statistical Package for the Social Sciences version 22 (IBM/SPSS Inc., Armonk, NY, USA) for the statistical calculations.

RESULTS

The characteristics of community-dwelling stroke survivors have been shown in **Table 1**. Across different KNHANES survey rounds from 2007–2009 to 2016–2018, stroke survivors were found to have statistically significant differences in terms of proportion of excessive alcohol consumption and education level. The proportions of older people aged ≥ 65 years, female sex, BMI categories, smoking habits, and residence status were not found to be statistically different between survey cycles.

Causes of disabilities in community-dwelling stroke survivors

As illustrated in **Fig. 1**, stroke (21.3%) was the most common cause of disabilities in community-dwelling stroke survivors, followed by musculoskeletal problems such as back

Table 1. Characteristics of community-dwelling stroke survivors

Characteristics	Total (n = 1,547)	KNHANES survey cycle				p value*
		IV (n = 385)	V (n = 338)	VI (n = 404)	VII (n = 420)	
Age (yr)	65.4 ± 0.4	65.8 ± 0.7	65.2 ± 0.8	65.0 ± 0.8	65.8 ± 0.7	0.849
Ages ≥ 65 (%)	56.7 (1.6)	58.0 (3.4)	56.8 (3.5)	56.2 (3.3)	56.2 (2.8)	0.981
Female sex (%)	45.3 (1.6)	47.6 (3.4)	45.1 (3.3)	44.1 (3.0)	45.1 (2.8)	0.884
BMI (kg/m ²)						0.547
< 18.5	2.2 (0.4)	2.9 (0.9)	2.2 (0.9)	2.4 (0.9)	1.5 (0.6)	
18.5–24.9	56.5 (1.5)	58.8 (2.9)	59.2 (3.3)	52.6 (3.0)	56.8 (2.8)	
≥ 25	41.4 (1.5)	38.4 (2.9)	38.6 (3.2)	44.9 (3.1)	41.7 (2.8)	
Excessive alcohol consumption (%)	7.2 (0.9)	4.8 (1.2)	6.2 (1.6)	5.4 (1.5)	10.9 (2.0)	0.020
Smoking (%)						0.652
Current	17.7 (1.2)	19.4 (2.6)	18.8 (2.8)	14.4 (2.2)	19.0 (2.3)	
Past	34.9 (1.5)	35.9 (3.3)	34.5 (3.3)	37.0 (2.9)	32.5 (2.5)	
Never	47.4 (1.5)	44.7 (3.0)	46.7 (3.2)	48.6 (3.0)	48.5 (2.8)	
Education (%)						0.013
Elementary school	51.6 (1.6)	62.7 (3.6)	52.7 (3.1)	50.1 (3.2)	45.2 (2.7)	
Middle school	18.1 (1.3)	17.7 (2.9)	13.4 (2.4)	19.6 (2.4)	19.9 (2.5)	
High school	20.3 (1.3)	14.1 (2.1)	23.1 (2.9)	19.8 (2.5)	22.9 (2.3)	
College or university	10.0 (1.0)	5.6 (1.6)	10.8 (2.0)	10.4 (2.1)	11.9 (1.9)	
Residence (%)						0.142
Urban	76.2 (1.6)	69.3 (3.2)	77.3 (3.2)	77.5 (2.8)	78.6 (2.7)	
Rural	23.8 (1.6)	30.7 (3.2)	22.7 (3.2)	22.5 (2.8)	21.4 (2.7)	

Data are presented as weighted means ± standard error or weighted percentage (standard error of percentage), as appropriate. KNHANES, Korea National Health and Nutrition Examination Survey; BMI, body mass index.

