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Public awareness of stroke risk factors in high-income countries: A systematic review

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ABSTRACT

Purpose: Stroke remains a significant health concern in high-income countries (HICs) and is increasing among younger adults. Although largely preventable, public awareness of stroke risk factors in HICs is not well established. We assessed awareness levels in World Bank-classified HICs and identified associated factors.

Methods: Systematic searches used Ovid MEDLINE, PsycINFO, Academic Search Complete, CINAHL, Cochrane Review Library, Emcare, and ASSIA. Two authors independently screened studies and extracted data. Risk of bias was assessed using Critical Appraisal Skills Programme checklists. Due to heterogeneity, narrative synthesis was conducted. **Exploratory analyses including visual mapping and descriptive cross-country comparisons were performed despite methodological heterogeneity.** Protocol registered on PROSPERO (CRD42025621931).

Findings: Of 2146 papers screened, 23 met inclusion criteria. Most studies reported low stroke risk factor awareness. Hypertension was most frequently identified, followed by smoking, dyslipidaemia, and diabetes. Sedentary lifestyle, alcohol consumption, ethnicity, and atrial fibrillation were least recognised. **Risk of bias assessment revealed sampling and generalisability concerns in most studies. Most reported associations were unadjusted for potential confounders.** Higher education was linked to greater awareness. **Marked geographical clustering occurred, with 65 % of studies from Middle Eastern countries, predominantly Saudi Arabia.**

Discussion: This review uniquely identifies critical evidence gaps including under-representation of diverse populations, lack of standardised awareness metrics, and predominance of unadjusted analyses in HIC stroke risk factor awareness research.

Conclusion: Stroke risk factor awareness gaps are prevalent and may limit prevention efforts. **Large-scale, methodologically robust studies across diverse geographical, socioeconomic, and ethnic populations within HICs are urgently needed, as awareness characteristics may vary dramatically even within high-income settings.** Targeted education is necessary for primary prevention strategies.

Introduction

Stroke remains a major contributor to global mortality and disability, presenting significant public health challenges.[1] While incidence has declined among older adults in high-income countries (HICs) in recent years, rates are rising among younger adults.[1] This is alarming given the substantial personal, societal, and economic consequences of stroke in younger populations, who are often in their most economically productive years.[2] Most current understanding of stroke is based on older populations, creating a gap in prevention and early detection efforts targeting younger adults.[3] A widespread lack of understanding of stroke risk factors in both HICs and low- and middle-income countries exists (LMICs).[4–8]

Although LMICs bear the greatest share of the global stroke burden,

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it remains a major health concern in HICs.[9] The United Kingdom's societal cost of stroke is estimated at £26 billion annually[10] and is expected to grow exponentially over the next two decades without effective prevention and intervention strategies.[11]

Closing the prevention gap is a global health priority, hence there is renewed focus on improving awareness of risk factors.[9,12] Previous systematic reviews have primarily focused on stroke awareness in low- and middle-income countries or have examined general stroke knowledge without specifically investigating risk factor awareness in HICs as defined by the World Bank.[13] This review addresses a critical evidence gap by providing the first comprehensive synthesis of stroke risk factor awareness conducted exclusively in high-income countries, with particular attention to methodological quality, population diversity, and between-country variations. This review also identifies factors associated with awareness levels. Findings aim to inform stroke prevention interventions.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[14] with the data search, screening, selection, extraction, and analysis conducted per a pre-specified protocol registered on the International Prospective Register of Systematic reviews (PROSPERO) (CRD42025621931).

Search strategies and selection criteria

An electronic literature search was conducted on 24th October 2024 using the following databases: Ovid MEDLINE, PsycINFO, Cochrane Review Library, Academic Search Complete, and CINAHL. Search terms included: "stroke," "cerebrovascular accident," "CVA," "awareness," "knowledge," "understanding," "risk factors," "causes," and "adults," combined using Boolean operators "OR" and "AND" (see supplementary Table S1 for full search). Reference lists of included studies were screened for additional papers. To strengthen the strategy, an updated search was conducted by the Royal College of Nursing (RCN) Library on 12th February 2025 using the original search string and additional databases: Emcare and ASSIA (See Table S2). A final update was conducted on 22nd May 2025.

Selection criteria

Papers were independently reviewed by two authors (BA, SML). Inclusion criteria were: (1) participants aged ≥18 with no prior stroke; (2) populations from HICs, as defined by the World Bank[13]; 3) studies investigating awareness of stroke risk factors in community settings; (4) publications from 2014 onwards, following the American Stroke Association's primary prevention guidelines.[9] While some studies reported other outcomes (e.g., stroke onset signs or response actions), only data on stroke risk factor awareness were included. Only peer-reviewed articles in English were eligible.

