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The prevalence and factors associated with neck and low back pain in patients with stroke: insights from the CHARLS

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Abstract

Background Although stroke is prevalent among Chinese, individuals with stroke may become more disabling if they have concomitant neck pain (NP) and low back pain (LBP). However, the prevalence and factors associated with post-stroke spinal pain among Chinese remain unknown. The current study used the 2018 cohort data from the China Health and Aged Care Tracking Survey (CHARLS) to determine the prevalence and factors associated with increased post-stroke NP and LBP in China.

Methods The CHARLS study was conducted on four cohorts of nationally representative samples of individuals aged 45 years and above from 30 provincial-level administrative units in China. We used data from the 2018 cohort of the CHARLS survey to determine the prevalence and factors associated with NP and LBP in the non-stroke and post-stroke populations. Participants aged 45 years or older who reported to have NP, and/or LBP were identified. The study was statistically analyzed using t-test, and ANOVA analysis of variance. A multiple logistic regression model was used to identify factors significantly associated with NP and/or LBP in the non-stroke and post-stroke populations.

Results A total of 19,816 individuals participated in the 2018 survey. The final inclusion of 17,802 subjects who met the criteria included 16,197 non-stroke and 885 stroke participants. The prevalence of NP and LBP in non-stroke population was 17.80% (95% CI: 17.21–18.39) and 37.22% (95% CI: 36.47–37.96), respectively. The prevalence of NP and LBP in the target stroke population was 26.44% (95% CI: 23.53–29.35) and 45.42% (95% CI: 42.14–48.71), respectively, and the difference was statistically significant ($p < 0.05$). Factors associated with increased post-stroke NP included female, short sleep duration, long lunch break, physical dysfunction, and depression. Factors associated with increased post-stroke LBP included female, comorbidities of two or more chronic diseases, physical dysfunction, and depression.

Conclusion The current study highlighted the high prevalence of post-stroke neck pain (26.44%) and LBP (45.42%) in China. While slightly different associated factors were found to be associated with a higher prevalence of post-stroke NP and LBP, female and individuals with more physical dysfunction or depression were more likely to experience post-stroke spinal pain. Clinicians should pay more attention to vulnerable individuals and provide pain management measures.

Keywords Stroke, Neck pain, Low back pain, Population-based study, Prevalence

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Introduction

Stroke is one of the non-communicable diseases causing massive economic and medical burdens in China. Stroke has been the leading cause of death in China since 2015 [1], and it accounts for almost one-third of all stroke deaths worldwide [2]. As a major cardiovascular disease, stroke poses a major threat to the physical health of Chinese people. With the intensification of population aging in the past 30 years, the overall incidence of stroke in China has been on the rise [3]. The incidence of cerebrovascular disease events in China is projected to increase by approximately 50% by 2030 as compared to the percentage in 2010 [4]. Stroke is known to cause chronic pain and physical dysfunction in these patients, which seriously affects their quality of life, and increases the medical burden on individuals and the society [5–8]. As the course of stroke prolongs and the condition progresses, the risk of complications in patients with stroke greatly increases [9–14].

Pain is a common post-stroke complication that leads to high morbidity, with approximately 10%–45.8% of stroke survivors experiencing some form of pain [15, 16]. The prevalence of pain in the subacute (42.73%) and chronic (31.90%) phases is higher than that in the acute phase (14.06%) [17]. However, pain is often overlooked by clinicians because of patients' cognitive impairment or suboptimal communication skills. A retrospective study found that more than one-third of stroke patients with pain did not receive pain treatment [18]. Post-stroke pain can hinder the rehabilitation process and reduce the quality of life of stroke survivors [19–22]. Given the high prevalence of post-stroke pain, a growing number of researchers have studied post-stroke shoulder pain and central post-stroke pain [23, 24]. However, post-stroke can also affect other body parts, such as neck and low back, although the prevalence and factors associated with these pain remain uncertain in China. As such, a nationwide population-based study is warranted to investigate the prevalence and factors associated with NP and LBP in the stroke population in China, which may help identify high risk individuals for timely intervention. Using data from the 2018 China Health and Retirement Longitudinal Study (CHARLS), this study aims to: (1) estimate the prevalence of NP and LBP in Chinese stroke populations aged 45 and above; (2) assess the associated factors of NP and LBP in Chinese stroke populations aged 45 and above.

