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# Impact of a training program for community health officers on neurological disorders: insights from the Karnataka brain health initiative

Mohammed Farhan Ansari[1], Deenadayalan Boopalan[1], Ganagarajan Inbaraj[1], Sarath Govindaraj[1], Rajani Parthasarathy[2], Girish N Rao[3], Rehan Shahed[1], Faheem Arshad[1*] and Suvarna Alladi[1] on behalf of the Karnataka Brain Health Initiative (KaBHI) Consortium

## Abstract

**Background** Neurological disorders pose a substantial burden on India's healthcare system, contributing significantly to disability and mortality. In rural areas, where access to specialists availability is limited, Community Health Officers (CHOs) play a crucial role in bridging the gap in care. However, the lack of structured training programs for CHO's in neurological disorder management highlights an urgent need for targeted capacity-building interventions.

This study evaluates the impact of a structured training program on the knowledge and skills of CHOs in managing common neurological disorders under the Karnataka Brain Health Initiative (KaBHI).

**Methods** The quasi-experimental study was conducted across three districts in Karnataka-Chikkaballapura, Kolar, and Bengaluru South. A total of 295 CHOs participated in a two-hour training program delivered by expert neurologists, covering headache, epilepsy, stroke, and dementia through lectures, discussions, and case-based scenarios. Pre- and post-training knowledge assessments using a standardized multiple-choice questionnaire evaluated the program's impact. Feedback from participants was collected to assess training quality.

**Results** Of the 295 participants, 280 completed both pre- and post-training assessments. Significant improvements were observed in knowledge scores across all disorders, with a mean score increase from 57.46 ± 16.4 to 75.79 ± 12.9 (mean difference: 18.3, $p<0.001$). The program was effective regardless of prior clinical experience, indicating its adaptability. Feedback highlighted high satisfaction with the training's structure, content, and delivery.

**Conclusion** This study provides strong evidence that structured training programs can significantly enhance CHOs' ability to diagnose and manage neurological disorders, particularly in resource-limited settings. Beyond immediate knowledge gains, these findings highlight the broader potential for integrating similar capacity-building initiatives for neurological care into national healthcare programs, such as the Ayushman Bharat Mission and Health and Wellness Centers (HWCs). By equipping frontline healthcare providers with specialized skills, such programs can

*Correspondence:
Faheem Arshad
faheem2285@gmail.com

Full list of author information is available at the end of the article

improve early diagnosis, facilitate timely intervention, and enhance patient outcomes, ultimately reducing the burden of neurological disorders at the primary care level. Future phases of KaBHI, implemented state-wide, will focus on ensuring long-term sustainability by refining and expanding this training model to address a wider range of neurological conditions and strengthening its integration into primary healthcare frameworks.

**Keywords** Community health officers, Neurological disorders, Capacity Building, India, KaBHI

## Background

Globally, neurological disorders represent a significant proportion of non-communicable diseases [1]. They are the leading cause of disability and the second leading cause of death worldwide [2]. In India, neurological disorders contribute to 8.2% of the total Disability-Adjusted Life Years (DALYs) and 10.9% of total deaths (GBD, 2019), highlighting the urgent need for public health measures to address this burden [3]. Given the increasing prevalence of these conditions, comprehensive healthcare services at the grassroot level are essential for their timely diagnosis, effective management and prevention [4]. Despite the high prevalence, neurological disorders often remain underdiagnosed in rural and underserved regions of India. Studies indicate that the crude prevalence of neurological disorders in rural areas is approximately 2.28%, with conditions such as migraine and epilepsy being most common [1]. However, limited availability of specialists in these regions, combined with barriers such as financial difficulties (44%), lack of awareness (43%), and transportation challenges (3.5%), significantly impedes timely diagnosis and treatment. As a result, many cases go undetected and untreated, contributing to increased disability and mortality rates and exacerbating the healthcare burden in these communities [5].

To achieve Universal Health Coverage (UHC) and ensure equitable access to affordable, quality healthcare services for all, the Government of India launched the Ayushman Bharat Mission, a nationwide initiative aimed at strengthening primary healthcare infrastructure and providing financial protection to vulnerable populations [6]. A key component of this initiative is the redevelopment and upgradation of 150,000 public peripheral health centers into Health and Wellness Centers (HWCs) [7]. These centers are proposed to provide comprehensive, free, and universal primary healthcare services, each accommodating to a population of 3,000–5,000 individuals [8]. Staffed by Community Health Officers (CHOs), these mid-level healthcare providers play a crucial role in bridging the gap between underserved communities and the healthcare system [6, 9, 10].

