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ORIGINAL RESEARCH

Temporal Trends in Public Stroke Awareness in Korea, 2009 to 2023

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BACKGROUND: No large-scale survey on public stroke awareness has been conducted in Korea since 2009. This study assessed temporal trends in awareness of stroke warning signs (WSs) and risk factors (RFs) from 2009 to 2023. We hypothesized that stroke awareness remains inadequate and that changes in information sources have influenced the depth of knowledge.

METHODS: Surveys were conducted nationwide in 2009 (n=1000) and 2023 (n=1012) assessing participants' knowledge of WSs, RFs, stroke treatment, response to stroke symptoms, and information sources. Multivariable logistic regression was used to analyze trends in RF knowledge and factors associated with adequate stroke response, which is contacting emergency medical services immediately.

RESULTS: Between 2009 and 2023, the percentage of participants unable to identify any WS or RF significantly decreased (WSs: 38.5% to 22.6%, RFs: 43.9% to 37.2%; $P<0.01$). However, recognition of multiple RFs declined significantly (51.4% to 40.2%, $P<0.01$), with a more pronounced decrease among those without vascular RFs (adjusted odds ratio, 0.33 [95% CI, 0.21–0.51]; $P=0.03$ for the interaction term). In contrast, the decline was less pronounced among individuals with vascular RFs (adjusted odds ratio, 0.56 [95% CI, 0.42–0.74]). Intravenous thrombolysis awareness increased (30.4% to 55.6%, $P<0.01$), and adequate stroke response improved (32.5% to 48.9%, $P<0.01$). Information sources shifted, with an increase in the use of digital platforms. Adequate stroke response was significantly associated with intravenous thrombolysis knowledge (adjusted odds ratio, 1.54 [95% CI, 1.09–2.18]; $P=0.02$) and recognition of ≥2 WSs (adjusted odds ratio, 1.43 [95% CI, 1.09–1.86]; $P=0.01$).

CONCLUSIONS: Although stroke awareness has seen some improvements, it remains insufficient, highlighting the need for targeted educational strategies.

Key Words: awareness ■ risk factors ■ signs and symptoms ■ stroke

Stroke has emerged as a leading cause of death in recent years, with its consequence of impaired neurological function becoming a significant global health burden.[1] In 2021, the incidence rate of stroke in South Korea was 212.2 cases per 100 000 person-years, with higher rates observed among older adults. The highest incidence was found in individuals aged ≥80 years, with a rate of 1508.4 cases per 100 000 person-years.[2] It is anticipated that the incidence of stroke will increase considerably as the population continues to age.[3] With the incidence of stroke on the rise, understanding

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RESEARCH PERSPECTIVE

What Is New?

- This nationwide survey is the first to compare public stroke awareness in Korea between 2009 and 2023, revealing improved awareness of symptoms and treatments but a decline in knowledge of multiple risk factors, especially among individuals without vascular risk factors.
- Awareness of intravenous thrombolysis and appropriate response behaviors has increased but remains suboptimal, while sources of information have shifted toward digital platforms such as the Internet and YouTube.

What Question Should Be Addressed Next?

- Future research should explore how evolving digital information sources influence public stroke knowledge retention and identify targeted educational strategies to improve general stroke awareness and in-depth understanding of stroke risk factors, especially among younger and low-risk populations.

Nonstandard Abbreviations and Acronyms

ASR	adequate stroke response
EVT	endovascular thrombectomy
IVT	intravenous thrombolysis
RF	risk factor
SA	stroke awareness
WS	warning sign

and managing stroke risk factors (RFs) is becoming increasingly important for both primary and secondary prevention.[4] The current standard of care for improving stroke prognosis, specifically intravenous thrombolysis (IVT) and endovascular thrombectomy (EVT), has limited time windows for application.[5] Thus, it is crucial for patients to recognize stroke warning signs (WSs) and seek immediate medical attention. However, in Korea, there has been no significant reduction in prehospital delay over the past decade, and the use of reperfusion therapy remains low, at <10% for IVT and 6% for EVT.[6] Additionally, the milder the initial stroke symptoms, the longer it takes for the patient to seek medical attention.[6] These findings suggest that stroke awareness (SA) is markedly deficient and that the general population is likely inadequately informed about the importance of early treatment and adequate stroke response (ASR), which involves calling emergency medical services (EMS) when stroke symptoms occur. A multifaceted approach is required to reduce prehospital delay, with understanding and the promotion of SA representing a crucial element.[7,8] However, no specific study on SA among the representative general population in Korea has been conducted since the last survey in 2009.[9] Since then, public health initiatives and digital information sources have evolved.[10,11] However, it remains unclear whether these developments have enhanced awareness or exacerbated knowledge gaps. There is a notable lack of research on trends in public SA.[12]

Therefore, we aimed to conduct a nationwide representative survey on stroke WSs, RFs, treatment, and ASR, reflecting the current distribution of the Korean population, to compare with the results of a nationwide study conducted in 2009.[9] We hypothesized that while general SA may have increased, the depth of knowledge regarding stroke RFs may have declined due to changes in information sources. Our objective was to identify trends and gaps in SA, explore the pathways through which information is acquired to facilitate appropriate education, and pinpoint the most vulnerable populations in terms of SA. This would provide insight into current SA levels and inform future strategies to reduce prehospital delays.