Methods

Study participants

This study used data from the CHARLS Project, which is sponsored by the National School of Development of Peking University and jointly implemented by the China Social Science Survey Center of Peking University and the Communist Youth League Committee of Peking University. CHARLS adopts strict random sampling. The sampling process involved four stages [25]. At the first stage, a random sample of 150 districts and counties was selected using the probability proportional to size (PPS) method and stratified by regions, urban and rural areas, counties nationwide (excluding Tibet), and GDP per capita. At the second stage, three village level units were randomly selected from each county-level unit using the PPS method. At the third stage, a sample of 24 households was randomly selected based on geographic locations and each PSU list. At the fourth stage, one resident at least 45 years old was randomly selected from a family and interviewed together with their spouse. In consideration of the complexity of the CHARLS survey design and the lack of response rate, weighted values were constructed based on sampling and response probabilities, which were provided by the CHARLS database.

The national baseline survey began in 2011, and follow-up surveys were conducted in 2013, 2015, and 2018. As of 2018, the CHARLS sample had a total of 19,816 respondents from 12,400 households. The present study was a secondary analysis of data from CHARLS. The National Institute of Development Studies at Peking University keeps all data collected by CHARLS, and the dataset is available at http://charls.pku.edu.cn/pages/data/111/zh-cn.

This study analyzed data from 2018 CHARLS cohort. The inclusion criteria were : (1) aged 45 years and above, (2) having information on NP and LBP, and (3) having information on stroke. The exclusion criteria were those with missing other covariates. Of the 19,816 participants included in the 2018 CHARLS cohort, 17,082 (16,197 non-stroke patients and 885 stroke patients) were ultimately included after excluding covariates with missing values. The detailed screening process is shown in Fig. 1.

Measures of demographic characteristics

Trained interviewers used a structured questionnaire to collect participants ' date of birth, sex, area of residence (rural or urban), and level of education (illiterate, primary school and below, and secondary school and above).

Measures of health status and functioning

The interviewers used a structured questionnaire to collect information on the participants' sleep duration, nap duration, drinking status (no or yes), physical dysfunction (no or yes), disability (no or yes), impairment in activities of daily living (ADL; no or yes), impairment in instrumental activities of daily living (IADL; no or yes), and physical activity and chronic diseases. In addition, the interviewers asked the participants if they used the following ways to treat or manage post-stroke

