REVIEW

The State of Stroke Research in Malawi: Results from a Mapping Review Study

Memory Lucy Mtambo [1,2], Didjier Danger Masangwi [3], Alpha Omega Soko [4], Thom Kaledzera [5], Fanuel Meckson Bickton [5,6], Mep Coretta Chipeta [7]

[1]Department of Clinical Sciences, Malawi University of Science and Technology, Blantyre, Malawi; [2]Jeffrey Cheah School of Medicine and Health Sciences, Monash University, Kuala Lumpur, Selangor, Malaysia; [3]Department of Applied Sciences, Malawi University of Science and Technology, Blantyre, Malawi; [4]Department of Basic Sciences, Lilongwe University of Agriculture and Natural Resources, Lilongwe, Malawi; [5]Department of Rehabilitation Sciences, Kamuzu University of Health Sciences, Blantyre, Malawi; [6]Lung Health Research Group, Malawi-Liverpool-Wellcome Programme, Blantyre, Malawi; [7]Department of Nursing and Midwifery, Mzuzu University, Mzuzu, Malawi

Correspondence: Memory Lucy Mtambo, Email lmtambo@must.ac.mw

Introduction: Stroke is one of the leading causes of death and disability globally, and low-income countries such as Malawi bear a heavy burden. Tailored, high-quality research is essential for bridging existing gaps and improving the healthcare provided in low-resource settings while maximizing available resources.

Aim: This mapping study aimed to synthesize the current state of stroke research in Malawi.

Methods: Six databases were thoroughly searched: CINAHL complete, Ovid MEDLINE and EMBASE, Web of Science Core Collection, PubMed, and Google Scholar.

Results: The search retrieved 598 references and identified 20 studies published between 2005 and 2023. Of these, 70% were conducted at Queen Elizabeth Central Hospital only; open-access journals published 95% of the studies. Cross-sectional studies were the most common (50%), followed by case-control studies (20%). The Malawi-Liverpool-Wellcome Trust Clinical Research Program authors contributed the most articles as main authors (25%). The number of citations per article ranged from 0 to 168 on Google Scholar, and the number of authors per article ranged from 1 to 15. Authors from thirty-five different institutions from 11 other countries partnered with Malawi on stroke articles, and England contributed 45.7% of the institutions. Most articles focused on pathophysiology (30%), followed by diagnosis (20%) and stroke management (15%). The highest number of participants included in the analysis was 739 and the highest number of stroke participants was 222. The identified challenges included the need for more infrastructure and under-utilization of available services. The Wellcome Trust has emerged as the primary funding agency for stroke research in Malawi.

Conclusion: The study found limited collaboration among local institutions in Malawi, with most research focused in Blantyre District. There is a critical need for increased interdisciplinary teamwork to boost nationwide research.

Keywords: corroboration, distribution, methods, output

Introduction

Stroke is the second leading cause of death worldwide and the third leading cause of death and disability, as calculated by disability-adjusted life-years lost (DALYs).[1,2] Literature indicates in 2016, there were 13.7 million new incidents of strokes globally, and ischemic strokes accounted for about 87% of the cases.[3] Meanwhile, the Global Burden of Disease study, 2019 estimated the incidence and prevalence of stroke per 100,000 population as higher in females than males. In females, 6.44 million new strokes (95% CI: 5.81–7.17 million) and 56.4 million existing cases (95% CI: 52.0–61.5 million) were recorded, representing 53% of all strokes. In comparison, males experienced 5.79 million new strokes (95% CI: 5.24–6.45 million) and had 45.0 million existing cases (95% CI: 41.1–49.3 million).[2] Despite a significant decrease in age-standardized stroke incidence and mortality rates, this trend is observed in high-income countries.[4] The incidence of stroke continues to increase in low and middle-income countries (LMICs), such as most African countries.[1,5–8] LMICs account for 80% of all stroke incidences, 77% of all stroke survivors, 87% of all stroke deaths, and 89% of all stroke-related DALYs.[7,9–11] In Africa, in particular, community-

based studies have shown age-standardized annual stroke incidence and prevalence rates reaching as high as 316 per 100,000 and up to 14.6 per 1000 populations, respectively.[12] Stroke poses a more significant concern in LMICs because it often affects individuals at a much younger age, a time when they are expected to participate in socio-economic activities actively.[4,13] Furthermore, diseases such as malaria, human immunodeficiency virus (HIV), and tuberculosis are still a considerable burden in most African countries.[7,14]

African nations are experiencing an epidemiological shift driven by changes in society and lifestyle due to unregulated industrialization, which has resulted in increased risk factors for vascular diseases.[6,15] The Malawi 2017 World Health Organization (WHO) STEPwise approach to noncommunicable diseases (NCDs) risk factor surveillance results revealed high-risk factors for NCDs such as smoking, excessive alcohol consumption, sedentary behavior, and poor dietary habits.[16] This indicates that Malawians are at high risk of suffering from stroke in their lifetime, and to reduce the incidence and improve the outcomes of stroke patients, high-quality research that can address the cultural and economic situation of the population is needed. However, in most low-income countries, the quality and quantity of research are hindered by factors such as lack of funding, lack of modern equipment, inadequate suppliers, and lack of specialist expertise,[17–19] which makes tailored interventions almost impossible.

Malawi is a land-locked country in Southeast Africa and is among the lowest-income countries in the world.[20] The most recent population and housing census conducted in 2018 recorded a population of 17,563,749 across the twenty-eight (28) districts.[21] Informal online sources of data such as Worldometer, which provides live statistics, state that Malawi had a total population of just over 21.3 million in March 2024.[22] Malawi relies on donor funding for most of its sectors, which includes health and has declined in recent years. The state publicly funds most healthcare and the income generation capacity of most councils that now run district health facilities is inadequate.[23] Most Malawi individuals cannot afford health insurance and rely on publicly funded local, district, and tertiary health facilities that are mainly provided at no or minor costs.[24]

Standards of care in most publicly funded facilities are often abysmal and marked by challenges such as scarcity of medicines and other supplies, extended waiting times, delayed facility opening hours, and equipment malfunctions that are too long to repair. Shortages of staff with advanced expertise and high travel costs due to long-distance access are widespread, and rural areas experience even more significant difficulties.[25,26] All these factors impede the optimal delivery of healthcare to Malawi residents. Based on this knowledge, this study sought to systematically review and analyze the literature on stroke research conducted in Malawi. The aim was to recognize research efforts, understand the methodologies used, examine geographical distribution, and identify research gaps for further exploration.

