

# Family Functioning is Associated with Post-Stroke Depression in First-Ever Stroke Survivors: A Longitudinal Study

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**Background:** Post-stroke depression (PSD) can aggravate the mortality and recurrence rate in stroke patients. The relationship between family functioning and PSD at different phases after a first-ever stroke is unclear. The purpose of this longitudinal study was to investigate the patterns and relationship of family functioning and PSD at acute hospitalization and 6 months post-discharge in first-ever stroke survivors.

**Methods:** This is a longitudinal study conducted in Guangzhou, China. Family functioning and depression were measured by the Short Form Family Assessment Device (SF-FAD) and Self-Rating Depression Scale (SDS) at baseline and 6 months post-discharge. Multiple linear regression analysis was used to explore the relationship between family functioning and PSD.

**Results:** The prevalence of PSD at acute hospitalization and 6 months post-discharge was 32.9% and 20.0%, respectively. SDS scores decreased significantly from baseline to 6 months post-discharge, while SF-FAD scores did not change significantly during this period. The Pearson correlation coefficient showed that SF-FAD scores were positively associated with SDS scores at the two time points ( $r_1 = 0.341$ ,  $r_2 = 0.510$ ,  $P < 0.05$ ). Multiple linear regression analyses indicated that SF-FAD scores could predict PSD at baseline (unstandardized coefficient: 7.010,  $P < 0.05$ ) and 6 months post-discharge (unstandardized coefficient: 9.672,  $P < 0.001$ ).

**Conclusion:** This study found that first-ever stroke survivors had good family functioning at baseline and 6 months post-discharge. The findings in this study verified that poor family functioning is positively associated with PSD at different phases post-stroke. Good family functioning is an important protective factor against PSD.

**Keywords:** family functioning, depression, stroke

## Introduction

The socio-economic burden of stroke in China is sharply increasing, and the number of stroke patients in China ranks first worldwide, with approximately 17.04 million people over the age 40 have experienced strokes.<sup>1</sup> Additionally, Chinese residents over the age of 25 have the highest lifetime risk of stroke in the world, which means about two-fifths of Chinese people have a stroke risk in their lifetime.<sup>2</sup> Stroke is the leading cause of death and disability in China, which is characterized by high prevalence, mortality, and disability rates, posing a serious threat to the health of the Chinese population.<sup>1</sup> The weighted prevalence of stroke in Chinese people over age 40 years is increasing with time, reaching 2.58% in 2019.<sup>3</sup> In 2019, there were 3.94 million new cases of stroke, and stroke caused 2.19 million deaths and 45.9 million disability-adjusted life years (DALYs) in China.<sup>4</sup>

Stroke severely impairs the physical condition of patients, with studies showing that 10.4% of stroke patients experienced severe disability within 1 month after a stroke.<sup>5</sup> Stroke survivors can also develop psychological disorders. Post-stroke depression (PSD) was the most common neuropsychiatric complication after a stroke, and about one-third of stroke patients experience post-

stroke depression.<sup>6</sup> The most common risk factors for PSD were stroke severity, cognitive deficits and physical impairment.<sup>7</sup> Current studies found that 35.2% to 87% stroke patients had cognitive deficits, and there is a strong correlation between cognitive deficits and PSD.<sup>8</sup> The Edelkraut study found that there is a higher incidence of depression in stroke patients with aphasia.<sup>9</sup> The Williams and Demeyere study found that cognitive deficits in spatial attention, executive function, memory, number and language processing, and praxis could exacerbate depressive symptoms at 6 months post-stroke.<sup>10</sup> Depression seriously threatens the recovery and health outcomes for stroke patients. Stroke survivors with depression are more likely to have less effective rehabilitation post-stroke, higher all-cause mortality, suicidal ideation and stroke recurrence.<sup>11–14</sup> The stroke recurrence of patients with PSD was 1.48 times higher than that in those without PSD.<sup>14</sup>

