# Frequency and predictors of post-stroke cognitive impairment in Ethiopian stroke survivors: A cross-sectional study

**Yared Z. Zewde** ( yared.zenebe@aau.edu.et )
Addis Ababa University
**Atalay Alem**
Addis Ababa University
**Susanne K. Seeger**
University of Wisconsin–Madison

**Research Article**

**Keywords:** Cognitive impairment, dementia, stroke, low education, Ethiopia

**Posted Date:** April 7th, 2022

**DOI:** https://doi.org/10.21203/rs.3.rs-1507728/v1

# Abstract

**Background:** Stroke is emerging as a public health threat to sub-Saharan African countries. Even though cognitive impairment is increasingly being recognized as a major cause of disability in stroke survivors there is no data on the burden of stroke related cognitive dysfunction from Ethiopia. In this study, we aimed to assess the frequency and predictors of post-stroke cognitive impairment in Ethiopian stroke survivors.

**Methods:** Participants were adult stroke survivors who came for follow-up at least 3 months after the last stoke. Demographic and clinical data were collected using a structured questionnaire. We employed the Montreal Cognitive Assessment Scale-Basic (MOCA-B), modified Rankin Scale (mRS) and Patient Health Questionnaire-9 (PHQ-9) to assess post-stroke cognition, functional recovery, and depression, respectively.

**Results:** Among 67 stroke survivors (mean age: 52.1 ± 12.7 years, females: 40.3%, low or no education: 41.8%, median stroke duration: 3 years), 28 (41.8%) had post-stroke cognitive impairment. Of these, 20 (30%) had mild cognitive impairment and 8 (12%) had post-stroke dementia. On multivariate analysis, increased age [AOR=0.24, 95% CI (0.07,0.83)], lower education [AOR=4.02, 95% CI (1.13,14.32)] and poor function recovery (mRS ³3) [AOR=0.27, 95% CI (0.08-0.81)] were independently associated with post-stroke cognitive impairment.

**Conclusion:**

Cognitive impairment is frequent among Ethiopian stroke survivors. We found that increased age, low educational attainment, and poor recovery on physical function were independently associated with cognitive decline. Although causality cannot be inferred, physical rehabilitation and better education might play a significant role in building cognitive resilience among stroke survivors.


# Introduction:

Globally, stroke remains one of the major causes of mortality and the most common cause of neurological disability in older persons. According to the 2019 Global Burden of Disease study, the age-standardized stroke related mortality and morbidity risks were 3.6 and 3.7 times higher in low-income groups than in high-income groups, respectively (1). In addition to physical disabilities, stroke survivors are often suffering from profound cognitive dysfunction and neuropsychiatric changes with adverse outcomes on patients functionality and quality of life (2). Studies reported that stroke increases the risk of cognitive impairment 5 to 8 times (3) as compared to the general population and the lifetime risk of developing either stroke, dementia or both is approximated 1 in 3 persons worldwide (4). Post-stroke cognitive impairment (PSCI) is a multidomain disruption of cognitive function, including executive function, attention, concentration, language, memory, and visuospatial ability, associated with stroke (5). The severity of PSCI exists in a continuum from post-stroke mild cognitive impairment (PS-MCI) to post-stroke dementia (PSD).

The prevalence of PSCI has been studied in different settings and the results vary based on study design, sample size, patient's characteristics, diagnostic criteria, and assessment methods (6). In the western countries, the prevalence of cognitive impairment 3-months after stroke ranges from 22% in England (7) to 47.3% in France (8). Also, recent studies in Africa reported that the frequency of PSCI ranges from 20% in Benin at 6 months after stroke (9) to 50% in Ghanaian stroke survivors after 2 years (10).

Multiple variables were identified as a possible risk factors that influence PSCI including demographic factors (such as age, gender, educational attainment), pre-stroke factors (such as physical and cognitive impairments), index stroke factors (including hemorrhagic stroke and recurrent strokes), post-stroke factors (such as infection, delirium, depression and early seizures), and neuroimaging predictors (such as cerebral small-vessel disease, cortical atrophy and medial temporal lobe atrophy) may all conspire to differentially influence the trajectory of cognitive impairment after stroke (11, 12).