Community Health Officers (CHOs) are trained professionals responsible for delivering primary healthcare services at Health and Wellness Centers (HWCs) under the Ayushman Bharat mission. Typically, CHOs are graduates with a Bachelor of Science in Nursing (BSc Nursing) or a Bachelor of Ayurvedic Medicine and Surgery (BAMS) and receive additional training in public health and primary care. Their responsibilities include health promotion, disease prevention, screening, diagnosis, and management of common conditions, including both communicable and non-communicable diseases. CHOs serve as the first point of contact for many patients in rural and underserved areas, playing a crucial role in strengthening primary healthcare and ensuring timely intervention for common and complex health conditions. CHOs, along with a multidisciplinary team, deliver a wide range of services that align with the 13 basic healthcare services outlined under National Health Programs, ensuring continuum of care at the grassroots level [11, 12].

In recent years, HWCs have adopted innovative service delivery models, including telemedicine consultations and digital health tools, to expand their reach and impact. These initiatives have enabled access to specialist care in remote areas [13]. Additionally, mental health services have been integrated under the National Tele-Mental Health Program (NTMHP), operational through HWCs, further strengthening the scope of primary healthcare [14].

Several studies have assessed the impact of CHO training programs on various health domains. For instance, training programs for communicable diseases, such as tuberculosis [6] and COVID-19 [15], and the use of diagnostic tools like point-of-care ultrasound (POCUS) in resource-limited settings [16], have demonstrated significant improvements in healthcare delivery. Mental health training programs have equipped CHOs with skills in early detection, counselling, and management of mental health conditions, integrating mental health services into primary care and addressing the treatment gap in underserved areas (NHSRC India) [17]. Similarly, maternal and child health training initiatives have enhanced CHOs' capabilities in antenatal care, safe delivery practices, postnatal care, and child nutrition, aiming to reduce maternal and infant mortality rates through improved community-level care (NHSRC India) [18]. In response to the rising burden of non-communicable diseases (NCDs), CHOs have been trained to screen, diagnose, and manage conditions like diabetes and hypertension, promoting continuous care and healthy lifestyles within communities (NHSRC India) [19].

Despite these advancements, there remains a noticeable lack of structured training programs specifically

designed for the management of neurological disorders. To address this gap, the current study was conducted as part of the KaBHI. KaBHI, a collaborative public health initiative in partnership with National Institution for Transforming India (NITI) Aayog, aims to establish an evidence-based, comprehensive model for the prevention, diagnosis, and management of neurological disorders at all levels of health care delivery. Guided by its eight foundational pillars—Policy and Financing, Strengthening Care Pathways, Capacity Building, Digital Health Management, Awareness and Risk Reduction Strategies, Intersectoral Coordination, Impact and Implementation Research, and National & International Policy—KaBHI focuses on strengthening healthcare systems to meet the neurological health needs of the population. Central to KaBHI's vision is the Capacity Building Pillar, which emphasizes equipping healthcare providers, including CHOs, with the knowledge and skills to manage neurological disorders effectively. This study, conducted under the Capacity Building Pillar of KaBHI, aimed to evaluate the impact of a structured training program on the knowledge and skills of CHOs in managing neurological disorders. By addressing this critical gap, the program seeks to enhance the capacity of CHOs to provide early diagnosis, effective management, and timely referrals, ultimately contributing to improved neurological health outcomes across Karnataka.

## Methods

### Ethics approval and consent to participate

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. All participants provided informed consent prior to their participation, and their confidentiality and anonymity were maintained throughout the study. The research protocol was reviewed and approved by the institute's review board, ensuring adherence to ethical standards for research involving human subjects.

### Study setting and design

The KaBHI was implemented in Karnataka, India, across three pilot districts: Chikkaballapura, Kolar, and Bengaluru South. This study employed a quasi-experimental single-group pre-test post-test design to evaluate the effectiveness of a structured training program on the knowledge and skills of CHOs regarding common neurological disorders. Ethical approval obtained from the Institutional Ethics Committee of the National Institute of Mental Health and Neurosciences (NIMHANS), and informed consent was secured from all participants.

### Sample size calculation and district selection

The sample size was determined based on an expected mean improvement of at least 15% in post-training knowledge scores, with a standard deviation of 20%, a power of 80%, and a significance level of 5%. The calculated sample size was approximately 260. Accounting for a 10% dropout rate, a final sample size of 290 was targeted.

The study employed a purposive sampling approach to select Community Health Officers (CHOs) from the three pilot districts: Chikkaballapura, Kolar, and Bengaluru South. This sampling approach was chosen to ensure that participants represented a diverse mix of healthcare providers from different geographical regions. The selection of these districts was based on demographic diversity, representation of both rural and urban populations, and logistical feasibility for conducting training sessions.

By selecting participants from districts with different healthcare challenges, this approach aimed to ensure that the study findings would be broadly applicable across various primary healthcare settings in Karnataka.