Material and Methods
Type of Study
This systematic mapping review study was conducted under the guidance of Campbell et al[27] and included six stages: (1). Identifying the need for a mapping review; (2). Establishing research questions; (3). Developing review protocol; (4). Identification, screening, and selection of articles; (5). Data charting and (6). Results synthesis and reporting. The authors registered the protocol with the Open Science Framework (OSF) on February 24, 2024.[28]

Research Questions
The mapping study aimed to answer the following six questions:

What are the most commonly used study designs for stroke research in Malawi? What specific areas have been the primary focus of stroke research in Malawi? Where are stroke research studies conducted predominantly in Malawi? What primary research methodologies are employed in the stroke studies conducted in Malawi? What are the emerging trends and patterns observed over time in stroke research in Malawi? What are the main findings reported in studies on stroke conducted in Malawi?

The Eligibility Criteria

All studies of all population ages focusing on stroke in Malawi were eligible. Studies were excluded if they did not have an entire article online, included information on several neurological conditions or NCDs and it was impossible to isolate stroke data from the study. Studies in languages other than English or with non-human participants were to be excluded; however, no non-English language or non-human participant studies were retrieved.

Information Sources

Six databases were searched, namely, Cumulative Index to Nursing and Allied Health Literature (CINAHL) complete, Ovid for MEDLINE and EMBASE, Web of Science Core Collection for Web of Science, PubMed, and Google Scholar via the Monash University Library. Grey literature was searched for using Google at www.google.com.my. and a manual search of the Malawi Medical Journal (MMJ) was also conducted. All databases were searched from their inception to the last date of the search, with no year or language restrictions. Notifications were configured for new monthly publications, and backward and forward citation searches of the included papers were also conducted. No contact with the authors was made; one researcher (MLM) performed all searches, and the last search date was March 30, 2024.

The Search Strategy

The search strategy used a combination of keywords such as (Stroke OR CVA OR, "Cardiovascular accident", OR "Cerebrovascular disease"), AND Malawi. The Monash University librarian assisted in developing the search strategy with input from all the research team members. Supplementary Material 1 contains a complete search strategy applied in the Ovid Medline and Ovid Embase.

Screening and Data Extraction

MLM retrieved references from the databases and imported them into EndNote version 20.0, where the deduplication process was conducted before exporting to Covidence. MLM performed title and abstract screening in Covidence and MLM, FMB, MCC, and TK reviewed the full-text documents and extracted relevant data for inclusion. MLM initially extracted the data and independently confirmed it with another member of the team (FMB, MCC, and TK). A data template was piloted in the first five articles, and any discrepancies regarding data extraction were resolved through discussions among the four members as the extraction progressed.

Data Charting Process

All data were entered and coded into IBM SPSS Statistics for Windows, Version 28.0. Armonk, NY: IBM Corp as numeric variables on a nominal scale to calculate percentages and counts; Supplementary Material 2 contains the codebook of all the variables.

Results

Included Articles

A total of 598 records were retrieved through electronic searches. 230 duplicate studies were removed, 368 articles were retained for title and abstract screening. Of these, 321 were excluded, and four studies could not be retrieved, leaving 43 studies for full-text reading. Upon review of the full texts, 23 studies were excluded, and 20 studies were identified for inclusion, which provided the results of this study; Figure 1 illustrates the selection process, adapted from Page et al.[29]

Table 1 provides a summary of the key details from the included studies. It includes authors' affiliations, the number of contributors, and the journals in which they were published; the author listed first in the articles was considered the main author. The Journal impact factors (JIF) quartile is based on the journal citation reports (JCR) for the year the paper was published to ensure objectivity of the assessment process, and the total number of citations was obtained from Google Scholar as of March 30, 2024.

The first article, based on our results, was published in 2005 with data collected from October 2001 to July 2002. The years with the most articles published were four in 2019 and three in 2018. Since the first article was published in 2005,
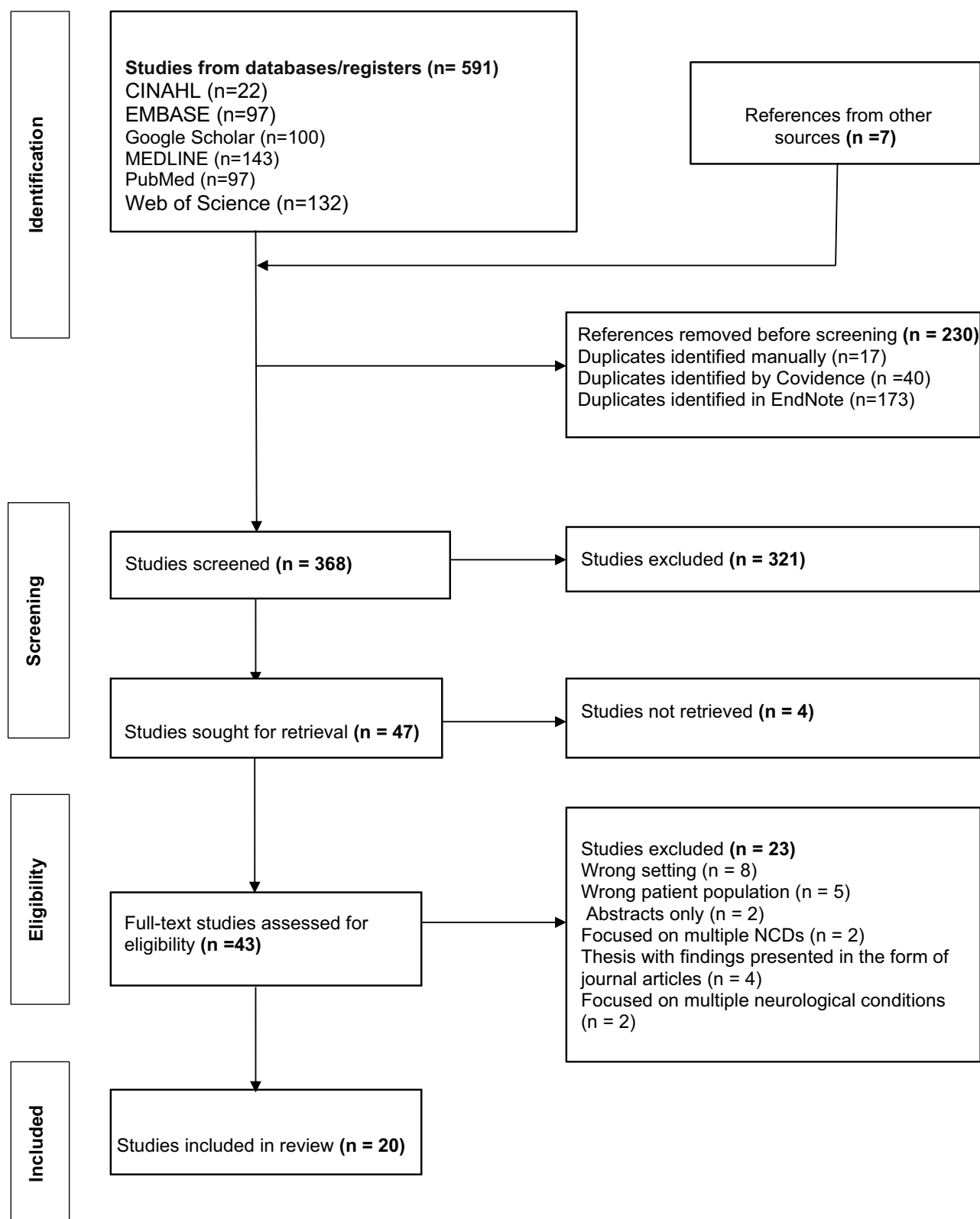
Figure 1 Flow chart of the identification, screening, and selection process of the included articles.