Exclusion criteria

Studies were excluded if: (1) participants were aged <18; (2) included participants with a history of stroke; (3) focused on populations from LMICs, due to differences in healthcare systems; (4) assessed pre- and post-intervention outcomes; (5) hospital-based participants; or (6) were published before 2014. Reviews, case studies, case series, letters, conference abstracts, and editorials were also excluded.

Data extraction

A data extraction tool was developed by two authors (BA, SG), according to Popay et al. framework.[15] Extracted data included author, year, country, study sample and setting, methods, study aim, analysis, percentage of identified stroke risk factors, conclusions, and limitations (see supplementary Table S3).

Extraction process and risk of bias assessment

Screening was in two stages: (1) title and abstract review, and (2) full-text assessment for relevance and eligibility. Data were independently extracted by BA and SG, with discrepancies resolved through discussion.

Study quality was appraised using the Critical Appraisal Skills Programme[16] (CASP) checklists for cross-sectional and cohort studies. Each checklist included 11 questions assessing study design, relevance, and overall research value (see supplementary Table S4). The traffic light risk of bias assessment system was used to complement the CASP checklist. The traffic light system has been adapted from established methodological frameworks used in systematic reviews and health services research to provide visual representation of study quality across multiple domains. [63,64]

Data analysis and synthesis

Due to heterogeneity in methods, outcomes, settings, and population characteristics, a quantitative meta-analysis was not feasible. A narrative synthesis, using Popay et al. framework[15] guided the identification of relationships within and between studies. Study characteristics were summarised in text and tables (see Table S3). Key themes identified included levels of awareness of specific risk factors and variables linked to higher or lower awareness, such as sex, age, education, and family history of stroke.

Results

Study selection

The initial search yielded 2146 studies. A final update on 22nd May 2025 found no additional studies. After removing 130 duplicates, 2103 studies were screened by title and abstract, with 1915 excluded. Full-text screening was conducted on 98 studies, of which 23 met the inclusion criteria. The PRISMA flow diagram (Fig. 1) outlines this process.

Study characteristics

Participant demographics

Participants had no prior history of stroke, mean age 41.2 (SD ±9.5). Across the 23 studies, 57 % were female and 43 % male. The largest group was Arab participants (30.9 %), followed by Israeli Jewish (14.1 %), European Canadian (7.9 %), Swedish (9.6 %), Polish (7.2 %), Italian (6.4 %), Greek (4.6 %), Chilean (4.5 %), African American (4.4 %), Chinese/Malaysian/Indian (4.4 %), and Māori/Asian (2.6 %).

Study origin, setting and sample size

All 23 studies were conducted in various HICs settings: shopping mall (n = 1), primary healthcare/urban healthcare centres (n = 3), regional populations (n = 12), online home settings (n = 4), and the general population (n = 3). Sample sizes ranged from 66[17] to 1500[18] with a total of 15,579 participants. Studies were conducted in Saudi Arabia (n = 8),[19–26] the USA (n = 3),[17,27,28] Canada (n = 2),[29,30],Italy,[31] Sweden,[18] New Zealand,[32] Poland,[33] Singapore,[34] Israel (n = 2),[35,36] Greece,[37] the UAE,[38] and Chile.[39]

Study designs and data collection

Most studies used a cross-sectional design (n = 20); longitudinal (n = 1), comparative (n = 1), or observational (n = 1). Data collection methods included self-administered questionnaires (n = 12), telephone surveys (n = 5), interviews (n = 4), secondary data analysis (n = 1), and a risk assessment form (n = 1).