Countries in sub-Saharan Africa (SSA) are facing an emerging public health problem of non-communicable diseases (NCDs) including stroke and dementia due to the rapid epidemiologic transition, lifestyle changes and population aging in the region. However, there is a dearth of information about the epidemiology and burden of stroke related cognitive impairment in those countries. The aim of this study was to assess the frequency and predictors of post-stroke cognitive impairment in Ethiopian stroke survivors attending the outpatient clinics in three neurology referral clinics at the capital, Addis Ababa, Ethiopia.

## Methods:

# Study design, area, and period

This hospital-based, cross-sectional study was conducted at the outpatient neurology clinics of Tikur Anbessa Specialized Hospital (TASH), Lancet General Hospital (LGH) and Yehuleshet Specialty Clinic (YSC) between February and June 2021. TASH was established in 1974 and it stands as the oldest and largest teaching and referral hospital in Ethiopia. It also serves as the only neurology training center in the country. LGH is a multi-specialty private hospital and YSC is a well-established private neurology center in the capital, Addis Ababa. Both centers are providing a comprehensive neurology service by qualified neurologists to patients who came from Addis Ababa and its surrounding towns. All adult (> 18 years old) stroke survivors who had a confirmed diagnosis of stroke and came for follow-up at least three months post-stroke and providing consent were enrolled into the study.

### Data collection tool and procedure

Data on sociodemographic, cardiovascular risk factors, and clinical features of stroke were obtained from patients and/or their caregivers. Detailed general and neurologic examinations were performed by qualified neurologists. Additional information was extracted from participant's electronic medical records.

### Cognitive evaluation

the short form of informant questionnaire for Cognitive Decline in the Elderly (IQCODE) was employed to assess the pre-stroke cognitive status. However, this data was excluded from final analysis as two-third of our participants presented without an informant to complete the questionnaire. Post-stroke cognitive status (mild cognitive impairment (MCI) or dementia) was evaluated using the Montreal Cognitive Assessment – Basic (MOCA-B). It has been validated for screening MCI in those with low literacy (< 6 years of education) and illiterate individuals in several languages (13). MOCA-B is a 30-point test that evaluates six cognitive domains (visual perception, executive functioning, language, attention, memory, and orientation). Literacy based MOCA-B cutoff classified patients with scores 17–22 for literate (14–19 for illiterate or under 6-year education) to have MCI, and ≤ 16 (≤ 13 for illiterate or under 6-year education) to have dementia, while scores of ≥ 23 for literate and ≥ 20 for illiterate and low education level were indicative of normal cognitive performance. (14).

### Functional status

post-stroke functional recovery was evaluated by the modified Rankin Scale (mRS), a six-point ordinal scale ranging from 0 (no symptoms) to 6 (death) measuring the degree of disability or dependence in everyday life, including instrumental and basic activities of daily living. It was categorized into good (mRS < 3) and poor (mRS ≥3) functional recovery.

### Post-stroke depression

The Patient Health Questionnaire [PHQ-9] was employed to screen for post stroke depression. The 9-item scale was scored as no depression = 0, mild depression = 1–9, moderated depression = 10–14 and severe depression = 15–27.

# Data analysis

Data were processed and analyzed using the Statistical Package for Social Sciences (SPSS) software Version 25 (IBM-SPSS Inc., Chicago, IL, USA). Descriptive statistics: mean, median, standard deviation (SD), range, frequency and proportion were calculated. Student t-test and Chi-square or Fisher's Exact test were used for comparing continuous and categorical variables, respectively. Independent predictors of dementia among stroke survivors were assessed by univariate and multivariate logistic regression model and results were presented using odds ratio (OR), 95% confidence interval (CI) and p value. It was considered statistically significant when the p value was < 0.05.

## Results:

# Baseline characteristics of stroke participants

A total of 79 stroke survivors were approached, 12 were excluded due to severe aphasia (8) and prior hearing (4) deficits and 67 were enrolled for the final analysis. The mean (± SD) age was 52.1 ±12.7 years (Range: 23–77 years) and females accounted for 40.3%. Two-third (65.7%) were married and living with either their families - spouse and/or children (80.6%) or close relatives (4.5%). More than half of the participants had either secondary (22.4%) or college education (35.8%), while 16.4% had only a primary education. The rest 25.4% were illiterate with no formal education. Around one-third (29.8%) of the participant had an office job and the majority (67.2%) came from an urban setting. The average monthly household income of 37.3% of the participants was less than 57 USD (poverty line) (Table 1).