METHODS

Data Availability Statement

The data supporting the findings of this study are available upon reasonable request from the corresponding author.

Participants

This study is based on the results of 2 surveys conducted on representative samples of Koreans at different points in time. The 2009 survey was conducted with a randomly selected sample of 1000 adults aged ≥20 years based on the 2005 census.[9] This survey was administered via telephone by trained interviewers. In contrast, the 2023 survey was a nationwide, web-based online survey targeting adults aged 19 to 79 years. The 2023 survey was conducted with technical support from Gallup Korea, a global social research company. Gallup Korea distributed the survey invitation via email and text messages to the panels stratified by age groups (19–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, and 75–79 years), sex, and regions (Seoul, Busan, Incheon, Daejeon, Gwangju, Daegu, Ulsan, Gyeonggi, Gangwon, Chungcheong, Jeolla,

Gyeongsang, and Jeju), using the proportional allocation method to ensure the sample accurately represented the South Korean population.[13–15] The stratification was based on the 2022 census data from Statistics Korea (Table S1).[16] A total of 10 759 invitations were sent, and 2707 (25.2%) participants initiated the survey. Among them, 1040 participants completed it. However, 28 responses were excluded due to incomprehensible or off-topic responses to open-ended questions. This resulted in a final sample of 1012 participants, with a response rate of 37.4% among those 2707 who initiated the survey and 9.4% among all individuals invited.

The participant recruitment period for the 2023 survey spanned 4 weeks, from September 9 to October 4, 2023. For the 2023 survey, the Seoul National University Hospital institutional review board waived the requirement for informed consent, as the entire process was anonymized and deidentified.

Survey Process and Measures

The survey was conducted as follows: Participants were informed of the study's purpose, consented to participate, and were directed to an encrypted website to complete the survey. Although the study was conducted anonymously, participants used a mobile phone–based verification system to prevent duplicate questionnaires. Upon entering their mobile phone numbers, respondents received a passcode, which was then used to verify the phone owner's identity on the basis of telecommunication company records, thereby avoiding duplicate submissions. The survey is designed so that respondents cannot move on to the next page if they do not answer closed-ended questions or write answers to open-ended questions. Therefore, respondents must complete the entire questionnaire to finish the survey.[17]

The 2023 survey expanded on the open-ended and multiple-choice questions from the 2009 survey, allowing for examining trends over time.[9] The questionnaire was reviewed and refined in consultation with experts in vascular neurology. Based on their feedback, modifications were made before finalization. The primary outcome variables included stroke WS knowledge, RF knowledge, awareness of stroke treatment, and ASR. Stroke WS knowledge was assessed using an open-ended question: "What are the signs or symptoms of a stroke?" Responses were categorized into predefined groups, including any paresis, unilateral weakness, language disturbances, dizziness, or loss of consciousness, and the total number of correct responses provided by each participant was calculated. Similarly, stroke RF knowledge was evaluated through another open-ended question: "What are the risk factors for stroke?" allowing participants to list any RFs of which they were aware. Participants' responses were categorized into known, predefined stroke RFs, including hypertension, diabetes, hyperlipidemia, smoking, excessive alcohol consumption, obesity, physical inactivity, and family history of stroke, and the mean number of correctly identified RFs was computed. In developing the survey questions, vascular neurology experts agreed on the definitions of stroke WS and RF and sought to compare them with the results of a 2009 study. Two independent reviewers (E.L. and M.K.K.) analyzed the responses to open-ended questions to identify common themes and ensure consistency in coding. Discrepancies were resolved through discussion or consultation with a third reviewer (J.B.). The mean numbers of correct answers provided by participants regarding stroke WSs and RFs were calculated by assigning 1 point for each correctly identified on the basis of established definitions.

Awareness of stroke treatment was measured by asking participants whether they were familiar with specific treatment options, including IVT, primary stroke centers, stroke units, and EVT, with responses recorded in a binary format (Yes/No). ASR was determined by asking participants: "If you or someone near you experienced stroke warning signs or symptoms, what would you do?" and categorizing their responses into calling EMS, considered an adequate response, using personal transportation to go to the hospital, contacting family or friends, or waiting for symptoms to improve.