Table 1 Key Details of the Included Articles in the Mapping Review

Reference	Affiliation of the Main Author: Total Number of Authors	Study Design: Participants: Total Sample Size	District of Participants: Facility Name Setting: (Clinical/ community)	Journal Published: Quartile Total Number of Citations	The Main Focus of the Study: Aim	Key Findings/Concepts/Conclusions
J.J. Kumwenda et al, 2005[30]	COM 6	Cross-sectional Stroke patients N=98	Blantyre QECH Clinical	Stroke Q1 82	Diagnosis: To investigate the causes of stroke in Blantyre, focusing on the differential diagnosis.	The mean age of HIV-positive individuals (48%) was 37.5 years. Ischemic stroke was the most common diagnosis among HIV-positive patients (58%). In HIV-negative patients (mean age 58.6 years), ischemic stroke and intracerebral hemorrhage were predominant, with no cases of brain infection diagnosed.
Chisomo Phethi, 2009[31]	KCN 1	Qualitative cross-sectional Stroke patients N= 15	Blantyre QECH Clinical	N/A Unpublished 0	Rehabilitation: To explore the perceptions of stroke patients on physiotherapy services.	There was absence of information on physiotherapy (PT) services. Most patients indicated PT was important. Patients expressed excitement during their initial PT sessions, with hospital-based PT preferred over home-based sessions. Overall, satisfaction with PT services was high. Challenges such as long travel distances and inadequate staffing were noted.
Elsayed. Soliman et al, 2010[32]	WFU 3	Case-control Stroke patients, general population N=184 Cases, n=92 Controls, n =92	Mzimba MCH Clinical	JSCVD Unranked 18	Pathophysiology: To evaluate using P-wave terminal force (PTF) as a risk stratification tool for ischemic stroke.	PTF was significantly more prevalent in patients with stroke compared to the comparison group (54% vs 17%, respectively; p < 0.001). PTF greater than or equal to 4 mm-s could serve as a risk stratification tool to distinguish between patients at high and low risk of ischemic stroke.
Karim M. Mahawish et al, 2010[33]	COM 2	Case-report Stroke patients N=2	Blantyre QECH Clinical	MMJ Unranked 13	Pathophysiology: To provide an overview of stroke in Malawi.	The summary includes the definition of stroke, its prevalence, risk factors, differentials, diagnosis, management, and prevention.

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Table 1 (Continued).

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Terttu Heikinheimo et al, 2012[19]	HUCH 5	Prospective cohort Stroke patients N= 147	Blantyre QECH Clinical & Community	PLOS ONE Q1 89	Epidemiology: To investigate the functional outcomes and mortality one year following the first-ever acute stroke.	34% of patients were HIV-seropositive, and poor outcome at one year (severe disability or death, mRS 4–6) was primarily related to stroke severity and female gender rather than the presence of HIV infection.
George L. Chimatiro et al, 2014[34]	UWC 2	Qualitative cross-sectional Stroke patients N=8	Blantyre Community	SAJPT Unranked 17	Community reintegration: To explore barriers to community reintegration of stroke survivors after discharge from rehab.	Stroke patients encountered attitudinal barriers, physical environmental obstacles, and resource limitations during their community reintegration process.
Terttu Heikinheimo et al, 2015[18]	HUCH 2	Cross-sectional Stroke patients N=81	Blantyre QECH Clinical & Community	MMJ Q4 42	Prognosis: To characterize the quality of life more than six months after a first-ever stroke.	Good functional outcomes (lower mRS scores) correlated positively with better quality of life (QoL) in the domains of activities of daily living (ADL)/self-care (p = 0.0024) and communication (p = 0.031). Women scored lower in the fatigue (p = 0.0081) and cognition (p = 0.048) domains. Older age was associated with poorer QoL in the ADL domain (p = 0.0122).
Yury Zverez 2015[35]	LSUNN 1	Case-control Stroke patients, general population N= 72 (not indicated actual number of controls) Cases, n=36 Controls, n= (assumed to be 36)	Blantyre QECH Clinical	TJHR Unranked 4	Pathophysiology: To assess the effectiveness of the footprint and symmetry index (SI) methods in evaluating gait asymmetry among hemiparetic post-stroke patients.	Both paretic and nonparetic steps were significantly shorter in stroke patients compared to controls (p < 0.05). The mean values of step length and foot rotation angle SI in patients were significantly higher than in controls (p < 0.001).

Laura A. Benjamin et al, 2016[36]	MLWTCRP 13	Case-control Stroke patients, general population N= 725 Cases, n=222 Controls, n= 503	Blantyre QECH Clinical & Community	Neurology Q1 168	Pathophysiology: To investigate HIV infection, its treatment, and hypertension as stroke risk factors among adults.	Researchers identified HIV infection (population attributable fraction [PAF] 15%) and hypertension (PAF 46%) as significant contributors to stroke risk. Among individuals under 45 years old, HIV was the predominant risk factor for stroke, with a prevalence of 67% and an adjusted odds ratio (aOR) of 5.57 (95% confidence interval: 2.43–12.8) (PAF 42%). Patients with untreated HIV infection faced an increased risk of stroke (aOR 4.48 [2.44–8.24], p < 0.001), particularly within the first six months of starting antiretroviral therapy (ART) (aOR 15.6 [4.21–46.6], p < 0.001.
Laura A. Benjamin et al, 2017[37]	MLWTCRP 15	Cross-sectional Stroke patients (included brain autopsies, n =4) N=171	Blantyre QECH Clinical	JID Q1 82	Pathophysiology: To investigate the clinical, radiologic, and histologic features of HIV-related ischemic stroke.	HIV-infected patients were more prone to extensive artery disease (21% vs 10%; P < 0.001). The most common etiology of stroke among HIV-infected individuals was HIV-associated vasculopathy (38%), followed by opportunistic infections (25%). Notably, 25% of HIV-infected patients experienced a stroke shortly after initiating antiretroviral therapy (ART), suggestive of an immune reconstitution–like syndrome. Despite a significantly lower HIV viral load in those recently started on treatment (P < 0.001), CD4+ T-lymphocyte counts remained low in this subgroup.
Yohane Gadama et al, 2017[38]	QECH 12	Case-report Stroke patients N=1	Blantyre QECH Clinical	MMJ Q4 8	Diagnosis: To discuss the challenges of stroke management in resource-limited settings.	The case highlights the complexities of managing stroke, particularly in resource-limited settings.