**Table 1: Sociodemographic characteristics of the study sample (n=67)**

| Variable | Frequency (%) |
|---|---|
| **Age in years (mean, SD)** | 52.1 (± 12.7) |
| **Age group** | |
| ≤ 45 years | 25 (37.3) |
| >45 years | 42 (62.7) |
| **Gender** | |
| Male | 40 (59.7) |
| Female | 27 (40.3) |
| **Marital status** | |
| Married | 44 (65.7) |
| Single | 9 (13.4) |
| Widowed | 7 (10.4) |
| Divorced | 7 (10.4) |
| **Educational attainment** | |
| No formal education | 17 (25.4) |
| Primary education | 11 (16.4) |
| Secondary education | 15 (22.4) |
| College and above | 24 (35.8) |
| **Occupation** | |
| Employed (Government office) | 20 (29.8) |
| Retired | 11 (16.4) |
| Housewife | 10 (14.9) |
| Merchant | 9 (13.4) |
| Daily laborer | 11 (16.4) |
| Unemployed | 4 (6) |
| Farmer | 2 (3) |
| **Living arrangement** | |
| With families | 54 (80.6) |
| Alone | 9 (13.4) |

| | |
|---|---|
| With relatives | 3 (4.5) |
| Nursing home | 1 (1.5) |
| **Monthly average household income** | |
| < 2000 (<57 USD) | 25 (37.3) |
| >2000 (>57 USD) | 42 (62.7) |
| **Living address** | |
| Urban | 45 (67.2) |
| Rural | 22 (32.8) |
| **PSCI** | |
| Yes | 28 (41.8) |
| No | 39 (58.2) |

# Vascular Risk Factors And Psci In Stroke Survivors

Hypertension (30%) was the major vascular risk factor identified followed by dyslipidemia (8.9%) and diabetes (7.4%). Infectious risks such as HIV and latent syphilis were identified in 8.7% & 4.4%, respectively. More than half (58.2%) of our participants had been admitted to a hospital and 12 (17.9%) had stroke related medical complications such as seizure and aspiration pneumonia (5 patients each) and 2 patients developed hydrocephalus. Although most of our participants had first-ever stroke, 19.4% had a recurrence. Table 2summarize the stroke risk factors.

Table 2
Stroke risk factors and clinical profiles of acute stroke survivors in Ethiopia (N = 67)

| Variable | Post-stroke Cognitive Impairment | | Total (%) |
| --- | --- | --- | --- |
| | Yes (%) | No (%) | |
| Hypertension | 20 (30) | 25 (37.3) | 45 (67.2) |
| Diabetes mellitus | 5 (7.4) | 6 (8.9) | 11 (16.4) |
| Dyslipidemia | 6 (8.9) | 11 (16.4) | 17 (25.4) |
| Smoking | 4 (5.9) | 11 (16.4) | 15 (22.4) |
| Alcohol misuse | 4 (5.9) | 5 (7.5) | 9 (13.4) |
| Obesity | 4 (5.9) | 4 (5.9) | 8 (11.9) |
| HIV infection | 4 (5.9) | 2 (2.9) | 6 (8.9) |
| Latent syphilis | 2 (2.9) | 1 (1.5) | 3 (4.4) |
| Hospital admission | 15 (22.4) | 24 (35.8) | 39 (58.2) |
| Post stroke medical complication | 4 (5.9) | 8 (11.9) | 12 (17.9) |
| Recurrent stroke | 7 (10.4) | 6 (8.9) | 13 (19.4) |

The median duration [interquartile range] since index stroke was 36 [12–50] months with a range of between 4 and 132 months. The severity of cognitive dysfunction seems to be better in those who had over 5 years duration after stroke, but the difference did not achieve statistical significance (Fig. 1). Thirty-nine participants were admitted to hospital after the stroke ictus and of those, 38.5% developed PSCI. The mean age and mean mRS score were significantly higher in the PSCI group as compared to those without PSCI (Table 3).