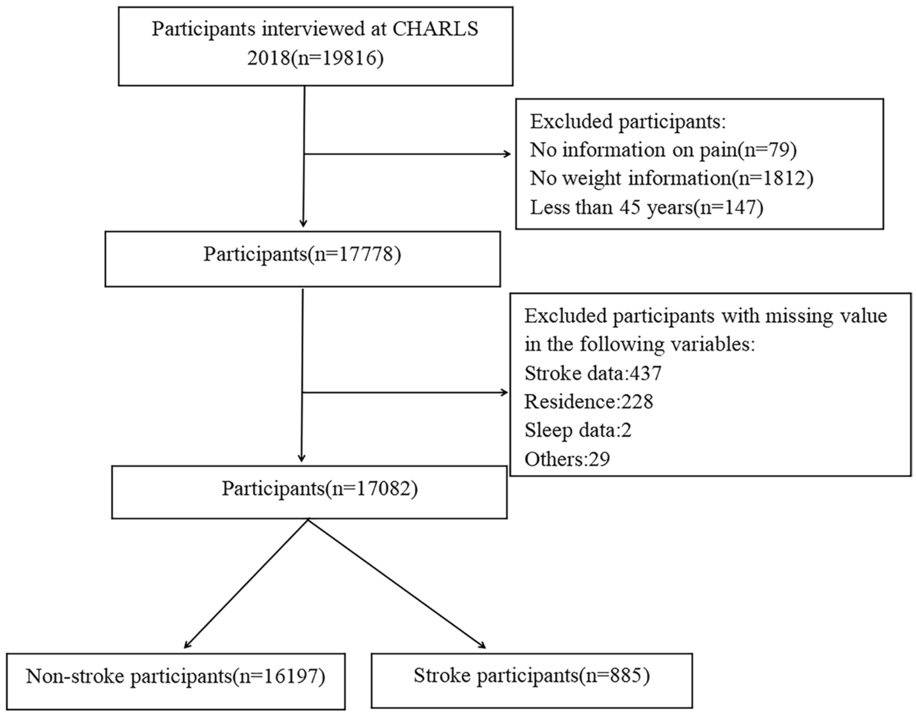

Fig. 1 Study flowchart

complications: taking Chinese medicine, taking Western medicine, physical therapy, acupuncture, and rehabilitation therapy.

Measures of cognition and health insurance use

The interviewers collected the participants ' depression status (no or yes) and health insurance information (no or yes). CHARLS used the Center for Epidemiological Studies Depression Scale (CESD- 10) to measure the psychological status of middle- aged and older people, and those with a total CESD- 10 self-assessment score of 11 and above were classified as having depression [26].

Outcome measures

Stroke event was assessed by the following question: "Have you been diagnosed with stroke by a doctor?". Participants who reported stroke were defined as having stroke. Pain event was assessed by the following questions: "Are you often troubled with any body pains?" and "What part of your body do you feel pain?". Participants were defined as having NP and LBP if they answered NP and LBP.

Statistical analysis

Descriptive statistics were used to report the demographic data. Categorical variables were represented by numbers and percentages, and the continuous variables were represented by means and standard deviations. Further, demographics and covariates of the stroke and non-stroke populations with and without NP and LBP were compared. Comparisons between groups were made using independent samples t-tests or analysis of variance (ANOVA). The test level $\alpha=0.05$, $P<0.05$ indicates that the difference is statistically significant. Individual factors associated with NP and LBP were determined using one-way logistic regression analysis. Covariates with p-values < 0.2 in the univariate analysis were entered into the multiple logistic regression model with stepwise reverse exclusion. The significance level was set at 0.05 to investigate factors associated with NP and LBP in stroke and non-stroke populations. The odds ratio (OR) and the corresponding 95% confidence interval (CI) was calculated. Sampling weights were applied to the study population to represent the Chinese population without bias. All analyses were conducted using Stata/MP17 software.

Results

The characteristics of participants are shown in Table 1. There were 885 stroke patients, accounting for 5.18% of the total. Their average age was 67.1 (9.1) years. As shown in Table 2, the prevalence of NP and LBP in non-stroke population was 17.80% (95% CI: 17.21–18.39) and 37.22% (95% CI: 36.47–37.96), respectively. The prevalence of NP and LBP in the target stroke population

Table 1 Baseline characteristics of the distribution of all participants by stroke status in Charls 2018

