Research Square

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Clinical Characteristics and Associated Factors of Musculoskeletal Pain After Stroke

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Abstract

Objective

The clinical characteristics of stroke patients complicated by musculoskeletal pain were analyzed. Reference data were provided for the prevention and treatment of musculoskeletal pain after stroke.

Methods

A retrospective analysis was performed on the clinical data of 387 patients with stroke who were admitted to the Department of Rehabilitation Medicine, Beijing Tiantan Hospital, from January to December 2025. The patients were divided into a control group without musculoskeletal pain (n = 276) and a study group with musculoskeletal pain (n = 111). Propensity score matching was conducted at a 1:1 ratio between the two groups. After matching, 111 patients were included in each group. The clinical characteristics of stroke patients with musculoskeletal pain were analyzed. Multivariate logistic regression was used to identify factors associated with the development of musculoskeletal pain after stroke.

Results

Among the 387 stroke patients, 111 developed musculoskeletal pain, corresponding to an prevalence of 28.68%. In the study group, the proportions of patients aged ≥ 65 years, with anxiety, with depression, with muscle tone > grade 1, with muscle strength ≤ grade 1, without proper limb positioning, with bed rest for ≥ 3 days, and without rehabilitation training were significantly higher than those in the control group ($P < 0.05$). Multivariate logistic regression showed that all of these variables were independent associated factors for musculoskeletal pain in stroke patients ($P < 0.05$).

Conclusion

In clinical practice, we should focus on patients with stroke complicated with musculoskeletal pain. Early and systematic rehabilitation after stroke is recommended.

Introduction

Stroke is a common cerebrovascular disease characterized by focal or global neurological dysfunction caused by disorders of cerebral circulation, and it is mainly classified into ischemic stroke and hemorrhagic stroke. The disease usually has an acute onset and is associated with high rates of disability and mortality. Therefore, patients' health, survival, and quality of life are markedly affected[1]. Various complications may occur after stroke, including musculoskeletal complications, visceral system complications, and neuropsychiatric complications. Among these complications, pain is frequently

observed and is defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. The presence of pain can significantly affect clinical treatment and rehabilitation outcomes in stroke patients. Post-stroke pain is generally classified into musculoskeletal pain and central pain[2, 3].

Musculoskeletal pain following stroke usually arises from injury to tissues such as muscles, bones, and joints. Common manifestations include shoulder pain, limb pain, neck pain, and low back pain[4]. This type of pain is distinct from pain caused directly by central nervous system injury, and differences are observed in clinical manifestations, pathogenesis, and treatment strategies[5]. The present study was designed to analyze the clinical characteristics of musculoskeletal pain after stroke and identify functioning and wellbeing factors independently associated with musculoskeletal pain. Such analysis may help reduce its prevalence and improve clinical management, and early prevention together with timely intervention is considered important for improving prognosis and rehabilitation outcomes in stroke patients.

1. Materials and methods

1.1 Clinical data

A retrospective analysis was conducted on the clinical data of 387 stroke patients admitted to the Department of Rehabilitation Medicine between January and December 2025. Among these patients, 301 had ischemic stroke and 86 had hemorrhagic stroke. The patients were divided into a control group without musculoskeletal pain (n = 276) and a study group with musculoskeletal pain (n = 111). Propensity score matching was performed at a 1:1 ratio using a nearest-neighbor matching algorithm with a caliper width of 0.2 of the standard deviation of the logit of the propensity score. The matching variables included age, sex, stroke type, and history of underlying diseases (hypertension, diabetes mellitus, and coronary heart disease). Balance between the two groups after matching was assessed using standardized mean differences, with all matched covariates showing standardized mean differences of less than 0.10, indicating adequate balance. The matching procedure was conducted using R software (version 4.3.0) with the "MatchIt" package, and 111 matched pairs were obtained after successful matching. The data presented in Table 1 represent the pre-matching comparison between the two groups. The inclusion criteria were as follows: (1) stroke was confirmed by CT or MRI; (2) for the study group, musculoskeletal pain (including shoulder pain, limb pain, neck pain, or low back pain) was present after stroke onset and assessed by the Visual Analogue Scale (VAS), with no musculoskeletal pain having been present before admission; (3) for the control group, no musculoskeletal pain was present before or after stroke onset; and (4) no other neurological lesions such as traumatic brain injury or brain tumors were identified. The exclusion criteria were as follows: the presence of central pain, visceral pain, or other forms of pain; pain caused by diabetic peripheral neuropathy, cervical spondylosis, lumbar disc disease, radiculitis, or nervous system tumors; and inability to cooperate with the study procedures. The study was approved by the Institutional Medical Ethics Review Committee (Ethics No. KY2025-321-03).