Table 3

Mean age and mean score difference in some variables between PSCI and those without PSCI

| Variables | PSCI | | Total | P value |
|---|---|---|---|---|
| | Yes | No | | |
| Age ± SD | 56.6 ± 12.9 | 48.9 ± 11.6 | 52.1 ± 12.6 | 0.013* |
| Stroke duration (months) | 32.9 ± 26.6 | 43.5 ± 36.41 | 39.14 ± 32.9 | 0.20 |
| Duration of hospitalization (days) | 14.6 ± 17.3 | 17.9 ± 13.8 | 16.6 ± 15.2 | 0.51 |
| mRS score | 2.3 ± 1.2 | 1.7 ± 1.1 | 1.9 ± 1.2 | 0.04* |
| PHQ-9 score | 1.7 ± 1.1 | 1.4 ± 1.1 | 1.5 ± 1.1 | 0.19 |
| * Statistically significant | | | | |

Of the participants, 28 (41.8%) had post stroke cognitive impairment, 20 (30%) had MCI and the remaining 8 (12%) had post stroke dementia. In both bivariate and multivariate logistic regression analysis, age ³ 45 years, illiteracy, and poor functional recovery after stroke were significantly associated with PSCI. However, gender, living arrangement, home address, income, and stroke subtype had no significant association with post stroke cognitive outcome.

An indirect correlation was observed between increasing age and lower MOCA-B mean score (r=-0.33, $R^2$=0.11, p=0.006) (Figure 2). This relationship remained significant when controlled for illiteracy and post-stroke functional status. Illiteracy was an independent predictor of PSCI where illiterate stroke survivors had 4 times increased risk for PSCI compared to literate participants [AOR=4.02, 95% CI (1.13,14.32)]. In addition, being middle-aged (³ 45 years) [AOR=0.24, 95% CI (0.07,0.83)] and having poor motor function recovery (mRS ³3) [AOR=0.27, 95% CI (0.08-0.81)] were each significantly associated with PSCI. (Table 4)

Table 4
Univariate and multivariate logistic regression of the determinant variables for PSCI (N = 67)

| Variables | Univariate | | Multivariate | |
|---|---|---|---|---|
| | **COR (95% CI)** | **P value** | **AOR (95% CI)** | **P value** |
| Gender | | | | |
| Male | 1 | | 1 | |
| Female | 0.83 (0.31–2.23) | 0.72 | 0.74 (0.26–2.16) | 0.58 |
| Age group | | | | |
| < 45 years | 1 | | 1 | |
| ≥ 45 years | 0.28 (0.09–0.86) | 0.02 | 0.24 (0.07–0.83) | 0.02* |
| Literacy | | | | |
| Literate | 1 | | 1 | |
| Illiterate | 5.1 (1.53–16.94) | 0.005 | 4.02 (1.13–14.32) | 0.03* |
| Living arrangement | | | | |
| With family | 1 | | 1 | |
| Alone | 0.66 (0.15–2.9) | 0.58 | 0.57 (0.12–2.87) | 0.5 |
| Income | | | | |
| >57 USD | 1 | | 1 | |
| <57 USD | 1.5 (0.55–4.08) | 0.43 | 1.43 (0.49–4.14) | 0.51 |
| Home address | | | | |
| Urban | 1 | | 1 | |
| Rural | 0.9 (0.29–2.79) | 0.85 | 0.71 (0.21–2.43) | 0.58 |
| Stroke subtype | | | | |
| Hemorrhagic | 1 | | 1 | |
| Ischemic | 0.69 (0.22–2.17) | 0.53 | 1.95 (0.55–6.83) | 0.29 |
| Functional recovery (mRS) | | | | |
| Good (mRS < 3) | 1 | | 1 | |
| Poor (mRS ≥3) | 3.33 (1.16–9.53) | 0.02 | 0.27(0.08–0.81) | 0.02* |
| Post stroke depression | | | | |

***Statistically significant, USD: United States dollar, mRS; modified Rankin Scale

| Variables | Univariate | | Multivariate | |
|---|---|---|---|---|
| | COR (95% CI) | P value | AOR (95% CI) | P value |
| No-mild | 1 | | | |
| Moderate-severe | 1.95 (0.71–5.33) | 0.19 | 0.61 (0.19–1.95) | 0.4 |
| ***Statistically significant, USD: United States dollar, mRS; modified Rankin Scale** | | | | |

