

Meta-analysis of risk factors associated with suicidal ideation after stroke: A focus on Asian populations

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Abstract

Background

Over the past decade, increasing attention has been paid on post-stroke suicide (PSS), which is one of complications of stroke. The rates of stroke and suicide are relatively high, especially in Asian populations. Thus, a deeper understanding of the prevalence and epidemiological impact of suicide after stroke is urgently needed. Clinical diagnosis and prevention of PSS are at the incipient stage, but the risk factors responsible for the occurrence of PSS in different regions and stages of the disease remain largely unknown. The present meta-analysis aimed to determine the incidence of PSS at different stages and time courses, and to identify the underlying risk factors for PSS.

Methods

We systematically searched the Cochrane library, Embase, PubMed, CNKI and Web of Science databases from their inception until April 2019. The research articles reporting on the risk factor for PSS were screened and included in the meta-analysis. The data from the included studies were extracted according to the predefined criteria.

Results

A total of 12 studies ($n = 2693036$) were included for meta-analyses. Of these studies, 7 reported suicide prevalence were meta-analyzed. The pooled estimate of suicidal ideation rates after stroke was 12%, which could be influenced by multiple risk factors, including men, smoking, depression, sleep disorders, previous stroke and low household income. Studies conducted in Asia demonstrated higher suicide prevalence (approximately 15%) compared to other regions. Smoking, alcohol consumption, low family income, depression, heart disease and sleep disorders were the important risk factors for the pathogenesis of suicide after stroke. When compared to PSS more than one year, the incidence of suicide within one year after stroke was more likely to be statistically significant. It was found that 4 out of every 1,000 stroke survivors tended to commit suicide. The results of this meta-analysis showed that depression ($OR = 2.32$; $p < 0.01$) was significantly associated with suicidal ideation, regardless of stroke duration.

Conclusion

Despite some limitations, we successfully identified the prevalence of PSS in Asian populations and the underlying risk factors. Based on the results of this meta-analysis, 4 out of every 1,000 stroke survivors committed suicide and the individuals with suicidal ideation tended to suicide within one year after stroke. Notably, depression was significantly associated with suicidal ideation, regardless of stroke

duration. In addition, stroke survivors with low household income had nearly double the risk of suicidal ideation, especially in Asian populations. Hence, targeting the identified risk factors may be helpful to improve stroke patient care and prevent suicidal ideation after stroke. (Registration No. CRD42019128813).

Background

Stroke is recognized as one of the most devastating neurological diseases, characterized by a combination of physical, behavioral, cognitive, and psychological impairments. Many studies have reported the higher rates of suicidal ideation in patients with stroke than in general population. Consistently, several studies have demonstrated that stroke patients are at high risk for suicide, and that the risk is particularly clustered in the first few years after stroke.

Suicide is a serious problem worldwide, and the Republic of Korea has the highest incidence of suicide among the Organisation for Economic Co-operation and Development (OECD) countries. Suicide is one of the leading cause of death, especially in the East Asia regions. In fact, the indirect socioeconomic costs for loss of productivity caused by death or disability in stroke patients are more than twice as much as the direct costs for health care management of stroke patients. Previous studies have shown that PSS is associated with depression, cognitive impairment, stroke severity and recurrent stroke, especially in female and young adolescents.⁵ In addition, being single, unemployed and low education level are at 1.5- to 2.0-fold increased risk of having suicidal ideation among stroke survivors.¹²

It is of great importance to assess the epidemiological impact for PSS and identify the underlying risk factors. This study aimed to determine the incidence of PSS, particularly in Asian populations, at different time periods. Moreover, we sought to evaluate the underlying risk factors for suicidal ideation in stroke survivors.

Methods

The systematic review and meta-analysis were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. This study was registered under PROSPERO, an International Prospective Register of Systematic Reviews (Registration No. CRD42019128813).

Search strategy

Comprehensive literature searches were carried out in April 2019. The databases such as Cochrane Stroke Group Trials Register (inception to April 2019), Medline (inception to April 2019), EMBASE (inception to April 2019) and PubMed (inception to April 2019) were searched. The search terms contained logical combinations of the keywords “stroke”, “Suicide”, “self-destruction”, “suicidal ideation after stroke” and “self-murder” (Supplementary Appendix I). The China’s largest academic websites, such

as Wanfang Data Knowledge Service Platform and China National Knowledge Infrastructure, were also searched. To maintain rigor, gray literature was excluded, and the literature searches were limited to peer-reviewed journals published in English or Chinese. The relevant search process of Pubmed and Embase is detailed in Appendix1 of the Supplementary Document

Selection criteria

According to the recommendations established by the Centers for Disease Control and Prevention, suicidal ideation refers to thinking about, considering or planning suicide. The original, observational and prospective cohort studies consisting of individuals with PSS (either first or recurrent, hemorrhagic or ischemic stroke) and at least one risk factor associated with suicidal ideation after stroke (either as a dichotomous or continuous variable). The intervention study was included if baseline (pre-intervention) data were available. Studies were excluded if they contained no PSS subjects (e.g. patients with traumatic brain injury or transient ischemic attack) or lacked of primary data (e.g., review article, case study, editorial or research protocol). In case of the redundant publications reported by the same group of authors, only the study with the most exhaustive information was included.