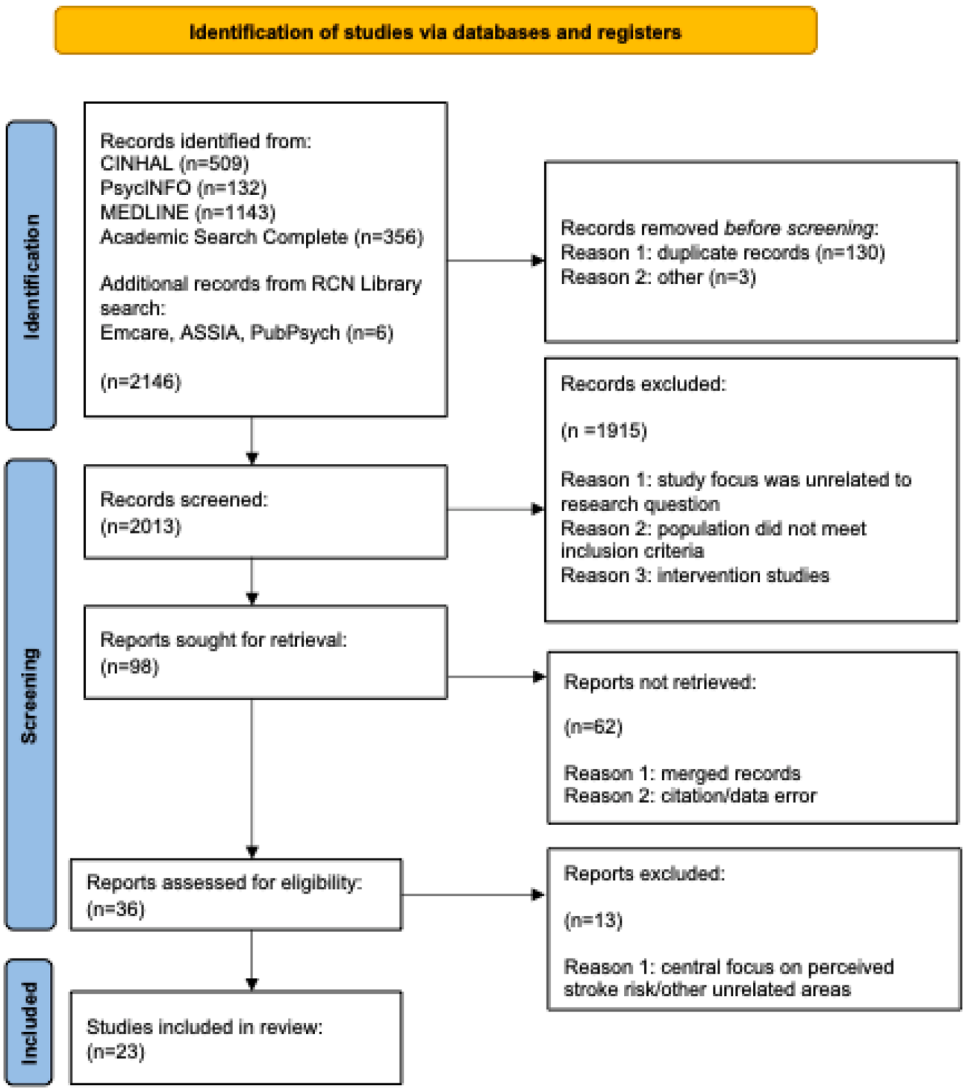

Fig. 1. PRISMA flow diagram.

Between-country patterns

Of the 23 studies, 8 (35 %) were conducted in Saudi Arabia, 3 (13 %) in the USA, 2 (9 %) each in Canada and Israel, and single studies in 9 other HICs. This geographical imbalance limits the generalisability of findings across the broader HIC category.

Table 1 presents exploratory between-country descriptive statistics for hypertension awareness (the most commonly assessed risk factor). Mean awareness ranged from 28 % in Sweden to 71.2 % % in Saudi Arabia, with substantial variation even within regions. Middle Eastern countries showed consistently higher awareness rates (mean 71.2 %, SD 12.4 %) compared to European countries (mean 54.3 %, SD 19.8 %) and North American studies (mean 39.7 %, SD 8.9 %).

Table 1
Between-country descriptive statistics for hypertension awareness.

Region	Country	Number of Studies	Mean Awareness % (SD)	Range min – max %
Middle East	Saudi Arabia	8	71.2 (12.4)	64-97 %
	UAE	1	69.0 (-)	-
Europe	Sweden	1	28.0 (-)	-
	Italy	1	68.0 (-)	-
	Poland	1	29.0 (-)	-
	Greece	1	66.0 (-)	-
North America	USA	3*	39.7 (8.9)	31-49 %
	Canada	2	40.5 (6.4)	37-44 %
Other	Israel	2	56.5 (8.8)	50-63 %
	Chile	1	42.0 (-)	-
	Singapore	1	49.0 (-)	-

* Only one USA study reported hypertension awareness data.

Risk of bias assessment

Table 2 summarises the risk of bias assessment across included studies using a traffic-light system. Key concerns identified include: sampling bias (78 % of studies), limited generalisability due to narrow population recruitment (83 % of studies), lack of sample size justification (65 % of studies), and inadequate statistical analysis (48 % of studies). Only 3 studies (13 %) were assessed as having low risk of bias across all domains.