1.2 Methods

Baseline data were collected, including age, sex, smoking history, alcohol consumption history, history of underlying diseases, anxiety and depression status, pain intensity assessed by the Visual Analogue Scale[6], muscle tone (assessed using the Modified Ashworth Scale)[7], muscle strength (assessed using the Medical Research Council scale)[8], laboratory findings, imaging findings, and stroke type. Functional impairment in stroke patients with musculoskeletal pain was analyzed. The clinical characteristics of the two groups were compared. Multivariate logistic regression analysis was performed to identify independent associated factors for musculoskeletal pain in stroke patients. Preventive measures and rehabilitation treatment programs for musculoskeletal pain after stroke were also analyzed.

1.3 Statistical analysis

Statistical analysis was performed using GraphPad Prism 9.0. Categorical variables were expressed as number of cases (%), and between-group comparisons were performed using the chi-square test. Variables with statistical significance ($P < 0.05$) in the univariate chi-square analysis were subsequently included in the multivariate logistic regression analysis (forward stepwise selection) to identify independent associated factors and associated symptoms of post-stroke musculoskeletal pain. No sample size calculation was performed a priori; however, the sample size of 387 patients was considered adequate based on the rule of thumb of at least 10 events per variable in the logistic regression model. Missing data were minimal (< 5%) and handled by complete case analysis. P value of < 0.05 was considered statistically significant.

2 Results

2.1 Functional Impairment in Stroke Patients with Musculoskeletal Pain

Among the 387 stroke patients, 111 (28.68%) developed musculoskeletal pain. The age of these patients ranged from 33 to 84 years. Of these 111 patients, 62 (55.86%) were male and 49 (44.14%) were female. Ischemic stroke was observed in 68 patients (61.26%), whereas hemorrhagic stroke was observed in 43 patients (38.74%). Motor dysfunction was present in all patients with musculoskeletal pain (111/111, 100.00%). In addition, language dysfunction was observed in 42 patients (37.84%), cognitive dysfunction in 40 patients (36.04%), and swallowing dysfunction in 38 patients (34.23%). The mean Visual Analogue Scale (VAS) score for musculoskeletal pain in the study group was 5.2 ± 1.6 (range: 2–9), with shoulder pain being the most common type (62/111, 55.86%), followed by limb pain (28/111, 25.23%), neck pain (12/111, 10.81%), and low back pain (9/111, 8.11%).

2.2 Comparison of clinical characteristics between the two groups of patients

Comparison of clinical characteristics between the two groups showed that the prevalence of musculoskeletal pain was significantly higher in patients aged ≥ 65 years, in those with anxiety or depression, in those with muscle tone > grade 1, in those with muscle strength ≤ grade 1, in those without optimal limb positioning, in those with bed rest for ≥ 3 days, and in those who did not undergo rehabilitation training ($P < 0.05$). No significant differences were found between the two groups with respect to sex, smoking history, alcohol consumption history, hypertension, diabetes mellitus, coronary heart disease, or stroke type ($P > 0.05$). Detailed results are presented in Table 1.

Table 1
Comparison of clinical characteristics between the two groups of patients (after propensity score matching)

Indicator	Study group(cases)	Control group(cases)	χ^2	*P*
Gender(male/female)	62/49	60/51	0.073	> 0.05
Age(≥ 65years/<65years)	70/41	54/57	4.677	< 0.05
Stroke Type (Hemorrhagic/Ischemic)	43/68	35/76	1.265	> 0.05
Drinking(yes/no)	60/51	49/62	2.181	> 0.05
Smoking(yes/no)	68/43	55/56	3.081	> 0.05
Combined diabetes (yes/no)	74/37	60/51	3.690	> 0.05
Combined hypertension (yes/no)	86/25	83/28	0.223	> 0.05
Combined coronary heart disease (Yes/No)	63/48	54/57	1.464	> 0.05
Anxiety (Yes/No)	76/35	50/61	12.41	< 0.05
Depression (Yes/No)	72/39	45/66	13.17	< 0.05
Bedridden time≥3d (Yes/No)	42/69	18/93	13.16	< 0.05
Muscle tone > Grade 1 (Yes/No)	63/48	35/76	14.32	< 0.05
Muscle strength ≤ Grade 1 (Yes/No)	69/42	26/85	34.02	< 0.05
No rehabilitation (Yes/No)	33/78	11/100	13.72	< 0.05
No optimal positioning (Yes/No)	29/82	9/102	12.70	< 0.05

