

A Correlation Study on Somatosensory and Motor Function in Stroke Patients of Different Ages and Considerations for Whole-Cycle Rehabilitation: Postprint

Authors: Lin Jiaying, Shuting Tu, Lin Jiali, Zhou Yuxin, He Xinyuan, Jia Jie, Jia Jie

Date: 2024-02-19T16:44:30+00:00

Abstract

Background Somatosensory dysfunction and motor dysfunction are common impairments following stroke. Deficits in both domains can limit patients' activities of daily living and social participation. However, there remains a lack of research evidence examining the relationship between them from multiple perspectives.

Objective To investigate the relationship between overall, upper limb, and lower limb somatosensory function and motor function in patients of different ages within one year after stroke.

Methods Patients within one year after stroke admitted to multiple hospitals in Fujian Province from October 2022 to April 2023 were enrolled as study subjects. General patient data were collected. Somatosensory function was assessed using the Fugl-Meyer Assessment sensory subscale (FMA-S) and the National Institutes of Health Stroke Scale (NIHSS) sensory sub-item. Motor function was evaluated using the Fugl-Meyer Assessment motor subscale (FMA-M), Brunnstrom Motor Recovery Stage, Berg Balance Scale (BBS), and NIHSS motor sub-item. Activities of daily living were assessed using the Modified Barthel Index (MBI), and anxiety and depression were evaluated using the Hospital Anxiety and Depression Scale (HADS). Patients were divided into an elderly group (≥ 65 years) and a young-middle-aged group (18-64 years) based on age. Differences in general data and rehabilitation assessment indicators between the two groups were compared, and correlations between somatosensory function and motor function, activities of daily living, and psychosocial indicators were analyzed.

Results A total of 254 patients were included, with a mean age of (61.0 ± 12.3) years; the median stroke duration was 30.0 (17.0, 65.5) days. The elderly group

comprised 112 patients (44.1%), and the young-middle-aged group comprised 142 patients (55.9%). In both groups, FMA-S scores were positively correlated with FMA-M scores ($rs=0.313$ and 0.171 , respectively, $P<0.05$), and NIHSS sensory sub-item scores were negatively correlated with FMA-M scores ($rs=-0.199$ and -0.177 , respectively, both $P<0.05$). In the elderly group, FMA-S-UE, FMA-S-UE light touch, and FMA-S-UE proprioception were positively correlated with FMA-M-UE, Brunnstrom upper limb, and Brunnstrom hand scores, respectively, and negatively correlated with NIHSS upper limb sub-item scores ($P<0.05$). In the young-middle-aged group, FMA-S-UE and FMA-S-UE light touch were positively correlated with FMA-M-UE and Brunnstrom hand scores, respectively, and FMA-S-UE proprioception was positively correlated with FMA-M-UE and Brunnstrom upper limb scores ($P<0.05$). In the elderly group, FMA-S-LE, FMA-S-LE light touch, and FMA-S-LE proprioception were positively correlated with FMA-M-LE, Brunnstrom lower limb, and BBS scores, respectively, and FMA-S-LE and FMA-S-LE light touch were negatively correlated with NIHSS lower limb sub-item scores ($P<0.01$). In the young-middle-aged group, FMA-S-LE and FMA-S-LE proprioception were positively correlated with FMA-M-LE, Brunnstrom lower limb, and BBS scores; FMA-S-LE light touch was positively correlated with Brunnstrom lower limb and BBS scores; and FMA-S-LE and FMA-S-LE proprioception were negatively correlated with NIHSS lower limb sub-item scores ($P<0.05$). In the elderly group, FMA-S scores were positively correlated with MBI scores ($rs=0.270$, $P<0.05$). In the elderly group, FMA-S scores were negatively correlated with HADS-A and HADS-D scores ($rs=-0.300$ and -0.374 , respectively, $P<0.01$), and NIHSS sensory sub-item scores were positively correlated with HADS-D scores ($rs=0.235$, $P<0.01$).

Conclusion Somatosensory function is positively correlated with motor function in patients within one year after stroke, and age may influence the correlations between somatosensory function and motor function, activities of daily living, and psychosocial function.