*p values by complex-sample analysis of variance for continuous variables and the χ^2 test for categorical variables.

or neck problems (7.0%), arthritis (5.7%), and leg pain excluding arthritis (2.3%). Sensory problems including visual problems (3.6%) and auditory problems (1.4%) were also common causes of disabilities. Medical problems such as diabetes (2.6%), hypertension (2.3%), heart disease (1.5%), respiratory problems (1.5%), and gastrointestinal problems (0.9%) also limited the daily or social activities of stroke survivors. Participants also complained of

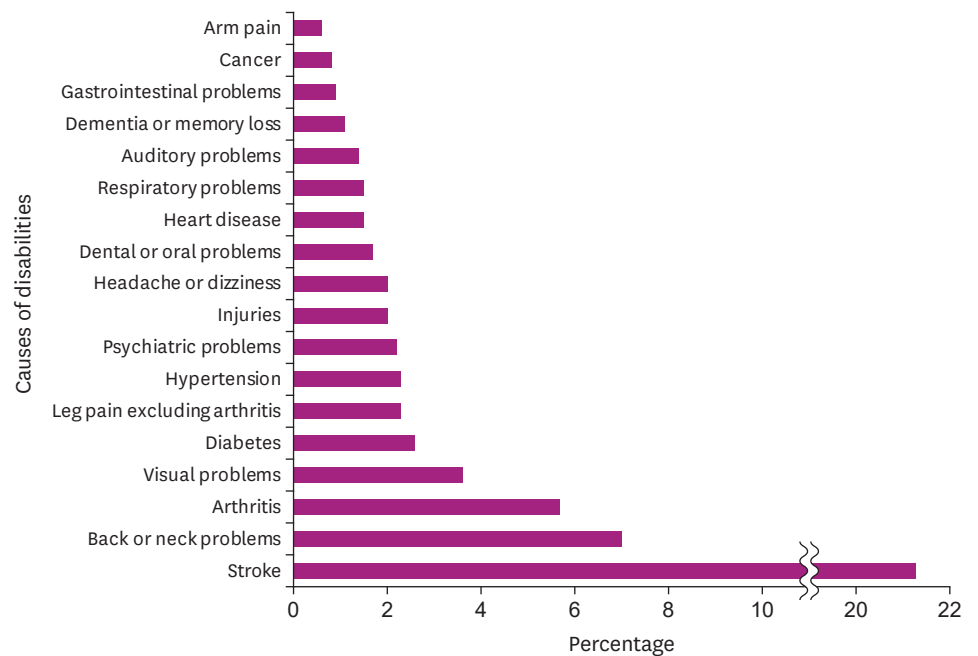


Fig. 1. Self-reported causes of disabilities in community-dwelling stroke survivors during 2007–2018.

psychiatric problems (2.2%), headache or dizziness (2.0%), dental or oral problems (1.7%), and dementia or memory loss (1.1%) as the causes of disabilities.

The proportion of men was significantly higher in the participants with disabilities by a stroke than in those without disabilities by a stroke (67.1% vs. 51.3%, $p < 0.001$). Meanwhile, the age and BMI of stroke survivors with and without disabilities by a stroke were similar ($p = 0.343$ and $p = 0.345$, respectively). **Table 2** shows the causes of disabilities other than a stroke according to the presence of disabilities by a stroke. Stroke survivors with disabilities by a stroke showed a significantly higher proportion of musculoskeletal problems (back or neck problems, arthritis, and leg pain excluding arthritis), medical problems (diabetes, hypertension, and heart disease), visual problems, psychiatric problems, and dental or oral problems compared to those without disabilities by a stroke.

Trends of disabilities in community-dwelling stroke survivors

The prevalence of community-dwelling stroke survivors in Korean adults aged ≥ 19 years and the proportion of individuals with disabilities among stroke survivors are shown in **Fig. 2**. The overall weighted prevalence of stroke survivors was 1.5% (SE, 0.1%) in the Korean adult population during 2007–2018. The prevalence of stroke survivors decreased from 1.5% (2007–2009) to 1.2% (2010–2012) and then increased to 1.7% (2013–2015) and 1.8% (2016–2018) (p for trend = 0.001). Among the 1,547 community-dwelling stroke survivors, the overall proportion of stroke survivors with disabilities by any cause was 38.0% (SE, 1.5%) during 2007–2018.

