ORIGINAL REPORT

Check for updates

PREDICTORS FOR SELF-REPORTED FEELING OF DEPRESSION THREE MONTHS AFTER STROKE: A LONGITUDINAL COHORT STUDY

Janina KAARRE, BSc[1]*, Tamar ABZHANDADZE, OT, MSc[1,2]* and Katharina S. SUNNERHAGEN, MD, PhD[1,3]

*From the [1]Institute of Neuroscience and Physiology, Rehabilitation Medicine, University of Gothenburg, [2]Department of Occupational Therapy and Physiotherapy, Sahlgrenska University Hospital and [3]Rehabilitation Medicine, Neurocare, Sahlgrenska University Hospital, Gothenburg, Sweden. *These authors contributed equally to this work.*

Objective: Depression and impaired cognition are common consequences of stroke. The aim of this study was to determine whether cognitive impairment 36–48 h post-stroke could predict self-reported feeling of depression 3 months post-stroke.
Design: A longitudinal, cohort study.
Patients: Patients aged ≥ 18 years at stroke onset.
Methods: Cognition was screened using the Montreal Cognitive Assessment, 36–48 h after admission to the stroke unit at Sahlgrenska University Hospital. Information about self-reported feeling of depression 3 months post-stroke was retrieved from Riksstroke (the national quality register for stroke in Sweden). Bootstrapped binary logistic regression analyses were performed.
Results: Of 305 patients, 42% were female, median age was 70 years, and 65% had mild stroke. Three months post-stroke, 56% of patients had self-reported feeling of depression; of these, 65% were female. Impaired cognition at baseline could not predict self-reported feeling of depression 3 months later. The odds for self-reported feeling of depression were twice as high in female patients (odds ratio 2.01; 95% confidence interval, 0.20–1.22; *p* < 0.01).
Conclusion: Impaired cognition early after stroke could not predict self-reported feeling of depression 3 months post-stroke. Compared with male patients, female patients had twice the odds of self-reported feeling of depression

Correspondence address: Tamar Abzhandadze, Institute of Neuroscience and Physiology, Rehabilitation Medicine, University of Gothenburg, Per Dubbsgatan 14, fl. 3, 413 45 Gothenburg, Sweden. E-mail: tamar.abzhandadze@gu.se

LAY ABSTRACT
Depression and impaired cognition are common consequences of stroke. This study investigated whether screening for cognitive function 36–48 h after stroke could predict self-reported feeling of depression 3 months later. Of the 305 patients with mild stroke, 56% had self-reported feeling of depression. Cognitive impairment could not predict self-reported feeling of depression. Therefore, cognitive screening within the first 2 days after stroke might be too early to predict self-reported feeling of depression 3 months after stroke. However, the high proportion of patients with self-reported feeling of depression indicates the severity of the problem that needs to be addressed.

Post-stroke depression (PSD) is a common condition identified in up to 40% of patients, 3 months after stroke (1–3). Since approximately only 17% of patients with PSD have a previous history of depression, PSD can primarily be considered a consequence of stroke (4). A previous study showed a high number of patients developing PSD in the first month after stroke (5). The prevalence of depression in the acute phase after stroke was 25%, with a slight increase of to 31% after 3 months (5). PSD is associated with increased mortality, decreased quality of life, physical disability, and poor functional outcomes after stroke (6). Therefore, timely detection of depression is important (1), but can be hindered by various factors, such as short duration of hospitalization, insufficient healthcare resources, and poor communication between healthcare facilities (7). Thus, the availability of other information gathered early after stroke that can help predict PSD will be of clinical value.

The mechanisms underlying PSD are complex and associated with multiple factors; including patients' pre-stroke characteristics, stroke-related risk factors, and post-stroke conditions (8). Impaired cognition has been linked to PSD (9, 10). Executive dysfunction, language impairment, and orientation deficits were also related to PSD (11). However, the cause–effect relationship between cognition and depression is unclear. Neurobiological pathways, such as vascular depression and neuroinflammation can cause PSD (12, 13). Nevertheless, none of these can be considered more dominant or the leading cause of PSD. However, these pathways could still be possible causes of PSD, together with cognitive impairment.

Unlike cognitive function, female sex is a well-known predictor of PSD (14, 15). Female patients are also more likely to be widowed before stroke, have a high mean age, more severe stroke, and a higher level of post-stroke disability (14). However, the results regarding patients' age and risk of PSD are conflicting, indicating that both young and old patients have a high risk of PSD 3–12

months after stroke (14, 16, 17). Furthermore, patients younger than 70 years have a high risk of PSD (16, 18). Other well-known predictors of PSD are severe stroke, stroke localization, high dependency level, and social isolation post-stroke (15, 16).