Full Text

A Full-Cycle Reflection: Based on the Correlation Between Somatosensory and Motor Function in Stroke Patients of Different Age Groups

Jia-Ying Lin¹, Shu-Ting Tu^{1,2}, Jia-Li Lin^{2,3}, Yu-Xin Zhou², Xin-Yuan He², Jie Jia^{1,2,4,5,6*}

1. School of Rehabilitation Medicine, Fujian University of Traditional Chinese Medicine, Fuzhou 350122, China
2. Department of Rehabilitation Medicine, Huashan Hospital, Fudan University, Shanghai 200040, China

3. The First Affiliated Hospital of Fujian Medical University, Fuzhou 350004, China
4. National Clinical Research Center for Aging and Medicine, Huashan Hospital, Fudan University, Shanghai 200040, China
5. National Center for Neurological Disorders, Shanghai 200040, China
6. National Regional Medical Center, Fuzhou 350000, China

*Corresponding author: Jie Jia, Chief Physician/Professor/Doctoral Supervisor;
E-mail: shannonjj@126.com*

Abstract

Background: Somatosensory and motor dysfunction are common sequelae of stroke that both limit activities of daily living and social participation. However, multi-perspective research evidence analyzing their relationship remains limited.

Objective: To investigate the correlation between somatosensory and motor function in overall, upper extremity, and lower extremity domains among patients of different age groups within one year post-stroke.

Methods: This prospective study enrolled stroke patients within one year of onset from multiple hospitals in Fujian Province between October 2022 and April 2023. Somatosensory function was assessed using the Fugl-Meyer Assessment sensory subscale (FMA-S) and the sensory subitem of the National Institutes of Health Stroke Scale (NIHSS). Motor function was evaluated using the Fugl-Meyer Assessment motor subscale (FMA-M), Brunnstrom assessment, Berg Balance Scale (BBS), and the motor subitems of NIHSS. Activities of daily living were measured with the Modified Barthel Index (MBI), and psychological status with the Hospital Anxiety and Depression Scale (HADS). Patients were divided into elderly (≥ 65 years) and young/middle-aged (18–64 years) groups based on age. Between-group differences in general characteristics and rehabilitation assessments were compared, and correlations between somatosensory function and motor function, daily living abilities, and psychological indicators were analyzed.

Results: A total of 254 patients were included with a mean age of (61.0 ± 12.3) years and median stroke duration of 30.0 (17.0, 65.5) days. The elderly group comprised 112 patients (44.1%), while the young/middle-aged group included 142 patients (55.9%). FMA-S scores correlated positively with FMA-M scores in both groups ($r_s=0.313$ and 0.171 , respectively; both $P<0.05$), while NIHSS sensory scores correlated negatively with FMA-M scores ($r_s=-0.199$ and -0.177 , respectively; both $P<0.05$). In the elderly group, FMA-S-UE, FMA-S-UE light touch, and FMA-S-UE proprioception scores correlated positively with FMA-

M-UE, Brunnstrom upper extremity, and Brunnstrom hand scores, and negatively with NIHSS upper extremity scores (all $P < 0.05$). In the young/middle-aged group, FMA-S-UE and FMA-S-UE light touch scores correlated positively with FMA-M-UE and Brunnstrom hand scores, while FMA-S-UE proprioception correlated positively with FMA-M-UE and Brunnstrom upper extremity scores (all $P < 0.05$). For lower extremity function, elderly patients showed positive correlations between FMA-S-LE, FMA-S-LE light touch, and FMA-S-LE proprioception scores with FMA-M-LE, Brunnstrom lower extremity, and BBS scores, and negative correlations between FMA-S-LE and FMA-S-LE light touch with NIHSS lower extremity scores (all $P < 0.01$). In the young/middle-aged group, FMA-S-LE and FMA-S-LE proprioception scores correlated positively with FMA-M-LE, Brunnstrom lower extremity, and BBS scores; FMA-S-LE light touch correlated positively with Brunnstrom lower extremity and BBS scores; and both FMA-S-LE and FMA-S-LE proprioception correlated negatively with NIHSS lower extremity scores (all $P < 0.05$). Additionally, in the elderly group, FMA-S scores correlated positively with MBI scores ($r_s = 0.270$, $P < 0.05$) and negatively with HADS-A and HADS-D scores ($r_s = -0.300$ and -0.374 , respectively; both $P < 0.01$), while NIHSS sensory scores correlated positively with HADS-D scores ($r_s = 0.235$, $P < 0.01$).

