Postprint of a Meta-Analysis on the Prevalence and Trends of Post-Stroke Fatigue in China

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Abstract

Background Post-stroke fatigue (PSF) severely impacts patients' recovery outcomes and is also an independent risk factor for stroke recurrence and post-stroke mortality. Understanding the epidemiological status of PSF is of great significance for advancing stroke prevention and control efforts in China.

Objective To systematically evaluate the current prevalence and development trends of PSF in China, in order to provide a reference basis for relevant departments in China to formulate targeted stroke prevention and control strategies.

Methods A computerized search was conducted on PubMed, Web of Science, EMbase, China National Knowledge Infrastructure (CNKI), Wanfang Data, VIP Chinese Science and Technology Journals Database (VIP), and Chinese Biomedical Literature Database (CBM) to collect cross-sectional studies on the prevalence of PSF in China, with the search period ranging from database inception to May 20, 2023. Two researchers independently screened literature, extracted data, and evaluated the risk of bias of included studies, after which Meta-analysis was performed using Stata 16.0 software. This study has been registered on the PROSPERO platform: CRD42023427915.

Results A total of 57 cross-sectional studies were included, covering 19 provinces, autonomous regions, municipalities directly under the Central Government, and special administrative regions in China, with a total sample size of 13,621 individuals, of whom 5,764 had PSF. The results of the Meta-analysis showed that the prevalence of PSF in China was 43.5% (95%CI=40.0%~47.0%). Subgroup analyses showed that by gender, the prevalence was 38.4% (95%CI=34.3%~42.5%) in males and 45.2% (95%CI=40.7%~49.7%) in females; by age group, it was 40.0% (95%CI=32.3%~48.0%) for those under 60 years, 67.9% (95%CI=54.2%~80.1%) for those aged 60-75 years, and 71.9% (95%CI=48.9%~90.5%) for those aged 75 years and above; by region, it was 40.0% (95%CI=35.0%~45.2%) in North China, 41.0% (95%CI=29.5%~53.0%) in Northeast China, 49.5%

(95%CI=43.1%~55.8%) in East China, 40.3% (95%CI=34.9%~45.8%) in Central China, 40.0% (95%CI=28.4%~52.2%) in South China, 59.3% (95%CI=54.0%~65.0%) in Southwest China, and 46.2% (95%CI=38.3%~54.2%) in Northwest China; by stroke type, it was 56.3% (95%CI=42.8%~69.4%) for hemorrhagic stroke and 40.0% (95%CI=36.7%~43.4%) for ischemic stroke; by stroke timing, it was 41.4% (95%CI=37.0%~45.8%) in the acute phase and 46.4% (95%CI=40.8%~52.1%) in the recovery phase; by education level, it was 56.0% (95%CI=43.7%~67.9%) for primary school and below, 46.7% (95%CI=39.6%~53.8%) for junior high school, 46.8% (95%CI=40.3%~53.4%) for senior high school, and 43.6% (95%CI=35.7%~51.6%) for college and above; by marital status, it was 45.8% (95%CI=40.8%~50.9%) for those with spouses and 53.6% (95%CI=47.4%~59.8%) for those without spouses; by employment status, it was 45.0% (95%CI=33.2%~57.0%) for employed individuals and 53.8% (95%CI=40.1%~67.2%) for unemployed or retired individuals; by assessment tool, the prevalence was 41.8% (95%CI=38.3%~45.3%) using the Fatigue Severity Scale (FSS), 65.8% (95%CI=57.1%~74.0%) using the Checklist Individual Strength (CIS), 50.5% (95%CI=44.6%~56.5%) using the Chinese version of the Neurological Fatigue Index for Stroke (NFI-stroke), 52.7% (95%CI=43.1%~62.1%) using the Chinese version of the Fatigue Assessment Scale (C-FAS), and 48.9% (95%CI=43.6%~54.2%) using the Mental Fatigue Scale (MFS). Additionally, regarding age distribution, the prevalence of PSF in China gradually increased with age (^{2} trend=87.081, r=0.209, P<0.01); regarding education level, the correlation trend between PSF prevalence and education was not statistically significant (^{2} trend=0.333, P=0.564); regarding spatial distribution, there were significant differences in PSF prevalence among the seven regions nationwide (40.0%~59.3%) (^{2}=122.615, P<0.0001), and also significant differences among provinces (23.3%~74.2%) (^{2}=504.294, P<0.0001); regarding publication time, the prevalence of PSF in China from 2013 to 2023 fluctuated between 32.4%~53.9% (^{2} trend=48.011, r=0.061, P<0.01).