Covariates included basic demographics, health status, and health behaviors. Demographic variables comprised sex, age, region, household income, education level, and marital status. Age was categorized into 3 groups (20–39, 40–59, and ≥60 years). Household income was divided into 3 categories (<US$30 000, US$30 000–$50 000, and ≥US$50 000 per year). Education level was classified as less than high school, high school graduate, and college/university graduate or higher. Marital status was classified into married and single, including divorced, separated, or widowed.

Regarding health status, the respondents were asked whether they had a family history of stroke and whether they themselves had vascular RF, including previous stroke or transient ischemic attack, coronary artery disease, hypertension, diabetes, hyperlipidemia, or atrial fibrillation. Self-reported health status was measured on a 5-point Likert scale, ranging from 1 (very poor) to 5 (excellent), and further categorized into 3 groups.

In terms of health behavior, we asked about smoking, binge drinking (defined as *consuming ≥5 drinks in a row for men or ≥4 drinks in a row for women* on at least 1 occasion),[18] obesity (defined as a body mass index of ≥25 kg/m^2),[19] and lack of exercise (defined as not meeting the recommended guidelines of

150 minutes of moderate-intensity activity, 75 minutes of vigorous-intensity activity, or an equivalent combination per week).[20] Participants were also asked to identify up to 2 primary sources of stroke-related information, choosing from television, newspapers and magazines, the Internet, YouTube, friends/colleagues, physicians, and offline public lectures. The questionnaire used in this study is provided in Data S1.

Statistical Analysis

We compared survey results from 2009 and 2023 to identify trends in SA within the Korean general population. Raw data from the 2009 survey were obtained by request from the responsible author (Y.S.K.). Categorical variables were expressed as frequencies and percentages, and *P* values were calculated using the χ^2 test or Fisher's exact test. Continuous variables were expressed as means±SDs, and *P* values were determined using Student's *t* test. The Wilcoxon rank-sum test was performed to compare the mean correct response between 2009 and 2023. To examine whether changes in awareness of multiple stroke RFs varied by key demographic and clinical factors, we included interaction terms between survey year (2009 versus 2023) and selected covariates, such as age group (20–39, 40–59, ≥60 years), sex (male versus female), education level (less than high school, at least high school graduate), household income (<$30 000, $30 000–$50 000, >$50 000 per year), and the presence of vascular risk factors (yes versus no). These interaction terms enabled us to evaluate whether the impact of the survey year on SA differed among these subgroups. Adjusted odds ratios (aORs) with 95% CIs were calculated to measure the likelihood of recognizing ≥2 stroke RFs in 2023 compared with 2009, while also evaluating differential changes across subgroups. This approach allowed us to explore differential trends in SA and identify populations that may benefit from more targeted educational interventions.

Furthermore, univariable and multivariable logistic regression analyses were conducted to identify factors associated with ASR, specifically the likelihood of calling EMS in 2023. Covariates included in the regression analyses were age, sex, household income, education levels, knowledge of stroke WSs, knowledge of RFs, knowledge of IVT, knowledge of EVT, unhealthy behaviors (defined as smoking, binge drinking, obesity, or lack of exercise), and the presence of vascular RFs. These covariates were selected on the basis of previous research, and variables that met a *P* value <0.10 in univariable analysis were included as covariates in the multivariable analysis.[9,21–24] All statistical analyses were performed using R statistical software version 4.4.3 (R Foundation for Statistical Computing, Vienna, Austria). Statistical significance was set at a 2-sided *P* value <0.05.

RESULTS

Baseline Characteristics

In 2023, the average age of participants was 48.5±15.6 years, significantly higher than in 2009 (*P*<0.01). However, there was no significant difference in sex distribution between the 2 years, with 49.8% of participants being men (49.2% versus 49.8%, *P*=0.79). Regarding the region of residence, there was a significant increase in participants from Gyeonggi province (21.4% versus 26.2%) and the inclusion of Jeju Province residents, which was not accounted for in the 2009 survey. Education level and household income both increased significantly in 2023, while the percentage of respondents who reported being married decreased significantly compared with 2009 (87.4% versus 65.6%, *P*<0.01).

Regarding health status, all vascular RFs, except for a history of stroke (1.1% versus 1.5%, *P*=0.45), were significantly higher in 2023 than in 2009. Conversely, no significant differences were observed in health behaviors such as smoking (18.4% versus 21.1%, *P*=0.14), binge drinking (10.2% versus 10.4%, *P*=0.90), or obesity (20.0% versus 21.4%, *P*=0.43) between 2009 and 2023 (Table 1).