## Discussion:

To our knowledge this is the first study to assess the frequency of cognitive impairment in a sample of stroke survivors from Ethiopia and to determine the association between cognitive dysfunction and demographic, clinical and stroke related factors. Findings from our study indicate that 42% of stoke survivors experiencing some form of cognitive impairment, including PS-MCI in 30% and PSD in 12%, in 3.4 years of average duration after the stroke incident. This result is comparable with prior studies conducted in high income countries, United Kingdom (32%) (15), Australia (39%) (16) and France (47.3%) (8) as well as low and middle income countries such as Chile (39%) (17), Ghana (7.6%) (10) and Nigeria (48.3%) (18). However, it is lower than those reported from Portugal (55%) (19), Norway (57%) (20) and South Korea (69.8%) (21). A community-based prevalence study by Qu Y et al from China reported the highest prevalence of PSCI at 80.9% with PSCI with-out dementia (49%) and PSD (32%) (22). This variation can be ascribed to the differences in the study design (institution-based), study area (urban setting), study participants (one third had stroke in the young), stroke duration (median of 3 years), and assessment method (MOCA-B) used in our study. Generally, the frequency of PSCI reported in our study is similar to that in the existing literature.

Although stroke risk increases with age, the average age of stroke survivors in our cohort was 52 years and more than one-third had stroke in the young, which is defined as stroke occurrence before the age of 45 years. This result is in agreement with our prior study in the same setting (23). However, most other regional and global studies reported a relatively higher age for stroke related cognitive impairment (9, 10, 18, 20). This might be explained by our sample population which is predominantly male, and males often developed stroke at earlier age as compared to females. Likewise other studies in Africa (10, 18), males represented 60% of our participants. This could be attributed to the reality that males have a better access to health services compared to females in low-income countries as males are the ones who make financial decisions.

Several sociodemographic and clinical variables determine the cognitive outcome of stroke survivors. Among these increasing age was found to be the major predictor of PSCI and PSD identified in prior studies (2, 12, 18). Similarly, we found a significant association between older age and PSCI although our cohort is relatively younger. Likewise, a Ghanaian study identified that the risk of PSCI increased by 44% for every 10-year increase in age and they attribute this to possible synergistic interaction between the vascular insult and neurodegenerative process which ends up in cognitive dysfunction (10). In the present study almost half of the participants had illiteracy and low literacy. This has been independently associated with PSCI and the risk of cognitive decline was 4 times higher in the illiterate/low literacy group that that of the literate group. A study from Nigeria compared 143 stroke survivors with 74 control subjects and found that lower education was associated with 5 times increased risk of PSCI (18). As the level of education is a surrogate marker for cognitive reserve, low education is strongly related with cognitive decline. To the contrary, better education increases the tenacity of brain function by improving cognitive reserve.

Also, post-stroke functional impairment was significantly related with cognitive decline. Functional recovery is a proxy marker for stroke severity and clinical deficit, stroke location and vascular burden, and acute stroke care and rehabilitation (10, 12). Similarly in our study, we found a significant association between poor function recovery and PSCI. A meta-analysis of randomized controlled trials (24) revealed that a structured physical activity and neurorehabilitation training enhances cognitive performance after stroke as early as in 12 weeks. Therefore, one way to address the growing burden of stroke on cognitive and physical outcomes of patients is by having a comprehensive and multimodal rehabilitation intervention at an early stage after the incidence.

Limitations to our study include small sample size and the cross-sectional nature of the study. Also, the study was limited to a hospital setting in urban centers which might introduce selection bias and overrepresent the sever cases referred to the neurology centers. The pre-stroke cognitive evaluation by short IQCODE was not considered in the analysis due to incomplete data.

# Conclusion:

Our finding suggests a high frequency of cognitive impairment among Ethiopian stroke survivors. Despite that our study had relatively young stroke cases, increasing age, low educational attainment and poor recovery of physical function were independently associated with cognitive impairment among Ethiopian stroke survivors. Although causality cannot be inferred, physical rehabilitation and better education might play a role in building cognitive resilience among stroke survivors.

# Abbreviations:

IQCODE: informant questionnaire for Cognitive Decline in the Elderly; LGH: Lancet general hospital; MCI: Mild cognitive impairment, MOCA-B: Montreal cognitive assessment-Basic; mRS: modified Rankin scale; PHQ-9: Patient health questionnaire-9; PSCI: Post-stroke cognitive impairment, PSD: Post-stroke dementia; TASH: Tikur Anbessa Specialized hospital: USD: United States dollar; YSC: Yehuleshet specialty clinic

# Declarations:

### Availability of data and materials

The datasets used and analyzed to support the findings of this study are available from the corresponding author upon reasonable request


## Acknowledgements

We are thankful to the Department of Neurology faculty and residents and to Sr. Wubit Bekele, Head nurse of Neurology clinic, for their unreserved support in the study. We remain incredibly grateful for Victor Valcour (MD) unreserved support. Finally, we would like to thank all participants and caregivers who took part in this study.