Psychotherapy plays a significant role in the treatment of PSD, and social support is considered the most meaningful factor against PSD.<sup>15</sup> In China, the family is the most basic social unit for individuals, and family relationships are an integral part of social support, especially for elder adults.<sup>16</sup> Family functioning refers to the family's ability to meet the basic needs of family members and personal growth needs, as well as the ability to cope with difficult circumstances.<sup>17</sup> Family plays an important role in regulating an individual's mental health, and one Chilean study conducted with 6206 families found that good family functioning is associated with fewer health problems in the family, especially a reduction of psychological and mental disorders.<sup>18</sup> A Chinese study of different family structures found that it is family functioning rather than family structure that can significantly affect an individual's psychological well-being.<sup>19</sup> Family care is directly related to the quality of life of stroke patients at home.<sup>20</sup>

Current study suggest an association between family functioning and depression in patients with major depressive disorder, and patients with healthy family functioning have shorter duration of depression.<sup>21</sup> Nan found that family care is beneficial in preventing depression in patients with chronic diseases, and patients with higher satisfaction with home support have lower depression levels.<sup>22</sup> One cross-sectional study of stroke patients in the acute phase found that family functioning is negatively associated with PSD.<sup>23</sup> Stroke patients remain at high risk of depression within 6 months post-stroke,<sup>24</sup> but there is a lack of longitudinal studies exploring the relationship between family functioning and PSD in different phases after stroke.

Therefore, the purposes of this study were to explore the development of family functioning and PSD from acute hospitalization to 6 months post-discharge, as well as the association between family functioning and PSD at the two time points in this population.

## Methods

### Study Design and Participants

This was a longitudinal study conducted over a period of 6 months. Convenience sampling was used in this study. Stroke survivors were recruited from the inpatient department of neurology of a hospital in Guangzhou, China. The inclusion criteria included the following: (1) hospitalized within one month after first-ever ischemic stroke, and (2) having clear consciousness to be able to read the questionnaires. The exclusion criteria were as follows: (1) history of depression; (2) Wernicke aphasia, or (3) accompanying diseases such as heart or liver disease, renal insufficiency, or malignant tumors.

### Questionnaire Instruments and Variables

#### Sociodemographic and Disease-Related Characteristics

Sociodemographic and disease-related information consisted of gender, age, education, marriage, job, family history of stroke, smoking, the diagnosis of diabetes, hyperlipidemia, and disability post-stroke. Disability post-stroke was assessed by the Modified Rankin Scale (mRS) with good validity and reliability.<sup>25</sup> The total scores ranged from 0 (no disability) to 5 (severe disability requiring ongoing care). A score of  $\geq 3$  represents post-stroke disability.

### Short Form Family Assessment Device

Family functioning was assessed by the Short Form Family Assessment Device (SF-FAD). The SF-FAD was simplified by Wang based on the Family Assessment Device.<sup>26,27</sup> The SF-FAD contains six sub-scales, including problem solving, communication, affective responsiveness, affective involvement, behavior control and general functioning. SF-FAD contains 24 items, and each item has four responses "much like my home", "like my home", "not like my home", or "not like my home at all" corresponding to a score of 1 to 4. The total SF-FAD score is equal to the total score of all entries/number of entries, and

the total SF-FAD score ranges from 1 to 4. A higher SF-FAD and sub-scales score represents poorer family functioning, and a score lower than 2 indicates good family functioning. Cronbach's alpha for the SF-FAD is 0.899.<sup>26</sup>