Conclusion The overall prevalence of PSF in China is relatively high, with significant differences among regions and provinces: Southwest China (59.3%) and Guizhou Province (74.2%) were the highest, while North China (40.0%), South China (40.0%), and Tianjin Municipality (23.4%) were the lowest. Additionally, higher PSF prevalence was found among females, individuals of advanced age, those without spouses, individuals with lower education levels, unemployed or retired persons, those in the stroke recovery phase, and patients with hemorrhagic stroke. Due to limitations in the number and quality of included studies, these conclusions should be verified by more high-quality studies.

Full Text

Prevalence and Trends for Post-Stroke Fatigue in China: A Meta-Analysis

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Abstract

Background: Post-stroke fatigue (PSF) significantly impacts patients' prognostic recovery and represents an independent risk factor for stroke recurrence and post-stroke mortality. Understanding the epidemiological status of PSF is crucial for advancing stroke prevention and treatment efforts in China.

Objective: To systematically evaluate the current prevalence and development trends of PSF in China, providing an evidence base for relevant departments to formulate targeted stroke prevention and treatment strategies.

Methods: We systematically searched PubMed, Web of Science, EMbase, CNKI, Wanfang Data, VIP, and CBM for cross-sectional studies on PSF prevalence in China from inception to May 20, 2023. Two investigators independently screened literature, extracted data, and assessed risk of bias. Meta-analysis was performed using Stata 16.0 software. This study was registered on PROSPERO (CRD42023427915).

Results: Fifty-seven cross-sectional studies covering 19 provinces/autonomous regions/municipalities directly under the central government and special administrative regions were included, with a total sample of 13,621 individuals, of whom 5,764 had PSF. Meta-analysis revealed an overall PSF prevalence of 43.5% (95%CI=40.0%-47.0%) in China. Subgroup analyses showed: prevalence was 38.4% (95%CI=34.3%-42.5%) in males and 45.2% (95%CI=40.7%-49.7%) in females; by age, 40.0% (95%CI=32.3%-48.0%) for those under 60, 67.9% (95%CI=54.2%-80.1%) for ages 60-75, and 71.9% (95%CI=48.9%-90.5%) for those 75 and older; by region, 40.0% (95%CI=35.0%-45.2%) in North China, 41.0% (95%CI=29.5%-53.0%) in Northeast China, 49.5% (95%CI=43.1%-55.8%) in East China, 40.3% (95%CI=34.9%-45.8%) in Central China, 40.0% (95%CI=28.4%-52.2%) in South China, 59.3% (95%CI=54.0%-65.0%) in Southwest China, and 46.2% (95%CI=38.3%-54.2%) in Northwest China; by stroke type, 56.3% (95%CI=42.8%-69.4%) for hemorrhagic stroke and 40.0% (95%CI=36.7%-43.4%) for ischemic stroke; by stroke phase, 41.4% (95%CI=37.0%-45.8%) in acute phase and 46.4% (95%CI=40.8%-52.1%) in recovery phase; by education, 56.0% (95%CI=43.7%-67.9%) for primary school and below, 46.7% (95%CI=39.6%-53.8%) for junior high school, 46.8% (95%CI=40.3%-53.4%) for senior high school, and 43.6% (95%CI=35.7%-51.6%) for college and above; by marital status, 45.8% (95%CI=40.8%-50.9%) for those with a spouse and 53.6% (95%CI=47.4%-59.8%) for those without; by

employment status, 45.0% (95%CI=33.2%-57.0%) for employed and 53.8% (95%CI=40.1%-67.2%) for unemployed/retired; by assessment tool, 41.8% (95%CI=38.3%-45.3%) using FSS, 65.8% (95%CI=57.1%-74.0%) using CIS, 50.5% (95%CI=44.6%-56.5%) using NFI-stroke, 52.7% (95%CI=43.1%-62.1%) using C-FAS, and 48.9% (95%CI=43.6%-54.2%) using MFS.

Trend analysis revealed: PSF prevalence increased significantly with age (^{2} trend=87.081, r=0.209, P<0.01); no significant correlation with education level (^{2} trend=0.333, P=0.564); significant regional variation across seven geographic areas (40.0%-59.3%, ^{2}=122.615, P<0.0001) and provinces (23.3%-74.2%, ^{2}=504.294, P<0.0001); and fluctuating prevalence from 2013-2023 (32.4%-53.9%, ^{2} trend=48.011, r=0.061, P<0.01).