Data extraction

One researcher (SMZ) conducted the searches, scrutinized every titles and abstracts, identified eligible studies according to the inclusion and exclusion criteria. Irrelevant references and duplicate articles were removed, and the full text of the relevant studies were retrieved. Two researchers (SMZ and ZYQ) independently screened the full texts for eligibility. Any disagreements between these two researchers were resolved by consensus, or through arbitration by a third researcher (ZXZ) if necessary.

Methodological quality of the included studies was evaluated using Newcastle-Ottawa Scale (NOS). Critical appraisal of the quality of the included studies was performed independently by two researchers (SMZ and ARW). Disagreements between researchers were resolved by consensus, or through arbitration by a third researcher (WFZ) if necessary.

The descriptive data of the included studies, such as year of publication, country, mean age, gender ratio, sample size, time from stroke onset and methods for assessing suicidal ideation, were extracted using an Excel spreadsheet. If further information on the risk factors of suicidal ideation were needed, the corresponding author of the study was contacted to obtain the missing or unpublished data.

Statistical analysis

Meta-analysis was conducted using Review Manager 5.3 and Stata 14.0 software. The analysis of risk factors for suicidal ideation after stroke was based on a pooled sample proportion, with related 95% confidence intervals (CIs). If heterogeneity (I^2) was $\geq 50\%$, random effects model was chosen; otherwise fixed effect model was selected. If more than one point factors was available in a study, the latest observation was adopted. The relationship between suicidal ideation after stroke and relevant factors was estimated by odds ratios (ORs) with 95% CIs. The meta-analysis was conducted if any risk factor

data were available from at least three individual studies. Subgroup analyses were performed to assess the influence of different regions.

Results

1. Study selection and characteristics of the included studies

The initial search yielded 2056 studies (Embase, $n = 956$; Web of Science, $n = 441$; PubMed, $n = 235$; Cochrane, $n = 27$; and CNKI, $n = 397$). After removing duplicate articles, a total of 1359 records were generated. The preliminary screening of titles and abstracts identified 72 potentially eligible studies, and the corresponding full text articles were subjected to final eligibility assessment. Finally, 12 studies ($n = 2693036$) were included for meta-analyses, and all studies were published since 2012 (see PRISMA flowchart in Fig. 1 and The PRISMA Checklist is in the second part of the supplementary file).

The median number of the included stroke patients was 1405 (range: 177–228735). The time from stroke onset ranged from < 48 hours (acute phase) to 5 year in the included studies. The follow-up period ranged from 7 days up to 12 year after stroke. Among the 12 included studies, 4 studies used the item suicidal thoughts and related depression Scale to evaluate suicidal ideation, 5 studies employed Clinical Interview or questionnaire, 3 studies of suicidal thoughts was defined using the International Classification of Diseases (ICD) codes. All studies have a minimum NOS score of 5, indicating the good quality of the included studies. Detailed characteristics of the included studies are summarized in Table 1.

2. Incidence of suicidal ideation in stroke survivors

Of the included 12 studies, 7 reported suicide prevalence and were meta analyzed. The pooled estimate of the rate of suicidal ideation after stroke was 12% (95% CI: 1–23%), with substantial heterogeneity between studies ($I^2 = 99.6\%$). Studies conducted in Asia demonstrated higher suicide prevalence ($n = 5$, 15% suicidal ideation, $p \leq 0.01$) than those conducted in other regions, but the heterogeneity was high. Figure 2 shows the forest plot, together with cumulative estimates. According to the follow-up time, a subgroup analysis was also performed. The forest plot displayed that the incidence of suicide in less than one year was relatively similar to the overall study results ($n = 4$, 11% suicidal ideation, $p \leq 0.01$), with moderate heterogeneity. Interestingly, when the suicidal ideation was assessed for more than one year after stroke, the incidence of suicide was not statistically significant, with moderate heterogeneity ($I^2 = 99.9\%$; $p = 0.178$), as shown in the forest plot (Fig. 3). Innovatively, we performed a careful meta analysis of studies that reported the number of patients who actually committed suicide. Our results indicated that approximately 4 out of 1,000 stroke survivors would commit suicide, with 3.85% suicide prevalence ($I^2 = 99.2\%$; $p \leq 0.01$). The detailed findings are illustrated in Fig. 3. Risk factors associated with suicidal ideation after stroke

Eighteen correlates, such as sociodemographic factors (e.g., age, gender, marriage status, education level, employment status and low household income), stroke-related characteristics (e.g., location, left-sided stroke, right-sided stroke, brainstem-cerebellum and previous stroke), physical comorbid conditions (e.g., diabetes mellitus, hypertension, myocardial infarction and sleep disturbance), mental disorders (e.g., depression), and substance-related behaviors (e.g., smoking and alcohol abuse) were taken into account if the data were available from at least three individual studies. Meta-analysis of the association between these risk factors and suicidal ideation after stroke was carried out, and the results are presented in Table 2. (All the funnel diagrams related to Table 2 are in Appendix 2 of the supplementary file.)