The predictive value of cognitive function for PSD remains unclear. Moreover, no studies were found that assessed the association between screening of cognition very early post-stroke and self-reported feeling of depression (SRFD) 3 months after stroke, when the first post-stroke follow-up is commonly done. Thus, the primary aim of this study was to explore the association between cognitive function screened very early after stroke and SRFD 3 months later. The secondary aims were to study the influences of sex and age on cognition and SRFD 3 months post-stroke.

METHODS

Study sample

In this longitudinal, cohort study, baseline data were obtained from a research database that was created as a consequence of the Gothenburg Very Early Supported Discharge study (GOTVED) (19). For GOTVED, patients admitted to a stroke unit at Sahlgrenska University Hospital (SU) from May 2011 to April 2016 were screened and registered (19). The SU was, at the time, the only hospital in Gothenburg performing thrombolysis and the only hospital in the Region Västra Götaland performing thrombectomy. Baseline data were merged with data in the Swedish national quality register for stroke care (Riksstroke) (20, 21). The primary aim of Riksstroke is to gather data for the assessment of stroke care quality and rehabilitation at stroke units. However, another aim is to make data available for research. The statistician at Riksstroke merged the data by using the patients' personal identification numbers. The data file received was anonymized. The acute and 3-month follow-up forms of Riksstroke were used. The study was approved by the Regional Ethics Review Board in Gothenburg (number 042–11, amendments 392–17 and 966–17).

Inclusion criteria were: patients with ischaemic and/or haemorrhagic stroke, who were aged ≥18 years at stroke onset; who spoke and understood Swedish; had been cognitively screened using the Montreal Cognitive Assessment (MoCA) within 36–48 h after admission, and returned the 3-month follow-up questionnaire with data on SRFD. Patients with other concomitant neurological diseases were excluded.

Procedure

Research database. Occupational therapists in the stroke unit screened the patients' cognitive function and the ability to perform basic activities of daily living (ADL) within 36–48 h after admission to the stroke unit. The occupational therapy department at SU collaborated with the research group during the screening period of the GOTVED study (19). Data on stroke type and neurological status at stroke onset were gathered from the patients' charts. Stroke-related neurological status at arrival was assessed by trained staff (a nurse or a doctor).

Riksstroke. Data in the acute modulus were registered by personnel in a stroke unit. The 3-month follow-up was completed with self-administered questionnaires.

Variables

The outcome variable was SRFD, estimated from Riksstroke's 3-month follow-up module. The question "do you feel depressed?" had multiple-choice responses, which were dichotomized for the analysis in this study. There were 4 options: never/nearly never, sometimes, often, or constantly. The option "never/nearly never" was categorized as "do not have SRFD" and coded as 0. The options "sometimes", "often", and "constantly" were categorized as "have SRFD" and coded as 1 (22).

The primary explanatory variable was cognitive function screened by the MoCA: the maximum score on MoCA was 30, and a cut-off score ≥26 indicated normal cognitive functioning (23). For the binary logistic regression analyses, the MoCA was dichotomized into normal cognition (MoCA score ≥26) and impaired cognition (MoCA score ≤25) (23). The secondary explanatory variable was the patients' sex.

Subgroup analyses were performed based on the patients' age at stroke onset. For the binary logistic regression analyses, age was dichotomized as follows: group 1 included patients aged 19–69 years, and group 2 included patients aged 70–100 years. The cut-off was chosen based on a previous study showing that patients younger than 70 years have a high risk of depression (18).

Other variables used in the study

The neurological status at hospital admission was assessed using the National Institutes of Health Stroke Scale (NIHSS) (24). The NIHSS is a clinical assessment scale used to evaluate stroke severity. The score ranges from 0 to 42, with a higher score indicating more severe stroke. For the logistic regression analyses, the NIHSS score was dichotomized as mild stroke (NIHSS score ≤2) and moderate to severe stroke (NIHSS score ≥3) (24).

The patients' independence in P-ADL was assessed using the Barthel Index (BI) (25), a standardized tool for measuring a patients' ability to perform P-ADL. The total score on the BI ranges from 0 to 100, with higher scores indicating higher independence in ADL. For the logistic regression analyses, the BI was dichotomized as ADL-independent (BI ≥95) and ADL-dependent (BI ≤90).