Conclusion: PSF prevalence in China is high overall, with marked regional and provincial differences. Southwest China (59.3%) and Guizhou Province (74.2%) showed the highest rates, while North China (40.0%), South China (40.0%), and Tianjin City (23.4%) had the lowest. Higher prevalence was observed among females, older adults, those without a spouse, individuals with lower education, unemployed/retired persons, stroke recovery phase patients, and hemorrhagic stroke cases. Due to limitations in number and quality of included studies, these findings require verification through additional high-quality research.

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Introduction

Stroke is the most common neurological disease, typically causing complications such as limb dysfunction, cognitive decline, and negative emotions [1-4], with complex interrelationships among various symptoms [5]. Post-stroke fatigue (PSF) is one of the most persistent physical and psychological symptoms experienced by stroke survivors [6-7], severely impacting daily living abilities and quality of life during recovery, prolonging rehabilitation time, and significantly increasing caregiving burden and economic costs [6,8]. PSF refers to persistent subjective exhaustion that appears early in stroke patients, unrelated to previous exertion levels, and cannot be relieved by rest [6,9]. Reportedly, the overall prevalence of PSF in China ranges from 23% to 74% [10-13], with significant

variations across different regions and population characteristics due to China' s vast territory. Furthermore, PSF is an independent risk factor for stroke recurrence and post-stroke mortality [6,14-15]. Therefore, understanding PSF prevalence is essential for advancing stroke prevention and treatment in China.

However, comprehensive reports on PSF prevalence and trends are currently lacking in China. This study aims to systematically evaluate the current status and development trends of PSF in China through meta-analysis, providing data support and reference basis for relevant departments to formulate targeted stroke prevention strategies. This study was registered on PROSPERO (Registration number: CRD42023427915).

Methods

1.1 Inclusion and Exclusion Criteria Inclusion Criteria: Cross-sectional studies with Chinese stroke patients as subjects, where the outcome measure was PSF prevalence diagnosed by validated assessment tools.

Exclusion Criteria: (1) Duplicate data; (2) Reviews, conference abstracts, and commentaries; (3) Non-Chinese or non-English literature; (4) Studies with unreasonable design or poor quality; (5) Unavailable original data; (6) Sample size below 100 cases.

1.2 Literature Search Strategy We systematically searched PubMed, Web of Science, EMbase, CNKI, Wanfang Data, VIP, and CBM databases for cross-sectional studies on PSF prevalence in China from inception to May 20, 2023. References of included studies were also reviewed to supplement relevant literature. English search terms included: stroke fatigue, post stroke fatigue, fatigue after stroke, PSF, prevalence, incidence, occurrence, epidemi*, Chinese, China, HongKong, MaCao, TaiWan. Chinese search terms included: 脑卒中, 脑梗死, 脑出血, 中风, 疲劳, 卒中后疲劳. The PubMed search strategy is detailed in Table 1 .

1.3 Literature Screening and Data Extraction Two investigators independently screened literature, extracted data, and cross-checked results. Disagreements were resolved through discussion or consultation with a third party. Literature screening involved initial title review to exclude obviously irrelevant studies, followed by abstract and full-text review for final inclusion. A "snowballing" method was applied by comprehensively analyzing references of included studies to obtain additional relevant literature [16]. Data extraction included: first author, publication year, study location, assessment timing, stroke type, total sample size, number of cases, assessment tools, and related data.

1.4 Quality Assessment Two investigators independently evaluated the risk of bias for included studies using the Agency for Healthcare Research and Quality (AHRQ) recommended criteria for cross-sectional studies and prevalence

methodology quality assessment standards [17]. The AHRQ scale contains 11 items, with each item scored as 1 for "yes" and 0 for "no" or "unclear." Total AHRQ scores of 8-11 indicate high quality, 4-7 moderate quality, and 0-3 low quality [18].

1.5 Statistical Analysis Stata 16.0 software was used for statistical analysis of PSF prevalence and trends. Heterogeneity was assessed using ^{2} test (α=0.1) and I^2 statistics. A fixed-effects model was used if no statistical heterogeneity existed; otherwise, random-effects model was applied after analyzing heterogeneity sources and excluding obvious clinical heterogeneity. Meta-analysis significance level was set at α=0.05. Subgroup analysis or sensitivity analysis addressed significant clinical heterogeneity. Publication bias was evaluated using funnel plots combined with Egger' s test. ^{2} test compared PSF prevalence across different levels. Trend analysis used SPSS 25.0 software for trend ^{2} test, with P<0.05 considered statistically significant.

Results

2.1 Literature Screening Process and Results The initial search retrieved 2,590 relevant articles. After screening, 57 cross-sectional studies [10-13,19-71] were included, covering 19 provinces/autonomous regions/municipalities directly under the central government and special administrative regions, with a total sample of 13,621 cases, including 5,764 PSF patients. The literature screening process is shown in Figure 1 [Figure 1: see original paper].