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Table 1 (Continued).

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George L. Chimatiro et al, 2018[39]	UWC 3	Cross-sectional Stroke patients, caregivers N=90 (It is not clear how many were patients and how many were caregivers)	Blantyre-QECH LL-KCH Zomba-ZCH Mzimba-MCH Clinical	MMJ Q4 21	Stroke management: To determine stroke outcomes, satisfaction with care, and quality of life among patients.	A notable improvement in patient functional status upon discharge compared to admission, particularly in self-care, sphincter control, locomotion, and social cognition (all p < 0.001). Satisfaction with care was high across genders, ages, and distances to the clinic, with no significant differences noted (all p > 0.05). Despite high satisfaction levels, patients' quality of life was generally poor.
Jayne P. Ellis et al, 2018[40]	MLWTCRP 8	Case-report Cryptococcal meningitis N=1	Blantyre QECH Clinical	BMC Infectious Diseases Q3 19	Diagnosis: To report the first documented case of IRIS presenting as an ischemic stroke in a patient with cryptococcal meningitis and HIV infection.	A case of an HIV-positive patient with cryptococcal meningitis who was later diagnosed with ischemic stroke.
Joseph K. Tatuene et al, 2018[41]	UoL 6	Case-control Stroke patients, general population N=139 Cases, n=48 Controls, n=91	Blantyre QECH Clinical	PLOS ONE Q1 8	Pathophysiology: To investigate the association between serum concentrations of anti-CMV IgG and ischemic stroke among HIV-infected individuals.	A high concentration of anti-CMV IgG was associated with ischemic stroke in the univariable model (OR = 2.56 [1.23–5.34]), but this association was not significant. Low CD4+ count emerged as an independent predictor of stroke. There was negative correlation between serum concentration of anti-CMV IgG and CD4+ count (rho = −0.30, p < 0.001).

George L. Chimatiro et al, 2019[42]	UWC 2	Qualitative cross-sectional Stroke patients, caregivers, healthcare professionals (HCP) N=27 Patients, n=6 Caregivers, n=7 HCP, n=14	Blantyre QECH Clinical	JGHR Unranked 7	Stroke management: To explore the challenges of stroke care provision.	Challenges identified include: Inadequate implementation of stroke care strategies. Challenges in physiotherapy provision. Patient-mix issues resulting from the mixing of patients with different conditions. Resource constraint.
Hazzie Mvula et al, 2019[43]	MEIRU 10	Cross-sectional General population N=739	Karonga Community	Stroke Q1 14	Public health: To assess community-level knowledge and perceptions regarding stroke in rural Malawi.	Stroke knowledge was poor, with 71% of participants needing help identifying any risk factors correctly. Witchcraft (20.6%) was mentioned as frequently as hypertension (19.8%) as a cause of stroke. Knowledge levels were highest among the most educated and wealthy individuals and lowest among men, those who were never married, and the youngest age group. HIV-positive individuals exhibited higher knowledge of stroke prevention compared to HIV-negative individuals (odds ratio (OR), 2.91; 95% CI, 1.21–7.03).
Reuben Kalavina et al, 2019[44]	UWC 4	Qualitative cross-sectional Stroke patients, caregivers N=18 Patients, n=9 Caregivers, n=9	Blantyre KRC Clinical & Community	MMJ Q4 54	Rehabilitation: To explore the challenges and experiences faced by stroke patients and their spouses during and after rehabilitation.	Stroke patients faced challenges in mobility and basic functional activities, leading to sudden dependence on spouses for care. At the same time, limited access to rehabilitation and health services at the grassroots level exacerbated caregiving burdens and revealed infrastructure challenges at the Kachere Rehabilitation Centre (KRC).

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Table 1 (Continued).

Reference	Affiliation of the Main Author: Total Number of Authors	Study Design: Participants: Total Sample Size	District of Participants: Facility Name Setting: (Clinical/community)	Journal Published: Quartile Total Number of Citations	The Main Focus of the Study: Aim	Key Findings/Concepts/Conclusions
Yohane Gadama et al, 2019[45]	MLWTCRP 5	Audit report Stroke patients N=50	Blantyre QECH Clinical	MMJ Q4 8	Stroke management: To assess current stroke management practices and outcomes at the QECH.	38% of patients diagnosed within 24 hours of admission. Electrocardiograms were performed on 68% of patients; 10% had their vital signs checked more than three times within the first 24 hours. At discharge, the modified Rankin scale (mRS) score was ≤2 for 32% of patients, and only 8% were transferred to a rehabilitation center. 32% of patients received stroke education upon discharge.
Joseph K. Tatuene et al, 2020[46]	MLWTCRP 7	Cross-sectional Stroke-like syndrome patients N= 66	Blantyre QECH Clinical	PLOS ONE Q2 6	Diagnosis: To assess the feasibility of using neurovascular ultrasound in Malawian adults presenting with acute stroke-like symptoms.	The frequency of intracranial atherosclerosis was 19.2% (95% CI: 6.6–39.4) among the 26 patients who underwent successful transcranial insonation. Hypertension was more prevalent in patients with extracranial atherosclerosis compared to those without (80.8% vs 52.5%, p = 0.03), as was hypercholesterolemia (11.5% vs 0.0%, p = 0.05).
Mirriam M. Chikumbanje et al, 2023[14]	USW 3	Economic evaluation NVAF patients N= (difficult to tell)	Census data All districts Population-based	VHRI Q3 0	Cost: To assess the budget implications of integrating DOACs into the treatment regimen for stroke prevention in patients with NVAF.	Savings of $6,644,141 to $6,930,812 in stroke care due to fewer stroke event could be recorded. The MoH budget, currently at approximately $260,400,000, may increase by $42,488,342 to $101,633,644 over five years.