Conclusion: Somatosensory function correlates positively with motor function in stroke patients within one year post-onset across different age groups. Age may influence the strength of correlations between somatosensory function and motor function, activities of daily living, and psychosocial functioning.

Keywords: Stroke; Age factors; Somatosensory function; Motor function; Full-cycle rehabilitation

1. Methods

1.1 Study Participants This study enrolled 254 stroke patients within one year of onset from multiple hospitals in Fujian Province between October 2022 and April 2023, including the First Affiliated Hospital of Fujian Medical University, National Regional Medical Center (Huashan Hospital Fujian Branch affiliated to Fudan University), Rehabilitation Hospital affiliated to Fujian University of Traditional Chinese Medicine, Fujian Provincial Hospital, Fuzhou First Hospital, Zhongshan Hospital Xiamen Branch affiliated to Fudan University, Quanzhou First Hospital, Longyan Traditional Chinese Medicine Hospital, Nanping First Hospital affiliated to Fujian Medical University, Fuding Hospital, Xiamen ITG Taihe Rehabilitation Hospital, Sanming Second Hospital, Changle District Hospital of Fuzhou, Yongchun County Hospital, Dehua County Hospital, Jianyang First Hospital, and Putian Affiliated Hospital. The study was approved by the Medical Ethics Committee of the First Affiliated Hospital of Fujian Medical University (Approval No.: [2022]280), and informed consent was obtained from all participants or their legal representatives.

Inclusion Criteria: (1) Met diagnostic criteria for cerebral infarction or hemorrhage according to the *Diagnostic Points for Major Cerebrovascular Diseases in China 2019* and confirmed by CT and/or MRI; (2) Stroke duration within one year (1-365 days); (3) Age \geq 18 years, regardless of gender; (4) Stable vital signs and ability to cooperate with rehabilitation assessments; (5) Provided informed consent and voluntary participation.

Exclusion Criteria: (1) Severe or uncontrolled hypertension, severe cardiac insufficiency, severe infection (e.g., pneumonia), diabetic ketoacidosis, frequent epilepsy, or other conditions deemed by clinicians as potentially causing deterioration during assessment; (2) History of peripheral nervous system disease, trauma, or other causes of severe limb dysfunction unrelated to stroke; (3) Inability to cooperate with assessments.

Dropout Criteria: (1) Occurrence of adverse events or complications during assessment; (2) Active withdrawal of consent by patient or immediate family; (3) Failure to complete all assessment items.

1.2 Data Collection General patient data were collected, including: (1) Demographics: gender, age, education level, residence; (2) Modifiable cerebrovascular risk factors: hypertension, smoking (>10 cigarettes/day for >6 months), alcohol consumption (≥ 30 g/day for >6 months); (3) Stroke duration, type, and hemiplegic side.

1.3 Assessment Methods 1.3.1 Somatosensory Function Assessment

- (1) **Fugl-Meyer Assessment Sensory Subscale (FMA-S):** The FMA-S-UE and FMA-S-LE were used to evaluate upper and lower extremity light touch and proprioception. This scale has demonstrated reliability and validity in stroke patients. Light touch assessment sites included the upper arm and palm for the upper extremity, and thigh and sole for the lower extremity. Proprioception assessment sites included shoulder, elbow, wrist, and thumb for the upper extremity, and hip, knee, ankle, and toe joints for the lower extremity. Patients were instructed to close their eyes during evaluation. Each item uses a 3-point scoring system (0-2), with higher scores indicating better sensory function.
- (2) **NIHSS Sensory Subitem:** The National Institutes of Health Stroke Scale is a comprehensive stroke assessment tool with established reliability and validity. The scale comprises 11 items, with higher scores indicating more severe neurological impairment. The sensory subitem evaluates sensory function across multiple body regions (upper extremity, lower extremity, trunk, face) using a 3-point scoring system (0-2), where higher scores indicate poorer sensory function.