Moreover, data on comorbidities (diabetes and previous stroke, yes/no), living conditions and ADL before stroke onset, stroke type (ischaemic and haemorrhage), reperfusion treatment (coded as yes for patients who received thrombolysis and/or thrombectomy and no for those who did not receive reperfusion treatment), hospitalization duration, and discharge destination from the hospital were registered and analysed.

Statistical analysis

The characteristics of the study sample are presented with descriptive statistics. Significant differences between included and excluded patients, as well as those between male and female patients were studied using the Mann–Whitney *U* test and χ^2 test for continuous/ordinal variables and nominal variables, respectively.

Binary logistic regression analyses

The outcome variable was SRFD 3 months after stroke, coded as "do not have SRFD "=0 or "have SRFD "=1. The following

independent variables were analysed: cognitive function assessed with the MoCA (primary explanatory variable, dichotomized), sex (secondary explanatory variable), age (dichotomized), stroke severity as assessed with the NIHSS score (dichotomized), living alone, diabetes, previous stroke, ADL assessed with BI (dichotomized), and stroke type (Table SI[1]). The independent variables were chosen based on previous literature and the authors' clinical experience.

Assumption checking. Independent variables were checked for ≥10 observations per outcome category. In addition, the collinearity between independent variables was studied with phi correlation coefficients, since all independent variables were binary. The independent variables with a correlation coefficient of ≥ ±0.7 were not entered in the same model.

Model building. Three binary logistic regression models were built. In model 1, the primary independent variable, MoCA, was entered. In model 2, patients' sex and MoCA were entered. Finally, the third model was based on 9 independent variables, including the primary and secondary explanatory variables (model 3). B coefficients and odds ratios (ORs) were presented for each independent variable.

Model stability. The sample size was relatively small. To investigate the model stability, simple bootstrapping was performed with 2,000 samples with replacement from the original dataset (23–25). Bootstrapped standard errors (SE, lower values were better), bias-corrected and accelerated 95% confidence intervals (95% CIs), and p-values were reported.

Evaluation of binary logistic regression models. The fit of the binary logistic regression model was evaluated with the Hosmer–Lemeshow test ($p > 0.05$ indicates good fit). The explained variance of the models was evaluated with Cox & Snell's R^2 and Nagelkerke's R^2 tests (higher values were desired), and the Omnibus test (χ^2 test, *p*-value ≤0.05 was desired).

Data were analysed using SPSS (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.); for bootstrapped logistic regression, the SPSS professional demo version was used. All tests were two-sided at a 5% significance level.

Subgroup analyses

Subgroup analyses for predicting SRFD were also performed. The patients' sex and age were used as control variables.

RESULTS

Study participants

Baseline data were available for 367 patients (Fig. 1). Of these, 305 met the inclusion criteria. The excluded patients (*n*=62) and included patients (*n*=305) showed no significant differences in terms of sex ($p=0.82$), age ($p=0.38$), or stroke severity ($p=0.35$) (Fig. 1). However, the excluded group contained a greater proportion of patients with severe cognitive impairment (median MoCA score, 22; $p=0.001$) and patients who were ADL-dependent (median BI, 87.5, $p=0.05$) 36–48 h post-stroke.

Of the 305 patients included in this study, 58% were female, and the median age was 70 years (range 19–100 years); 199 (65%) patients had mild stroke, 184 (60%) had impaired cognition (MoCA score ≤25), and 127 (42%) were ADL-dependent (BI ≤90). A significantly greater proportion of females were living alone before stroke, and a significantly greater number of males had prior stroke (Table I).

Three months after stroke, 170 (56%) patients reported that they did not need assistance from relatives, 251 (82%) patients were living in their own homes without community services, and 112 (37%) were living alone. Regarding SRFD, 135 (44%), 145 (47%), 18 (6%), and 7 (3%) patients reported feeling depressed never/nearly never, sometimes, often, or constantly, respectively. There was no significant difference in SRFD between the patients who were cognitively impaired (MoCA score ≤25) and the remainder (MoCA score ≥26); $p=0.46$ (Fig. 2). The proportion of female patients (65%) who felt depressed sometimes, often, or constantly was significantly higher than that of male patients (48%; $p=0.002$). No significant difference was found between the age groups ($p=0.06$), (Fig. 2).