### Participants

The study included CHOs from Karnataka, specifically from three districts: Kolar, Chikkaballapura, and South Zone BBMP. In total, there were 406 CHOs available across these districts, including 180 CHOs in Kolar, 136 in Chikkaballapura, and 90 Public Health CHOs (PHCOs) in South Zone BBMP. Of these, 295 CHOs participated in the training program, with data from 280 included in the final analysis due to incomplete post-training assessments. The participants comprised CHOs with either a Bachelor of Ayurvedic Medicine and Surgery (BAMS) or nursing qualifications [8]. The mean age of participants was 28.02 ± 4.5 years, with 72.9% female participants. On average, CHOs had 2.98 ± 3.2 years of clinical experience.

### Training program

The training program was developed by expert neurologists at NIMHANS, with adaptations from the World Health Organization's mental health GAP action program to specifically address four common neurological disorders: headache, epilepsy, stroke, and dementia [20]. The primary objective was to enhance CHOs' knowledge and skills in early detection, management, and referral of these conditions at the primary healthcare level. Training sessions were conducted by two expert neurologists over two hours, with 30 minutes dedicated to each disorder. The sessions comprised didactic lectures, group discussions, and case vignettes illustrating real-world clinical scenarios, combined with interactive elements supported by audio-visual aids to reinforce learning.

The curriculum followed a structured and practical approach to neurological disorder management, covering all aspects outlined in the training protocol. CHOs

were trained in screening methods to identify individuals at risk, with a focus on history-taking, symptom recognition, and risk factor assessment. The training covered the clinical features of each disorder, enabling CHOs to distinguish between benign and serious cases that require urgent medical attention. A key focus was on red flag signs that required immediate referral, including severe, sudden-onset headache with neurological deficits suggestive of secondary causes, uncontrolled seizures or first-time seizures in adults, sudden facial drooping, arm weakness, and slurred speech indicating stroke (as per the BE FAST framework), and progressive cognitive decline and behavioral changes suggestive of dementia.

Beyond diagnosis, CHOs were trained in first aid and basic management strategies for each disorder, following standardized guidelines from the training protocol. Headache management included non-pharmacological pain relief techniques and medication overuse counseling. Seizure management emphasized immediate first aid, such as placing the patient on their side, avoiding restraints, and ensuring airway safety. Stroke management training reinforced the BE FAST framework for rapid symptom recognition and the importance of timely intervention. Dementia training focused on caregiver education, behavioral interventions, and the promotion of community-based support strategies to improve long-term patient care.

To strengthen patient care pathways, the training included referral and follow-up protocols. CHOs were provided with a standardized KaBHI referral framework, outlining clear criteria for escalating cases to higher-level healthcare facilities, including primary health centers (PHCs), district hospitals, and specialized neurology centers. This structured approach ensured that CHOs could effectively screen, diagnose, manage, and refer patients, ultimately enhancing neurological care at the primary healthcare level.

#### Assessment procedure

To measure the effectiveness of the training, CHO's completed both pre-training and post-training assessments. These assessments were administered online and consisted of 25 multiple-choice questions distributed uniformly across common neurological disorders including Headache, Epilepsy, Stroke, and Dementia. Each assessment was allotted 30 minutes, and participants' responses were matched using their mobile phone numbers to ensure consistency between pre-test and post-test results. The questionnaire used in this study was specifically developed to address the objectives of the research. It was designed following an extensive review of existing literature to ensure relevance and comprehensiveness. The initial draft of the questionnaire was reviewed by experts in the field to assess its content validity, clarity, and appropriateness. The final version of the questionnaire was then used for data collection (Supplementary file). The pre- and post-test knowledge assessments were conducted by trained research staff who were not involved in the training sessions. This approach was used to minimize potential bias and ensure that the assessment process remained objective and standardized.

#### Questionnaire development and validation

A structured questionnaire was developed to assess CHOs' knowledge before and after the training. The questionnaire consisted of 25 multiple-choice questions, evenly distributed across four neurological disorders: headache, epilepsy, stroke, and dementia. The validation process followed a systematic approach to ensure reliability and accuracy.

Content validity was established through an extensive review of existing literature and training materials. A panel comprising five neurologists and two public health experts assessed the questionnaire for relevance, clarity, and comprehensiveness. The Content Validity Index (CVI) was calculated by evaluating the proportion of experts rating each question as "essential," with a CVI threshold of ≥0.80 considered acceptable.

Face validity was assessed by pilot-testing the questionnaire on a small group of CHOs ($n$ = 10) who were not included in the final study. This step ensured that the questions were clear, easy to understand, and appropriate for the target audience.

To evaluate construct validity, an exploratory factor analysis (EFA) was conducted on pre-test responses, confirming that the questionnaire effectively measured different domains of knowledge. Following this validation process, the final version of the questionnaire was used for data collection.

#### Feedback collection

Feedback on the training program was collected from participants using a structured questionnaire designed to assess various aspects of the training, including trainer preparedness and knowledge, clarity and relevance of the content, adequacy of time allocation for each session, and overall satisfaction [21]. The questionnaire also evaluated the usefulness of distributed training materials and the level of engagement and participation encouraged by the trainers.