Abbreviations: UoL, University of Liverpool; COM, College of Medicine; BMC, BioMed Central; MLWTCRP, Malawi-Liverpool-Wellcome Trust Clinical Research Program; MCH, Mzuzu Central Hospital; QECH, Queen Elizabeth Central Hospital; MEIRU, Malawi Epidemiology and Intervention Research Unit; KCN, Kamuzu College of Nursing; ZCH, Zomba Central Hospital; KCH, Kamuzu Central Hospital; LL, Lilongwe; KRC, Kachere rehabilitation center; WFU, Wake Forest University; HUCH, Helsinki University Central Hospital; UWC, University of the Western Cape; LSUNN, Lobachevsky State University of Nizhny Novgorod; USW, The University of South Wales; MMJ, Malawi Medical Journal; N/A, Not applicable; JSCVD, Journal of stroke and cerebrovascular diseases; SAJPT, South African Journal of Physiotherapy; Q, Quartile; TJHR, Tanzania Journal of Health Research; JID, Journal of Infectious diseases; JGHR, Journal of Global Health Reports; VHRI, Value in Health Regional Issues; MoH, Ministry of Health; CI, Confidence interval; PTF, P-wave terminal force; IRIS, Immune reconstitution inflammatory syndrome; mRS, modified Rankin Scale: HIV, Human Immunodeficiency Virus; DOACs, Direct oral anticoagulants; NVAF, Nonvalvular atrial fibrillation; IgG, Immunoglobulin G; CMV, Cytomegalovirus; Rehab, rehabilitation; aOR, adjusted Odds Ratio.
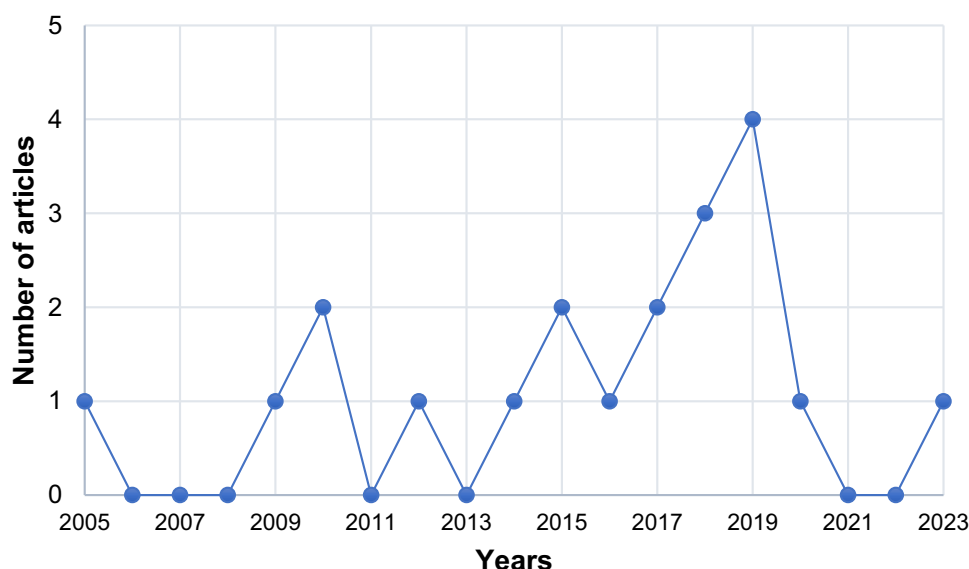
Figure 2 Line graph indicating the trend in published articles online since the first paper was published in 2005.

30% (6) of the articles were published between 2005 and 2014 and 70% were published between 2015 and March 30, 2024. Figure 2 illustrates the trend in the number of online articles over the years.

Characteristics of the Authors and Institutions

Most articles involving an individual as the main author were by George L. Chimatiro.[34,39,42] 25% (5) of the articles had their main author from the Malawi-Liverpool-Wellcome Trust Clinical Research Program (MLWTCRP).[36,37,40,45,46] In comparison, 20% (4) had their main author from the University of the Western Cape (UWC).[34,39,42,44] Overall, researchers from the College of Medicine (COM) contributed to more papers than those from any other institution (50%).[18,19,30,33,36–38,41,44,46] The total number of authors for an article ranged from 1[31,35] to 15;[37] 20% of the articles had all coauthors from the same institutions,[14,33,34,42] 70% had at least one author from a different institution, with only 10% had one author. All 18 studies included the names of the institutions of affiliations of coauthors, but only eight stated the roles of each author. Authors from six institutions, namely, University College London (UCL), University of Liverpool (UoL), COM, Liverpool School of Tropical Medicine (LSTM), University of Western Cape (UWS), and the Malawi-Liverpool-Wellcome Trust Clinical Research Program (MLWTCRP) featured in more articles, with each institution featuring in at least 20% of the articles. Authors from only eleven countries around the world, namely, the Republic of South Africa (RSA),[34,36,37,39,42,44] England,[36–38,40,41,43,45,46] Finland,[18,19] Russia,[35] Canada,[45] the Netherlands,[30] Wales,[14] the United States of America,[32] Switzerland,[38] Belgium,[39] and Scotland[36,37] have partnered with Malawi to publish articles on stroke. A total of 35 institutions took part to publish stroke articles, with 45.7% (16) from England; 20% (7) of the institutions are locally based in Malawi, namely, the College of Medicine (COM), Queen Elizabeth Central Hospital (QECH),[30,38,45] Mzuzu Central Hospital (MCH),[32] Kamuzu College of Nursing (KCN),[31] Blantyre Malaria Program (BMP),[40] MLWTCRP[36–38,40,41,45,46] and the Malawi Epidemiology and Intervention Research Unit (MEIRU).[43]

Publication and Citations

Ninety-five percent of the articles were research articles, published articles in peer-reviewed journals and open-access articles. According to Google Scholar, the total number of citations per article ranges from 0[14] to 168.[36] According to Journal citation reports (JCR), Journal impact factor (JIF) quartile, six articles were published in Q1 journals of their year,[19,30,36,37,41,43] five papers were published in journals unranked with JCR, JIF quartile in their years;[32–35,42] and another five papers were published in Q4 journals in their year.[18,38,39,44,45] MMJ was the journal with the most articles (30%) with a JIF rank of 197 out of 207 for JCR year 2022.[47]

Geographical Distribution of Research Efforts

Of twenty-eight (28) districts in Malawi, research were conducted in five districts, namely, Blantyre, Karonga,[43] Mzimba, Zomba, and Lilongwe. However, 80% of stroke research is conducted only in Blantyre district and 70% is conducted only at the Queen Elizabeth Central Hospital (QECH). Only one study collected data from all four public tertiary referral hospitals in all regions in Malawi, namely, QECH in Blantyre city and district of the southern region; Kamuzu Central Hospital (KCH) in Lilongwe city and district of the central region; Zomba Central Hospital (ZCH) in Zomba city and district in the southeastern region; and Mzuzu Central Hospital (MCH) in Mzuzu city and Mzimba district in the northern region of Malawi.[39] Sixty-five percent of the studies occurred in the clinical setting only, and 30% involved participants in their community. Figure 3 is a map of Malawi illustrating the districts in which participants were actively recruited in the included studies, drawn with the assistance of MapChart.[48]