Prediction of self-reported feeling of depression 3 months after stroke

The number of observations between the categories of independent and dependent variables was >10 patients (Table SI[1]); thus, they could be pooled into the binary logistic regression model. Furthermore, phi correlation
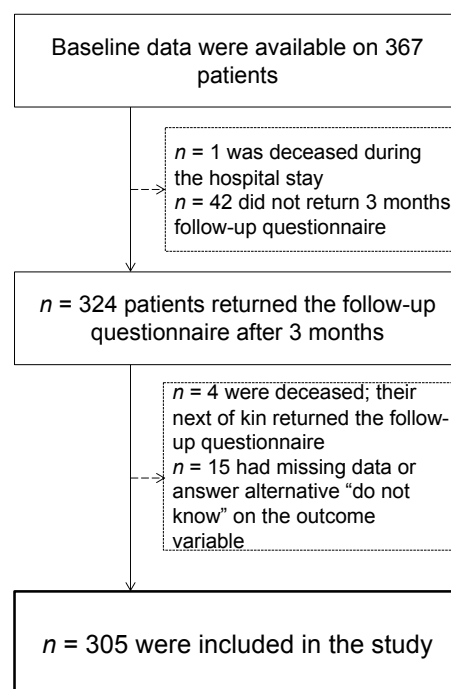
**Fig. 1.** Flow chart of the study participants with stroke.

Baseline data were available on 367 patients

n = 1 was deceased during the hospital stay
n = 42 did not return 3 months follow-up questionnaire

n = 324 patients returned the follow-up questionnaire after 3 months

n = 4 were deceased; their next of kin returned the follow-up questionnaire
n = 15 had missing data or answer alternative "do not know" on the outcome variable

n = 305 were included in the study

Table I. Characteristics of patients with stoke in the study

Characteristics	Total $n = 305$	Male[a] $n = 177$	Female[a] $n = 128$	*p*-value
Age, years, mean (SD)	69 (14)	68 (13)	69 (16)	0.17
Living alone before stroke, yes, *n* (%)	127 (41)	61 (34)	66 (52)	**0.003**[b]
Accommodation before stroke, *n* (%)				0.06[b]
Home without help	282 (92)	168 (95)	114 (89)	
Home/community facility with help	23 (8)	9 (5)	14 (11)	
ADL independent before stroke, *n* (%)	298 (97)	174 (98)	123 (96)	NA[b]
Previous stroke, *n* (%)	54 (18)	38 (22)	16 (13)	**0.04**[b]
Diabetes, *n* (%)	40 (13)	26 (15)	14 (11)	0.32[b]
Reperfusion treatment, *n* (%)	72 (24)	42 (25)	30 (24)	0.86[b]
Stroke type, *n* (%)				0.34[b]
Ischaemic	278 (91)	159 (90)	119 (93)	
Stroke severity, NIHSS score, median (IQR)	2 (0–4)	1 (0–3)	2 (1–4)	0.20
Cognitive function, MoCA score, median (IQR)	24 (21–27)	24 (21–27)	25 (21–27)	0.82
ADL, BI, median (IQR)	95 (80–100)	100 (80–100)	95 (80–100)	0.48
Length of hospital stay, days, mean (SD)	8 (6)	8 (6)	8 (6)	0.94
Discharge destination, *n* (%)				0.37
Own home with/without community services	270 (88)	159 (90)	111 (87)	
Other hospitals/rehabilitation units	25 (11)	11 (6)	14 (11)	
Community facility	3 (1)	7 (4)	3 (2)	