2.3 Analysis of Independent Influencing Factors of Musculoskeletal Pain in Stroke Patients

The results of the multivariate logistic regression analysis show that age ≥ 65 years, anxiety, depression, bedridden time ≥ 3 days, muscle tone > grade 1, muscle strength ≤ grade 1, improper limb positioning,

and lack of rehabilitation training were independent associated factors for musculoskeletal pain in stroke patients (P < 0.05). The forest plot of independent associated factors from multivariate logistic regression analysis is shown in Fig. 1 and the analysis of independent influencing factors of musculoskeletal pain in stroke patients is shown in Table 2.

Note

The solid squares represent the point estimates of odds ratios (OR), and the horizontal lines represent the 95% confidence intervals (95% CI). The red dashed vertical line indicates OR = 1 (no effect). All 95% CIs do not cross the reference line, indicating all listed factors are statistically significant independent associated factors.

Table 2
Analysis of independent influencing factors of musculoskeletal pain in stroke patients

Variable	β	Z	SE	OR	95%CI	*P*
Age	1.744	2.163	0.273	1.802	1.024 ~ 2.992	0.031
Anxiety	2.563	3.492	0.279	2.649	1.491 ~ 4.461	< 0.001
Depression	2.711	3.596	0.277	2.708	1.582 ~ 4.700	< 0.001
Bedridden time ≥ 3 days	3.103	3.493	0.324	3.145	1.666 ~ 5.968	< 0.001
Muscle tone > grade 1	2.842	3.740	0.280	2.850	1.650 ~ 4.959	< 0.001
Muscle strength ≤ grade 1	5.637	5.637	0.298	5.371	3.021 ~ 9.729	< 0.001
No optimal positioning	3.908	3.318	0.411	4.008	1.808 ~ 9.203	< 0.001
No rehabilitation	3.767	3.536	0.381	3.846	1.835 ~ 8.260	< 0.001

Note: The assignment of each factor was: Age (< 65 years = 0, ≥ 65 years = 1); Anxiety (no = 0, yes = 1); Depression (no = 0, yes = 1); Bedridden time ≥ 3 days (no = 0, yes = 1); Muscle tone > grade 1 (no = 0, yes = 1); Muscle strength ≤ grade 1 (no = 0, yes = 1); No optimal positioning (no = 0, yes = 1); No rehabilitation (no = 0, yes = 1).

3 Discussion

This study retrospectively analyzed the prevalence of musculoskeletal pain during hospitalization in patients admitted with stroke. A total of 387 patients were included, and musculoskeletal pain developed in 111 patients (28.68%). Once musculoskeletal pain occurs after stroke, physical and psychological

suffering is increased. The rehabilitation process is also adversely affected. In addition, the length of hospital stay may be prolonged, and the economic burden on patients and their families may be increased[5, 9].

In the study, age ≥ 65 years was identified as an independent associated factor for musculoskeletal pain in stroke patients. In elderly patients, post-stroke musculoskeletal pain may be understood as the result of a series of pathological reactions that arise when age-related physical decline is superimposed on acute brain injury[10]. It should not be regarded as a simple consequence of muscle strain, but rather as a complex process involving neurological dysfunction, biomechanical alteration, and degeneration of aging tissues[11]. Neurological dysfunction after stroke constitutes a unique pathological basis for pain development, as normal central control of body movement and posture is impaired. In elderly individuals, sensory perception may already be diminished. After stroke, sensory reduction or loss in the affected limb may further impair the perception of harmful stimuli, such as pressure or traction. As a result, poor posture may be maintained unconsciously, or minor injuries caused by bedding pressure or contact with bed rails may not be recognized in time. At the same time, the cumulative effects of physiological aging make elderly patients more vulnerable to musculoskeletal injury after stroke than younger patients[12]. Osteoporosis and soft tissue degeneration are common in older adults and are characterized by reduced bone strength. Even minor external forces during rehabilitation training or routine nursing care, such as traction during assisted movement, may therefore induce microfractures or soft tissue injury. Degeneration of articular cartilage and reduced ligament elasticity further impair joint cushioning and stability, and joint damage is therefore more likely to occur during abnormal movement[13]. In addition, muscle mass declines naturally with age. Severe muscle weakness may then further reduce joint protection and aggravate joint instability. Through the combined effects of these factors, susceptibility to musculoskeletal pain is markedly increased in elderly stroke patients.