## Self-Rating Depression Scale

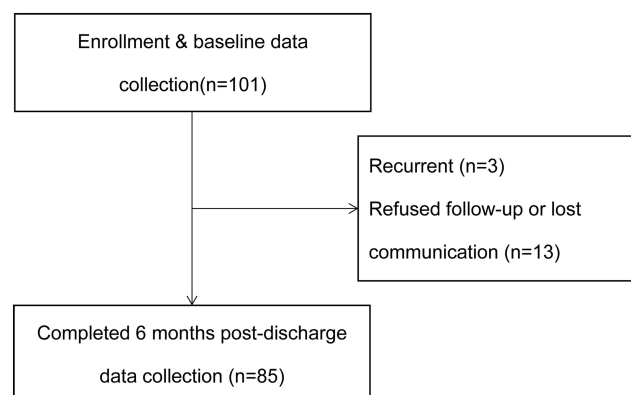
Depression was measured using the Self-Rating Depression Scale (SDS). This scale was developed by Zung to assess depression in terms of psychotic emotional symptoms, corporality disorders, psychomotor disorders and depressed psychological disorders.<sup>28</sup> The SDS consists of 20 items and the total score ranges from 20 to 80. Higher SDS scores indicate more severe depressive symptoms. The depression severity index is calculated from the cumulative score of 20 items out of 80 (maximum total score). The index ranges from 0.25 to 1.00. The higher the index, the more severe the depression, with an index  $\geq 0.5$  indicating depression.

## Data Collection

For patients who met the study inclusion criteria, the investigator explained the purpose, significance, requirements of the study, and the principles of privacy protection. Patients were informed that they had the right to decide to participate in or refuse this study, and they could withdraw from the study at any time for any reason, which would not negatively affect their treatment. Data collection began after patients voluntarily participated and signed an informed consent form. Sociodemographic and disease-related characteristics were collected during acute hospitalization (T1), and family functioning and PSD were assessed using the SF-FAD and SDS at the two time points (T1, at acute hospitalization and T2, 6 months post-discharge). Baseline data were collected at T1, including sociodemographic and disease-related characteristics, SF-FAD and SDS. The investigators collected baseline data with participants face-to-face in the ward. Prior to the time point of 6 months post-discharge, the investigators contacted participants in advance by telephone to determine the follow-up time. Participants needed to complete the SF-FAD and SDS at T2. Follow-up data were collected during participants' outpatient review. If the patient could not return to the hospital, telephone interviews or electronic questionnaires were used to collect information. One hundred and one participants were recruited at baseline and completed the baseline measurement (Figure 1). Eighty-five participants completed follow-up measurement at T2. Sixteen participants were excluded in this study because they did not complete follow-up assessment at T2 (three of whom had a recurrence of stroke and 13 refused follow-up or lost communication).

## Statistical Analysis

Descriptive statistical analyses were performed to describe sociodemographic and disease-related characteristics, family functioning and PSD. Paired *t*-tests were used to explore the changes in SF-FAD and SDS scores at the two time points. The relationship between participants' sociodemographic and disease-related characteristics and PSD was measured by the independent sample *t*-test and one-way analysis of variance. The Pearson correlation coefficient was used to examine the relationship between SF-FAD and SDS scores at the two time points. Multiple linear regression analysis (stepwise method) was used to verify the association between family functioning and PSD at baseline and 6 months post-discharge.



**Figure 1** Flow chart of participants.

All variables with  $P < 0.3$  in the univariate analysis, as well as some common influencing factors (age, gender),<sup>29,30</sup> were included as independent variables in the multivariate analyses at the two time points. All statistical analyses were performed by SPSS 25.0 (IBM Corp, Armonk, NY, USA), and  $P$  values less than 0.05 were considered statistically significant.

## Results

### Sociodemographic and Disease-Related Characteristics

The sociodemographic and disease-related characteristics are shown in Table 1. Eighty-five participants completed the 6 months follow-up. Among them, 62.4% participants were male, 51.8% were over 60 years old, 50.6% had a high school/technical secondary school education or higher, 91.8% had a spouse and 31.8% were in service. Of the participants,

**Table 1** Associations Between Sociodemographic and Disease-Related Characteristics of Participants and PSD at the Two Time Points (Univariate Analysis)