Results are given for the total study sample ($n = 305$) as well as for male and female patients ($n = 177$ and $n = 128$, respectively).
[a]Sums may vary due to missing values. The *p*-value shows the differences between female and male patients, and group comparisons were made with the Mann–Whitney *U* test and χ^2 test[b]. Bold text indicates statistically significant differences. SD: standard deviation; ADL: activities of daily living; NIHSS: National Institutes of Health Stroke Scale; IQR: interquartile range; MoCA: Montreal Cognitive Assessment; BI: Barthel Index. Variables with missing values, *n* (%) of the total sample: diabetes, 7 (2); previous stroke, 7 (3); reperfusion treatment, 9 (3).
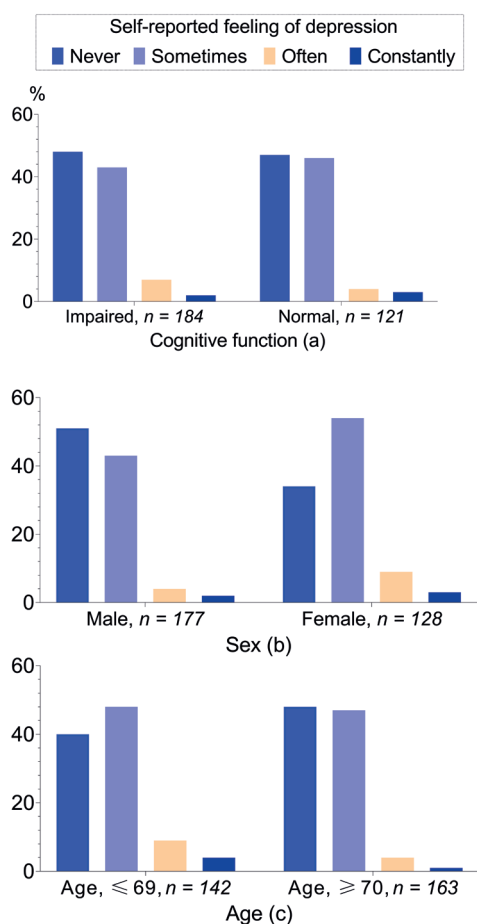
Fig. 2. Bar chart showing the proportional distribution between patients' cognitive function, sex, age, and self-reported feeling of depression. In total, data from 305 patients with stroke were included. MoCA: Montreal Cognitive Assessment.

coefficients between independent variables were ≤ ± 0.40, indicating no collinearity between the variables (Table SII[1]).

Cognitive function screened 36–48 h after stroke was not a significant predictor for SRFD in the univariable and multivariable models (Table II). Furthermore, the odds of SRFD were high in female patients. Patients ≥ 70 years had decreased odds of SRFD. The patients who were living alone before stroke had higher odds of SRFD than those not living alone (Table II).

Sex differences in relation to cognitive function and self-reported feeling of depression 3 months post-stroke

Cognitive impairment could not predict SRFD 3 months post-stroke in the simple and adjusted models (Table SIII[1]). Male patients who lived alone before stroke had two times higher odds for SRFD 3 months post-stroke (OR = 2.35; 95% CI, 0.01–1.95; *p* = 0.02) than female patients. Furthermore, the odds for SRFD were 71% lower in older (≥ 70 years) female patients (OR = 0.29; 95% CI, –2.41 to –0.39; *p* = 0.02) compared with the younger female patients (Table SIII[1]).

Age differences in relation to cognitive function and self-reported feeling of depression 3 months post-stroke

Cognitive impairment could not predict SRFD in the univariable or adjusted models for either age group (Table SIV[1]). The models with all explanatory variables showed that, in the age group < 70 years, patients had 3-fold higher odds of SRFD 3 months after stroke if they were living alone before stroke (OR = 3.69; 95% CI, 0.20–3.19; *p* = 0.007) and three-fold higher odds

Table II. Binary logistic regression analysis models predicting self-reported feeling of depression in 305 patients with stroke

Models	Conditions	B (SE[a,b])	OR[b]	95% CI[a,b]	p-value[a,b]
1	Impaired cognition (MoCA score ≤ 25)	0.13 (0.23)	1.14	−0.33 to 0.61	0.56
2	Impaired cognition (MoCA score ≤25)	0.13 (0.24)	1.14	−0.33 to 0.61	0.59
	Female sex	0.70 (0.25)	2.01	0.20 to 1.22	**0.008**
3	Impaired cognition (MoCA score ≤25)	0.28 (0.27)	1.32	−0.26 to 0.85	0.28
	Female sex	0.69 (0.27)	1.99	0.15 to 1.26	**0.008**
	Age ≥70 years	−0.61 (0.29)	0.54	−1.17 to −0.11	**0.02**
	Lived alone before stroke	0.59 (0.28)	1.81	0.03 to 1.23	**0.02**
	Previous stroke	0.003 (0.36)	1.00	−0.67 to 0.65	0.99
	Having diabetes	0.15 (0.36)	1.16	−0.55 to 0.98	0.67
	Haemorrhagic stroke	−0.14 (0.48)	0.87	−1.07 to 0.80	0.74
	Moderate to severe stroke (NIHSS ≥3)	0.14 (0.29)	0.15	−0.44 to 0.73	0.62
	ADL-dependent (BI ≤90)	0.15 (0.30)	0.16	−0.45 to 0.75	0.60