1.3.2 Motor Function Assessment

- (1) **Fugl-Meyer Assessment Motor Subscale (FMA-M):** The FMA-M-UE and FMA-M-LE were used to assess upper and lower extremity motor function. This scale demonstrates good reliability and validity. The FMA-M-UE consists of 33 items (total score 66), while FMA-M-LE comprises 17 items (total score 34), yielding a total FMA-M score of 100. Each item uses a 3-point scoring system (0-2), with higher scores indicating better motor function.
- (2) **Brunnstrom Motor Assessment:** Based on Brunnstrom's six-stage recovery theory, this assessment has proven clinical reliability. It grades upper extremity, hand, and lower extremity motor function on a scale of I-VI, with higher stages indicating better motor function quality.
- (3) **Berg Balance Scale (BBS):** As the gold standard for balance assessment with established reliability and validity, the BBS comprises 14 balance-related tasks performed in sitting, standing, and single-leg positions. Using a 5-point scoring system (0-4), the total score ranges from 0-56, with higher scores indicating better balance function.
- (4) **NIHSS Motor Subitems:** NIHSS includes two motor subitems for upper and lower extremity assessment, each using a 5-point scale (0-4), where higher scores indicate poorer motor function.

1.3.3 Activities of Daily Living Assessment

Modified Barthel Index (MBI): The MBI evaluates activities of daily living and has demonstrated improved reliability over previous versions. Consisting of 10 items rated on a 5-level scale (1=complete dependence, 5=complete independence), the total score ranges from 0-100, with higher scores indicating greater independence.

1.3.4 Psychosocial Assessment

Hospital Anxiety and Depression Scale (HADS): This reliable and valid clinical tool assesses anxiety and depression in patients. It comprises 7 anxiety items (HADS-A) and 7 depression items (HADS-D), each using a 4-point scale (0-3), with higher scores indicating more severe symptoms.

1.4 Participant Grouping Based on age classification standards from China's National Bureau of Statistics, participants were divided into elderly (≥65 years) and young/middle-aged (18-64 years) groups. General characteristics and post-stroke dysfunction profiles were compared between groups, and correlation analyses were performed.

1.5 Sample Size Calculation Referencing previous literature reporting a Spearman rank correlation coefficient of 0.413 between upper extremity FMA-S and FMA-M scores, sample size was calculated using PASS 15 software. With a test power of 0.90 and significance level of 0.05, the required sample size was

68 per group. This study enrolled 254 patients (112 elderly, 142 young/middle-aged), meeting sample size requirements.

1.6 Statistical Analysis SPSS 25.0 software was used for data analysis. Normality tests were performed first. Normally distributed continuous data with homogenous variance were expressed as mean \pm SD and analyzed using t-tests. Non-normally distributed or heteroscedastic data were expressed as median (P25, P75) and analyzed using Wilcoxon rank-sum tests. Categorical data were expressed as percentages and analyzed using χ^2 tests or Fisher's exact test. Correlations between somatosensory function and motor function, daily living abilities, and psychosocial function were analyzed using Spearman rank correlation. All tests were two-tailed with $\alpha=0.05$.

2. Results

2.1 Comparison of General Characteristics Between Age Groups The study included 254 patients with a mean age of (61.0 \pm 12.3) years; 194 (76.4%) were male and 60 (23.6%) female. Right-handedness was present in 243 cases (95.7%). Median stroke duration was 30.0 (17.0, 65.5) days. Ischemic stroke occurred in 163 patients (64.2%), and left hemiplegia was present in 132 (52.0%). The elderly group included 112 patients (44.1%), while the young/middle-aged group comprised 142 (55.9%).

Compared with the young/middle-aged group, the elderly group showed higher proportions of ischemic stroke and coronary artery disease but lower proportions of smokers and highly educated individuals (all $P<0.05$). No significant between-group differences were observed in gender, disease stage, ischemic stroke proportion, right-handedness, rehabilitation history, hypertension, alcohol consumption, residence, or lesion location (all $P>0.05$).

2.2 Comparison of Rehabilitation Assessment Indicators Between Age Groups Young/middle-aged patients scored higher on NIHSS sensory items than elderly patients ($Z=1.974$, $P=0.048$). No significant differences were found in other rehabilitation assessment indicators between groups (all $P>0.05$).