Recognition of Stroke WSs and RFs

For the open-ended question on stroke WSs, the proportion of respondents correctly identified any paresis, loss of consciousness, dizziness, and hemiparesis, except for language disturbance (26.9% versus 27.4%, *P*=0.81), increased significantly in 2023 compared with 2009. In terms of stroke RFs, there was a significant increase in the proportion reporting hyperlipidemia (14.0% versus 23.3%, *P*<0.01) and a significant decrease in recognition of the family history of stroke (8.0% versus 4.5%, *P*<0.01). However, no significant changes were observed for recognition of other RFs between 2009 and 2023 (Table 2, Figure 1). When comparing the mean number of correct answers between 2009 and 2023, a significant increase was found for the WSs (1.1±1.0 versus 1.3±1.0, *P*<0.01), but no significant difference was observed for the RFs (1.3±1.3 versus 1.4±1.6, *P*=0.52). The results were also compared between 2009 and 2023 regarding the number of correct responses (0, 1, 2, and >3). The proportion of respondents who did not provide any correct answers was significantly lower for both WSs (38.5% versus 22.6%, *P*<0.01) and RFs (43.9% versus 37.2%, *P*<0.01) in 2023 compared with 2009. However, the proportion of those who correctly identified ≥2 WSs was not significantly different (37.8% versus 40.4%, *P*=0.23), while

Table 1. Baseline Characteristics

	2009 N=1000	2023 N=1012	*P* value
Sociodemographics			
Age, y, mean±SD	42.69±14.08	48.5±15.6	<0.01
20–39, n (%)	449 (44.9)	313 (30.9)	
40–59, n (%)	374 (37.4)	412 (40.7)	
≥60, n (%)	177 (17.7)	287 (28.4)	
Sex, male, n (%)	492 (49.2)	504 (49.8)	0.79
Residence, region, n (%)			<0.01
Seoul	216 (21.6)	196 (19.4)	
6 metropolitan cities	269 (26.9)	238 (23.5)	
Gyeonggi Province	214 (21.4)	265 (26.2)	
Gangwon Province	30 (3.0)	34 (3.4)	
Chuncheong Province	69 (6.9)	69 (6.8)	
Jeolla Province	79 (7.9)	76 (7.5)	
Gyeongsang Province	123 (12.3)	115 (11.4)	
Jeju Province	0 (0)	19 (1.9)	
Level of education, n (%)			<0.01
Less than high school	99 (9.9)	21 (2.1)	
High school graduate	491 (49.1)	195 (19.3)	
College/university or higher	411 (41.1)	796 (78.7)	
Household income, y, n (%)			<0.01
<$30 000	614 (61.4)	259 (25.6)	
$30 000–$50 000	231 (23.1)	444 (43.9)	
≥$50 000	100 (10.0)	309 (30.5)	
Do not wish to answer	55 (5.5)	0 (0)	
Marital status, n (%)			<0.01
Married	874 (87.4)	664 (65.6)	
Single/divorced/separated/widowed	126 (12.6)	348 (34.4)	
Health status factors			
Comorbidities, n (%)			
Stroke or transient ischemia attack	11 (1.1)	15 (1.5)	0.45
Coronary heart disease	19 (1.9)	41 (4.1)	0.01
Hypertension	134 (13.4)	245 (24.2)	<0.01
Diabetes	39 (3.9)	104 (10.3)	<0.01
Hyperlipidemia	93 (9.3)	236 (23.3)	<0.01
Atrial fibrillation		11 (1.1)	…
Family history of stroke	143 (14.3)	137 (13.5)	0.62
Subjective health assessment, n (%)			…
Good/excellent		271 (26.8)	
Fair		473 (46.7)	
Poor/very poor		268 (26.5)	
Health behavior factors, n (%)			
Current smoker	184 (18.4)	213 (21.1)	0.14
Binge drinking	102 (10.2)	105 (10.4)	0.90
Obesity	200 (20.0)	217 (21.4)	0.43
Lack of exercise		478 (47.2)	…

Table 2. Recognition of Stroke Warning Signs, Risk Factors, Treatment, and Adequate Response

	2009 N=1000	2023 N=1012	*P* value
Stroke warning signs, n (%)			
Any paresis	437 (43.7)	506 (50)	0.01
Language disturbance	269 (26.9)	277 (27.4)	0.81
Loss of consciousness	106 (10.6)	218 (21.5)	<0.01
Dizziness	90 (9)	135 (13.3)	<0.01
Hemiparesis	76 (7.6)	228 (22.5)	<0.01
Knowledge of ≥2 warning signs, n (%)	378 (37.8)	409 (40.4)	0.23
Correct response, mean±SD	1.1±1.0	1.3±1.0	<0.01
Risk factors			
Hypertension	312 (31)	345 (34.1)	0.17
Heavy drinking	232 (23)	218 (21.5)	0.37
Smoking	212 (21)	202 (20.0)	0.49
Hyperlipidemia	139 (14)	236 (23.3)	<0.01
Obesity	135 (14)	120 (11.9)	0.27
Diabetes	86 (9)	89 (8.8)	0.88
Family history of stroke	81 (8)	45 (4.5)	<0.01
Physical inactivity	81 (8)	105 (10.4)	0.08
Knowledge of ≥2 risk factors, n (%)	514 (51.4)	407 (40.2)	<0.01
Correct response, mean±SD	1.3 (1.3)	1.4 (1.6)	0.52
Stroke treatment, n (%)			
Primary stroke center		502 (49.6)	…
Stroke unit		401 (39.6)	…
Intravenous thrombolysis	304 (30.4)	563 (55.6)	<0.01
Endovascular thrombectomy		543 (53.7)	…
Adequate stroke response (call EMS), n (%)	325 (32.5)	495 (48.9)	<0.01