Reports showed that anxiety and depression may increase the risk of musculoskeletal pain after stroke, and a vicious cycle of mutual aggravation may thereby be established[14, 15]. This is similar to our findings. In simple terms, anxiety and depression not only alter the way pain is processed in the brain, but also modify the body’s functional state and the patient’s recovery behavior. Depression and anxiety may lead to abnormal levels of neurotransmitters involved in emotional regulation and pain modulation, particularly serotonin and norepinephrine. As a result, the sensitivity of the nervous system to pain may be increased, and the pain threshold may be reduced. Under such conditions, the same degree of muscle tension or joint stress may be perceived as more severe pain when mood is depressed. Prolonged negative emotional states may also induce functional changes in the central nervous system and contribute to central sensitization. In this state, the nervous system becomes hyperexcitable, and even normal touch or otherwise harmless stimuli may be misinterpreted as pain, thereby rendering musculoskeletal pain persistent and difficult to relieve[16, 17].

Spasticity is a common complication after stroke. The pain caused by spasticity results from sustained involuntary muscle contractions, imposing a significant mechanical burden and causing damage to bones, joints, and soft tissues[18]. After a stroke, the brain's ability to control spinal reflexes is weakened.

This leads to hyperactive stretch reflexes and leaves muscles in a state of sustained tension or even spasm. Spastic muscles act like a stretched rubber band, continuously pulling on tendons, ligaments, and joint capsules. Muscles compress internal blood vessels when they remain in a contracted state for a prolonged period, leading to poor local circulation and the accumulation of metabolic waste. This in turn causes soreness or severe spasmodic pain. Spasticity disrupts the balance of muscle forces around the joint by producing an imbalance between agonist and antagonist muscles, and the joint is thereby maintained in an abnormal position for prolonged periods, which may subsequently lead to a series of secondary injuries. If spasticity is not effectively controlled, muscles and tendons may gradually shorten and undergo fibrotic change because of chronic insufficient stretching. [19, 20]Previous studies have suggested that both spasticity and pain are associated with an imbalance between excitatory and inhibitory neurotransmission within the central nervous system, particularly with excessive excitatory amino acids such as glutamate and insufficient inhibitory amino acids such as γ-aminobutyric acid. This imbalance may not only increase muscle excitability and induce spasticity, but may also lower the pain threshold and increase pain sensitivity. In addition, partial overlap has been reported between the neuronal networks involved in spasticity and the pathways responsible for pain transmission, and amplification of pain signaling is therefore often observed when spasticity develops[20]. Proper limb positioning is regarded as an important antispastic intervention. In patients with paralysis or abnormal muscle tone, prolonged maintenance of an incorrect limb position may cause continuous mechanical stress and pathological changes in joints, muscles, and ligaments. In the early stage after stroke, especially during the flaccid phase, the muscles on the affected side are often unable to provide adequate support, and muscle strength may be lower than grade 2. Under such conditions, if the limb is allowed to hang passively or is positioned improperly, gravitational force may act directly on the lax joint capsule and ligaments.