TABLE 1 General Information of Patients [n=254, n (%)]

TABLE 2 Comparison of General Information Between Age Groups [n (%)]

TABLE 3 Comparison of Rehabilitation Assessment Scores Between Age Groups [M(P25, P75), points]

2.3 Correlation Between Somatosensory and Motor Function **2.3.1 Overall Correlation:** FMA-S scores correlated positively with FMA-M scores in both elderly and young/middle-aged groups ($r_s=0.313$ and 0.171 , respectively; both $P<0.05$), while NIHSS sensory scores correlated negatively with FMA-M

scores ($r_s = -0.199$ and -0.177 , respectively; both $P < 0.05$). The absolute r_s values were greater in the elderly group than in the young/middle-aged group.

2.3.2 Upper Extremity Correlation: In the elderly group, FMA-S-UE, FMA-S-UE light touch, and FMA-S-UE proprioception scores correlated positively with FMA-M-UE, Brunnstrom upper extremity, and Brunnstrom hand scores (all $P < 0.05$), and negatively with NIHSS upper extremity scores (all $P < 0.05$).

In the young/middle-aged group, FMA-S-UE and FMA-S-UE light touch scores correlated positively with FMA-M-UE and Brunnstrom hand scores (both $P < 0.05$), while FMA-S-UE proprioception correlated positively with FMA-M-UE and Brunnstrom upper extremity scores (both $P < 0.05$). No other significant correlations were observed.

2.3.3 Lower Extremity Correlation: In the elderly group, FMA-S-LE, FMA-S-LE light touch, and FMA-S-LE proprioception scores correlated positively with FMA-M-LE, Brunnstrom lower extremity, and BBS scores (all $P < 0.01$), while FMA-S-LE and FMA-S-LE light touch scores correlated negatively with NIHSS lower extremity scores (both $P < 0.01$). The correlation between FMA-S-LE proprioception and NIHSS lower extremity scores was not significant ($P > 0.05$).

In the young/middle-aged group, FMA-S-LE and FMA-S-LE proprioception scores correlated positively with FMA-M-LE, Brunnstrom lower extremity, and BBS scores (all $P < 0.05$). FMA-S-LE light touch correlated positively with Brunnstrom lower extremity and BBS scores (both $P < 0.05$), while FMA-S-LE and FMA-S-LE proprioception scores correlated negatively with NIHSS lower extremity scores (both $P < 0.05$). Correlations between FMA-S-LE light touch and FMA-M-LE or NIHSS lower extremity scores were not significant ($P > 0.05$).

2.4 Correlation Between Somatosensory Function and Other Functional Domains

2.4.1 Activities of Daily Living: In the elderly group, FMA-S scores correlated positively with MBI scores ($P = 0.004$), while NIHSS sensory scores showed no significant correlation with MBI ($P > 0.05$). In the young/middle-aged group, neither FMA-S nor NIHSS sensory scores correlated significantly with MBI (both $P > 0.05$).

2.4.2 Psychosocial Function: In the elderly group, FMA-S scores correlated negatively with HADS-A and HADS-D scores ($P = 0.001$ and $P < 0.001$, respectively), while NIHSS sensory scores correlated positively with HADS-D scores ($P = 0.013$). The correlation between NIHSS sensory scores and HADS-A scores was not significant ($P > 0.05$). In the young/middle-aged group, no significant correlations were found between somatosensory measures and HADS scores (all $P > 0.05$).

3. Discussion

Stroke often results in multiple functional impairments, among which somatosensory dysfunction—frequently overlooked clinically—is closely related to motor recovery and other functional outcomes. Baseline studies provide reliable insights into disease status and dysfunction patterns in research populations. Previous research has demonstrated that baseline neurological assessment of somatosensory and motor systems predicts rehabilitation outcomes, with some investigators suggesting that somatosensory system measurements may have greater predictive value than motor system assessments. Most existing baseline studies on post-stroke somatosensory function have focused on single extremities (upper or lower), with limited research examining correlations across multiple limbs from different age perspectives. This study addresses this gap by analyzing differences in sensory, motor, and other functional indicators between age groups within one year post-stroke and exploring correlations between somatosensory function and motor function, daily living abilities, and psychosocial functioning.

Our analysis revealed between-group differences in coronary artery disease prevalence, likely related to the small sample size, statistical susceptibility, and age-related disease characteristics. The young/middle-aged group showed higher smoking rates, consistent with previous research linking smoking to increased stroke risk in younger populations. Educational level differences likely reflect generational and age-related cohort effects, though this did not affect assessment compliance as trained professionals provided explanations and guidance. The difference in NIHSS sensory scores may be attributed to the subscale's singular focus and coarse grading system.