The effectiveness of the training was primarily measured through pre-test and post-test knowledge assessments. Additionally, feedback on the quality and relevance of the training was collected using closed-ended questions with Likert-scale ratings and open-ended questions for qualitative insights.

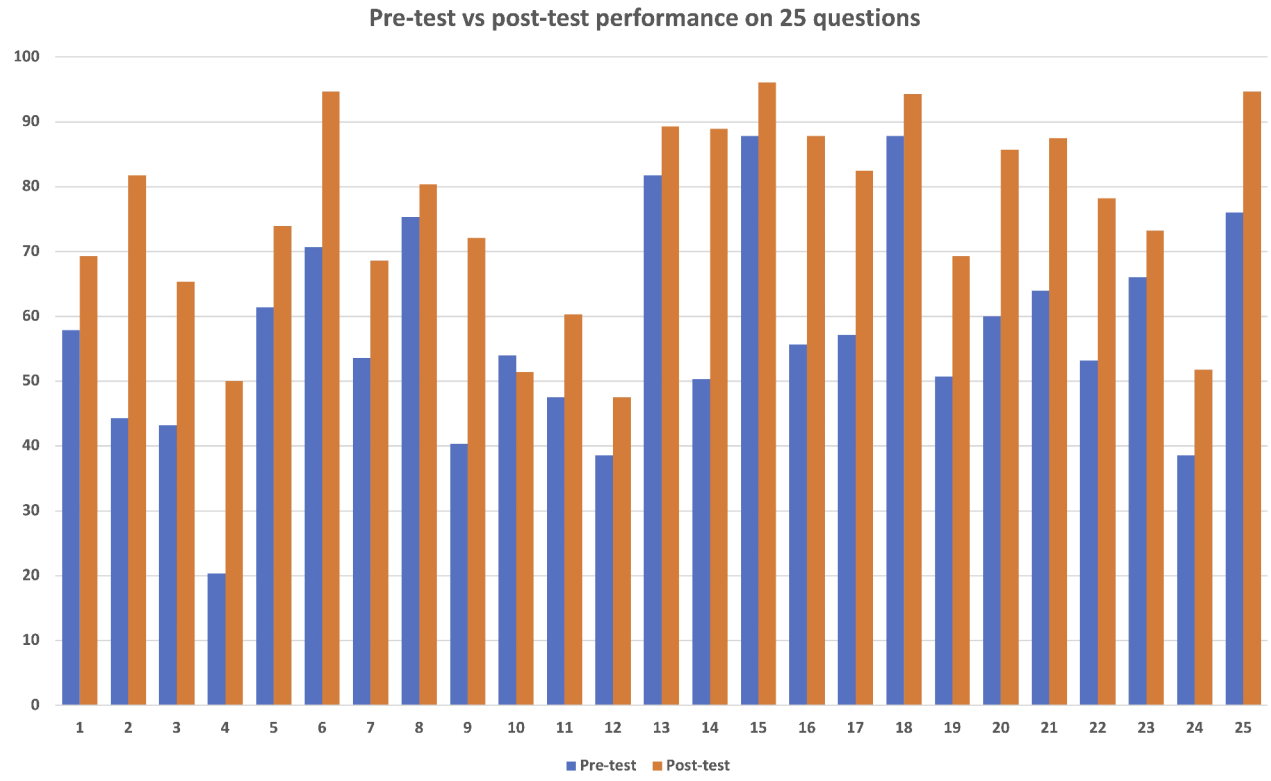


**Fig. 1** Pre-test vs post-test performance on each question

**Table 1** Pre-training and post-training scores of CHOs across common neurological disorders

| | Pre-test Score (*n* = 280) | Post-test Score (*n* = 280) | Mean difference | *p* value (2 tailed) | Effect Size (Cohen's d) |
|---|---|---|---|---|---|
| Total score | 57.46 (16.4) | 75.79 (12.9) | 18.3 | **< 0.001** | 1.22 |
| Headache | 11.91 (6.1) | 17.4 (5.6) | 5.5 | **< 0.001** | 0.95 |
| Epilepsy | 12.37 (5.3) | 15.21 (4.3) | 2.8 | **< 0.001** | 0.60 |
| Stroke | 18.86 (6.5) | 24.33 (4.8) | 5.5 | **< 0.001** | 0.96 |
| Dementia | 14.31 (5.5) | 18.85 (4.5) | 4.5 | **< 0.001** | 0.86 |

### Statistical analysis

Data were analyzed using IBM SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). Continuous variables, such as scores, were expressed as mean and standard deviation, while categorical variables, such as gender distribution, were presented as percentages. A paired t-test was used to compare pre-training and post-training scores, with statistical significance set at $p<0.05$.