Variables	N (%)	Post-Stroke Depression (SDS Scores)					
		At Baseline			At 6 Months Post-Discharge		
		Mean±SD	t <sup>a</sup> /F <sup>b</sup>	P	Mean±SD	t <sup>a</sup> /F <sup>b</sup>	P
Gender							
Male	53 (62.4)	34.91±7.83	−0.629	0.531	32.79±8.30	0.092	0.927
Female	32 (37.6)	35.97±7.06			32.63±7.78		
Age (years)							
≤59	41 (48.2)	35.56±6.88	0.300	0.765	32.46±7.52	−0.292	0.771
≥60	44 (51.8)	35.07±8.15			32.98±8.61		
Education							
Elementary school and below	17 (20.0)	36.18±7.39	0.512	0.675	33.76±9.00	0.382	0.766
Middle school	25 (29.4)	36.44±8.04			32.40±7.24		
High school/junior high school	24 (28.2)	34.25±8.21			33.50±8.37		
University and above	19 (22.4)	34.37±6.20			31.26±8.22		
Marriage							
With spouse	78 (91.8)	35.26±7.58	−0.201	0.841	32.42±8.03	−1.173	0.244
Without spouse	7 (8.2)	35.86±7.34			36.14±8.19		
Job							
In-service	27 (31.8)	36.07±7.55	0.640	0.524	33.33±7.93	0.469	0.640
Non-service	58 (68.2)	34.95±7.55			32.45±8.17		
Family history of stroke							
Yes	30 (35.3)	34.77±7.92	0.486	0.628	32.00±7.10	0.614	0.541
No	55 (64.7)	35.60±7.36			33.13±8.57		
Smoking							
Yes	27 (31.8)	36.30±7.78	−0.827	0.411	34.00±8.06	−0.992	0.324
No	58 (68.2)	34.84±7.42			32.14±8.06		
Diabetes							
Yes	26 (30.6)	37.04±7.71	−1.418	0.160	33.65±9.08	−0.700	0.486
No	59 (69.4)	34.54±7.38			32.32±7.61		
Hyperlipidemia							
Yes	38 (44.7)	35.18±7.77	0.133	0.894	33.74±7.86	−1.037	0.303
No	47 (55.3)	35.40±7.40			31.91±8.21		
Disability at baseline							
Yes	16 (18.8)	38.31±7.96	−1.798	0.076	34.19±8.99	−0.802	0.425
No	69 (81.2)	34.61±7.30			32.39±7.86		

**Notes:** <sup>a</sup>Independent-sample t-test; <sup>b</sup>One-way analysis of variance (ANOVA).

**Abbreviation:** SDS, Self-Rating Depression Scale.

35.3% had a family history of stroke, 31.8% were smokers, 30.6% also had diabetes, 44.7% also had hyperlipidemia, and 18.8% had post-stroke disability.

## The Levels and Changes in Family Functioning and PSD at T1 (at Baseline) and T2 (6 Months Post-Discharge)

The SDS scores were  $35.31 \pm 7.52$  at T1 and  $32.73 \pm 8.06$  at T2, reducing significantly ( $P=0.013$ ). Table 2 indicates that 28 (32.9%) participants developed PSD during acute hospitalization, and 17 (20.0%) participants developed PSD at 6 months post-discharge, respectively.

The SF-FAD scores were  $1.79 \pm 0.37$  and  $1.78 \pm 0.42$  at the two time points, with no statistical difference in the SF-FAD scores during this period ( $P>0.05$ , Table 2). All sub-scale scores of the SF-FAD were not statistically changed between T1 and T2 ( $P>0.05$ ).

## Relationship Between Family Functioning and PSD at T1 (Baseline)

At T1, there was a positive correlation between SF-FAD and SDS score ( $r_1=0.341$ ,  $P=0.001$ , Table 3). Since higher SF-FAD and SDS score represent poorer family functioning and higher levels of depression severity, respectively, poor family functioning is positively associated with PSD at baseline. Scores on the sub-scales of “problem solving”,