EMS indicates emergency medical services.

it was significantly lower for RFs (51.4% versus 40.2%, $P<0.01$) in 2023 compared with 2009 (Figure 1).

Trends in Stroke RF Knowledge in 2023 Versus 2009 by Demographics

In 2009, 51.4% (514/1000) of participants knew ≥2 RFs, compared with 40.2% (407/1012) in 2023, indicating a significant decline in RF knowledge. The largest decline in RF knowledge between 2009 and 2023 was observed in respondents with a household income >$50 000 per year (odds ratio, 0.27 for 2023 versus 2009 [95% CI, 0.16–0.47]). However, the interaction term between income and year was not significant ($P=0.26$). Participants without vascular RFs also showed a disproportionate decline in knowledge of ≥2 RFs between 2009 and 2023 (odds ratio, 0.33 for 2023 versus 2009 [95% CI, 0.21–0.51]; $P=0.03$ for the interaction term). This decline was more pronounced than that observed in those with vascular RFs (odds ratio, 0.56 for 2023 versus 2009 [95% CI, 0.42–0.74]; Figure 2).

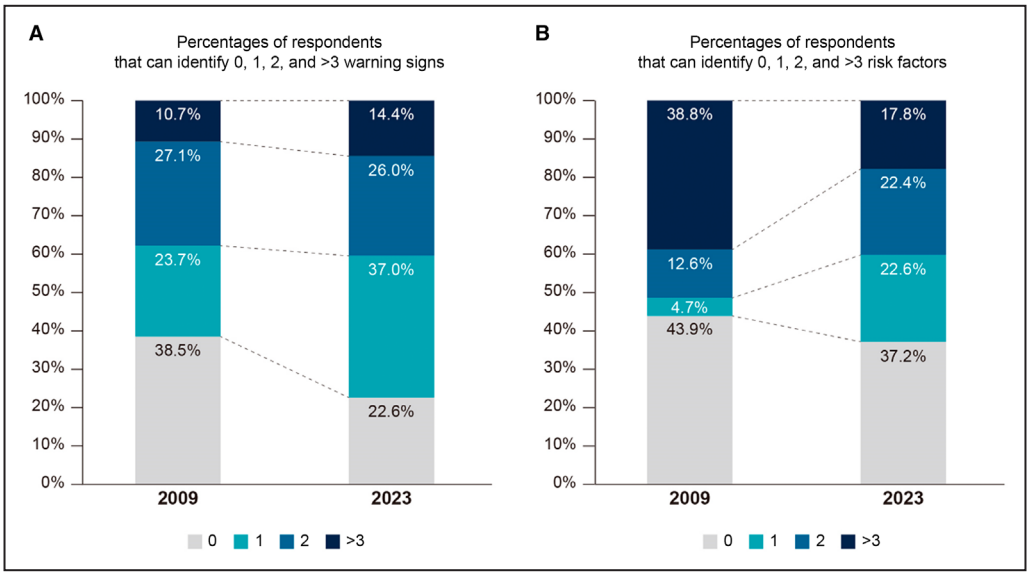

Figure 1. Changes in the recognition of stroke warning signs and risk factors.
A, Percentage of respondents who can identify stroke warning signs. **B**, Percentage of respondents who can identify stroke risk factors.

Knowledge of Stroke Treatment and Proper Action

In the survey results on general population awareness of stroke treatment, the percentage of people who reported knowing about IVT increased significantly in 2023 compared with 2009 (30.4% versus 55.6%, $P<0.01$). However, less than half of the population knew about primary stroke centers (49.6%) and stroke units (39.6%), and only 53.7% were aware of EVT. When asked what they would do if they experienced WSs of stroke, the percentage of respondents who said they would call an ambulance immediately increased significantly from 2009 to 2023 (32.5% versus 48.9%, $P<0.01$). However, this was still less than half of all respondents (Table 2).