## Results

A total of 295 Community Health Officers (CHOs) participated in the study, of whom 280 completed both the pre-training and post-training assessments and their data were included in the final analysis (Fig. 1). The mean age of the participants was 28.02 ± 4.5 years, with a majority being female (72.9%). The CHOs had an average clinical experience of 2.98 ± 3.2 years, and most were graduates with a BSc in nursing qualifications (Table 1).

### Pre- and post-training knowledge assessment

The total mean pre-training score was 57.46 ± 16.4, which increased to 75.79±12.9 after the training, reflecting a statistically significant improvement in knowledge (mean difference: 18.3, $p < 0.001$). This improvement was consistent across all four neurological disorders included in the training program. For headache, the mean score improved from 11.91 ± 6.1 to 17.4 ± 5.6 (mean difference: 5.5, $p < 0.001$); for epilepsy, from 12.37 ± 5.3 to 15.21 ± 4.3 (mean difference: 2.8, $p < 0.001$); for stroke, from 18.86 ± 6.5 to 24.33± 4.8 (mean difference: 5.5, $p < 0.001$); and for dementia, from 14.31 ± 5.5 to 18.85 ± 4.5 (mean difference: 4.5, $p < 0.001$) (Table 2) (Supplementary Figure 1).

**Table 2** Comparison of pre-training and post-training scores of CHOs with respect to years of clinical experience

| | Pre-test Score | Post-test Score | Mean difference | *p* value (2 tailed) | Effect Size (Cohen's d) |
|---|---|---|---|---|---|
| **Less than 2 years of clinical experience (*n* = 180)** | | | | | |
| Total score | 57.2 (16.4) | 75.6 (12.3) | 18.74 | **< 0.001** | 1.23 |
| Headache | 11.82 (6.2) | 17.69 (5.1) | 5.9 | **< 0.001** | 0.98 |
| Epilepsy | 12.47 (5.6) | 15.11 (4.5) | 2.6 | **< 0.001** | 0.48 |
| Stroke | 18.44 (6.7) | 24.11 (4.8) | 5.7 | **< 0.001** | 0.84 |
| Dementia | 14.47 (5.3) | 18.67 (4.4) | 4.2 | **< 0.001** | 0.79 |
| **Two to five years of clinical experience (*n* = 49)** | | | | | |
| Total score | 57.06 (17.6) | 74.2 (16.9) | 17.1 | **< 0.001** | 1.03 |
| Headache | 11.67 (6.2) | 16.33 (6.7) | 4.7 | **< 0.001** | 0.72 |
| Epilepsy | 12.9 (4.6) | 15.35 (4.6) | 2.4 | **0.001** | 0.52 |
| Stroke | 19.59 (6.8) | 23.76 (95.8) | 4.2 | **< 0.001** | 0.61 |
| Dementia | 12.9 (6.2) | 18.78 (5.0) | 5.9 | **< 0.001** | 0.92 |
| **More than 5 years of clinical experience (*n* = 51)** | | | | | |
| Total score | 58.75 (15.8) | 77.96 (10.3) | 19.2 | **< 0.001** | 1.41 |
| Headache | 12.47 (5.9) | 17.41 (6.2) | 4.9 | **< 0.001** | 0.79 |
| Epilepsy | 11.53 (4.8) | 15.45 (3.1) | 3.9 | **< 0.001** | 0.96 |
| Stroke | 19.61 (5.7) | 25.65 (3.4) | 6.0 | **< 0.001** | 1.05 |
| Dementia | 15.14 (5.5) | 19.45 (3.9) | 4.3 | **< 0.001** | 0.78 |

### Impact of clinical experience

The training program was equally effective across participants with varying levels of clinical experience. CHOs with less than two years of clinical experience ($n$ = 180), those with two to five years ($n$ = 49), and those with more than five years (n = 51) all showed significant improvements in post-training scores for all four neurological disorders. For example, among participants with less than two years of experience, the mean total score improved from 57.2 ± 16.4 to 75.6 ± 12.3 (mean difference: 18.74, $p < 0.001$). Similarly, participants with more than five years of experience showed a mean total score increase from 58.75 ± 15.8 to 77.96 ± 10.3 (mean difference: 19.2, $p < 0.001$).

### Individual question performance

Performance improved for nearly all questions across the four domains. The median improvement was 19%, with the exception of one question where performance declined slightly (Fig. 1). This highlights the overall effectiveness of the training program while identifying areas for further refinement in the curriculum.

### Participant feedback

Participant feedback indicated high satisfaction with the training program. Most participants reported that the sessions were well-structured, the trainers were knowledgeable and prepared, and the allocated time for each neurological disorder was adequate. The interactive nature of the training, which included group discussions and case vignettes, was particularly appreciated (Fig. 2). The feedback also emphasized the trainers' effectiveness in delivering the content and engaging participants, further supporting the program's success.