Statistics: Binary logistic regression analyses, [a]Bootstrapped estimates from 2,000 random samples. [b]Adjusted values are presented for models 2 and 3.
Model 1: Hosmer–Lemeshow test, $p=0$; Cox & Snell's R^2, 0.001; Nagelkerke's R^2, 0.001; Omnibus test for the model, $p=0.56$. Model 2: Hosmer–Lemeshow test, $p=0.87$; Cox & Snell's R^2, 0.03; Nagelkerke's R^2, 0.04; Omnibus test for the model, $p=0.01$. Model 3: The Hosmer–Lemeshow test, $p=0.29$; Cox & Snell's R^2, 0.07; Nagelkerke's R^2, 0.09; Omnibus test for the model, $p=0.01$.
Bold text indicates statistically significant results. B: beta coefficient; SE: standard error; OR: odds ratio; 95% CI: 95% confidence interval; MoCA: Montreal Cognitive Assessment; NIHSS: National Institutes of Health Stroke Scale; ADL: activities of daily living; BI: Barthel Index.

of SRFD if they were female (OR=3.56; 95% CI 0.20−2.82; $p=0.008$). No significant attributes were identified in the patient group ≥70 years of age (Fig. 3). Detailed information is presented in Table SIV[1].

DISCUSSION

This longitudinal cohort study showed that cognitive function screened with the MoCA could not predict SRFD either in the total sample or in the analyses stratified by sex and age. The current study results differ from those of earlier studies (10, 26, 27), which showed a positive association between impaired cognitive function and depression. According to previous studies (10, 26), depressive patients had severe neurological impairment and were more likely to be ADL-dependent. In these studies, cognitive impairment was assessed using either the Scandinavian Stroke Scale or the Mini-Mental State Examination and the Trail Making test. The patients in the current study had mostly either mild or moderate stroke, which can, in turn, explain why the current results differ from those of previous studies. Theoretically, the inclusion of patients with more severe neurological impairment could have shown a significant relationship between poor cognitive function and SRFD 3 months after inclusion.

Female patients generally had higher odds for SRFD 3 months post-stroke, and younger females (<70 years) had 3-fold higher odds. These results are in line with those of earlier studies, showing that the female sex is a risk factor for developing PSD (28, 29). In Sweden, approximately every fifth person is diagnosed with depression during their lifetime, and the number of women with this diagnosis is almost double that of men (30). The results of the current study are consistent with this finding; they further validate the generally high odds for depression among women as well as among female patients after stroke.

Patients living alone before stroke showed higher odds of SRFD after stroke in the total sample. This result was consistent with previous findings showing that patients living alone before stroke show increased odds of PSD (1). Moreover, when sensitivity analyses were performed based on sex, the current study found that male patients who were living alone before stroke had higher odds for SRFD 3 months post-stroke. This phenomenon has not been reported previously to the same extent and could be regarded as new information. The reason living alone is a risk factor for SRFD among male patients remains poorly understood and should be
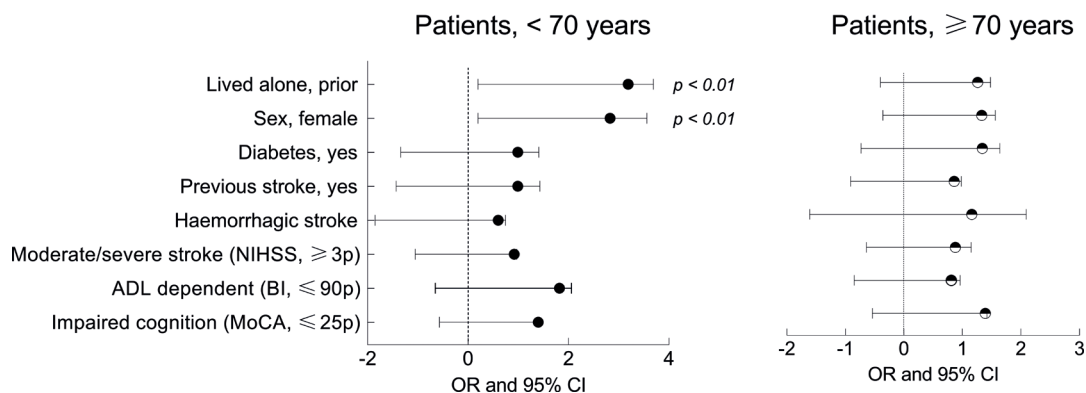
Fig. 3. Forest plot showing the odds ratios (OR) and 95% confidence intervals (95% CIs) for predicting self-reported feeling of depression 3 months after stroke; 305 patients were stratified on the basis of age. 95% CI and p-values are derived from bootstrapped binary logistic regression analyses. NIHSS: National Institutes of Health Stroke Scale; ADL: activities of daily living; BI: Barthel Index; MoCA: Montreal Cognitive Assessment.

assessed more closely in future. There was no significant difference identified among patients aged 70 years. Previous studies reported conflicting results regarding age as a possible risk factor for PSD (16, 17). However, the current study showed that younger patients had higher odds for SRFD, which could be due to disappointment with unexpected change in their aspirations and frustration with loss of their earlier healthy life (31).