3.1 Sociodemographic factors

There were no significant effects of age (OR = 1.17; $p = 0.07$), female (OR = 0.86; $p = 0.45$), marriage status (OR = 0.81; $p = 0.53$) on PSS patients, with moderate to high heterogeneity. Interestingly, a remarkable trend of high suicidal ideation rates was observed among male (OR = 1.07; $p = 0.02$) and low household income (OR = 1.96; $p = 0.04$), with moderate to high heterogeneity across studies. On the contrary, the rate of suicidal ideation was decreased in stroke survivors who were employed (OR = 0.37; $p = 0.02$). However, stroke survivors with low education level were not likely to have suicidal ideation, but statistically not significant (OR = 1.49; $p = 0.27$). Furthermore, the results showed that being employed was a protective factor for suicidal ideation after stroke (OR = 0.37; $p = 0.02$). The detailed results are summarized in Table 2.

3.2 Stroke-related characteristics

No significant effects of left-sided stroke ($p = 0.16$), right-sided stroke ($p = 0.06$) and brainstem-cerebellum ($p = 0.58$) were found on PSS patients, with no or moderate heterogeneity across studies. Interestingly, the results showed that previous stroke was closely associated with PSS, (OR = 1.55, CI:1.06–2.28; $p < 0.01$). The detailed findings are presented in Table 2.

3.3 Physical comorbid conditions

Unexpectedly, no obvious effects of diabetes mellitus (OR = 1.22; $p = 0.07$), hypertension (OR = 1.36; $p = 0.6$) and myocardial infarction (OR = 1.22; $p = 0.16$) were found on PSS. Notably, sleep disturbance (OR = 2.01; $p < 0.01$) was closely associated with PSS, with no heterogeneity across studies. The detailed findings are shown in Table 2.

3.4 Mental disorders

Consistently, a remarkable trend of high PSS rates was observed among subjects with anxiety (OR = 2.32; $p < 0.01$), with high heterogeneity across studies ($I^2 = 96\%$).

3.5 Substance-related behaviors

There was no significant effect of alcohol abuse ($p = 0.53$) on PSS. In contrast, stroke survivors who smoke (OR = 1.75; $p < 0.01$) tended to have PSS as compared to non-smokers, with low heterogeneity across studies ($I^2 = 15\%$). The detailed data can be seen in Table 2.

3.6 Subgroup analysis

In the subgroup analysis stratified by region, the risk factors of smoking, low household income, depression, myocardial infarction, sleep disturbance and alcohol abuse were all tightly associated with PSS in Asian populations, with increased incidence of 1.23- to 2.5-fold. Of these studied factors, the heterogeneity values were low, only those of sleep disturbance and depression were high. The remaining risk factors did not significantly increase the risk of suicide in Asian populations. The detailed findings are presented in Table 2. Typically, the incidence of suicide after stroke varied over time. Therefore, a subgroup analysis was performed according to the follow-up time. Stroke survivors with older age, male, sleep disturbance and alcohol abuse were more likely to have suicidal ideation within 1 year. Besides, the risk of PSS in patients with depression was remarkably increased by 1.89- to 5.84-fold in less than one year, with moderate to high heterogeneity across studies. Surprisingly, depression also increased the susceptibility of PSS, regardless of stroke duration. The remaining risk factors did not significantly increase the risk of suicide in subgroup analysis stratified by the time course of stroke. The detailed findings are presented in Table 3. (All the funnel diagrams related to Table 3 are in Appendix3 of the supplementary file.)

Discussion

Although stroke patients with suicidal ideation do not all eventually commit suicide, it is understandable that the continued suicidal idea can increase the risk of commit suicide in patients suffered from the sequelae of stroke. Consistent with previous studies, our meta-analysis demonstrated a high rate of suicidal ideation, accounting for approximately 12% subjects with stroke worldwide. Similar to previous studies, our results demonstrated the occurrence and development of PSS were influenced by multiple risk factors, including men, smoking, depression, sleep disorders, previous stroke and low household income. Although previous studies have suggested that female gender can confer increased risk for commit suicide, this study revealed that male stroke survivors were more likely to commit suicide. This may be related to a variety of factors such as the age structure of a population and the different study regions, and to a certain extent, we remain skeptical about the role of gender in PSS. Indeed, this trend was consistent with the published studies showing that the incidence rates of suicide were higher in men than in women, regardless of stroke status.²⁵

Smoking, alcohol consumption, low family income, depression, heart disease and sleep disorders were the important risk factors for the pathogenesis of suicide after stroke. According to the results of our meta-analysis, stroke-related clinical factors, such as male, smoking, depression, sleep disturbance, recurrent stroke, appear to play a critical role in the increased rates of PSS. Recurrent stroke, depression and sleep disturbance raised the PSS rates approximately twice, while older age, men, smoking and depression were closely related to PSS for more than 1 year. The main risk factors for PSS were previous stroke and depression²⁶, but only the predictive value of depression was confirmed.¹² Depression after stroke, together with suicidal ideation, could worsen stroke outcomes and life expectancy, by affecting

treatment adherence.²⁷⁻²⁸ The results of this meta-analysis showed that depression was significantly associated with suicidal ideation, regardless of stroke duration. Therefore, prevention and early intervention of depression after stroke should be an essential part of stroke rehabilitation, in order to reduce the risk of PSS-related behaviors, even though the biological mechanisms underlying PSS remain largely unclarified.^{19,29}