## Discussion

This study highlights the significant impact of a structured training program in enhancing the knowledge and skills of CHOs regarding the diagnosis and management of neurological disorders at the grassroots level. Post-training assessments demonstrated substantial improvements in knowledge, with statistically significant increases in scores across all four neurological disorders examined: headache, epilepsy, stroke, and dementia. These findings highlight the importance of targeted capacity-building initiatives in addressing the escalating burden of neurological disorders in India, particularly in underserved and rural areas where access to specialist care is limited.

In India, neurological disorders represent a significant and growing public health challenge, exacerbated by factors such as an aging population, increased prevalence of non-communicable diseases, and changing lifestyles have further intensified this burden. Despite the high prevalence, neurological disorders remain underdiagnosed and undertreated, particularly in rural and underserved areas, due to limited access to specialist care. This highlights the critical need for grassroots-level training programs to equip mid-level healthcare providers with the knowledge and skills to address these challenges effectively.

The structured training program evaluated in this study resulted in a mean knowledge improvement of 18.3 points, with statistically significant gains across all disorders ($p < 0.001$). These findings align with the outcomes of other training programs for healthcare providers, such

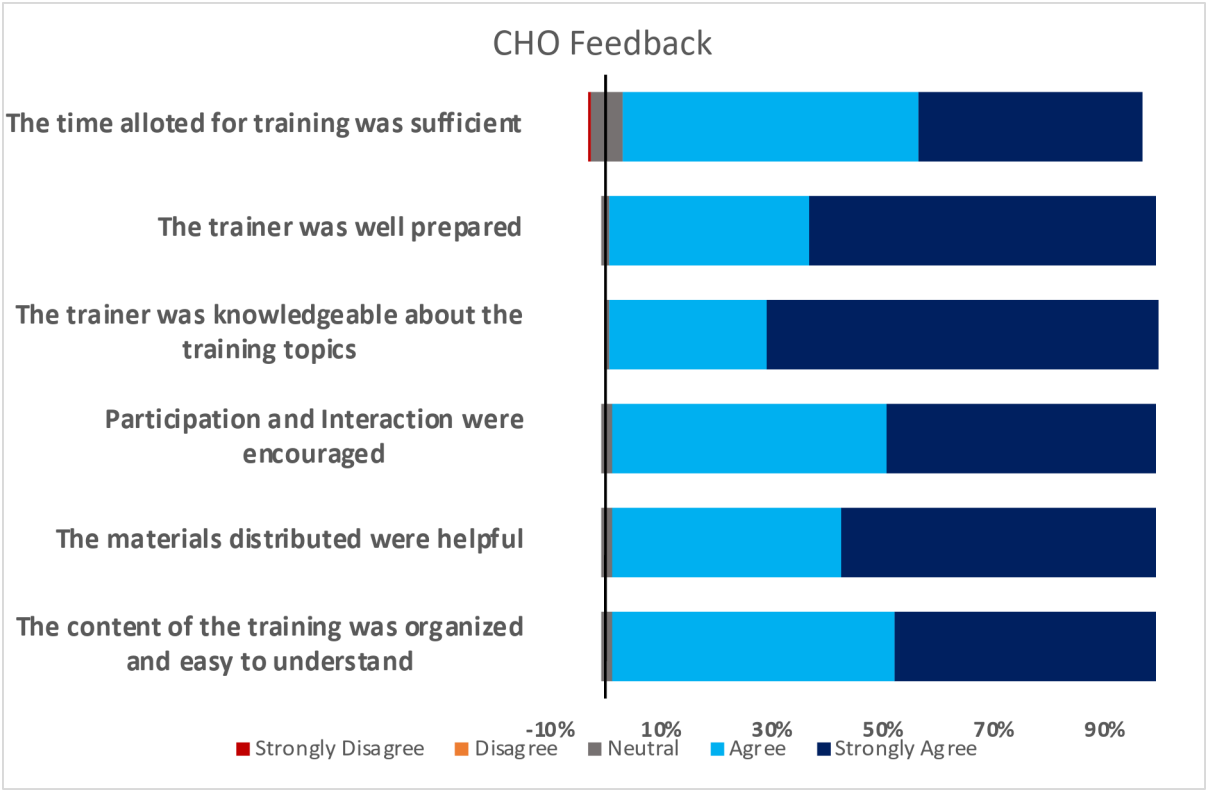


**Fig. 2** CHO feedback for training

as mental health training programs in low-resource settings, which reported similar improvements in knowledge and skills [22]. For instance, mental health training programs for community health workers in India have demonstrated significant improvements in participants' ability to recognize and manage mental health conditions. A study conducted in Bangalore Rural District reported enhanced mental health literacy among community health workers following a four-day training intervention, with assessments conducted at baseline, post-training, and three months follow-up [23].