## Funding

This research project was financially supported by the Medical Education Partnership Initiative (MEPI) – Ethiopia under the NIH/Fogarty International Center (D43 TW010143)


## Author's contributions

YZZ in study planning, designing, data acquisition, analysis, interpretation, and manuscript preparation. AA and SKS in data interpretation, review, manuscript writeup and critique. All authors read and approved the final manuscript.

## Author details


Yared Z. Zewde, MD is an Assistant Professor at the Department of Neurology, CHS-AAU, Addis Ababa, Ethiopia. He is also an Atlantic fellow for Equity in Brain Health at the Global Brain Health Institute at the University of California, San Francisco (UCSF), USA with active engagement in dementia and cognitive neuroscience with particular interest in vascular risk factors and neurodegenerative dementia.

Atalay Alem, MD, PhD, is a Professor at the Department of Psychiatry, College of Health Sciences, Addis Ababa University, Addis Ababa, Ethiopia with an extensive experience in mental health research in Ethiopia.

Susanne K. Seeger, MD, is a Clinical Professor at the department of Neurology, University of Wisconsin, School of Medicine and Public Health, Wisconsin, USA with active engagement in cognition, pain, and vascular neurology.


## Ethics declaration

**Ethics approval and consent to participate**: The study protocol received ethical approval from the Institutional Ethics Review Board (IRB) of the College of Health Sciences, Addis Ababa University (Protocol no. 099/19/Neuro). A written informed consent was obtained from each participant (or their family caregivers or legal guardian in the case of illiterate or severely disabled subjects) before commencing with the interview. The study was performed in accordance with the Declaration of Helsinki.

### Consent for publication

Not applicable

### Competing interests

The authors declare they have no actual or potential competing financial interests

# References:


1. Feigin VL, Stark BA, Johnson CO, Roth GA, Bisignano C, Abady GG, et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Neurol. 2021 Oct;20(10):795–820.
2. Pendlebury ST. Stroke-related dementia: Rates, risk factors and implications for future research. Maturitas. 2009 Nov;64(3):165–71.
3. Merino JG. Dementia after stroke: high incidence and intriguing associations. Stroke. 2002 Sep;33(9):2261–2.
4. Seshadri S, Beiser A, Kelly-Hayes M, Kase CS, Au R, Kannel WB, et al. The Lifetime Risk of Stroke: Estimates From the Framingham Study. Stroke. 2006 Feb;37(2):345–50.
5. Gorelick PB, Scuteri A, Black SE, DeCarli C, Greenberg SM, Iadecola C, et al. Vascular Contributions to Cognitive Impairment and Dementia: A Statement for Healthcare Professionals From the American Heart Association/American Stroke Association. Stroke. 2011 Sep;42(9):2672–713.
6. Sun J-H, Tan L, Yu J-T. Post-stroke cognitive impairment: epidemiology, mechanisms and management. Ann Transl Med. 2014 Aug;2(8):80.
7. Douiri A, Rudd AG, Wolfe CDA. Prevalence of Poststroke Cognitive Impairment: South London Stroke Register 1995–2010. Stroke. 2013 Jan;44(1):138–45.
8. Jacquin A, Binquet C, Rouaud O, Graule-Petot A, Daubail B, Osseby G-V, et al. Post-Stroke Cognitive Impairment: High Prevalence and Determining Factors in a Cohort of Mild Stroke. J Alzheimers Dis. 2014 May 19;40(4):1029–38.
9. Gnonlonfoun DD, Ossou-Nguiet PM, Diallo LL, Adjien C, Avlessi I, Goudjinou G, et al. Post-Stroke Cognitive Disorders and Associated Factors in French Speaking West Africa, Benin Case. Neurosci Med. 2014;05(01):32–41.
10. Sarfo FS, Akassi J, Adamu S, Obese V, Ovbiagele B. Burden and Predictors of Poststroke Cognitive Impairment in a Sample of Ghanaian Stroke Survivors. J Stroke Cerebrovasc Dis. 2017 Nov;26(11):2553–62.
11. Pendlebury ST, Rothwell PM. Prevalence, incidence, and factors associated with pre-stroke and post-stroke dementia: a systematic review and meta-analysis. Lancet Neurol. 2009 Nov;8(11):1006–18.
12. Leys D, Hénon H, Mackowiak-Cordoliani M-A, Pasquier F. Poststroke dementia. Lancet Neurol. 2005 Nov;4(11):752–9.