The proportion of stroke survivors with disabilities by any cause decreased from 59.9% (2007–2009) to 35.4% (2010–2012) and then remained similar in 2013–2015 (31.0%) and in 2016–2018 (32.5%) (p for trend < 0.001). The proportion of stroke survivors with disabilities due to a stroke showed similar trends from 36.0% in 2007–2009, 17.9% in 2010–2012, 17.6% in 2013–2015, and 17.7% in 2016–2018 (p for trend < 0.001), with an overall proportion of 21.3% (SE, 1.3%) during 2007–2018.

Table 2. Causes of disabilities other than a stroke according to the presence of disabilities by a stroke

Causes of disabilities other than a stroke	Disabilities by a stroke*		p value*
	No (n = 1,205)	Yes (n = 342)	
Back or neck problems	5.8 (0.8)	11.3 (2.0)	0.003
Arthritis	5.1 (0.7)	8.0 (1.5)	0.042
Visual problems	2.7 (0.6)	6.9 (1.5)	0.003
Diabetes	1.2 (0.4)	8.0 (1.7)	< 0.001
Leg pain excluding arthritis	1.8 (0.4)	4.0 (1.2)	0.029
Hypertension	0.7 (0.2)	8.1 (1.5)	< 0.001
Psychiatric problems	1.7 (0.4)	4.3 (1.0)	0.006
Injuries	1.7 (0.4)	2.9 (1.4)	0.263
Headache or dizziness	1.9 (0.4)	2.2 (0.8)	0.685
Dental or oral problems	1.0 (0.4)	4.1 (1.1)	0.001
Heart disease	1.0 (0.2)	3.5 (1.1)	0.001
Respiratory problems	1.3 (0.4)	1.8 (0.6)	0.504
Auditory problems	1.2 (0.3)	2.3 (0.8)	0.131
Dementia or memory loss	1.1 (0.3)	1.3 (0.6)	0.765
Gastrointestinal problems	1.0 (0.3)	0.9 (0.5)	0.876
Cancer	1.0 (0.4)	0.3 (0.3)	0.200
Arm pain	0.6 (0.3)	0.5 (0.3)	0.735

Data are presented as weighted percentage (standard error of percentage).

*p values by the complex-sample χ^2 test.

Table 3. Trends in the common causes of disabilities among stroke survivors

Common causes of disabilities	KNHANES survey cycle				p value*
	IV (n = 385)	V (n = 338)	VI (n = 404)	VII (n = 420)	
Back or neck problems	10.7 (1.8)	6.4 (1.7)	5.3 (1.2)	6.5 (1.4)	0.163
Arthritis	13.1 (2.2)	5.9 (1.4)	2.2 (0.6)	4.3 (1.0)	< 0.001
Visual problems	10.3 (1.9)	1.5 (0.6)	2.4 (1.1)	1.8 (0.6)	< 0.001
Diabetes	7.5 (1.6)	1.1 (0.6)	1.6 (0.8)	1.5 (0.7)	< 0.001
Leg pain excluding arthritis	3.2 (1.0)	2.5 (0.8)	0.6 (0.4)	3.1 (0.9)	0.065
Hypertension	9.5 (1.6)	1.2 (0.6)	0.3 (0.2)	0.1 (0.1)	< 0.001
Psychiatric problems	5.3 (1.4)	1.2 (0.8)	1.3 (0.5)	1.8 (0.7)	0.003

Data are presented as weighted percentage (standard error of percentage).

KNHANES, Korea National Health and Nutrition Examination Survey.

*p values by the complex-sample logistic regression analyses adjusting for age, sex, body mass index, smoking, alcohol, education, and residence.

As shown in **Table 3**, disabilities due to arthritis, visual problems, diabetes, hypertension, and psychiatric problems showed significant differences across KNHANES cycles. The proportion of disabilities due to back or neck problems, the most common causes of disabilities other than a stroke, did not show a statistical difference across the survey rounds.