Contradictory results have been reported on the location and laterality of PSS³⁰⁻³¹, but we did not observe a clear trend on this point as well. Both socioeconomic and clinical factors have been shown to increase the risk for suicide.^{8,32} From the clinical points of view, it can be speculated that Asian populations are more embarrassed towards stroke disability and patients who receive less support from their families tend to be more skeptical of continuing to live. Epidemiological evidence has indicated that the incidence of PSS is higher in Asian populations, accounting for approximately 15%. In this study, we sought to explore the difference in risk factors between PSS in Asia and other regions. Regardless of the whole study populations or Asian subgroup, our findings showed that low household income nearly doubled the incidence of PSS. This suggests that stroke survivors with low socioeconomic status may be more susceptible to commit suicide.³³ Considering that delayed suicidal plans were associated with poor social support¹², the improvement of medical care and insurance investment for low-income groups can potentially help to prevent suicidal ideation, especially in Asian populations.

A considerable proportion of stroke survivors attempted to commit suicide within one year³⁴⁻³⁵, and the risk decreased sharply after 5 years.⁷ Other studies also found that the risk of suicide was particularly high in Europe within the first two years after stroke^{20,36}. Similar results were revealed in the present study. In fact, compared to PSS more than one year, the incidence of suicide within one year after stroke was more likely to be statistically significant. Thus, more efforts should be focused on this point, which can effectively help to prevent PSS.

In addition, among the tested sociodemographic characteristics, being employed was identified as a protective factor for PSS, which corresponded to our findings that low household income is a risk factor for PSS. Our findings revealed that 4 out of every 1,000 stroke survivors committed suicide, which was the most innovative aspect of this study. Given that a previous suicide attempt is a strong predictor for future suicide attempt³⁷, targeted treatment with the above-mentioned risk factors can help to improve the overall prognosis of stroke. For instance, stroke survivors who smoke and jobless as well as those with low household income, depression, sleep disorders and recurrent stroke, should be specifically targeted for suicide prevention.

Nevertheless, this meta-analysis has some limitations, thus, the results should be interpreted with caution. Firstly, we found moderate to high heterogeneity across some studies for assessing the rate and risk factors of PSS. Consistent with other studies, such phenomenon might be attributed to some methodological differences with regard to inclusion criteria, stroke severity, assessment time points, study regions and screening measures for suicidal ideation.

Secondly, data on the assessment of suicidal ideation were overlapped, leading to a high study heterogeneity. In particular, only few studies have examined PSS with the purposively developed measure, such as the Beck Scale for Suicidal Ideation (BSI). The majority of studies acquired the information of suicidal ideation from the scales for exploring depression. Moreover, only a limited number of included studies reported on the detailed data of risk factors, such as alcohol consumption, smoking, diabetes severity, hypertension grades and heart disease types, which in turn limits the actual confidence of estimates for some variables.

Thirdly, numerous studies excluded stroke patients with communication or cognitive impairment, and no conclusion can be drawn from these studies. Although the limitation regarding cognition or communication impairment is common in many studies, it is necessary to pay some attention on patients with less-severe illness in the study populations.

Finally, although comprehensive literature search and contacting corresponding authors for additional data could help us to minimize the possibility of bias, as consistent with other studies, it is impossible to fully exclude the potential bias. Besides, we are focusing on Asian patients who committed suicide after stroke. Therefore, it is essential to retrieve Chinese academic articles; but unfortunately, there is a lack of articles written in Chinese about the risk factors of PSS. We also hope to encourage Chinese doctors to explore this aspect through our meta-analysis.

Conclusion

PSS is one of the common complications of stroke. A deeper understanding of risk factors for suicidal ideation may not only enable healthcare workers to realize this “invisible handicap”, but also facilitate the implementation of new prevention strategies. Despite several limitations, this meta-analysis identified a number of risk factors for suicidal ideation in stroke survivors. Our results indicated that approximately 4 out of 1000 patients were actually committed suicide. Considering the high incidence of PSS within one year, new interventions should be designed to reduce suicide risk in stroke survivors by focusing on the multiple risk factors identified within this period of time.

Abbreviations

PSS:Post-Stroke Suicide; NOS: Newcastle-Ottawa Scale; PRISMA: Preferred Reporting Items for Systematic Reviews and MetaAnalyses;PHQ-9:Patient Health Questionnaire-9; SCID: Structured Clinical Interview for DSM;BSI:The Beck Scale for Suicide Ideation .

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

The author(s) completely agree for publication.

Availability of data and materials

All data generated or analyzed during this study are included in this article. All data are fully available without restriction.

Competing interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Authors' contributions

One researcher (SMZ) performed the search, scrutinizing all titles and abstracts for eligibility against the inclusion and exclusion criteria. researcher (SMZ) and a second researcher (ZYQ) independently reviewed all full texts for eligibility. The critical appraisal was performed independently by two researchers (SMZ and ARW). Disagreements between researchers were resolved by consensus, with the involvement of a third researcher (WFZ) where necessary. ZXZ participated in discussion and consensus and approved the final manuscript. All authors have read and approved the manuscript.