In overall correlation analysis, both age groups demonstrated positive correlations between somatosensory and motor function, reflecting the sensorimotor interplay characteristic of post-stroke brain function. Environmental sensory information ascends through specific pathways to central brain regions for analysis and integration, with processed information descending to peripheral motor organs. However, the precise neural mechanisms underlying this sensorimotor integration remain unclear.

Upper extremity analysis revealed positive correlations between sensory and motor function in elderly patients, partially consistent with He et al.'s findings in subacute stroke patients. However, half of the upper extremity correlations were non-significant in the young/middle-aged group, possibly due to age stratification effects. Zhang et al. reported that older stroke patients exhibit more somatosensory abnormalities in the affected limbs compared to younger patients. Lower extremity analysis showed that while some specific correlations were non-significant within each age group, both groups demonstrated positive correlations between lower extremity sensory function and BBS scores, suggesting a relationship between sensory function and balance. This aligns with Gorst et al.'s findings linking lower limb somatosensory impairment to balance deficits and falls in chronic stroke patients. Other research has demon-

strated that acute-stage sensorimotor function predicts walking independence up to 90 days post-stroke.

Notably, only the elderly group showed significant correlations between somatosensory function and both activities of daily living and psychosocial function. Carey et al. found that somatosensory impairment significantly impacts daily activities and social participation in middle-aged and older adults, reducing activity engagement. Lin et al. demonstrated that somatosensory function can directly and indirectly influence daily living independence through sensorimotor pathways. To our knowledge, no previous studies have reported correlations between somatosensory and psychosocial function after stroke; our findings of age-related differences in this relationship warrant further investigation.

This study has limitations. Currently, China lacks objective, comprehensive somatosensory assessment scales, and our evaluation methods, though clinically common, remain relatively subjective. Additionally, our assessment focused on overall sensory performance and light touch/proprioception in upper and lower extremities; correlations between other composite or special sensory modalities and motor function require future exploration. Furthermore, our analysis was limited to age stratification; future large-sample studies should examine temporal phases post-stroke and lesion locations for multidimensional insights.

4. Full-Cycle Rehabilitation Considerations for Stroke Patients

Our findings indicate that compared to the young/middle-aged group, the elderly group showed more statistically significant correlations across overall, upper extremity, and lower extremity sensorimotor indicators, with generally larger absolute r s values. Moreover, only the elderly group demonstrated significant correlations between sensory function and both daily living abilities and psychosocial function. Overall, age appears to influence the relationships between somatosensory function and motor function, daily living activities, and psychosocial functioning.

Elderly patients often present with multimorbidity, multi-system functional decline, complex clinical manifestations, and prominent psychological factors, requiring rehabilitation professionals to consider comprehensive rehabilitation planning from a full-cycle perspective to optimize functional outcomes. For elderly patients in the acute and subacute phases, cardiopulmonary fitness should serve as the foundation for functional recovery, with attention to sensory impairment and its impact on other functional domains, emphasizing holistic rehabilitation addressing cardiopulmonary, sensory, motor, and psychosocial functions. For chronic-phase elderly patients who typically return to community and home settings, community rehabilitation resources should be fully utilized to promote health education, address fall risks, and emphasize comprehensive rehabilitation of daily living skills, psychological well-being, and social participation.

Beyond disease-stage considerations, full-cycle perspectives on geographical coverage, tiered healthcare delivery, and multidisciplinary team involvement are

equally critical. Currently, primary care lacks rehabilitation specialists, with general practitioners serving as core community rehabilitation providers. Given that general medicine addresses diverse diseases while rehabilitation medicine addresses diverse functional impairments, both share a “generalist” nature. Breaking down barriers between general practice and rehabilitation in community settings is essential. We should vigorously promote rehabilitation competency development and standardized training for general practitioners, forming comprehensive community rehabilitation teams with therapists, nurses, and disability support workers to deliver high-quality, accessible, and effective rehabilitation services for elderly patients in community and home settings.