DISCUSSION

The present study investigated the causes and trends of disabilities among community-dwelling Korean stroke survivors. Among the stroke survivors, 38.0% complained of disabilities by any cause and 21.3% suffered disabilities caused by the sequelae of a stroke. Other causes of disabilities in stroke survivors included musculoskeletal, sensory, and medical problems. There was a significant decrease in the proportion of stroke survivors with disabilities from survey rounds IV to V. Nevertheless, one-third of community-dwelling stroke survivors complained of disabilities even in recent years (2016–2018). A comprehensive approach to the various causes of disabilities in non-hospitalized stroke survivors should be investigated in future studies.

In the current study, only one-fifth of stroke survivors reported disabilities caused by a stroke. In addition, stroke survivors commonly reported disabilities by musculoskeletal problems, sensory problems, and medical problems. Those results are consistent with the previous

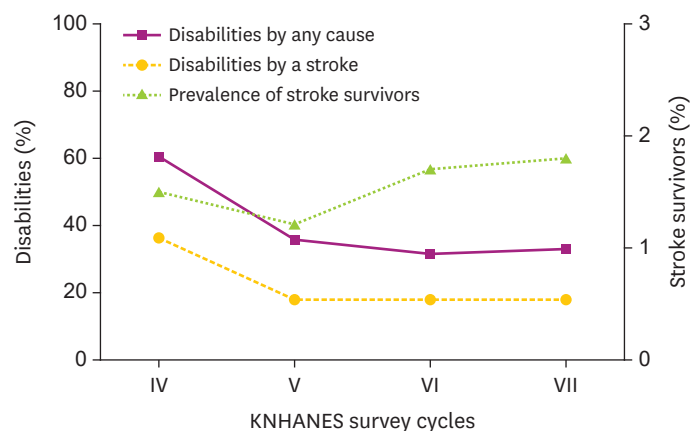


Fig. 2. Trends in the proportion of stroke survivors with disabilities. KNHANES, Korea National Health and Nutrition Examination Survey.

studies that reported musculoskeletal problems, sensory problems, and medical problems are common and negatively affect the lives of stroke survivors [6,8,16]. However, disabilities experienced by stroke survivors differed from previous community-based studies using modified Rankin Scale [9] or Barthel Index [10] to assess disabilities. Because the objective disability evaluation tools are fixed and simple, they may not reveal the diverse potential causes of disabilities in stroke survivors. Furthermore, the disabilities found in the present study based on community-dwelling stroke survivors were different from the complications found in inpatient-based studies [17]. Infections, sores, falls, and confusion were the most common complications in hospitalized stroke patients. Therefore, the current study, to the best of the authors' knowledge, is the first to present findings that better reflect the real-world causes of disabilities in stroke survivors living in Korea.

Among the causes of disabilities in stroke survivors, the prevalence of back or neck problems was not found to change significantly during the study period despite the high prevalence. It has been reported that the prevalence of musculoskeletal pain is higher in the subacute and chronic period than in the acute period after stroke [18]. Considering that the proportion of people with disabilities due to musculoskeletal problems has not decreased despite the decrease in the proportion of stroke survivors with disabilities, it seems that appropriate management for musculoskeletal problems in stroke survivors may not be properly provided in the community health services. Therefore, careful attention and intervention for back or neck problems should be considered for community-dwelling stroke survivors. In addition, these results can be used to better inform health care policy decisions incorporating the needs of stroke survivors living in the community.

Patients with disabilities due to a stroke are more likely to have combined musculoskeletal, visual, and medical problems than patients without disabilities due to a stroke. Motor deficits are the most prevalent impairments seen after stroke and involve the face, upper extremities, and/or lower extremities [19]. Impaired mobility caused by motor impairments post-stroke can result in a variety of musculoskeletal problems including joint contracture, shoulder subluxation, pressure ulcer, and nociceptive pain and medical problems including deep vein thrombosis and pulmonary thromboembolism. Therefore, the probability of accompanying musculoskeletal and medical problems may be higher in the group of patients with disabilities due to stroke. In addition, various neurologic problems caused by stroke including neurogenic bladder and/or bowel and dysphagia may increase the risk of comorbid medical complications such as urinary tract infection and pneumonia. Furthermore, the stroke itself can cause monocular visual loss, homonymous hemianopia, or cortical blindness [19].