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Tables

Table 1. Characteristics of the studies that included in the meta-analysis.

Study	Country	Enrolled year	Sample size	age	Female (%)	Time after stroke	Measurement	Follow-up time	NOS
Santos2012 ¹²	Portugal	2000.4-2001.6	177	56.8±13.1	41.2%	04 days	the item suicidal thoughts of the Montgomery and Asberg Depression Rating Scale.	6 month	6
Jae Ho Chung2016 ¹⁶	Korea	2003-2008	228735	70.1±10	49.4%	Unclear	the Korean version of the World Health Organization Composite International Diagnostic Interview Short Form	12month	6
TAKASHI YAMAUCHI2014 ⁷	Japan	1990-2010	93027	52±7.9	52.5%	0-5year	medicolegal examinations by licensed physicians and police investigations	10year	7
Jin Dou2015 ¹⁷	China	2013.7.6-2013.12.6	281	65.2	41.45%	07 days	The Beck Scale for Suicide Ideation (BSI).	7 days	7
Marie Eriksson2015 ⁸	Sweden	2001-2012	220336	018	48.7%	03months	A suicide attempt was identified by arecord of hospital admission for or an underlying or contributing cause of death by intentional self-harm (ICD-10: X60-X84).	12year	7
Jin Pyo Honga ¹⁸	Korea	2005.1-2012.12	7175	62.5±13	31.5%	Admission	Suicidal death was defined using the ICD-10 codes X60-X84 (intentional self-harm).	7year	8
Eun-Young Park2016 ¹⁹	Korea	2006-2010	225	69.3	44.8%	Unclear	Suicidal ideation was assessed by "yes" or "no" responses to the question "Have you ever thought about suicide?"	4year	5
Pohjasvaara2001 ²⁰	Finland		486	69.9±7.6	46.9%	03months	Beck Depression Inventory	15months	8
Tomor Harnod2018 ²¹	China	2000.1-2010.12	2139699	67	42.6%	Unclear	followed up until a diagnosis of suicide attempt (ICD-9-CM codes E950-E959),	10year	8
Yang Yang2017 ²²	China	2008.4-2010.4	2324	61.9	34.4%	014 days	Suicidal ideation was measured using item 3 of the Hamilton Rating Scalefor Depression.	1year	8
Altura2016 ²³	Canada	2012.8-2013.9	204	60.1	55.7%	048 hours	The PHQ-90The SCID is a semistructured diagnostic interview	2week	5
Wai Kwong Tang2012 ²⁴	China	2006.6-2009.9	367	67±107	45.2%	07 days	the relevant items in the Geriatric Mental State Examination-Version A.	3months	6

Table 2. Risk factors for suicidal ideation after stroke.

Risk factors for suicidal ideation after stroke					Risk factors of suicidal ideation after stroke in Asia				
Variables	Eligible studies	OR (95% CI)	<i>P</i> value	Heterogeneity (I ²)	Eligible studies	OR (95% CI)	<i>P</i> value	Heterogeneity (I ²)	
Age ≥65 years	6	1.17 [0.99, 1.39]	0.07	82%	4	1.02 [0.99, 1.04]	0.26	20%	
Male	9	1.07 [1.01, 1.13]	0.02	44%	7	1.05 [0.98, 1.11]	0.16	45%	
Female	5	0.86 [0.60, 1.26]	0.45	19%	3	0.84 [0.49, 1.45]	0.54	32%	
Left-sided stroke	4	0.77 [0.53, 1.11]	0.16	0					
Right-sided stroke	3	1.37 [0.99, 1.90]	0.06	0					
Brainstem-cerebellum	4	1.25 [0.57, 2.74]	0.58	70%					
Smoking	5	1.42 [1.35, 1.50]	≤0.01	15%	4	1.42 [1.35, 1.50]	≤0.01	32%	
Alcohol abuse	8	0.73 [0.28, 1.93]	0.53	98%	3	2.03 [1.70, 2.42]	≤0.01	0	
Married	4	0.81 [0.42, 1.55]	0.53	94%	4	0.81 [0.42, 1.55]	0.53	94%	
Education	9	1.49 [0.73, 3.02]	0.27	92%	4	1.70 [0.63, 4.60]	0.3	88%	
Employment	3	0.37 [0.16, 0.83]	0.02	69%					
Low Household income	5	1.96 [1.02, 3.77]	0.04	99%	4	2.31 [1.17, 4.57]	0.02	98%	
Depression	11	2.32 [1.73, 3.13]	≤0.01	96%	7	2.50 [1.66, 3.76]	≤0.01	98%	
Diabetes mellitus	7	1.22 [0.98, 1.50]	0.07	81%	5	1.23 [0.95, 1.60]	0.12	82%	
Hypertension	5	1.36 [0.42, 4.37]	0.6	100%	5	1.36 [0.42, 4.37]	0.6	100%	
Myocardial infarction	5	1.22 [0.93, 1.61]	0.16	71%	3	1.23 [1.13, 1.35]	≤0.01	0	

Sleeping disturbances	3	1.80 [1.55, 2.08]	0.01	0	3	1.80 [1.55, 2.08]	0.01	0
Previous stroke	8	1.55 [1.06, 2.28]	0.03	60%	4	1.31 [0.90, 1.91]	0.16	0

Table 3. Risk factors for suicidal ideation in stroke survivors according to the follow-up time.