2.2 Basic Characteristics and Quality Assessment of Included Studies Basic characteristics of included studies are presented in Table 2 . The AHRQ scores for the 57 cross-sectional studies ranged from 6 to 11, indicating moderate to high quality.

2.3 Meta-Analysis Results

2.3.1 PSF Prevalence Random-effects meta-analysis of 57 studies showed an overall PSF prevalence of 43.5% (95%CI=40.0%-47.0%) in China (Figure 2 [Figure 2: see original paper]).

2.3.2 Subgroup Analysis Subgroup analyses were conducted by gender, age, region, stroke type and phase, education level, marital status, employment status, and assessment tools.

Gender: Male PSF prevalence was 38.4% (95%CI=34.3%-42.5%) and female prevalence was 45.2% (95%CI=40.7%-49.7%).

Age: Prevalence was 40.0% (95%CI=32.3%-48.0%) for those under 60, 67.9% (95%CI=54.2%-80.1%) for ages 60-75, and 71.9% (95%CI=48.9%-90.5%) for those 75 and older.

Region: Prevalence by geographic region was 40.0% (95%CI=35.0%-45.2%) in North China, 41.0% (95%CI=29.5%-53.0%) in Northeast China, 49.5% (95%CI=43.1%-55.8%) in East China, 40.3% (95%CI=34.9%-45.8%) in Central China, 40.0% (95%CI=28.4%-52.2%) in South China, 59.3% (95%CI=54.0%-65.0%) in Southwest China, and 46.2% (95%CI=38.3%-54.2%) in Northwest China.

Stroke Type: Hemorrhagic stroke prevalence was 56.3% (95%CI=42.8%-69.4%) versus 40.0% (95%CI=36.7%-43.4%) for ischemic stroke.

Stroke Phase: Acute phase prevalence was 41.4% (95%CI=37.0%-45.8%) compared to 46.4% (95%CI=40.8%-52.1%) in recovery phase.

Education Level: Prevalence was 56.0% (95%CI=43.7%-67.9%) for primary school and below, 46.7% (95%CI=39.6%-53.8%) for junior high school, 46.8% (95%CI=40.3%-53.4%) for senior high school, and 43.6% (95%CI=35.7%-51.6%) for college and above.

Marital Status: Those with a spouse had 45.8% (95%CI=40.8%-50.9%) prevalence versus 53.6% (95%CI=47.4%-59.8%) for those without.

Employment Status: Employed individuals had 45.0% (95%CI=33.2%-57.0%) prevalence compared to 53.8% (95%CI=40.1%-67.2%) for unemployed/retired persons.

Assessment Tools: Prevalence varied by tool: 41.8% (95%CI=38.3%-45.3%) using FSS, 65.8% (95%CI=57.1%-74.0%) using CIS, 50.5% (95%CI=44.6%-56.5%) using NFI-stroke, 52.7% (95%CI=43.1%-62.1%) using C-FAS, and 48.9% (95%CI=43.6%-54.2%) using MFS (Table 4).

2.3.3 Trend Analysis Trend analysis from four perspectives showed: PSF prevalence increased significantly with age (^{2} trend=87.081, r=0.209, P<0.01); no significant correlation with education level (^{2} trend=0.333, P=0.564); significant spatial variation across seven regions (40.0%-59.3%, ^{2}=112.615, P<0.01, Figure 3 [Figure 3: see original paper]) and provinces (23.3%-74.2%, ^{2}=504.294, P<0.01, Table 5); and fluctuating prevalence from 2013-2023 (32.4%-53.9%, ^{2} trend=48.011, r=0.061, P<0.01, Figure 4 [Figure 4: see original paper], Table 6).

2.4 Sensitivity Analysis Sensitivity analysis using the leave-one-out method showed no significant change in effect size, indicating stable results.

2.5 Publication Bias Funnel plot analysis showed roughly symmetric distribution (Figure 5 [Figure 5: see original paper]), and Egger' s test (t=1.78, P=0.081) indicated no significant publication bias.

Discussion

This meta-analysis summarized 57 cross-sectional studies with AHRQ scores of 6-11, indicating moderate to high quality and reliable results. The overall PSF prevalence of 43.5% in China is slightly higher than the 37.98% reported by ZHAN et al. [73], possibly due to differences in sample sources, sizes, geographic environments, cultural backgrounds, assessment tools, and evaluation timing.