Prolonged absence of rehabilitation training after stroke, particularly in patients with paralysis, may initiate a series of pathological changes that progress from muscle atrophy to joint stiffness and ultimately to musculoskeletal pain[21]. During extended bed rest, active contraction of the affected limb is markedly reduced or absent, muscle protein synthesis is decreased, and progressive muscle atrophy consequently occurs[22]. Muscle strength is thereby substantially diminished, and effective joint support and stabilization can no longer be maintained.[3] For example, when the muscles surrounding the shoulder joint, such as the deltoid and supraspinatus, undergo atrophy, support of the humeral head is reduced, shoulder subluxation may develop, and shoulder pain may subsequently occur. At the same time, in the absence of regular maintenance of joint mobility, the joint capsule, ligaments, and tendons may gradually shorten, stiffen, and adhere. These structural changes are referred to as joint contracture and may severely restrict the range of motion. When passive movement is later attempted, the stiffened tissues are forcibly stretched, and severe pain may be induced. A common manifestation is adhesive capsulitis, in which pain is typically aggravated during arm elevation and abduction[23]. In addition, muscle contraction normally facilitates venous and lymphatic return through a pump-like mechanism, but this function is lost during prolonged immobilization. Impaired circulation may therefore lead to distal limb swelling, especially in the hands and feet. The resulting increase in interstitial pressure may

stimulate nerve endings and produce distension and pain. Bone tissue also requires weight-bearing and muscle traction to maintain normal density. When such stimulation is absent for a prolonged period, loss of inorganic bone salts may occur, leading to disuse osteoporosis. Bone strength is thereby reduced, and even slight external force or traction may result in microfracture or periosteal traction pain, particularly in weight-bearing regions such as the spine and hip.

Therefore, early prevention of musculoskeletal pain is of major importance during stroke rehabilitation[24]. Under professional guidance, early positioning and range-of-motion training may effectively reduce the occurrence of shoulder pain and spasticity. Once musculoskeletal pain has developed, timely pharmacological treatment should be initiated. Oral nonsteroidal anti-inflammatory drugs or topical analgesics are generally regarded as first-line options. For spastic pain, antispastic agents may be administered orally or by local injection, such as botulinum toxin[19]. Interventional and physical therapies may also be applied. Injection of corticosteroids and local anesthetics into trigger points or joints may provide rapid short-term pain relief, and nerve block techniques, such as suprascapular nerve block, may be effective for shoulder pain. [5]Physical modalities include neuromuscular electrical stimulation, ultrashort-wave therapy, magnetotherapy, extracorporeal shock wave therapy, and ultrasound therapy[25]. After pain relief has been achieved, standardized and individualized rehabilitation training remains fundamental for functional recovery and prevention of recurrence. In addition, psychological status should be closely monitored throughout treatment, because assessment and management of emotional disturbance should be considered a core component of pain management, and an integrated strategy addressing both physical and psychological factors should therefore be adopted.

Limitations of this study should be acknowledged. First, pain is a highly subjective experience, and the temporal relationship between influencing factors and pain onset could not be definitively determined, limiting causal inference. Second, this retrospective, single-center study was prone to selection bias and residual confounding effects. Third, the present analysis did not fully characterize pain heterogeneity, including pain location, intensity, functional impairment, and detailed rehabilitation characteristics, which may affect the accuracy and generalizability of the results. Therefore, the findings should only be interpreted as correlational rather than causal. This study serves only as a preliminary exploration, and further comprehensive, prospective, and multicenter investigations are warranted to validate our conclusions.

4 Conclusion

In clinical practice, we should focus on stroke patients' musculoskeletal pain. In stroke patients aged ≥ 65 years, or in those with anxiety, depression, muscle tone > grade 1, muscle strength ≤ grade 1, improper limb positioning, bed rest for ≥ 3 days, or no rehabilitation training, increased vigilance should be maintained for the occurrence of musculoskeletal pain. Early and systematic rehabilitation after stroke is recommended.

Declarations

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Consent for publication

Not Applicable

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Author Contribution

CL: Methodology, Writing – original draft. PD: Writing – review & editing, Data curation. XT: Software, Writing – review & editing. YZ: Writing – review & editing, Methodology. YZ: Writing – review & editing, Project administration. HH: Writing – review & editing. DZ: Formal analysis, Writing – review & editing. HY: Supervision, Project administration, Funding acquisition, Writing – review & editing

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the institutional medical ethics review committee (Ethics Approval Number: KY2025-321-03). The studies were conducted in accordance with the local legislation, institutional requirements and the Declaration of Helsinki. Given the retrospective nature of this study, the requirement for written informed consent was waived by the institutional medical ethics review committee. Patient data were anonymized and de-identified prior to analysis.