The Focus of the Studies

Pathophysiology (30%) and diagnosis (20%) were the main focuses of stroke research in Malawi, and only two studies focused on rehabilitation. Eighty-five percent of studies focused on stroke patients, with one study each concentrating on cryptococcal meningitis,[40] nonvalvular atrial fibrillation (NVAF)[14] and the general population.[43]

Research Methods Used

Study Designs

The most commonly used types of study design were cross-sectional (50%), with 20% of the studies as qualitative cross-sectional studies, followed by case-controls (20%)[32,35,36,41] and case reports (15%).[33,38,40] The researchers identified only one prospective cohort with 1-year follow-up.[19]

### Characteristics of Participants, Recruitment, and Data Collection

All the participants in the study were "adults" with an age range of 15 years and above in three articles, and all other participants were 18 years and above. Seven studies involving stroke patients had unknown stroke subtypes, six had both hemorrhagic and ischemic stroke subtypes, and four had only ischemic stroke subtypes. Most studies (7) recruited stroke patients during the acute phase (days 0–7); four studies recruited survivors after more than six months (chronic), only three studies involved caregivers, and only one study involved healthcare professionals as participants. Ten studies reported participant recruitment start and end dates; participants were recruited face-to-face (95%), while one study used census-based data.[14] Most studies (10) did not report sampling methods when recruiting study participants, and only six justified the recruitment method. Eight articles included information on HIV status of the participants, and 85% of the articles included both sexes. The most common methods for data collection were clinical findings and investigations, including laboratory tests, cardiology tests, radiology tests, and patient medical records. The highest number of participants included in the analysis was 739,[43] and the highest number of stroke patients recruited and included in the results was 222.[36]

The Trends and Patterns in Research

The researchers observed no actual trends due to fewer papers; however, they noted a shift from pathophysiology and diagnosis to improving acute care management and stroke outcomes. There was also a notable general increase in publications from 2015 to 2019 and a decrease in papers from 2020 to 2023.

Assessment of the Completeness of the Articles

50% of the articles included ethics approval numbers, while 75% explained how informed consent was obtained and provided the name of the body in which the ethics was approved. Seventy percent of the articles included limitations of the study, while only 25% indicated strengths. The small sample size was the most commonly mentioned limitation. 90% of the articles included recommendations for future studies and a summary or conclusion of the findings, 50% included a risk of bias, and selection bias was the most commonly mentioned risk. Only 35% of the authors included a statement on data availability and 60% of the articles included a statement on funding sources. Of these, 50% (6) were funded
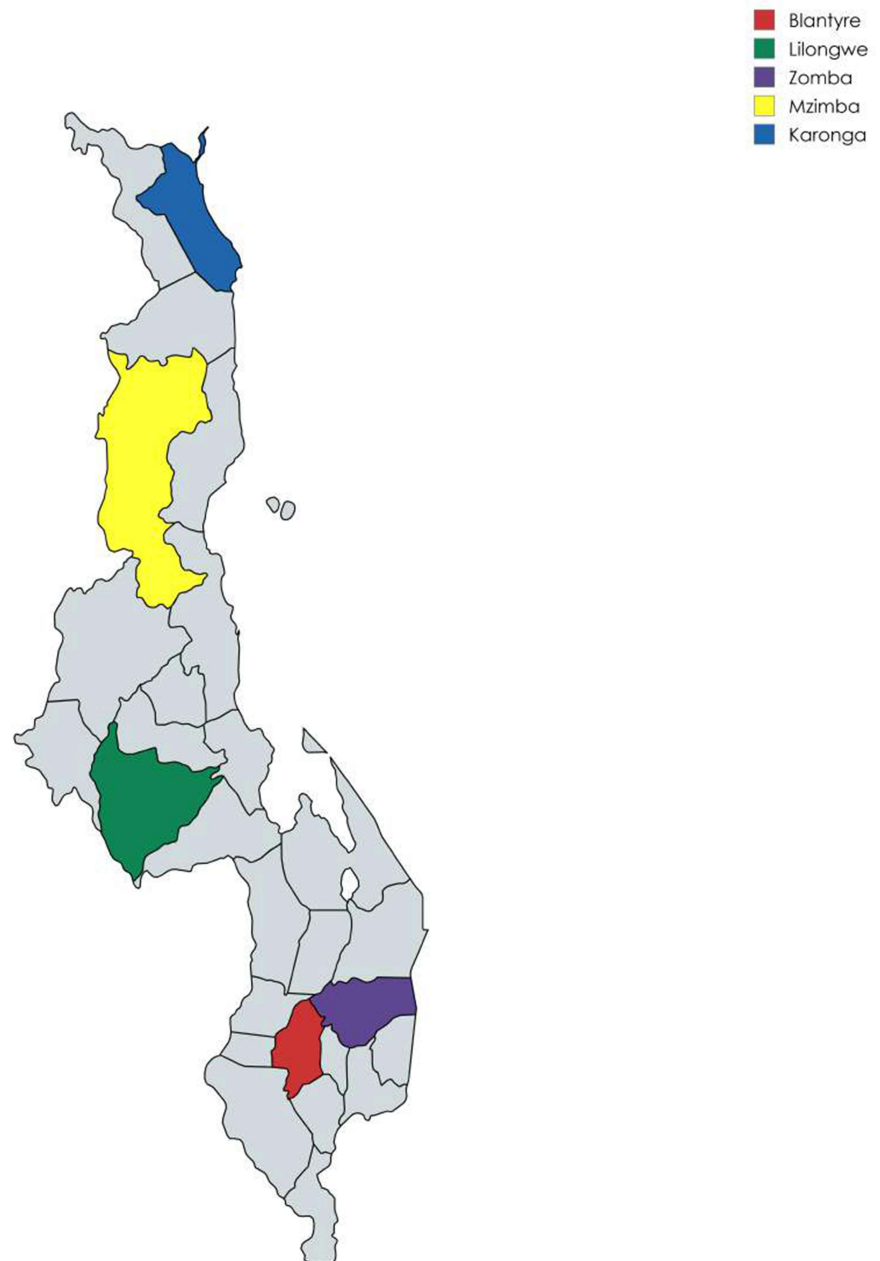
Figure 3 A map of Malawi indicating the districts in which participants in the included studies were actively recruited from.

directly by the Wellcome Trust,[36,37,40,41,45,46] and two declared no funding.[14,42] Other funding sources included the Southern Africa Consortium for Research Excellence (SCORE),[44] the Royal Netherlands Embassy,[30] the Wellcome postdoctoral fellowship funding,[43] and the Maire Taponen Foundation,[19] each mentioned in one article.The study identified only five funding agencies for stroke research in Malawi; 55% of the articles included a section on conflicts of interest, and only one article declared any.