**Table 2** Changes in Family Functioning and PSD at the Two Time Points

Variables	T1	T2	t (Paired Sample t-test)	P
	Mean $\pm$ SD	Mean $\pm$ SD		
SF-FAD	1.79 $\pm$ 0.37	1.78 $\pm$ 0.42	0.096	0.924
Problem solving	1.65 $\pm$ 0.56	1.73 $\pm$ 0.58	-1.121	0.266
Communication	1.91 $\pm$ 0.54	1.88 $\pm$ 0.58	0.517	0.607
Affective responsiveness	2.11 $\pm$ 0.64	2.03 $\pm$ 0.61	1.161	0.249
Affective involvement	1.52 $\pm$ 0.59	1.49 $\pm$ 0.56	0.416	0.678
Behavior control	1.82 $\pm$ 0.47	1.72 $\pm$ 0.48	1.677	0.097
General functioning	1.66 $\pm$ 0.38	1.72 $\pm$ 0.45	-1.087	0.280
SDS score	35.31 $\pm$ 7.52	32.73 $\pm$ 8.06	2.551	0.013*
PSD, n (%)				
Yes	28 (32.9)	17 (20.0)		
No	57 (67.1)	68 (80.0)		

**Notes:** T1, at baseline; T2, at 6 months post-discharge, \* $P<0.05$ .

**Abbreviations:** SF-FAD, Short Form Family Assessment Device; SDS, Self-Rating Depression Scale.

**Table 3** The Association Between Family Functioning and PSD by Pearson Correlation Coefficients at the Two Time Points

Variables	Pearson Correlation Coefficients (Total SDS Scores)			
	T1		T2	
	r	P	r	P
SF-FAD score	0.341	0.001**	0.510	<0.001**
Problem solving	0.297	0.006**	0.419	<0.001**
Communication	0.219	0.045*	0.399	<0.001**
Affective responsiveness	0.288	0.008**	0.435	<0.001**
Affective involvement	0.296	0.006**	0.341	0.001**
Behavior control	0.099	0.368	0.336	0.002**
General functioning	0.257	0.018*	0.440	<0.001**

**Notes:** T1, at baseline; T2, at 6 months post-discharge; \* $P<0.05$ , \*\* $P<0.01$ .

**Abbreviations:** SF-FAD, Short Form Family Assessment Device; SDS, Self-Rating Depression Scale.

**Table 4** The Association Between Family Functioning and PSD at the Two Time Points by Multiple Linear Regression (Stepwise Method)

Time	Model	Variables	Unstandardized Coefficient	Standard Error	Standardized Coefficient	t	P
T1	Model 1	(Constant)	22.770	3.876		5.875	<0.001**
		SF-FAD score at T1	7.010	2.124	0.341	3.300	0.001**
T2	Model 2	(Constant)	15.476	3.284		4.713	<0.001**
		SF-FAD score at T2	9.672	1.791	0.510	5.400	<0.001**

**Notes:** Model 1: age, gender, diabetes, disability at baseline, and family functioning at T1 as independent variables;  $R^2=0.116$ ,  $R_{ad}^2=0.105$ . Model 2: age, gender, marriage, family functioning at T2 as independent variables;  $R^2=0.260$ ,  $R_{ad}^2=0.251$ . T1, at baseline; T2, at 6 months post-discharge. \*\* $P<0.01$ .

**Abbreviation:** SF-FAD, Short Form Family Assessment Device.

“communication”, “affective responsiveness”, “affective involvement”, and “general functioning” were positively correlated with SDS score ( $r_1=0.297, 0.219, 0.288, 0.296, 0.257$ , all  $P < 0.05$ ).

At baseline, the results of univariate analysis showed that sociodemographic and disease-related characteristics of participants were not associated with PSD (Table 1). The results of multiple linear regression analysis with the stepwise method at T1 showed that family functioning was the only factor for PSD (Table 4), and patients with higher SF-FAD score (poorer family functioning) had more severe depressive symptoms (unstandardized coefficient: 7.010,  $P=0.001$ , for model 1). This model explained approximately 10.5% of the variance in PSD at baseline ( $R_{ad}^2=0.105$ ).