Methodological evaluation of included studies

Cross-sectional studies capture data at a single time point. While cost-effective, they limit the ability to assess causality or changes over time. Most data were self-reported, risking recall, social desirability, and non-response bias.[18–26,28,29,31–39] The regional focus of most studies limits generalisability, and telephone interviews may exclude lower socioeconomic groups, introducing non-coverage bias.[18,31,32,37,39] Analyses were mostly descriptive with some studies lacking clear statistical

Table 2
Summary risk of bias assessment (Traffic light system).

Study	Sampling Method	Generalisability	Sample Size	Statistical Analysis	Overall Risk
Abdalla et al. (Saudi Arabia)	🔴	🔴	🔴	🟡	High
Abutaima et al. (Saudi Arabia)	🔴	🔴	🔴	🟡	High
Alhubail et al. (Saudi Arabia)	🟡	🔴	🟢	🟢	Moderate
Alluqmani et al. (Saudi Arabia)	🟡	🔴	🟢	🟢	Moderate
Aycock et al. (USA)	🔴	🔴	🔴	🔴	High
Bakraa et al. (Saudi Arabia)	🟢	🔴	🟢	🔴	Moderate
Baldereschi et al. (Italy)	🔴	🔴	🟢	🔴	High
Claeys et al. (USA)	🟢	🟢	🟢	🟢	Low
Feinberg et al. (USA)	🔴	🔴	🟢	🔴	High
Nordanstig et al. (Sweden)	🔴	🔴	🟢	🟢	Moderate
Krishnamurthi et al. (New Zealand)	🔴	🔴	🟢	🟢	Moderate
Krzystanek et al. (Poland)	🟢	🟢	🟢	🟢	Low
Li et al. (Canada)	🟢	🟢	🟢	🟢	Low
Lim et al. (Singapore)	🟡	🔴	🟢	🟢	Moderate
Melnikov et al. (2016) (Israel)	🟢	🔴	🟢	🟢	Moderate
Melnikov et al. (2018) (Israel)	🟢	🔴	🟢	🟢	Moderate
Metias et al. (Canada)	🟢	🟡	🟢	🟢	Low
Naguib et al. (Saudi Arabia)	🔴	🔴	🟢	🟢	Moderate
Navia et al. (Chile)	🔴	🔴	🟢	🟢	Moderate
Ntaios et al. (Greece)	🟡	🟡	🟢	🔴	Moderate
Ramadan et al. (UAE)	🟡	🟢	🟢	🟢	Low
Syed et al. (Saudi Arabia)	🔴	🔴	🟢	🔴	High
Zafar et al. (Saudi Arabia)	🔴	🔴	🟢	🔴	High

🟢 = Low risk, 🟡 = Moderate risk, 🔴 = High risk.
Summary: Low risk: 5 studies (22 %), Moderate risk: 9 studies (39 %), High risk: 9 studies (39 %).

results, reducing robustness.[27,28,31,37] Sample size variation affected statistical power, internal validity, and generalisability of results.[17,20,22,23]

Levels of awareness of stroke risk factors

This review found no standard criteria for assessing awareness of stroke risk factors. Some studies used predetermined criteria to define high awareness, [19–21,25,26,33,38] for example, identifying ≥5 risk factors,[24] or ≥2–3 factors.[18,21,36] One study considered identifying more than one risk factor as stroke literate.[30] Others assessed awareness based solely on the number of correctly identified risk factors without set criteria.[17,18,22–24,27,29–32,34–37,39]

Most studies concluded that awareness of stroke risk factors was low.[18,19,22–24,26,29,32–35] Five studies reported adequate or moderate awareness of stroke risk factors [25,31,37–39] whilst three studies reported high awareness of stroke risk factors.[20,21,30]

Table 3 summarises stroke risk factors identified by participants per study. Hypertension was the most commonly identified modifiable stroke risk factor[18–26,29–31,33–39], followed by smoking[18–26,29,30,33–39], dyslipidaemia/high cholesterol.[18,19,21–26,29–31,33–36,38,39] Diabetes mellitus and heart disease were also frequently identified, though awareness levels varied.[18,20–26,29–31,33–36,38,39] Awareness of obesity varied, with higher recognition reported in Saudi Arabia[19,21,24,38] compared to other countries.[18,29–31,33–35,37,39] One study showed an increase in obesity awareness from 15.7 % in 2010 to 27.4 % in 2015.[30]