Similarly, the National Health Mission (NHM) of India has implemented training programs aimed at improving maternal and child health outcomes. These programs include a 10-day training in Basic Emergency Obstetric Care (BEmOC) for newly recruited medical officers, focusing on skill development to manage obstetric emergencies [24, 25]. Such structured initiatives have played a crucial role in strengthening healthcare providers' competencies, contributing to improved maternal and child health outcomes.

Beyond mental and maternal health, training programs targeting non-communicable diseases (NCDs) have also shown promising results. In rural India, a five-day training program was developed and evaluated for Accredited Social Health Activists (ASHAs), focusing on NCD prevention and management. The program significantly improved ASHAs' knowledge and skills in managing NCDs, enabling them to effectively contribute to community health improvement [26]. Similarly, in Ethiopia, the Ministry of Health, in collaboration with Last Mile Health, launched the country's first integrated in-service training on NCDs for community health workers. This initiative aimed to enhance CHWs' capacity to provide essential NCD services at the community level, thereby improving early detection and management of chronic conditions [27].

Training programs focused on infectious diseases have also demonstrated significant benefits. For instance, the Infectious Diseases Institute (IDI) at Makerere University in Uganda has played a crucial role in strengthening health systems by providing comprehensive training for healthcare workers. These programs have enhanced the capacity of health professionals to manage infectious diseases, including tuberculosis, effectively, contributing to improved patient outcomes and a stronger public health response [28, 29].

The success of these programs highlights the vital role of targeted training interventions across various healthcare domains. Our findings contribute to this body of evidence by demonstrating that structured training programs can significantly enhance the knowledge and skills of CHOs in managing neurological disorders, an area that remains largely underserved in community healthcare.

While previous studies have assessed CHO training initiatives for communicable diseases, mental health, and maternal and child health, limited research has explored their role in neurological care. This study addresses that gap by providing evidence on the effectiveness and scalability of structured neurological training programs, making it one of the first to systematically evaluate their impact within primary healthcare settings.

Nearly all the participants expressed satisfaction with the training program with regards to time allotment, the preparedness, and knowledge of trainers, and the materials and content of the training program. The positive feedback from CHO in this study aligns with findings from other training programs, such as epilepsy training program, where interactive and practical components, including case vignettes and group discussions, were particularly appreciated [30]. This suggests that incorporating practical, scenario-based learning methods enhances knowledge retention and application.

The implications of this study extend beyond immediate knowledge gains. By equipping CHOs with the skills to identify, manage, and refer cases of neurological disorders, the program can contribute to earlier diagnoses, timely interventions, and improved patient outcomes in resource-limited settings. The integration of such training programs into existing public health initiatives, such as the Ayushman Bharat Mission and HWCs, can strengthen the healthcare system's capacity to address the rising burden of neurological disorders. Overall, the findings from this study and the application of this knowledge in the community will lead to early diagnosis and better management of common neurological disorders, ultimately improving patient care and outcomes in the community.

#### Identifying persistent knowledge gaps and areas for improvement

While the training program resulted in an overall 18.3-point improvement in mean knowledge scores, a closer analysis of individual disorder domains reveals that certain knowledge areas remained challenging for CHOs despite the intervention. For example, the smallest improvement was observed in epilepsy-related questions, where post-training scores increased only by 2.8 points (Table 1). This suggests that while the training effectively introduced fundamental epilepsy concepts, CHOs may require more in-depth exposure to specific aspects, such as seizure classification and long-term management.

Similarly, while significant score increases were seen in stroke and dementia, feedback from CHOs indicated that identifying early warning signs of cognitive decline and differentiating stroke subtypes remained areas of uncertainty. These persistent gaps suggest that single-session, lecture-based training may not be sufficient for more complex topics.

#### Addressing suboptimal performance despite training

One explanation for these remaining knowledge gaps could be the short duration of training (two hours in total). CHOs with limited prior exposure to neurology may require reinforcement through additional case-based learning, follow-up sessions, or digital learning modules. Studies in other training domains, such as mental health and maternal care, have shown that multi-session reinforcement strategies lead to greater retention and application of knowledge in clinical settings.

Another challenge could be the clinical experience levels of CHOs. While participants with less than two years of experience showed substantial improvements, those with greater than five years of experience had more modest gains (mean improvement: 19.2 points vs. 17.1 points). This suggests that prior clinical biases or established habits may affect knowledge acquisition among more experienced providers. Tailoring training to account for experience levels—for instance, using advanced case discussions for senior CHOs and foundational skill-building for newer CHOs—could improve training impact across all participants.

#### Strengths and limitations

A major strength of this study is its large sample size and focus on a relatively unexplored area of CHO training on neurological disorders. The use of standardized assessments and feedback tools further enhances the reliability of the findings. However, the study has certain limitations. The absence of a control group limits the ability to attribute improvements solely to the training program. Additionally, the study did not evaluate long-term knowledge retention or the practical application of skills in real-world settings, which are critical for understanding the sustained impact of the training. Although our current analysis did not explicitly stratify learning outcomes by professional background, exploring this aspect in future studies could support the design of more targeted and effective capacity-building initiatives. These limitations are acknowledged, and as KaBHI is an ongoing initiative, future phases are designed to address these gaps. Planned improvements include the incorporation of control groups, assessments of long-term knowledge retention, and evaluations of the practical application of training in clinical settings, ensuring a comprehensive understanding of the program's overall impact.