13. Julayanont P, Tangwongchai S, Hemrungrojn S, Tunvirachaisakul C, Phanthumchinda K, Hongsawat J, et al. The Montreal Cognitive Assessment-Basic: A Screening Tool for Mild Cognitive Impairment in Illiterate and Low-Educated Elderly Adults. J Am Geriatr Soc. 2015 Dec;63(12):2550–4.
14. Saleh AA, Alkholy RSAEHA, Khalaf OO, Sabry NA, Amer H, El-Jaafary S, et al. Validation of Montreal Cognitive Assessment-Basic in a sample of elderly Egyptians with neurocognitive disorders. Aging Ment Health. 2019 May 4;23(5):551–7.
15. Ballard C, Stephens S, McLAREN A, Wesnes K, Kenny RA, Burton E, et al. Neuropsychological Deficits in Older Stroke Patients. Ann N Y Acad Sci. 2002 Nov;977(1):179–82.
16. Sachdev PS, Brodaty H, Valenzuela MJ, Lorentz L, Looi JCL, Wen W, et al. The neuropsychological profile of vascular cognitive impairment in stroke and TIA patients. Neurology. 2004 Mar 23;62(6):912–9.
17. Delgado C, Donoso A, Orellana P, Vásquez C, Díaz V, Behrens MI. Frequency and Determinants of Poststroke Cognitive Impairment at Three and Twelve Months in Chile. Dement Geriatr Cogn Disord. 2010;29(5):397–405.
18. Akinyemi RO, Allan L, Owolabi MO, Akinyemi JO, Ogbole G, Ajani A, et al. Profile and determinants of vascular cognitive impairment in African stroke survivors: The CogFAST Nigeria Study. J Neurol Sci. 2014 Nov;346(1–2):241–9.
19. Madureira S, Guerreiro M, Ferro JM. Dementia and cognitive impairment three months after stroke. Eur J Neurol. 2001 Nov 14;8(6):621–7.
20. Ihle-Hansen H, Thommessen B, Wyller TB, Engedal K, Øksengård AR, Stenset V, et al. Incidence and subtypes of MCI and dementia 1 year after first-ever stroke in patients without pre-existing cognitive impairment. Dement Geriatr Cogn Disord. 2011;32(6):401–7.
21. Yu K-H, Cho S-J, Oh MS, Jung S, Lee J-H, Shin J-H, et al. Cognitive Impairment Evaluated With Vascular Cognitive Impairment Harmonization Standards in a Multicenter Prospective Stroke Cohort in Korea. Stroke. 2013 Mar;44(3):786–8.
22. Qu Y, Zhuo L, Li N, Hu Y, Chen W, Zhou Y, et al. Prevalence of Post-Stroke Cognitive Impairment in China: A Community-Based, Cross-Sectional Study. Stewart R, editor. PLOS ONE. 2015 Apr 13;10(4):e0122864.
23. Zewde YZ, Mengesha AT, Gebreyes YF, Naess H. The frequency and impact of admission hyperglycemia on short term outcome of acute stroke patients admitted to Tikur Anbessa Specialized hospital, Addis Ababa, Ethiopia: a cross-sectional study. BMC Neurol. 2019 Dec;19(1):342.
24. Oberlin LE, Waiwood AM, Cumming TB, Marsland AL, Bernhardt J, Erickson KI. Effects of Physical Activity on Poststroke Cognitive Function: A Meta-Analysis of Randomized Controlled Trials. Stroke. 2017 Nov;48(11):3093–100.