Suicidal ideation cases at ≤ 1 year post-stroke					Suicidal ideation cases at ≥ 1 year post-stroke				
Variables	Eligible studies	OR (95% CI)	<i>P</i> value	Heterogeneity (I^2)	Eligible studies	OR (95% CI)	<i>P</i> value	Heterogeneity (I^2)	
Age ≥ 65 years					5	1.20 [1.01, 1.43]	0.04	85	
Male	4	1.08 [0.79, 1.48]	0.61	0	5	1.07 [1.01, 1.14]	0.02	70	
Female					4	0.88 [0.58, 1.35]	0.56	39	
Brainstem-cerebellum	3	0.79 [0.53, 1.18]	0.25	0					
Smoking					3	1.43 [1.35, 1.51]	0.01	40	
Alcohol abuse	3	0.78 [0.32, 1.90]	0.58	72	5	0.78 [0.22, 2.84]	0.71	99	
Education	3	1.54 [0.72, 3.29]	0.26	29	6	1.40 [0.59, 3.30]	0.44	94	
Low Household income					4	1.91 [0.93, 3.94]	0.08	99	
Depression	5	3.33 [1.89, 5.84]	0.01	88	6	1.96 [1.33, 2.90]	0.01	98	
Diabetes mellitus	3	1.64 [0.90, 2.99]	0.1	63	4	1.12 [0.89, 1.41]	0.35	87	
Hypertension					3	1.69 [0.37, 7.68]	0.5	100	
Myocardial infarction					4	1.24 [0.92, 1.67]	0.16	78	
Previous stroke	4	1.30 [0.90, 1.86]	0.16	0	4	2.22 [0.86, 5.72]	0.1	82	