Discussion

This study revealed a significant gap in research on stroke in Malawi. Twenty papers published online in the last 18 years since the first paper was published indicate that Malawi produces one paper per year with very little stroke research. A cross-sectional study design is most commonly used, followed by case–controls and case reports, which limits the conclusions of these studies and their application in practice. Most studies were conducted in Blantyre and although the QECH is the largest public referral hospital in Malawi,[19,42] researchers believe that the funding agency's location at the QECH plays a crucial role. The Malawi-Liverpool-Wellcome Programme, which the Wellcome Trust funds, is a longstanding collaboration involving the College of Medicine (COM), the Liverpool School of Tropical Medicine (LSTM), and the University of Liverpool (UoL) based at QECH.[49] It is clear that this collaboration helps bring advanced expertise, increased output, and improved quality of stroke research to the facility. The mapping review revealed a lack of collaboration among Malawian institutions and a lack of interdisciplinary teams in research, as more English institutions than local institutions participated in authorship. Additionally, most Malawian institutions, including MLWTCRP, COM, and QECH, are situated in Blantyre and are physically close to each other, where they collaborate closely. Many researchers in this cluster are affiliated with multiple institutions, accounting for the abundance of research in Blantyre. However, the limited research output from other regions, especially the capital city of Lilongwe, is surprising, considering that it is the most populated district and houses the Kamuzu Central Hospital, Malawi's second-largest public health facility. Increasing engagement in and investment in stroke research initiatives beyond Blantyre is imperative to improve overall research output.

More than 70% of the articles were published between 2015 and the present, indicating an overall increase in research activity in recent years. There are only two papers published in the years after COVID-19 from 2020 to 2023; a study that involved the recruitment of participants finished recruitment in August 2017.[46] The other paper is an economic evaluation[14] that did not require active recruitment of participants, which may indicate the overall effect of COVID-19 on research output in Malawi. The results from Malawi suggest that research efforts have shifted from pathophysiology, where most articles published from 2005 to 2017 focused on understanding the role of HIV in stroke. Recent evidence indicates a reduced number of new HIV infections and 96.9% of HIV-positive patients have a suppressed viral load,[50] thus there is a shift in the focus to acute stroke management and outcomes. This observation reflects ongoing efforts to improve stroke care in Malawi, with excellent diagnosis and management that will lead to acceptable outcomes.

Although few studies are published, a considerable percentage are published in Q1 or Q2 journals as indicated by the JIF of the JCR for the specific years the articles were published, which indicates the quality of the research from Malawi. It is also noted that most authors prefer the Malawi Medical Journal; this may be because it is the only journal in Malawi that is free for open-access publications, peer-reviewed, indexed, and ranked by both JCR, JIF quartile and rank and Scopus in the health field. Moreover, most authors and co-authors are affiliated with COM, the journal's publisher, and using the journal for publication is exemplary and commendable for enhancing its visibility and impact on a global scale. However, the journal is ranked as one of the bottom 10% in this category in the JCR 2022, JIF rank.[47] The JIF rank and quartile could impact the article's citation rate, deter other researchers from publishing in the journal, and make research published in the journal even less visible. Enhancing the JIF rank and quartile could go a long way in advancing the visibility of the research published with the journal.

In terms of access to the articles, the review revealed that almost all the articles (95%) were fully open access under the Creative Commons Attribution 4.0 International Licence (CC BY 4.0) and the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International Licence (CC BY-NC-ND 4.0). The articles are indexed and can be fully accessed for free via Google Scholar. This suits researchers and students from Malawi and other low-income countries, who may struggle with database subscription fees. The high expenses associated with journal subscriptions could obstruct the widespread distribution of academic research.[51]

The analysis of citation rates, JIF, and authorship patterns offers insights into the dissemination and visibility of stroke research in Malawi. While no statistical tests were applied and the age of the article could play a part, the four leading papers with the most citations on Google Scholar[19,30,36,37] were published in journals of JIF Q1 and Q2 of their year in JCR. This concurs with observations made by Tahamtan et al[52] that papers from journals with a high impact factor would yield higher citation rates than papers published in journals with lower impact factors. The lack of citations could also be attributed to the need for more research from Malawi, which is the most significant user of outputs. Articles with more

authors recruited more participants and had more citations. This underscores the need for continuous corroborations to ensure that research outputs from Malawi are equally distributed and globally visible.

Due to the unavailability of advanced diagnostic tools such as computed tomography (CT) and magnetic resonance imaging (MRI) in Malawi, most participants in the studies were diagnosed with stroke, according to the definition of the World Health Organization (WHO).[45,46,53] Malawi's most advanced healthcare facilities lack the resources to diagnose and categorise stroke sub-types according to international recommendations.[54] This suggests a high likelihood of misdiagnoses, leading to underestimated or overestimated stroke participants in the studies. The lack of a definitive diagnosis of the stroke adversely affects the care of the survivors, leading to poor outcomes, as illustrated in a particular case.[38] Additionally, the limited number of studies that have diagnosed and categorized stroke into different subtypes using standardized methods did not offer outcomes based on these subtypes, likely due to small sample sizes post-categorization. Further studies should seek to identify variations in outcomes among different stroke subtypes in Malawi.

Acute stroke care management in Malawi faces significant challenges, such as poor adherence to stroke management protocols, lack of multidisciplinary teamwork, and underutilization of resources. Heikinheimo et al[19] first reported in 2012; Gadama et al and Chimatiro et al reported similar results in 2019.[42,45] The delivery of post-stroke care in Malawi is far from meeting international recommendations.[45,55] However, this accurately represents most African countries where stroke care is below the expected standards.[56] The lack of multidisciplinary teamwork is more pronounced in one of the papers in which medical doctor registrars and consultants had to be interviewed independently in their offices. Attempts to gather them together for a focus group discussion were unsuccessful but were achieved with other groups of healthcare professionals who participate in stroke care.[42] This suggests the presence of internal challenges that necessitate further investigation, identification, and resolution to improve the delivery of services.

A high mortality rate due to stroke has been reported in previous studies. These studies reported in-hospital mortality rates between 18%[45] and 22.4%,[19] similar to those reported elsewhere between 19.81%[57] and 22%[8] in Africa. The only cohort study reported a mortality rate of 40.1% at one year;[19] however, this was conducted over a decade ago and calls for studies with much longer durations and larger sample sizes in recent years. The lack of data on the incidence of stroke makes it challenging to determine its exact effects in Malawi. While the lack of proper research on stroke in Africa is well-documented,[7,12,57,58] the case of Malawi could be one of the worst in this region. These findings underscore the critical need for intensive research and interdisciplinary corroborations to address this significant public health challenge.