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Figures

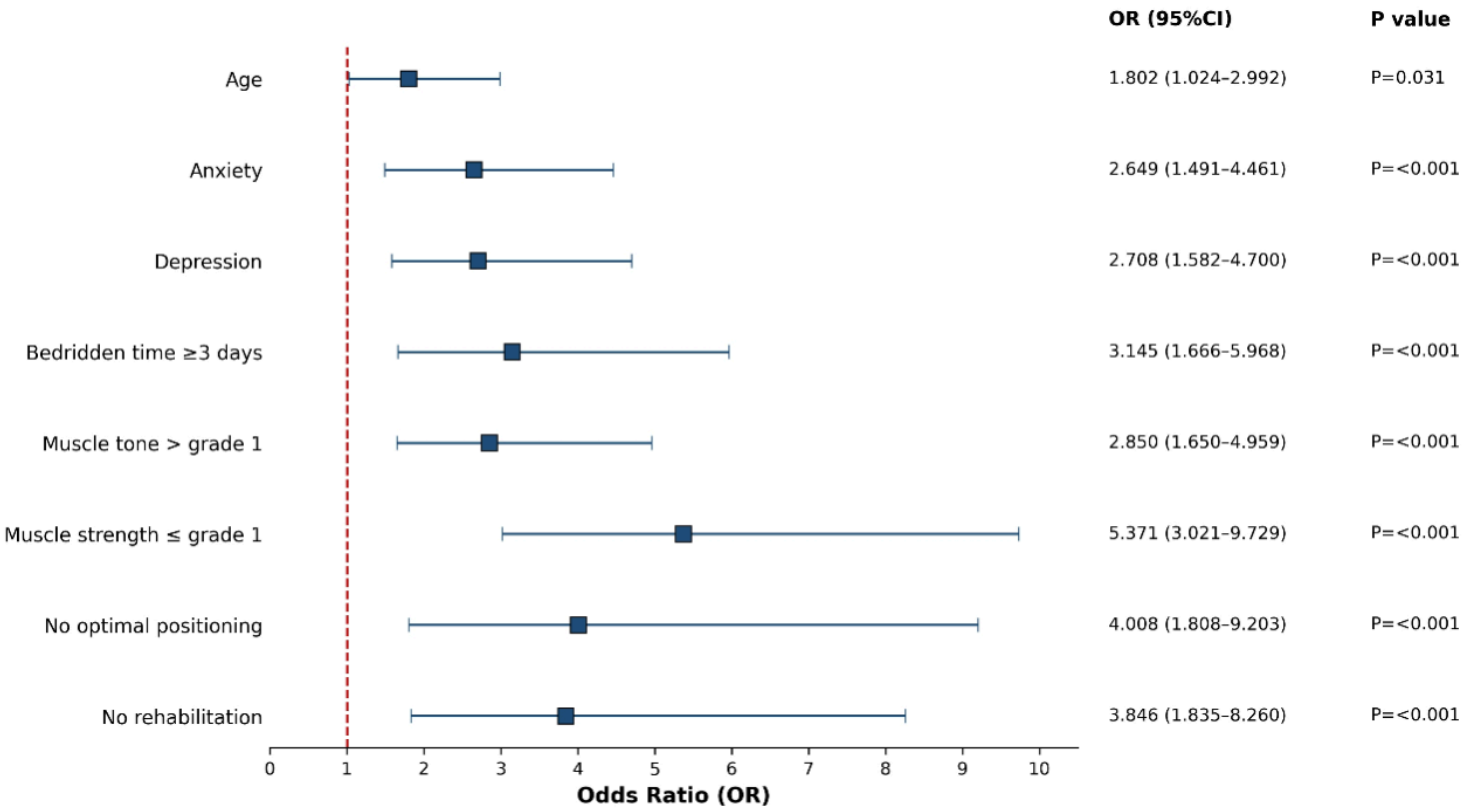


Figure 1

Forest plot of independent associated factors from multivariate logistic regression analysis.

Note：The solid squares represent the point estimates of odds ratios (OR), and the horizontal lines represent the 95% confidence intervals (95% CI). The red dashed vertical line indicates OR = 1 (no effect). All 95% CIs do not cross the reference line, indicating all listed factors are statistically significant independent associated factors.

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- STROBEcohortstudychecklist.docx