## Relationship Between Family Functioning and PSD at T2 (at 6 Months Post-Discharge)

At T2, scores on SF-FAD and its six sub-scales (including problem solving, communication, affective responsiveness, affective involvement, behavior control and general functioning) were positively correlated with SDS score ( $r_2=0.510, 0.419, 0.399, 0.435, 0.341, 0.336, 0.440$ , respectively, all  $P<0.05$ , Table 3).

Univariate analysis showed that there were no significant relationships between sociodemographic and disease-related characteristics and PSD at T2 (Table 1). The multiple linear regression results showed that family functioning remained associated with PSD at T2 (unstandardized coefficient: 9.672,  $P<0.001$ , Table 4). Family functioning explained approximately 25.1% of the variance in PSD at 6 months post-discharge in stroke patients ( $R_{ad}^2=0.251$ ).

## Discussion

This study shows that first-ever stroke survivors had a high risk of PSD. The prevalence of PSD at acute hospitalization and 6 months post-discharge was 32.9% and 20.0%, respectively. Poor family functioning is positively associated with PSD at the two time points, and good family functioning is an important factor in preventing PSD.

A previous study has found that depressive symptoms show a non-statistically significant downward trend from 1 month to 3 months post-stroke.<sup>31</sup> This study further found that depressive symptoms significantly decreased from baseline to 6 months post-discharge. This study also found a high prevalence of PSD in the acute phase, which is similar to that in other studies.<sup>32,33</sup> Of first-ever stroke survivors, 32.9% developed depression at acute hospitalization that needed attention. This study indicated that the risk of PSD is gradually reduced from acute hospitalization to 6 months post-discharge. It is noteworthy that one-fifth of participants suffered from PSD at 6 months post-discharge. PSD could contribute to a decline in the stroke patient's physical function.<sup>34</sup> Therefore, early identification and treatment of PSD are necessary. However, the screening and diagnosis of depression in stroke patients is seriously insufficient.<sup>35</sup> One study found that only approximately 5% of stroke patients were diagnosed with depression in clinical practice.<sup>36</sup> Considering stroke patients have a high risk of PSD, attention should be paid to depression screening of hospitalized stroke patients and continuous follow-up post-discharge.

The results showed that participants in this study had good family functioning at baseline and 6 months post-discharge, which is better than that one Chinese study of outpatient stroke patients.<sup>37</sup> There were no significant differences in family functioning between the two time points. This suggests that the family system of the participants was robust enough to withstand the challenges of stroke post-discharge. This may have something to do with the family's active coping with stroke.



After a stroke, Chinese families make full use of family resources to meet the patient's care and emotional needs,<sup>38</sup> which contributes to the stability of the family system. Gawulayo's study suggests that when families provide a support system for stroke patients, stroke may improve family relationships and strengthen emotional ties.<sup>39</sup>

This is the first longitudinal study to explore the association between family functioning and depression in stroke survivors. The results demonstrated the positive correlation between poor family functioning and PSD at baseline and 6 months post-discharge, and good family functioning is an important factor in preventing PSD. In addition, the sub-scale of general functioning represents overall functioning of family, and the "general functioning" sub-scale score is also positively related to PSD at the two time points. This further confirms the important role of family functioning in overcoming post-stroke depression. The observed preventive effect of good family functioning on PSD can be attributed to the stroke patients' seeking support from their families. Family support and health status were found to be the most important protective factors against depression in Chinese older adults in one study.<sup>40</sup> Elderly people with good family functioning had a comfortable home environment and better care, thereby reducing depressive symptoms.<sup>41</sup> Stroke patients are dependent on family support, especially those with disabilities. One study showed that harmonious relationships between stroke patients and family members (including spouses and children) could enhance their life satisfaction.<sup>42</sup> Therefore, when a stroke patient has a good and stable family support system, family members provide adequate life and emotional support to the patient, which helps to reduce the psychological stress in stroke patients.

An interesting finding was that "problem solving" sub-scale score was positively associated with PSD over time. Problem solving refers to the family's ability to cope with challenges and resolve instrumental or emotional problems and conflicts to maintain the effective functioning of the family system.<sup>43</sup> When a problem persists and cannot be solved, it will threaten the family system. For stroke patients and families, the onset of a stroke is a huge challenge, and it leads to a range of problems over time, including physical disability, psychological problems, and caregiving issues.