Subgroup analyses revealed several key findings. First, female PSF prevalence exceeded male rates, consistent with previous research [72,74-76], potentially because women are generally more sensitive to perceiving fatigue symptoms [39,72,77]. Additionally, menopausal middle-aged and older women may experience endocrine dysfunction and abnormal hormone metabolism, leading to negative emotions, anxiety, depression, and chronic fatigue [12,61]. Healthcare providers should therefore focus on psychological health screening in female stroke patients to reduce adverse impacts on fatigue and recovery.

Second, hemorrhagic stroke patients showed higher PSF prevalence than ischemic stroke patients, aligning with multiple studies [73,78-79], though specific mechanisms warrant further investigation.

Third, PSF prevalence was slightly lower in the acute phase (41.4%) than recovery phase (46.4%), possibly related to using 2 weeks post-stroke as the cutoff [72]. Literature indicates PSF prevalence increases over time post-stroke, with fatigue persisting long-term [15,79]. Healthcare providers should implement screening during acute phase and establish longitudinal follow-up systems.

Fourth, unmarried individuals showed higher prevalence than married persons (53.6% vs 45.8%, $P<0.05$), likely due to poorer family support. Research shows unmarried patients experience more psychological problems and adopt negative coping mechanisms when facing major illness, leading to family dysfunction that affects health outcomes [47,64]. Healthcare providers should explain the importance of family involvement in rehabilitation and encourage caregiver participation to enhance patients' perceived support and reduce fatigue.

Fifth, employed individuals had lower prevalence than unemployed/retired persons (45.0% vs 53.8%, $P<0.05$), consistent with previous reports [11-12,20,24,41]. This may reflect younger average age, better physical condition, faster recovery, more stable income, and higher social support among employed individuals, which are protective factors against PSF [36,42,47].

Sixth, regarding assessment tools, the Fatigue Severity Scale (FSS) is most commonly used in PSF research due to its brevity and simplicity [78,80], with 89.5% usage in this study (51/57). However, FSS detected significantly lower prevalence than other tools (41.8% vs 48.9%-65.8%, $P<0.05$), possibly because PSF as a self-reported syndrome is complex and multidimensional [81]. Healthcare

providers should comprehensively assess fatigue from social, family, and individual physical/psychological perspectives [80] to identify specific sources and implement targeted interventions.

Trend analysis revealed PSF prevalence increased significantly with age ($P<0.0001$), possibly because older adults have multiple chronic diseases and pre-existing fatigue that worsens with stroke-induced functional limitations [82-83]. However, some studies show similar or even higher PSF prevalence in younger adults [43,73,84], requiring further investigation. No significant correlation with education level was found ($P>0.05$), consistent with ZHAN et al. [73], likely because PSF is heavily influenced by subjective experience.

Significant spatial variation existed across regions and provinces, with Guizhou Province in Southwest China showing the highest prevalence (74.2%), possibly related to regional cultural differences, economic development, and healthcare conditions. Authorities should prioritize stroke prevention in high-prevalence regions and develop targeted strategies.

From 2013-2023, PSF prevalence fluctuated between 32.4%-53.9%, peaking in 2018 (53.9%), declining for four consecutive years (2019-2022), then rising slightly in 2023. Whether this 2023 increase relates to long-term fatigue from COVID-19 [85-86] requires further study. Regardless of trends, continued efforts in stroke prevention and health education are essential to reduce stroke risk fundamentally.

Limitations

This study has several limitations. First, all included studies were cross-sectional, with substantial heterogeneity due to design, quality, sample sources, and sizes that persisted after subgroup analysis. Second, non-uniform PSF assessment tools and diagnostic standards may introduce measurement bias. Third, lack of original data from some provinces may cause bias and limit generalizability. Fourth, the search ended May 20, 2023, so 2023 prevalence may not represent the entire year.

Conclusion

Current evidence shows high overall PSF prevalence in China with marked regional/provincial differences and dynamic temporal trends. Higher prevalence occurs among females, older adults, unmarried individuals, those with lower education, unemployed/retired persons, stroke recovery phase patients, and hemorrhagic stroke cases. Healthcare institutions should prioritize these populations and implement comprehensive PSF prevention strategies to reduce prevalence and alleviate social and economic burdens.

Author Contributions: XUE Chao conceived and designed the study, drafted and revised the manuscript; XUE Chao, YU Jie, and HAO Mingqing conducted literature search, data extraction, quality assessment, and data analysis; LI Juan and FANG Qian reviewed and quality-controlled the manuscript and take overall responsibility.

Conflict of Interest: None declared.

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Note: Figure translations are in progress. See original paper for figures.