# Figures

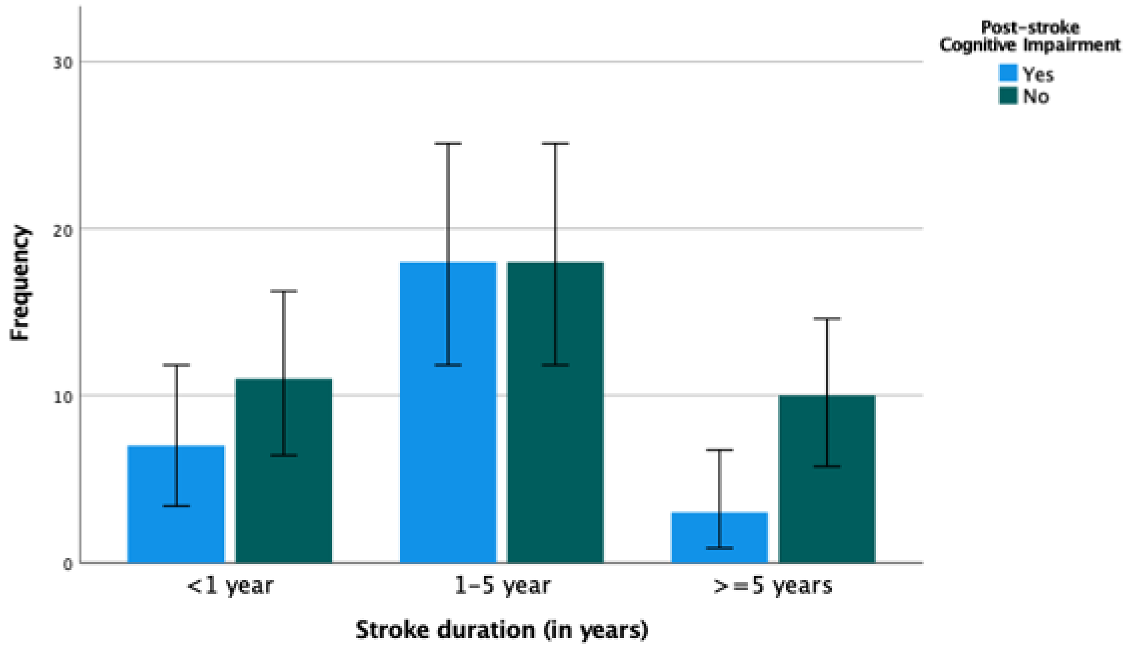


Figure 1

Cluster bar graph showing decreasing frequency of cognitive impairment with increased duration after stroke

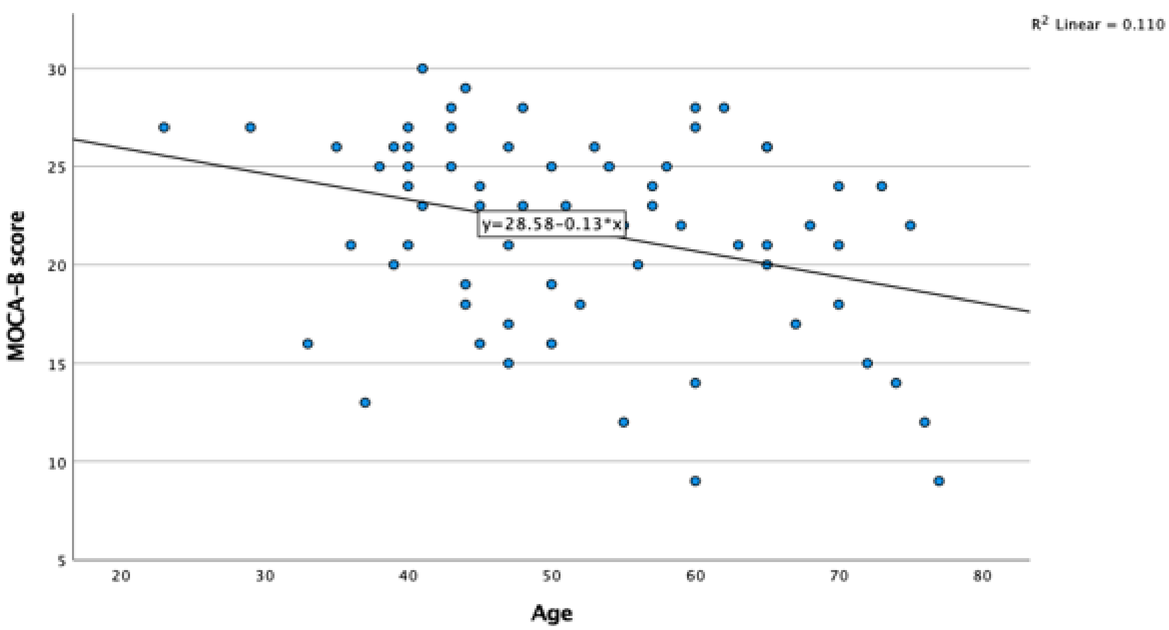


Figure 2

Scatter Plot showing the MOCA-B score decreases with increasing age