Factors Associated With an Adequate Response to Stroke WSs

Based on the 2023 survey results, a multivariable logistic regression analysis was performed to identify factors independently associated with an ASR, defined as calling EMS, which may most directly influence reduced prehospital delays. The results showed that knowledge of IVT (adjusted odds ratio [aOR], 1.54 [95% CI, 1.09–2.18]; $P=0.02$) and knowledge of ≥2 stroke WSs (aOR, 1.43 [95% CI, 1.09–1.86]; $P=0.01$) were significantly associated with ASR. Conversely, age <40 years (aOR, 0.61 [95% CI, 0.45–0.81]; $P<0.01$) and unhealthy lifestyle factors (smoking, binge drinking, obesity, or lack of exercise) (aOR, 0.66 [95% CI, 0.50–0.87]; $P<0.01$) were negatively associated with ASR. Additionally, knowledge of EVT was not statistically significantly associated with ASR (aOR, 0.90 [95% CI, 0.64–1.28]; $P=0.57$; Table 3).

Sources of Information About Stroke

As in the 2009 survey, the 2023 survey asked respondents to identify 2 sources of information about stroke. The results showed a significant decrease in television as a primary source, which was the top response in 2009 (59.1% versus 48.5%, $P<0.01$), and a significant increase in information obtained from YouTube (19.9%) and the Internet (27.8% versus 63.0%, $P<0.01$). On the other hand, the role of offline lectures (17.1% versus 10.1%, $P<0.01$) and newspapers and magazines (33.1% versus 5.6%, $P<0.01$) as sources of information decreased significantly (Table 4).

DISCUSSION

This study examined changes in public SA in Korea by comparing survey data from 2009 and 2023. The prevalence of vascular RFs increased significantly, whereas health behaviors did not show comparable improvement. The findings revealed that while general awareness of stroke has significantly improved, the proportion of individuals who can accurately identify multiple stroke RFs has rather declined. Additionally, the proportion of participants who reported that they would call EMS for suspected stroke WSs increased significantly. This appropriate response was strongly associated with knowledge of at least 2 stroke WSs and awareness of IVT. However, a significant negative association was observed for those aged <40 years