Caring for stroke patients is regarded as long-term, painful, and hard work for family caregivers that might impair their own physical and mental health.<sup>44,45</sup> Family caregivers required a broad range of caregiving skills (such as medication administration, physical care, and nutrient), and they rely on clinical workers to obtain these relevant education.<sup>44</sup> However, the truth is that it is difficult for caregivers to get the information they need from clinical workers.<sup>44</sup> An intervention study found that problem-solving therapy was effective in reducing anxiety and depression levels and improving quality of life in stroke patients.<sup>46</sup> Therefore, clinical workers should educate stroke patients' families on skills for daily living and caregiving to improve their problem-solving abilities and thus improve the mental health of stroke patients.

This study found that a positive association between "communication" sub-scale score and PSD over time. A previous study in patients with major depression has found poor communication ability of families was associated with longer depression duration.<sup>21</sup> This suggests that there should be a focus on the importance of family communication in alleviating the patient's depressive symptoms.

There has been interest in studying the role of emotional support of family in preventing depression. The "affective involvement" sub-scale refers to family members taking an interest in each other's affairs, and the "affective responsiveness" sub-scale indicates that family member could provide appropriate affective reactions.<sup>17</sup> The findings in this study showed the scores of "affective involvement" and "affective responsiveness" were positively correlated to PSD at the two time points, which means poor affective involvement and affective responsiveness ability was associated with more severe depressive symptoms. Fang's study found that the positive attitude of family member would improve patients' cognitive recovery.<sup>47</sup>

While the scores on "affective responsiveness" and "communication" sub-scales at the two time points indicate that stroke patients were performed poorly in these areas, which is consistent with the results of Jiang's study.<sup>37</sup> This may be related to the introverted character of the Chinese people, especially the elderly, who are not good at expressing their thoughts and emotions directly. Therefore, family members should be encouraged to pay attention to the patient's psychological condition and actively communicate and respond to the patient's emotional needs to help alleviate depressive symptoms.

It is noteworthy that first-ever stroke patients had a high incidence of PSD. This study demonstrated that good family functioning is an important factor in preventing PSD. This study makes important contributions for management of PSD in stroke patients: (1) Clinical staff should recognize the importance of involving family systems in caring for patients'

mental health; (2) Current interventions for PSD in stroke patients typically target the individual and ignore the impact of the family system on the individual's mental health. Studies in patients with major depression have found positive outcomes of family interventions in alleviating depressive symptoms.<sup>48</sup> This suggests that clinical workers should conduct family-based psychosocial interventions to prevent and treat PSD. (3) Family members should improve family functioning, including improving problem-solving skills, providing good care, offering adequate emotional support and communicating effectively to decrease stroke patients' depressive symptoms.

## Study Limitations

There are some limitations in this study. For instance, the participants enrolled in this study are from a single region in China, which may limit the generalization of the results. Patients' family functioning and PSD were self-reported and therefore prone to bias. The sample size of this study was limited and future studies could expand the sample size to further investigate the relationship between family functioning and sociodemographic and disease-related factors and PSD.

## Conclusion

First-ever stroke survivors are at high risk of depression at acute hospitalization and 6 months post-discharge. Medical workers need to monitor depressive symptoms in hospitalized stroke patients and continue to track their mental health post-discharge. This study demonstrates that family functioning is associated with PSD at acute hospitalization and 6 months post-discharge, and good family functioning is an important factor in preventing depression. Future interventions based on family systems should be considered to alleviate depression in post-stroke patients.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Ethics Approval and Informed Consent

This study was approved by the ethics committee of The Third Affiliated Hospital of Sun Yat-sen University (Approval no. [2018]02-421-01) in Guangzhou, China. This study was carried out in accordance with the Declaration of Helsinki. All participants signed the informed consent prior to their participation.

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## Disclosure

All authors report no conflicts of interest in this work.

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