The current study found that the proportion of stroke survivors with disabilities by any cause and the proportion of stroke survivors with stroke-related disabilities have significantly decreased from 2007–2009 (KNHANES IV) to 2010–2012 (KNHANES V). The causes and implications of this difference may be multifactorial. Considering the larger decrease in disabilities by a stroke (50.3%) than that by any cause (40.9%), factors alleviating the severity and sequelae of the disease may have contributed to better health outcomes in 2010–2012 (KNHANES V) and beyond. These factors include the improvement of a healthcare system for hyper-acute management and the introduction of the delivery system for early and continuous rehabilitation [20]. The innovations in stroke treatment and the introduction of intensive stroke units may have affected the decrease in the incidence of disabilities in community-dwelling stroke survivors [21–24]. The increase in the number of stroke

units in Korea may lead to the reduction of complications through active monitoring and management in the early stages of acute stroke.

The expansion of Regional Cardiocerebrovascular Centers (RCCVCs) might also have affected the outcomes of acute stroke patients. The RCCVC project in Korea was launched in 2008 with the aim to manage acute stroke patients within 3 hours. The inexpensive and efficient rehabilitation services covered by National Health Insurance system in Korea may also have affected the reduction of the incidence of disabilities in stroke survivors [20,25]. A previous study reported that transfer time to the rehabilitation department after onset decreased from 44 days in 2007 to 30 days in 2011 [26]. On the other hand, with the rapidly increasing number of long-term care facilities, many stroke survivors can easily stay in nursing hospitals and relatively mild stroke patients without disabilities may remain in the community [27]. With the introduction of the long-term care insurance system in 2008, the proportion of beds in nursing hospitals has increased from 16.2% (76,608/472,297 beds) in 2008 to 44.0% (277,101/629,219 beds) in 2018 [28].

During the study period, one-third of community-dwelling stroke survivors were still found to have disabilities. Considering this high prevalence of disabilities in non-hospitalized stroke survivors, the recent implementation of the pilot project for acute patient discharge support and community-linked activities seems meaningful [29]. This system helps patients return to society in a healthy way by establishing a care plan for patients who need continuous health care after discharge and providing integrated health-medical-welfare services. Additionally, appropriate rehabilitation interventions after discharge should be implemented to reduce disabilities in stroke survivors.

The strength of the present study stems from the utilization of a nationally representative database with a complex sampling design. Therefore, findings from our study can be generalized to the entire non-hospitalized Korean stroke survivors. Moreover, although hospital-based information on stroke survivors is abundant, community-based data on stroke survivors are limited in Korea. Our study therefore provides vital information that can be used to inform policy decisions.

This study has several limitations. First, there is a possibility of methodological limitation with a risk of recall bias since the self-reported questionnaire was employed. Second, due to the lack of validated questionnaires on self-reported disabilities in stroke survivors, a narrative questionnaire was used. Furthermore, although the causal relationships can be present between each self-reported cause of disabilities, the current cross-sectional study could not assess these potential causal relationships. Third, only the variables included in the KNHANES database were analyzed. Finally, there was no detailed information about stroke severity. Therefore, since community residents were the participants of the KNHANES, we speculate that very severe stroke patients might have been excluded.

In conclusion, the current study shows the causes and recent trends of disabilities in stroke survivors residing in the Korean community. The proportion of stroke survivors with disabilities has decreased but reached a plateau with no further decrease. As one-third of community-dwelling stroke survivors still have disabilities, attention to the causes of the disabilities are mandatory. The result of the current study will provide valuable information to make the life of stroke survivors in the community better.

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