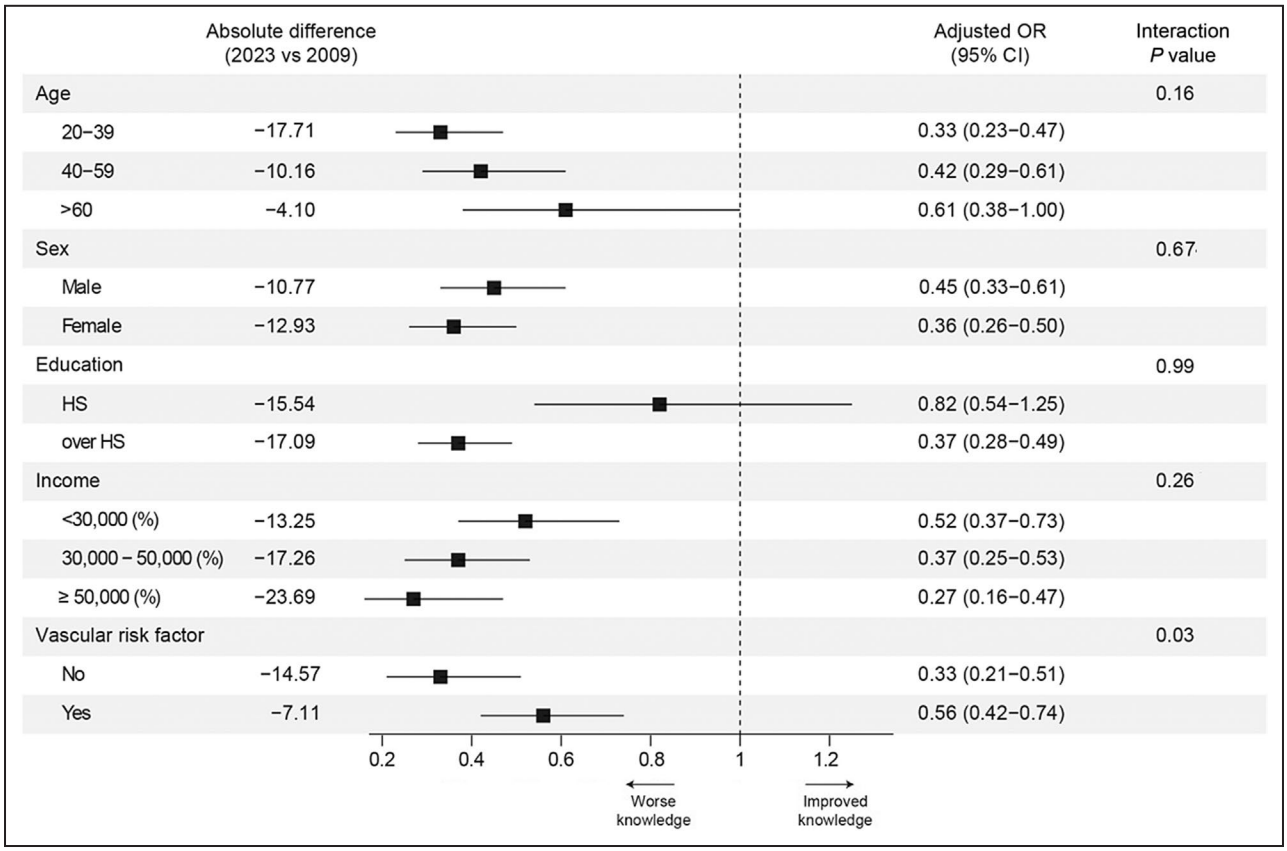

Figure 2. Decline in stroke risk factor knowledge in 2023 versus 2009.
Absolute difference refers to a change in unadjusted percentages of identifying stroke risk factors (RFs) ≥2 from 2009 to 2023. Adjusted OR and CI refer to fully adjusted models, including each of the following: age, sex, educational attainment, household income, vascular RFs, and 1 of the 5 interaction terms (age by year, sex by year, education by year, household income by year, and vascular RFs by year). Adjusted ORs interpreted as the ratio of the odds of identifying stroke RFs ≥2 in 2023 compared with 2009 (ie, the referent group is the odds in 2009). The significant interaction term between year and vascular RFs suggests that the decline in knowledge of stroke RFs ≥2 from 2009 to 2023 in participants without vascular RFs was more significant than in those with vascular RFs. HS indicates high school; OR, odds ratio; and RF, risk factor.

or those with an unhealthy lifestyle. Despite this improvement, the overall proportion remained low, with only 48.9% of respondents in 2023 indicating that they would call EMS. Furthermore, the study highlighted a shift toward digital platforms as primary sources of health information.

Over the 14 years, significant changes were observed in the Korean population, particularly regarding stroke management. The prevalence of vascular RFs such as coronary heart disease, hypertension, hyperlipidemia, and diabetes increased significantly, suggesting that stroke incidence may rise in the future as the population ages. Therefore, education and promotion of SA are essential.

A comparison of SA between 2009 and 2023 reveals a paradoxical trend. While there has been a notable improvement in general understanding of stroke WSs, RFs, treatment options, and ASR, there has also been a decline in the depth of knowledge regarding stroke RFs. This decline suggests that while more people are aware of the broader concept of stroke and its immediate symptoms, fewer possess a comprehensive understanding of the underlying RFs. This shift could have significant implications for stroke prevention efforts, as a superficial understanding of stroke may not be sufficient to drive behavior change or encourage timely medical intervention.[25,26]

A notable decline in awareness of ≥2 stroke RFs was observed among individuals without a history of vascular RFs. Our findings indicate a relative absence of public education initiatives targeting these individuals. However, the prevalence of vascular RFs is gradually increasing, particularly among younger age groups.[27–29] These findings emphasize the necessity for a more proactive approach to stroke prevention, which may entail an increased focus on educating the general public about the risk and prevention of stroke, even among those currently without vascular RFs. Consequently, it is necessary to implement more comprehensive and targeted educational initiatives to

Table 3. Factors Associated With Adequate Response to Stroke Onset

	Univariable			Multivariable		
	OR	95% CI	*P* value	aOR	95% CI	*P* value
Age <40 y	0.54	0.41–0.71	<0.01	0.61	0.45–0.81	<0.01
Female sex	0.98	0.76–1.25	0.85			
Education less than high school	0.44	0.17–1.16	0.09	0.41	0.15–1.12	0.08
Household income, y						
<$30 000	Reference			Reference		
$30 000–$50 000	1.09	0.83–1.41	0.54			
>$50 000	1.31	0.87–1.98	0.20			
Knowledge of at least 2 stroke WSs	1.64	1.27–2.11	<0.01	1.43	1.09–1.86	0.01
Knowledge of at least 2 stroke RFs	1.44	1.12–1.85	<0.01	1.22	0.93–1.60	0.15
Knowledge of IVT	1.75	1.36–2.25	<0.01	1.54	1.09–2.18	0.02
Knowledge of EVT	1.41	1.10–1.80	<0.01	0.90	0.64–1.28	0.57
History of vascular RFs	1.29	1.01–1.67	0.04	1.14	0.87–1.52	0.34
Unhealthy lifestyle	0.74	0.57–0.96	0.02	0.66	0.50–0.87	<0.01

EVT indicates endovascular thrombectomy; IVT, intravenous thrombolysis; OR, odds ratio; RF, risk factor; and WS, warning sign.

ensure that the entire population, including those without vascular RFs rather than focusing on high-risk individuals, is aware of the RFs and WSs of stroke and can respond effectively.