Study limitations and strengths

This study has several limitations. The dropout rate between baseline and 3-month follow-up was 17%. The excluded group contained patients with more severe cognitive impairment as well as greater dependency in ADL. A further limitation was that the variable "depression" was extracted from Riksstroke's 3-month follow-up data, and was based on self-reported feelings. Moreover, it is possible that cognitive impairments identified within 36–48 h after admission to the stroke unit reflect other stroke-related consequences, such as acute delirium, tiredness, and health-related stress reaction; this, in turn, could lead to insignificant results.

The current study also had several strengths. The study sample was relatively large and included a wide age range with verified stroke diagnosis. Most of the patients had mild to moderate stroke (NIHSS score ranged from 0 to 19). The study sample was representative of the Swedish population with stroke, where most patients have mild to moderate stroke at hospital admission. The Riksstroke's question about depression used in this study has been validated previously by Eriksson et al. (28). However, in their study, different dichotomizations were used for logistic regression analyses. The MoCA has been considered the most valid and clinically practical screening tool for identifying cognitive impairment in stroke patients (31). In summary, the results of the current study can be generalized to the stroke population with mild to moderate stroke.

Conclusion

The results of this study showed that cognitive impairment 36–48 h after stroke, screened using the MoCA could not predict SRFD 3 months after stroke. Moreover, patients aged <70 years, either female or living alone, had higher odds ratios for SRFD. These findings are clinically important and provide new information about the groups with high odds of developing PSD. A high proportion of patients reported feeling depressed, indicating that the prevalence of depression might be high in stroke survivors. Thus, mood screening is an important aspect of regular follow-up after stroke.

REFERENCES

1. Lee AC, Tang SW, Yu GK, Cheung RT. Incidence and predictors of depression after stroke (DAS). Int J Psychiatry Clin Pract 2007; 11: 200–206.
2. Koivunen RJ, Harno H, Tatlisumak T, Putaala J. Depression, anxiety, and cognitive functioning after intracerebral hemorrhage. Acta Neurol Scand 2015; 132: 179–184.
3. Ayerbe L, Ayis S, Rudd AG, Heuschmann PU, Wolfe CD. Natural history, predictors, and associations of depression 5 years after stroke: The South London Stroke Register. Stroke 2011; 42: 1907–1911.
4. Taylor-Rowan M, Momoh O, Ayerbe L, Evans J, Stott D, Quinn T. Prevalence of pre-stroke depression and its association with post-stroke depression: a systematic review and meta-analysis. Psychol Med 2019; 49: 685–696.
5. Aström M, Adolfsson R, Asplund K. Major depression in stroke patients. A 3-year longitudinal study. Stroke 1993; 24: 976–982.
6. Nys GMS, van Zandvoort MJE, van der Worp HB, de Haan EHF, de Kort PLM, Jansen BPW, et al. Early cognitive impairment predicts long-term depressive symptoms and quality of life after stroke. J Neurol Sci 2006; 247: 149–156.
7. Gache K, Leleu H, Nitenberg G, Woimant F, Ferrua M, Minvielle E. Main barriers to effective implementation of stroke care pathways in France: a qualitative study. BMC Health Serv Res: BioMed Central; 2014; 14: 95.
8. Villa RF, Ferrari F, Moretti A. Post-stroke depression: mechanisms and pharmacological treatment. Pharmacol Ther 2018; 184: 131–144.
9. Scult MA, Paulli AR, Mazure ES, Moffitt TE, Hariri AR, Strauman TJ. The association between cognitive function and subsequent depression: a systematic review and meta-analysis. Psychol Med 2017; 47: 1–17.
10. Hama S, Yoshimura K, Yanagawa A, Shimonaga K, Furui A, Soh Z, et al. Relationships between motor and cognitive functions and subsequent post-stroke mood disorders revealed by machine learning analysis. Sci Rep 2020; 10: 19571.
11. Ghaffari A, Akbarfahimi M, Rostami HR. Discriminative factors for post-stroke depression. Asian J Psychiatr 2020; 48: 101863.
12. Jeon SW, Kim YK. The role of neuroinflammation and neurovascular dysfunction in major depressive disorder. J Inflamm Res 2018; 11: 179–192.
13. Feng C, Fang M, Liu XY. The neurobiological pathogenesis of poststroke depression. ScientificWorldJournal 2014; 2014: 521349.