Awareness of stress as a stroke risk factor varied: four studies reported high awareness (56.4 %–73.5 %),[19,22,26,38] while others showed low[17,20,21,24,25,27–29,31,32,36,37] or did not report. Awareness of family history ranged widely (2 %–82 %).[17 30] Older age was frequently recognised as a risk factor in several studies,[19,24,26,33,36] with one reporting it as the most identified factor (55.3 %), surpassing hypertension (29 %) and stress (13 %).[33]

Less commonly identified risk factors included sedentary lifestyle,[19,21,23,35,36,39] alcohol consumption,[18,19,21,25,26,29,30,34] atrial fibrillation, [38]and poor diet, which mostly had low awareness apart from two studies.[23,36] Table 4 summarises factors associated with awareness of stroke risk factors.

Factors associated with awareness levels

Most associations between demographic factors and stroke risk factor awareness reported in the included studies were unadjusted for potential confounders. Of the 15 studies that examined demographic associations, only 4 (27 %) used multivariable analyses adjusting for age, sex, education, or other relevant variables. This limits the reliability of reported associations and makes it difficult to determine independent predictors of awareness.

Discussion

This systematic review represents a comprehensive examination of stroke risk factor awareness specifically within HICs, revealing significant evidence gaps that distinguish it from previous reviews focusing on LMICs or general stroke knowledge. Key unique findings include the marked geographical clustering of research, lack of standardised awareness measurement, and predominance of unadjusted analyses. Overall, awareness of stroke risk factors was low. This is consistent with previous research reporting suboptimal knowledge of stroke risk factors in European populations [40] and findings from studies conducted in LMICs.[41–43]

Modifiable risk factors

Globally, hypertension remains the leading modifiable risk factor for stroke. [45] In our study, hypertension was the most commonly identified risk factor, consistent with previous findings. [18,21,44] However, awareness varied dramatically between countries (28 % in Sweden vs 71.2 % mean in Saudi Arabia, with individual studies ranging up to 97 %), suggesting that cultural, healthcare systems, and educational factors significantly influence public knowledge. This variation within HICs challenges the assumption of uniform health literacy across high-income settings. Poor knowledge, detection, and treatment contributes to increased stroke risk, earlier onset, and a higher prevalence of intracerebral haemorrhage.[44] Therefore, it is vital to educate populations of the link between hypertension and stroke and promote strategies that enhance self-efficacy, enabling individuals to adopt healthier lifestyles and adhere to prescribed medication for effective blood pressure control.

About 87 % of strokes are linked to modifiable risk factors (i.e., dyslipidaemia, obesity, hyperglycaemia), and 47 % to behaviours (i.e., smoking, poor diet, sedentary lifestyle).[46] Between-country analysis revealed that awareness of smoking as a risk factor ranged from 11 % in Polish populations to 77 % in some Saudi Arabian studies, highlighting the need for targeted educational interventions that consider local contexts. For example, obesity was more widely recognised in Arab countries, likely due to high prevalence rates and strain on healthcare systems.[47,48] Globally, obesity affects >2 billion people (~30 % of the world population) and is the fastest-growing stroke risk factor since 1990.[1]

Emerging and under-recognised modifiable risk factors

Awareness of dyslipidaemia as a stroke risk factor was generally high, but knowledge of unhealthy diets (i.e., high in salt, sugar, processed foods) and alcohol's impact remains low. [18,26,29,30,34,35] Healthy lifestyle choices can reduce stroke risk by up to 80 %.[49] Guidelines emphasise a mediterranean diet, regular physical activity, and reduced sedentary behaviour.[9] Limited awareness of the links between diet, dyslipidaemia, and stroke risk suggests a gap in public health education. Smoking is an established risk factor for stroke [50] however, awareness varies.

While generally high[20,23–25,30,36,38] only 10.9 % of Chinese Canadians identified it as a risk compared to 57.6 % of European Chinese Canadians. [29] Cultural and geographic differences highlight the need for targeted education.

Particularly concerning was the consistently low awareness of atrial fibrillation (average 24 % across the three studies that assessed it), given its strong association with cardioembolic stroke and the availability of effective preventive treatments. Awareness of **atrial fibrillation (AF)** as a stroke risk factor is low, consistent with previous data. [51] AF is an important cause of ischemic stroke, linked to high morbidity and mortality and its incidence has tripled with an aging population.[52] Raising awareness may encourage people to seek timelier stroke preventive care.

Key modifiable risk factors such as female-specific risk factors were not addressed in reviewed studies despite their association with stroke.[9] Women experience a higher stroke burden due to greater mortality, and disability, and are more likely to experience stroke due to increased life expectancy, hence women are a vulnerable group. [2,46,53] More research is needed to incorporate sex-specific relevant factors into stroke risk prediction models.