Another significant result from the article in this review is the establishment of the role of HIV in stroke incidence, with HIV identified as the second most common risk factor for stroke, with a population attributable fraction (PAF) of 15% just after hypertension.[36] HIV was identified as the most contributing factor for ischemic stroke in the younger population,[19,36] which coincided with the first six months of antiretroviral therapy (ART)[37] and a low CD4 count.[41] Hemorrhagic stroke was less common but was associated with HIV-negative individuals.[19] Ischemic stroke was more common, was associated with an abnormal P-wave terminal force (PTF) greater than or equal to 4 millimetres per second,[32] and can be a complication of cryptococcal meningitis in immune reconstitution inflammatory syndrome (IRIS).[40]

The results also indicate that overall, women have poorer outcomes, with a mortality rate at 1 year of 55% in females compared to 36.6% in males,[18] which is consistent with other findings reported elsewhere across the globe.[59] However, this is the only study that had critically compared outcomes based on sex, despite the understanding that sex differences play a crucial role in stroke incidences and stroke outcomes.[2] There is a need for studies to critically quantify differences in incidences and prevalences of stroke among the sexes in Malawi, which can assist in addressing any sex-based hindrances to stroke prevention and acute care management. Studies could also examine tailored interventions for the management of high systolic blood pressure control among the different sexes, as it is currently the largest risk for stroke worldwide.[1] While stroke in Malawi is managed in both secondary and tertiary hospitals, the studies included in the review do not provide any findings from secondary healthcare facilities. This creates a significant gap in understanding the services and outcomes for stroke survivors in these settings. Secondary facilities serve the most rural areas compared to tertiary facilities located in major cities. This may further highlight differences in care based on sex, as rural areas may have different healing practices and cultural expectations for men and women that are different from those in the cities.

Therefore, further research in district health facilities is needed to understand stroke management for the entire population in Malawi.

Research on the experiences of stroke patients with rehabilitation has shown that they are satisfied with services, as both Phethi[31] and Chimatiro et al[39] reported. However, coordinated rehabilitation plans are lacking, and no studies have critically quantified the impact of rehabilitation on outcomes. The studies also reveal challenges with community reintegration ranging from financial to physical, environmental, and attitudinal barriers.[34] One study conducted at Kachere Rehabilitation Center, Malawi's only adult admission medical rehabilitation centre, reported that it needs to be renovated because its current state is not patient-friendly,[44] especially the bathrooms and toilets. However, this study was conducted about a decade ago and a follow-up study to investigate the institution's current state is highly recommended. Only 30% of the studies involved community participants, highlighting the need for community-based studies. This is crucial because stroke survivors spend most of their time in the community and researchers should conduct direct prevention studies in this area. In addition, Mvula et al[43] identified witchcraft as the most commonly mentioned suggested risk factor for stroke. Further research should focus on understanding how cultural beliefs impact the healthcare-seeking behaviour of stroke survivors in Malawi. Only four of the studies were qualitative and emphasized the need for research that offers healthcare providers, survivors and caregivers a platform to provide meanings, experiences, and perspectives on stroke. This type of research provides valuable insights that can improve patient care, inform policy, and enhance the development of targeted interventions.

Finally, while the original authors' efforts are appreciated, the researchers would like to highlight crucial areas that were missed or unclear in some articles. First, some articles need to explicitly state the total number of participants, participants in each group, age of participants, and study setting because deriving such important details is difficult and almost impossible. Additionally, authors who had previously published and used the same journal for subsequent publications should have included details such as funding source, coauthor roles, data availability statements, conflicts of interest, and corresponding information. Regardless of whether the authors provided these details, they should appear in every paper because each report is unique. These details are crucial when the type of evidence in an article is evaluated and may contribute to researchers worldwide disregarding study findings from Malawi.

Strengths of the Mapping Review

The strengths of this study include the vigorous search and incorporation of unpublished literature, which enriches the breadth of findings and offers valuable insight into the state of stroke research in Malawi. This study is also the first review to summarize research efforts and can aid researchers and funders who would like to corroborate with Malawi in stroke research in areas they may need to focus on.

Limitations of the Mapping Review

Despite these strengths, this study had several limitations. First, the lack of interaction with the authors may have led to the omission of relevant papers where the entire article was not retrieved online. Second, the inclusion of gray literature and lack of formal risk of bias assessment means that the results of this study may not be used for change in practice. However, this study provides a valuable summary of the research efforts and identifies critical gaps that require further exploration.

Recommendations

Medical doctors lead stroke research in Malawi, and the authors recommend encouraging collaborations among healthcare professionals and researchers across the country to cover a wider range of topics. In addition, higher education institutions must prioritize ongoing training of staff and students in research skills, promote publishing opportunities, create initial funding for research projects, and engage relevant stakeholders. Furthermore, the Malawi Medical Journal should be regularly updated to increase the visibility of research. Moreover, there is a need for a data-sharing platform to streamline research efforts and minimize duplication of data collection. Finally, establishing a national stroke registry is necessary for large, long-term, population-based studies, ultimately advancing stroke research in Malawi.

Conclusion

The review identified that most studies on stroke are conducted in the Blantyre district and at QECH using study designs like cross-sectional, case-control, and case reports. Recent studies have focused on improving stroke management and outcomes, involving collaborations with authors from institutions in England funded by the Wellcome Trust. The review identified a lack of infrastructure, teamwork, and underutilization of available resources as significant challenges in post-stroke care. Future research could focus on:

1. Developing personalized interventions to prevent and manage high systolic blood pressure, the leading risk factor for stroke.
2. Investigate the integration of advanced diagnostic tools such as computed tomography (CT) and magnetic resonance imaging (MRI) to assess the effectiveness of targeted interventions for different stroke subtypes, particularly lacunar infarcts in Malawi.
3. Explore the impact of sex differences on stroke outcomes, focusing on secondary health facilities.
4. Gather qualitative insights on the understanding and impact of stroke and healing practices among survivors in Malawi.
5. Explore the impact of integrating teleneurology to improve access to advanced expertise and enhance multi-disciplinary teamwork in managing stroke.

Data Sharing Statement

The data used in this study can be accessed by emailing the corresponding author.

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Author Contributions

All authors contributed significantly to the conception, study design, data extraction, synthesis and interpretation of the results. All authors took part in drafting and critically reviewing the article, gave final approval of the version to be published, agreed on the journal to which the article has been submitted, and agreed to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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