Figures

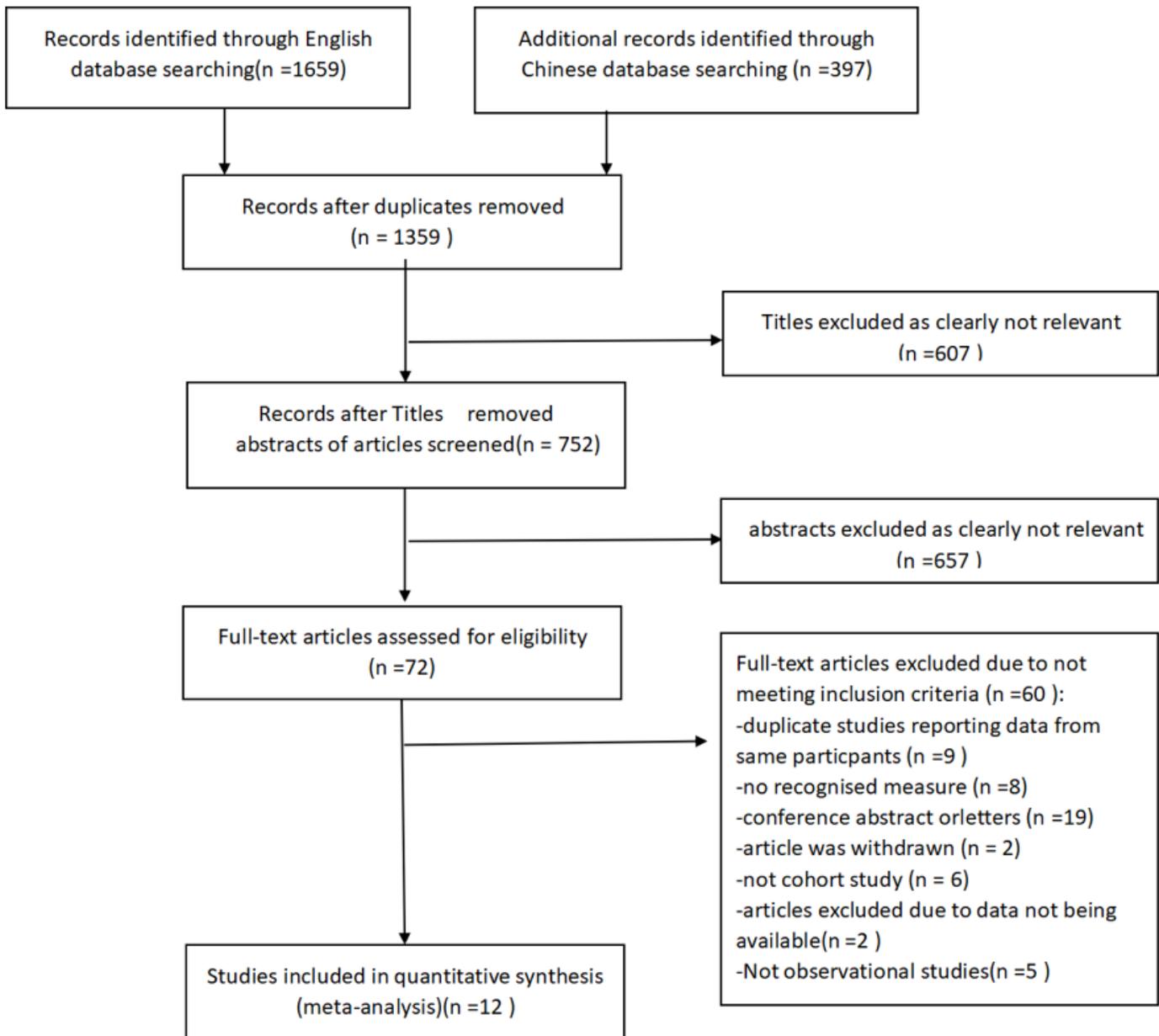


Figure 1

Modified PRISMA flow diagram of included/excluded studies.

Rates of suicidal ideation after stroke in overall studies

Rates of suicidal ideation after stroke in Asia

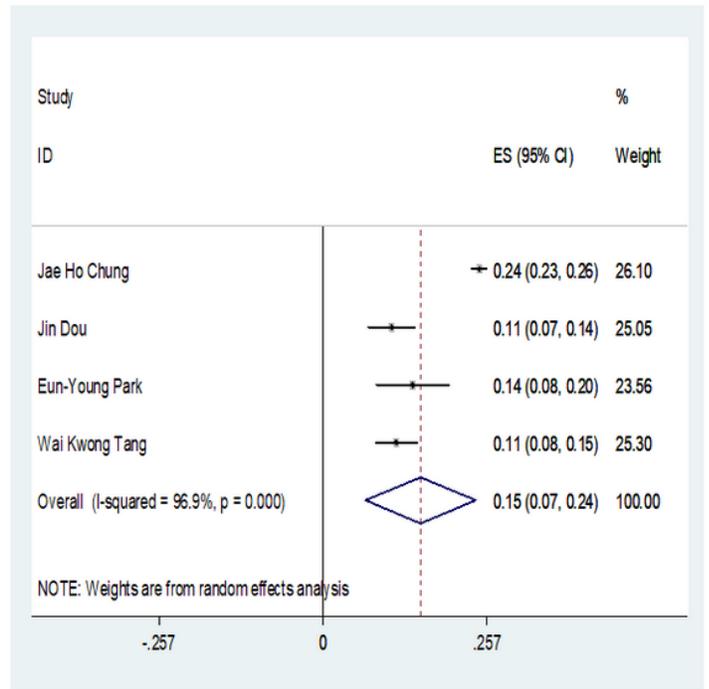
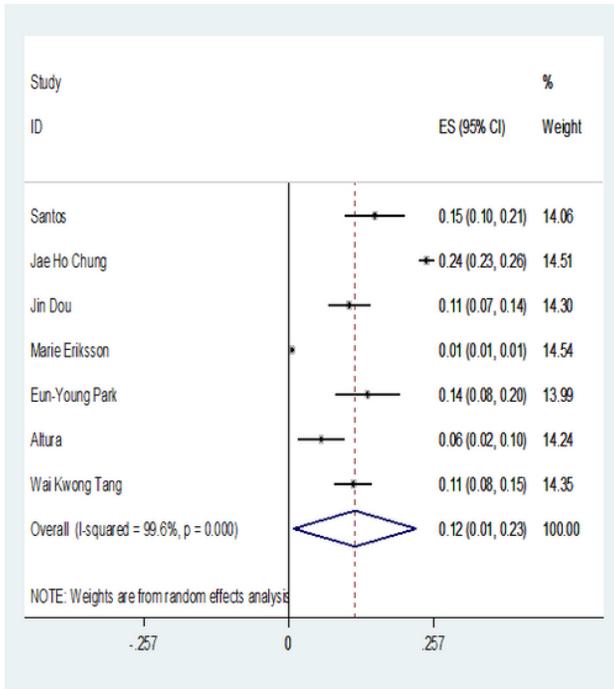