#### Future directions

Future research should focus on assessing the long-term effectiveness of training programs by evaluating knowledge retention and the application of learned skills in

clinical practice. Studies examining patient outcomes following CHO-led interventions for neurological disorders could provide further insights into the real-world impact of such programs. Expanding the scope of training to include other neurological diseases and scaling up the program across different regions would further enhance its relevance and utility. Additionally, qualitative research exploring CHOs' perspectives on training and identifying barriers to implementation could help inform the design of more effective training interventions.

To address persistent knowledge gaps, future programs should consider incorporating follow-up refresher courses or expanding session durations to reinforce complex topics such as epilepsy management and stroke recognition. Incorporating interactive elements, such as virtual patient case simulations, could further enhance knowledge retention and application in clinical settings. A blended learning approach, combining live training with digital self-learning modules, would allow CHOs to reinforce concepts at their own pace. Additionally, tailoring training intensity based on prior clinical experience can optimize learning outcomes, ensuring that junior CHOs receive structured foundational content while more experienced CHOs engage in advanced problem-solving exercises.

Future training initiatives should incorporate standardized referral pathways to enhance CHOs' ability to ensure timely referral of care for patients with neurological disorders, improving the overall continuity of care.

Given the differences in training, skill sets, and experience of BAMS doctors and BSc/GNM/ANM nurses, separately assessing the learning outcomes for each group could provide additional insights into specific domains that require further training. This approach would enable more targeted interventions and maximize the effectiveness of training programs, ultimately improving patient care outcomes. Additionally, future studies should aim to identify the optimal frequency of training sessions through longitudinal research, ensuring that knowledge retention and practical application of skills are sustained over time.

### Policy recommendations

The findings of this study emphasize the need for integrating structured training programs into national health policies. Policymakers should prioritize continuous professional development for CHOs and allocate resources for regular training and evaluation. Additionally, incorporating telemedicine and digital tools into CHO training can further enhance their capacity to manage complex conditions and improve access to specialist care in remote areas.

## Conclusion

This study assessed the impact of a structured training program implemented under the KaBHI to enhance the knowledge and skills of CHOs in diagnosing and managing neurological disorders. Conducted across three districts in Karnataka, the program demonstrated significant improvements in post-training knowledge scores across four key neurological conditions: headache, epilepsy, stroke, and dementia. The consistent improvements observed among CHOs, regardless of their clinical experience, highlight the program's adaptability and potential to bridge critical knowledge gaps in neurological care. The findings emphasize the value of targeted capacity-building initiatives in strengthening healthcare delivery, particularly in underserved areas. By equipping CHOs with the necessary skills for early diagnosis, management, and timely referral, such programs have the potential to improve patient outcomes and address the rising burden of neurological disorders.

#### Abbreviations

| | |
|---|---|
| BAMS | Bachelor of Ayurvedic Medicine and Surgery |
| CHO | Community Health Officer |
| DALY | Disability-Adjusted Life Years |
| HWC | Health and Wellness Centers |
| KaBHI | Karnataka brain health initiative |
| NTMHP | National Tele-Mental Health Program |
| POCUS | Point-of-care ultrasound |
| NITI | National Institution for Transforming India |
| NIMHANS | National Institute of Mental Health and Neurosciences |
| UHC | Universal Health Coverage |

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-025-12549-4.

Supplementary Material 1

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#### Authors' contributions

SA, FMA, RP, GNR, and FA contributed to the study design development. FMA, SG, RS, FA and IG contributed towards data collection, verification, and statistical analysis. SA, FA, FMA, SG, DB, IG and GNB contributed to the manuscript preparation. The manuscript was finalized with considerable input from the KaBHI Consortium (Supplementary Table).

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#### Data availability

Data supporting the findings of this study are available from the corresponding author [FA] and first author [FMA] on request.

## Declarations

### Ethics approval and consent to participate
The research study was approved by the Institutional Ethics Committee of National Institute of Mental Health and Neurosciences (NIMHANS) and informed consent was obtained from all participants.

### Consent for publication
Not applicable.

### Competing interests
The authors declare no competing interests.

### Author details
[1]Department of Neurology, National Institute of Mental Health and Neurosciences, Bengaluru, Karnataka 560029, India
[2]Department of Health and Family Welfare, Government of Karnataka, Bengaluru, India
[3]Center for Public Health, Department of Epidemiology, National Institute of Mental Health and Neurosciences, Bengaluru, Karnataka 560029, India

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