Concerning the appropriate response to stroke WSs, the study revealed that awareness of WSs and IVT was significantly associated with the likelihood of calling EMS in the event of a stroke. This finding underscores the necessity of comprehensive education that not only increases awareness of stroke WSs but also emphasizes the understanding of available immediate therapies like IVT. Reducing prehospital delay is crucial for the timely application of reperfusion therapies such as IVT and EVT, which have narrow therapeutic windows.[5,30,31] Conversely, younger individuals (aged <40 years) and those with unhealthy lifestyles (smoking, binge drinking, obesity, or lack of exercise) were less likely to respond appropriately to stroke WSs. These findings highlight a critical need for targeted interventions aimed at those who may not perceive themselves as at risk of stroke or who may lack adequate health literacy.

Table 4. Sources of Information About Stroke

Source of information	2009 N=1000	2023 N=1012	*P* value
Television, n (%)	591 (59.1)	491 (48.5)	<0.01
Newspaper/magazines, n (%)	331 (33.1)	57 (5.6)	<0.01
Internet, n (%)	278 (27.8)	638 (63.0)	<0.01
YouTube, n (%)		201 (19.9)	…
Friends/colleagues, n (%)	277 (27.7)	200 (19.8)	<0.01
Physicians, n (%)	171 (17.1)	166 (16.4)	0.68
Offline public lectures about health, n (%)	171 (17.1)	101 (10.0)	<0.01

Notably, the study revealed no significant correlation between awareness of EVT and an ASR to stroke WSs. This may indicate that the general public is still not fully aware of the advances in stroke treatment, particularly the role of EVT, which has become a cornerstone of stroke management in recent years.[32–34] Public health initiatives may need to emphasize the latest advances in stroke treatment to address this knowledge gap and improve stroke outcomes.

The transition from traditional media to digital platforms, such as YouTube and the Internet, as primary sources of information, may partially account for the observed decline in the depth of stroke knowledge.[35] Although these platforms are readily accessible and have the potential to reach a broad audience,[36] the information they provide is often fragmented, superficial, or not evidence based.[37,38] The decline in more conventional, structured sources of information, such as television, printed materials, and offline lectures, may have contributed to this phenomenon. Therefore, it is essential to develop reliable and accessible online educational resources to ensure that the public receives accurate and actionable information about stroke prevention and response. Given the growing dependence on digital platforms for health information, future public health campaigns should focus on providing evidence-based stroke education through online media. This approach should target younger populations who typically exhibit lower SA.

The study has some limitations that should be acknowledged. First, the study relied on self-reported data, which may be subject to recall or social desirability bias. Second, the cross-sectional nature of the survey means that causality cannot be inferred from the associations observed. Third, despite the rigorous sampling

approach, the response rate of 9.4% among all invited individuals suggests the potential for nonresponse bias. However, demographic stratification likely mitigated significant selection biases (Table S1). Another consideration is the difference in survey methods between 2009 and 2023, with the former conducted via telephone interviews and the latter via a web-based survey. This methodological difference may introduce selection bias, as web-based surveys could underrepresent older individuals and those with limited Internet access. However, our analysis showed that the tendency to recognize multiple stroke RFs remained consistent across all age groups and education levels, with no significant interaction between survey year and age group (P=0.16) or education level (P=0.99, Figure 2). Previous studies have also suggested that the difference between telephone interviews and web-based surveys has little impact on knowledge-based responses.[39,40] To enhance generalizability, we applied the proportional allocation method on the basis of the 2022 national census data (Table S1). Despite these efforts, differences in sample characteristics between the 2 surveys should be considered. Over the 14 years between surveys, South Korea has experienced substantial societal and economic changes, leading to shifts in age distribution, education levels, and socioeconomic factors among respondents. Nevertheless, these demographic shifts and methodological differences are unlikely to fully account for the observed trends. Importantly, we maintained consistency in the core survey questions regarding WSs, RFs, stroke treatment, and ASR to allow for direct comparison between the 2009 and 2023 surveys.[9] Future studies using mixed-method design, combining quantitative surveys with qualitative interviews or focus groups, and standardized survey formats to ensure comparability across different time points and populations would further validate these findings.

In conclusion, this study reveals significant changes in SA in Korea between 2009 and 2023. While general awareness of stroke has improved, it remains inadequate, and a deeper understanding of stroke RFs has declined, particularly among those without vascular RFs. A strong link was observed between knowledge of stroke WSs, IVT, and an ASR. However, younger adults and those with poorer health behaviors were less likely to respond appropriately. The shift toward digital information sources was evident. Targeted, accurate, and integrated public health education is needed, and future research should focus on developing and evaluating educational interventions to address these gaps.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

Data S1
Table S1

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