Non-modifiable risk factors

Awareness of age as a stroke risk factor showed interesting patterns, with some studies reporting it as the most recognised factor (55.3 % in Poland) while others showed minimal recognition (3 % in Sweden). This disparity may reflect different cultural perceptions of aging and stroke risk, but the lack of adjusted analyses makes it difficult to determine whether these differences reflect true population variations or methodological artifacts.

Family history is a key non-modifiable stroke risk factor.[54] Awareness of family history as a stroke risk factor ranged dramatically from 2 % to 82 % across studies. Notably, several studies found that having a family history of stroke did not translate to increased awareness of stroke risk factors or preventive behaviours[17,27]. This highlights a public health gap among high-risk ethnic minorities and underscores the need for targeted interventions that make familial risk personally relevant and encourage prevention.

Stroke incidence is higher among ethnic minorities who already face disparities in care and outcomes.[55] Despite higher exposure to risk factors like hypertension, diabetes, and high BMI in young Black African and Caribbean groups, [56] awareness of ethnicity as a stroke risk factor was low among young Black African Americans, Māori pacific, and Asian minorities.[17,28,29,32,34] As ethnic minorities may have lower awareness of their vulnerability to stroke, further studies are needed to

Table 3
Stroke risk factors identified by participants per study.

StudyCountry	Hypertension	Smoking	Dyslipidaemia	Diabetes mellitus	Heart disease	Obesity	Stress	Family history of stroke	Older age	Exercise	Alcohol consumption	Sedentary lifestyle	Atrial fibrillation	Poor diet
19. Saudi Arabia	73 %	61 %	59 %	-	-	59 %	60 %	49 %	60 %	69 %	19 %	66 %	-	48 %
20. Saudi Arabia	90 %	77 %	-	76 %	74 %	-	-	-	-	-	-	-	-	-
21. Saudi Arabia	97 %	49 %	84 %	76 %	-	49 %	-	61 %	47 %	-	39 %	42 %	-	-
22. Saudi Arabia	66 %	33 %	34 %	21 %	40 %	20 %	41 %	-	-	-	-	-	-	-
17. USA	-	-	-	-	-	-	-	FHS: 82 % No FHS:58 %	-	-	-	-	-	-
23. Saudi Arabia	82 %	55 %	57 %	19 %	-	-	-	-	-	-	-	23 %	-	67 %
31. Italy	68 %	-	44 %	13 %	8 %	15 %	-	16 %	5 %	-	-	-	-	-
27. USA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28. USA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18. Sweden	28 %	40 %	9 %	3 %	5 %	23 %	30 %	8 %	3 %	19 %	11 %	-	-	23 %
32. New Zealand	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33. Poland	29 %	11 %	2 %	3 %	-	3 %	13 %	2 %	55 %	5 %	-	-	-	7 %
29. Canada	CC: 44 % EC:37 %	CC: 11 % EC:58 %	CC:24. % EC:13 %	CC:5 % EC:4 %	CC:4 % EC:4 %	CC:4 %–12 %	-	-	-	CC:4 %–12 %	CC:4 %–12 %	-	-	-
34. Singapore	49 %	17 %	40 %	13 %	3 %	13 %	21 %	13 %	6 %	28 %	11 %	-	-	42 %
35. 2016 Israel	VR:50 % FSU:63 %	VR:27 % FSU:27 %	VR:34 % FSU:33 %	VR:18 % FSU:20 %	VR:10 % FSU:12 %	VR:22 % FSU:20 %	VR:15 % FSU: 15 %	FSU:10 % FSU:5 %	VR:6 % FSU:18 %	-	-	VR:9 % FSU:7 %	-	VR:8 % FSU:6 %
36. Israel	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (75 %) F (62 %)	-	<45 years M (53 %) F (62 %) 45-65 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	-	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)	-	<45 years M (53 %) F (62 %) 45-64 years M (61 %) F (74 %) >64 years M (75 %) F (62 %)
30. Canada	2010: 31 % 2015: 49 %	2010:58 % 2015:44 %	2010:16 % 2015:27 %	2010: 8 % 2015:12 %	-	2010:19 % 2015:21 %	2010: 13 % 2015: 14 %	2010:2 % 2015:10 %	2010:2 % 2015:4 %	2010:18 % 2015:17 %	2010:1 % 2015:5 %	-	-	-
24. Saudi Arabia	65 %	58 %	58 %	36 %	-	50 %	-	-	55 %	-	-	-	-	-
39. Chile	42 %	38 %	32 %	14 %	17 %	33 %	39 %	-	-	-	-	34 %	-	23 %
37. Greece	66 %	44 %	-	-	-	34 %	-	-	-	-	-	-	-	-
38. UAE	69 %	63 %	50 %	35 %	54 %	54 %	56 %	46 %	-	52 %	-	-	24 %	43 %
25. Saudi Arabia	70 %	57 %	43 %	-	45 %	-	-	27 %	37 %	51 %	77 %	-	-	-
26. Saudi Arabia	64 %	42 %	37 %	42 %	32 %	32 %	74 %	21 %	52 %	2 %	27 %	-	-	-