5. Conclusion

Within one year post-stroke, somatosensory function correlates positively with motor function across age groups, with age potentially influencing the strength of these relationships and their associations with daily living and psychosocial function. Future research should explore underlying mechanisms to support comprehensive rehabilitation assessment, develop novel rehabilitation paradigms for somatosensory impairment, and increase clinical emphasis on sensory function recovery.

Author Contributions: Jia-Ying Lin was responsible for study design and implementation, statistical analysis, and manuscript writing. Shu-Ting Tu, Jia-Li Lin, Yu-Xin Zhou, and Xin-Yuan He conducted assessments and collected and organized sample data. Jie Jia supervised quality control and revision and assumed overall responsibility for the manuscript.

Conflicts of Interest: None declared.

Funding: Fujian Provincial Science and Technology Innovation Joint Fund Project (2021Y9130)

References

- [1] Wu SM, Wu B, Liu M, et al. Stroke in China: advances and challenges in epidemiology, prevention, and management[J]. *Lancet Neurol*, 2019, 18(4): 394-405. DOI:10.1016/S1474-4422(18)30500-3.
- [2] Jia J. Upper limb rehabilitation after stroke: hand-brain perception and hand-brain movement[J]. *Chin J Rehabil Med*, 2020, 35(4): 385-389. DOI:10.3969/j.issn.1001-1242.2020.04.001.
- [3] Connell LA, Lincoln NB, Radford KA. Somatosensory impairment after stroke: frequency of different deficits and their recovery[J]. *Clin Rehabil*, 2008, 22(8): 758-767. DOI:10.1177/0269215508090674.
- [4] Zandvliet SB, Kwakkel G, Nijland RHM, et al. Is recovery of somatosensory impairment conditional for upper-limb motor recovery

early after stroke?[J]. *Neurorehabil Neural Repair*, 2020, 34(5): 403-416. DOI:10.1177/1545968320907075.

[5] Carey LM, Matyas TA, Baum C. Effects of somatosensory impairment on participation after stroke[J]. *Am J Occup Ther*, 2018, 72(3): 7203205100p1-7203205100p10. DOI:10.5014/ajot.2018.025114.

[6] Umida T, Isa T, Nishimura Y. The somatosensory cortex receives information about motor output[J]. *Sci Adv*, 2019, 5(7): eaaw5388. DOI:10.1126/sciadv.aaw5388.

[7] Hagiwara K, Ogata K, Okamoto T, et al. Age-related changes across the primary and secondary somatosensory areas: an analysis of neuromagnetic oscillatory activities[J]. *Clin Neurophysiol*, 2014, 125(5): 1021-1029. DOI:10.1016/j.clinph.2013.10.005.

[8] Heft MW, Robinson ME. Somatosensory function in old age[J]. *J Oral Rehabil*, 2017, 44(4): 327-332. DOI:10.1111/joor.12488.

[9] Chinese Society of Neurology, Cerebrovascular Disease Group of Chinese Society of Neurology. Diagnostic points for major cerebrovascular diseases in China 2019[J]. *Chin J Neurol*, 2019, 52(9): 710-715. DOI:10.3760/cma.j.issn.1006-7876.2019.09.003.

[10] Sullivan KJ, Tilson JK, Cen SY, et al. Fugl-Meyer assessment of sensorimotor function after stroke: standardized training procedure for clinical practice and clinical trials[J]. *Stroke*, 2011, 42(2): 427-432. DOI:10.1161/STROKEAHA.110.592766.

[11] Kwah LK, Diong J. National institutes of health stroke scale (NIHSS)[J]. *J Physiother*, 2014, 60(1): 61. DOI:10.1016/j.jphys.2013.12.012.

[12] Hernández ED, Galeano CP, Barbosa NE, et al. Intra- and inter-rater reliability of Fugl-Meyer Assessment of Upper Extremity in stroke[J]. *J Rehabil Med*, 2019, 51(9): 652-659. DOI:10.2340/16501977-2590.

[13] Hernández ED, Forero SM, Galeano CP, et al. Intra- and inter-rater reliability of Fugl-Meyer Assessment of Lower Extremity early after stroke[J]. *Braz J Phys Ther*, 2021, 25(6): 709-718. DOI:10.1016/j.bjpt.2020.12.002.