14. Dong NL, Sánchez EB, Skolarus BL, Stulberg DE, Morgenstern DL, Lisabeth DL. Sex difference in prevalence of depression after stroke. Neurology 2020; 94: e1973–e1983.
15. Huang J, Zhou FC, Guan B, Zhang N, Wang A, Yu P, et al. Predictors of remission of early-onset poststroke depression and the interaction between depression and cognition during follow-up. Front Psychiatry 2018; 9: 738.
16. Carota A, Berney A, Aybek S, Iaria G, Staub F, Ghika-Schmid F, et al. A prospective study of predictors of poststroke depression. Neurology 2005; 64: 428–433.
17. Jørgensen TSH, Wium-Andersen IK, Wium-Andersen MK, Jørgensen MB, Prescott E, Maartensson S, et al. Incidence of depression after stroke, and associated risk factors and mortality outcomes, in a large cohort of Danish patients. JAMA psychiatry (Chicago, Ill). 2016; 73: 1032–1040.
18. Shi Y, Yang D, Zeng Y, Wu W. Risk factors for post-stroke depression: a meta-analysis. Front Aging Neurosci 2017; 9: 218.
19. Sunnerhagen KS, Danielsson A, Rafsten L, Bjorkdahl A, Axelsson AB, Nordin A, et al. Gothenburg very early supported discharge study (GOTVED) NCT01622205: a block randomized trial with superiority design of very early supported discharge for patients with stroke. (Study protocol) (Report). BMC Neurol 2013; 13: 66–73.
20. Asplund K, Hulter Åsberg K, Appelros P, Bjarne D, Eriksson M, Johansson Å, et al. The Riks-Stroke story: building a sustainable national register for quality assessment of stroke care. Int J Stroke 2011; 6: 99–108.
21. Abzhandadze T, Rafsten L, Lundgren Nilsson Å, Palstam A, Sunnerhagen KS. 2019. Very Early MoCA can predict functional dependence at 3 months after stroke: a longitudinal, cohort study. Front Neurol 2019; 10: 1051.
22. Bråndal A, Eriksson M, Glader EL, Wester P. Effect of early supported discharge after stroke on patient reported outcome based on the Swedish Riksstroke registry. BMC Neurol 2019; 19: 40.
23. Nasreddine ZS, Phillips NA, Bédirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc 2005; 53: 695–699.
24. Nedeltchev PK, Schwegler PB, Haefeli PT, Brekenfeld PC, Gralla PJ, Fischer PU, et al. Outcome of stroke with mild or rapidly improving symptoms. Stroke 2007; 38: 2531–2535.
25. Mahoney FI, Barthel DW. Functional evaluation: the Barthel Index. Md State Med J. 1965; 14: 61–65.
26. Kauhanen M, Korpelainen JT, Hiltunen P, Brusin E, Mononen H, Määttä R, et al. Poststroke depression correlates with cognitive impairment and neurological deficits. Stroke 1999; 30: 1875–1880.
27. Tu J, Wang LX, Wen HF, Xu YC, Wang PF. The association of different types of cerebral infarction with post-stroke depression and cognitive impairment. Medicine (Baltimore), 2018; 97: e10919.
28. Eriksson M, Asplund K, Glader E-L, Norrving B, Stegmayr B, Terént A, et al. Self-Reported depression and use of antidepressants after stroke: a national survey. Stroke 2004; 35: 936–941.
29. Medeiros GC, Roy D, Kontos N, Beach SR. Post-stroke depression: a 2020 updated review. Gen Hosp Psychiatry 2020; 66: 70–80.
30. Johansson R, Carlbring P, Heedman Å, Paxling B, Andersson G. Depression, anxiety and their comorbidity in the Swedish general population: point prevalence and the effect on health-related quality of life. PeerJ 2013; 1: e98.
31. Burton L, Tyson S. Screening for cognitive impairment after stroke: a systematic review of psychometric properties and clinical utility. J Rehabil Med 2015; 47: 193–203.