Key: HTN: Hypertension; SM: Smoking; D: Dyslipidaemia/high cholesterol/hyperlipidaemia; UDM: Uncontrolled diabetes (DB) mellitus/diabetes; HD: Heart disease; O: Obesity; S: Stress; FHS: Family history of stroke; OA: Older Age; EX: Exercise; AC: Alcohol consumption; SD: Sedentary lifestyle; AF: Atrial fibrillation; PD: Poor diet; CC: Chinese Canadian; EC: European Canadian; VR: Veteran resident; FSU: Former Soviet union; M: male; F: female.

*Studies that did not include/report on individual stroke risk factors.

*Percentages were rounded to the next whole number.

*Studies that did not include/report on individual stroke risk factors.

*Percentages were rounded to the next whole number.

Table 4
Summary table of results.

Factor	Findings	References
Sex	Higher awareness in women	18,21,24,33
	Women more aware of hypertension	31
	Higher awareness of smoking in men	39
	No significant difference	22,25,34,38
Education	Higher education consistently high awareness	18,19,21,22,24,25,30,32,33,35
Age	Younger adults (18–40 years): high awareness	21,24,25,30,31,33,34
	Older adults (>45 years): higher awareness in some studies	19,22,36
Ethnicity	Only one study identified ethnicity as a stroke risk factor	27
Young African Americans (18–30 years)	Limited understanding of modifiable risk factors	28
African Americans with family history of stroke and hypertension	No greater awareness or preventive behaviour despite higher risk.	17
Pacific people (New Zealand)	Less likely to identify stroke risk factors than Europeans.	32
Chinese Canadians	Unaware of smoking, inactivity, and obesity as stroke risks; good hypertension awareness	29
Singaporean adults	Fewer than half of Singaporean adults identified at least two risk factors	34

investigate awareness of stroke risk factors amongst ethnic minority populations to help inform culturally sensitive health campaigns.

Factors associated with awareness levels

Whilst the link between sex and stroke risk awareness was inconsistent other factors such as education, age, and culture may influence awareness. For example, higher education was associated with greater awareness. [18,19,21,22,24,25,30,32,33,35] In the WHO European region, those with lower education, income, or occupational status face higher stroke risk and worse clinical outcomes.[57] Reducing socioeconomic disparities in health knowledge should be a priority for stroke prevention efforts.

Awareness of stroke risk factors varied by age. Higher awareness among younger participants may reflect better health literacy and digital engagement supported by early preventative education in many European countries.[58] Lower awareness in younger populations, may be due to the misconception that stroke only affects older adults.[59,60] Traditional cardiovascular risk factors are now prevalent in younger adults (<55 years) with stroke often linked to smoking, alcohol use, and inactivity with adverse effects seen as early as age 36.[2,61] Campaigns should target all age groups, and ensure everyone has access to healthcare support for adopting behaviours that reduce stroke risk.[9]

Critical Evidence Gaps and Geographic Limitations

The geographical distribution of included studies reveals a critical limitation in the current evidence base. With 35 % of studies conducted in Saudi Arabia alone and 65 % from Middle Eastern countries, the generalisability to the broader category of HICs is questionable. This clustering may reflect publication bias, research funding patterns, or genuine differences in research priorities across HICs.

Furthermore, the lack of representation from major HICs such as Japan, Germany, UK, France, and Australia represent a significant evidence gap. The socioeconomic diversity within HICs also remains underexplored, with most studies focusing on urban, educated populations rather than investigating awareness across different socioeconomic strata within these countries.