[14] Safaz I, Yilmaz B, Yaşar E, et al. Brunnstrom recovery stage and motricity index for the evaluation of upper extremity in stroke: analysis for correlation and responsiveness[J]. *Int J Rehabil Res*, 2009, 32(3): 228-231. DOI:10.1097/MRR.0b013e32832a62ad.

[15] Downs S, Marquez J, Chiarelli P. The Berg Balance Scale has high intra- and inter-rater reliability but absolute reliability varies across the scale: a systematic review[J]. *J Physiother*, 2013, 59(2): 93-99. DOI:10.1016/S1836-9553(13)70161-9.

[16] Leung SOC, Chan CCH, Shah S. Development of a Chinese version of the Modified Barthel Index—validity and reliability[J]. *Clin Rehabil*, 2007, 21(10):

912-922. DOI:10.1177/0269215507077286.

[17] Ohura T, Hase K, Nakajima Y, et al. Validity and reliability of a performance evaluation tool based on the modified Barthel Index for stroke patients[J]. BMC Med Res Methodol, 2017, 17(1): 131. DOI:10.1186/s12874-017-0409-2.

[18] Yang Y, Ding RJ, Hu DY, et al. Reliability and validity of a Chinese version of the HADS for screening depression and anxiety in psychocardiological outpatients[J]. Compr Psychiatry, 2014, 55(1): 215-220. DOI:10.1016/j.comppsy.2013.08.012.

[19] National Bureau of Statistics. Age range for middle-aged and elderly populations in China[EB/OL]. [2023-11-16]. http://www.stats.gov.cn/hd/lyzx/zxgk/202207/t20220704_{1858761}.htm

[20] He JY, Li C, Lin JL, et al. Relationship between upper extremity sensory and motor function in stroke patients of different ages in subacute stage[J]. Chin J Stroke, 2021, 16(3): 259-264. DOI:10.3969/j.issn.1673-5765.2021.03.008.

[21] Ingemanson ML, Rowe JR, Chan V, et al. Somatosensory system integrity explains differences in treatment response after stroke[J]. Neurology, 2019, 92(10): e1098-e1108. DOI:10.1212/WNL.0000000000007041.

[22] Gorst T, Rogers A, Morrison SC, et al. The prevalence, distribution, and functional importance of lower limb somatosensory impairments in chronic stroke survivors: a cross sectional observational study[J]. Disabil Rehabil, 2019, 41(20): 2443-2450. DOI:10.1080/09638288.2018.1468932.

[23] Markidan J, Cole JW, Cronin CA, et al. Smoking and risk of ischemic stroke in young men[J]. Stroke, 2018, 49(5): 1276-1278. DOI:10.1161/STROKEAHA.117.018859.

[24] Jia J. Sensorimotor interplay in elderly stroke[J]. Chin J Stroke, 2022, 17(10): 1037-1039. DOI:10.3969/j.issn.1673-5765.2022.10.001.

[25] Zhang YH, Xu HR, Wang YC, et al. Pressure pain threshold and somatosensory abnormalities in different ages and functional conditions of post-stroke elderly[J]. BMC Geriatr, 2022, 22(1): 830. DOI:10.1186/s12877-022-03515-4.

[26] Hiratsuka K, Tamiya T, Matsuoka S, et al. Stroke impairment, balance, and cognitive status on admission predict walking independence up to 90 days post-stroke but their contributions change over time[J]. Int J Rehabil Res, 2023, 46(1): 61-69. DOI:10.1097/MRR.0000000000000561.

[27] Lin SH, Yang TR, Chuang IC, et al. Upper extremity motor abilities and cognitive capability mediate the causal dependency between somatosensory capability and daily function in stroke individuals[J]. Sci Rep, 2022, 12(1): 690. DOI:10.1038/s41598-021-04491-2.

[28] Jia J. Full-cycle rehabilitation for stroke[J]. Chin J Stroke, 2021, 16(3): 219-222. DOI:10.3969/j.issn.1673-5765.2021.03.001.

[29] Fan QW, Jia J. Translating research into clinical practice: importance of improving cardiorespiratory fitness in stroke population[J]. Stroke, 2020, 51(1):

361-367. DOI:10.1161/STROKEAHA.119.027345.

(Received: November 2, 2023; Revised: January 22, 2024)

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

Source: ChinaXiv –Machine translation. Verify with original.