Figure 2

Rates of suicidal ideation among stroke survivor

Suicidal ideation of stroke course ≤ 1 year

Suicidal ideation of stroke course > 1 year

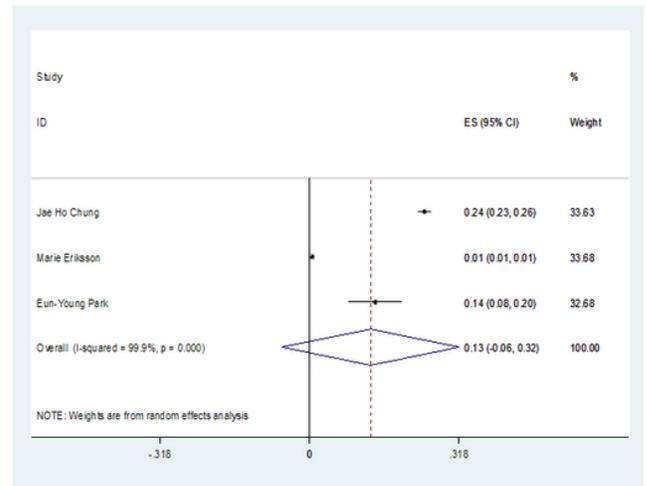
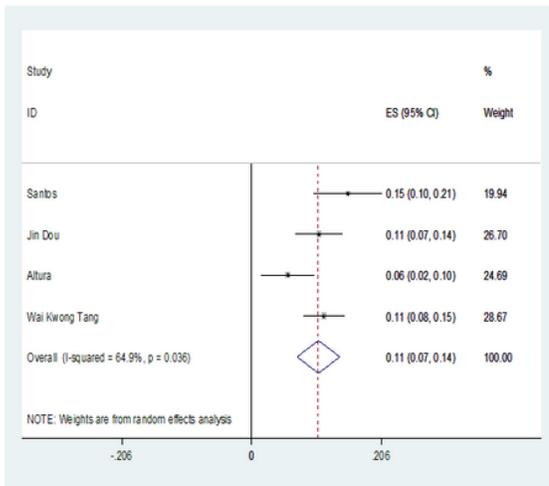


Figure 3

Rates of suicidal ideation among stroke survivors according to the follow-up time.

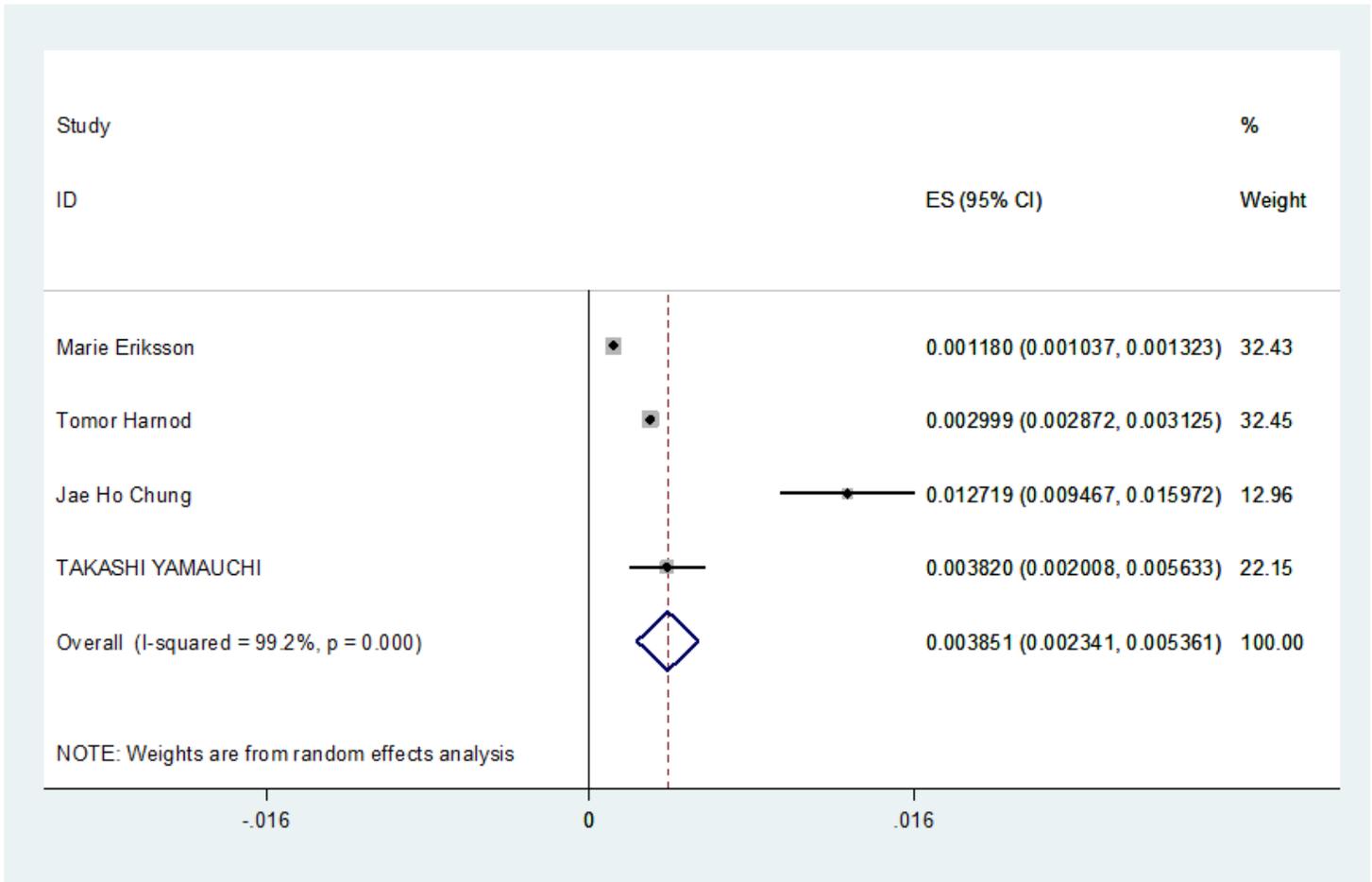


Figure 4

Rates of Completed suicide among stroke survivors.

Supplementary Files

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- [Supplementary.pdf](#)