Stroke awareness in HIC's calls for large population studies in diverse geographical and socioeconomic areas as well as within diverse ethnic/racial groups as differences may exist. HICs may possess areas with stroke awareness characteristics resembling low-income countries, a phenomenon well-documented in health inequality research. For example, geographical health disparities within HICs can be substantial such as in London's borough of Croydon in England, life expectancy varies by over 10 years between the most and least deprived areas within the same high-income setting, with health outcomes in deprived areas comparable to those found in some middle-income countries.[65] Such intra-country variations in health literacy, healthcare access, and social determinants suggest that stroke awareness may similarly vary dramatically within HICs, with some areas potentially exhibiting awareness levels more characteristic of resource-limited settings despite being located in wealthy nations. Hence the need for cross country comparisons in future reviews. Additionally, socioeconomic disparities within HICs, such as relative poverty, and educational disadvantage, may impact stroke awareness and preventative behaviours but remain inadequately studied. Future research should adopt consistent awareness measures and examine socioeconomic influences to enhance generalisability and inform targeted public health interventions.

Limitations

This review has several limitations. The marked geographical clustering, with 65 % of studies from Middle Eastern countries and 35 % from Saudi Arabia alone, severely limits generalisability to other HICs due to substantial differences in political systems, cultural contexts, healthcare structures, and population demographics.[62] Cultural factors may shape behaviours and attitudes further affecting generalisability to Western or other non-Middle Eastern HICs.

The lack of methodological standardisation across studies presents another significant limitation. No consensus exists on defining "adequate" or "high" awareness, with different studies using varying thresholds (ranging from identifying ≥1 to ≥5 risk factors). This inconsistency prevents meaningful cross-study comparisons and limits the development of evidence-based awareness targets.

Additionally, the predominance of unadjusted analyses (73 % of studies) means that reported associations between demographic factors and awareness levels may be confounded by unmeasured variables. This limits our ability to identify independent predictors of awareness and develop targeted interventions.

Most studies were cross-sectional, restricting causal inferences and the ability to assess temporal changes. Excluding intervention studies may have overlooked valuable data on strategies to improve awareness. The lack of representation from diverse ethnic groups within HICs, particularly given the established ethnic disparities in stroke incidence, represents a critical evidence gap that future research must address.

Conclusions

Our findings reveal low awareness of stroke risk factors, specifically ethnicity, sedentary lifestyle, poor diet, alcohol consumption, and atrial fibrillation, highlighting key targets for education. However, the geographical clustering of studies and methodological heterogeneity limit the generalisability of these findings across the diverse landscape of HICs.

This review identifies critical evidence gaps that future research must address: (1) the need for large-scale, population-representative studies across diverse HICs beyond the Middle Eastern focus of current research; (2) the development of standardised metrics for measuring stroke risk factor awareness; (3) the inclusion of adjusted analyses to identify independent predictors of awareness; and (4) specific attention

to ethnic minorities and socioeconomically disadvantaged populations within HICs.

Stroke awareness may vary within HICs, with some populations potentially having awareness levels more characteristic of resource-limited settings despite residing in high-income nations, making targeted, context-specific interventions essential rather than assuming uniform health literacy across these nations. Geographic and demographic variation calls for culturally tailored education strategies that address ethnicity, lifestyle, socioeconomic status, and health beliefs. Individuals with lower educational levels should be prioritised for intervention.

Current stroke and cardiovascular prevention strategies remain inconsistent or insufficient.[46] Given the overlap of stroke risk factors with other non-communicable diseases, a multimorbidity approach is needed for more personalised, coordinated prevention. While healthcare professionals and families are key sources of information, broader community engagement (including health champions and eHealth technologies) could drive relatable, supportive behaviour change. Future research should prioritise methodologically rigorous, large-scale studies that include diverse populations within HICs, use standardised awareness measurements, and employ multivariable analyses to identify independent predictors of awareness. Only through such comprehensive research can we develop evidence-based, targeted interventions to improve stroke prevention across the diverse populations within high-income countries. Overall, these results emphasise the need to consider a wider range of social determinants to enhance public health campaigns and prevention efforts in HICs.

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Data availability

All data supporting the findings of this study can be made available upon request.

Ethical approval

As this was a systematic review of previously published literature, ethical approval was not necessary

Informed consent

As this was a systematic review of previously published literature, informed consent was not necessary.

CRediT authorship contribution statement

Mc Lernon S: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Appiah B:** Writing – review & editing, Writing – original draft, Visualization, Data curation. **Moorley C:** Writing – review & editing. **Thomas N:** Writing – review & editing. **Mussa R:** Writing – review & editing. **Gonzales S:** Data curation. **Werring D:** Writing – review & editing. **D.B Olawade:** Writing – review & editing, Formal analysis. **Flood C:** Writing – review & editing.

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Supplementary materials

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