	All study participants (n = 17,082)	No stroke (n = 16,197)	Stroke (n = 885)
Participants distribution	100%	94.82%	5.18%
Mean age, years	62.57(9.85)	62.32(9.83)	67.11(9.11)
Age, years			
45–54	4352(25.48%)	4270(26.36%)	82(9.27%)
55–64	5795(33.92%)	5535(34.17%)	260(29.38%)
65–74	4683(27.41%)	4332(26.75%)	351(39.66%)
≥ 75	2252(13.18%)	2060(12.72%)	192(21.69%)
Gender			
female	9024(52.83%)	8567(52.89%)	457(51.64%)
male	8058(47.17%)	7630 (47.11%)	428(48.36%)
Residence			
rural	13,077(76.55%)	12,424(76.71%)	653(73.79%)
urban	4005(23.45%)	3773(23.29%)	232(26.21%)
Education			
illiterate	4040 (23.65%)	3795 (23.43%)	245 (27.68%)
elementary school or below	7361 (43.09%)	6982 (23.43%)	379 (42.82%)
secondary school and above	5681 (33.26%)	5420 (33.46%)	261 (29.49%)
Disability			
no	14,984 (87.72%)	14,356 (88.63%)	628 (70.96%)
yes	2098 (12.28%)	1841 (11.37%)	257 (29.04%)
Chronic Disease			
0	9993 (58.5%)	9643 (59.54%)	350 (39.55%)
1	4637 (27.15%)	4355 (26.89%)	282 (31.86%)
2	2452 (14.35%)	2199 (13.58%)	253 (28.59%)
Low back pain			
no	10,652 (62.36%)	10,169 (62.78%)	483 (54.58%)
yes	6430 (37.64%)	6028 (37.22%)	402 (45.42%)
Neck pain			
no	13,965(81.75%)	13,314(82.2%)	651(73.56%)
yes	3117(18.25%)	2883(17.8%)	234(26.44%)
Sleep Time			
≤ 6h	9347(54.72%)	8838(54.57%)	509(57.51%)
6-8h	6096(35.69%)	5821(35.94%)	275(31.07%)
≥ 8h	1639(9.59%)	1538(9.5%)	101(11.41%)
Nap Time			
≤ 30min	9494(55.58%)	9039(55.81%)	455(51.41%)
31-60min	4287(25.1%)	4087(25.23%)	200(22.6%)
≥ 61min	3301(19.32%)	3071(18.96%)	230(25.99%)
Dyspraxia			
no	5090(29.8%)	4986(30.78%)	104(11.75%)
yes	11,992(70.2%)	11,211(69.22%)	781(88.25%)
Depressive			
no	11,268(65.96%)	10,762(66.44%)	506(57.18%)
yes	5814(34.04%)	5435(33.56%)	379(42.82%)
Drink			
no	11,366(66.54%)	10,683(65.96%)	683(77.18%)
yes	5716(33.46%)	5514(34.04%)	202(22.82%)
Insurance			
no	512(3%)	499(3.08%)	13(1.47%)

Table 1 (continued)

	All study participants (*n* = 17,082)	No stroke (*n* = 16,197)	Stroke (*n* = 885)
yes	16,570(97%)	15,698(96.92%)	872(98.53%)
Number of pain			
None	6669(39.04%)	6414(39.6%)	255(28.81%)
One	2062(12.07%)	1966(12.14%)	96(10.85%)
Two	1520(8.9%)	1453(8.97%)	67(7.57%)
Three	1278(7.48%)	1210(7.47%)	68(7.68%)
Four or above	5553(32.51%)	5514(31.82%)	399(45.08%)
ADL			
no	13,905(81.4%)	13,397(82.71%)	508(57.4%)
yes	3177(18.6%)	2800(17.29%)	377(42.6%)
ADL_ins			
no	12,987(76.03%)	12,561(77.55%)	426(48.14%)
yes	4095(23.97%)	3636(22.45%)	459(51.86%)
Activity_intensive			
Less than 10 min	11,600(67.91%)	10,895(67.27%)	705(79.66%)
10 min to 30 min	168(0.98%)	157(0.97%)	11(1.24%)
30 min to 2 h	1001(5.86%)	955(5.9%)	46(5.2%)
2 h to 4 h	1249(7.31%)	1219(7.53%)	30(3.39%)
More than 4 h	3064(17.94%)	2971(18.34%)	93(10.51%)
Activity_moderate			
Less than 10 min	8705(50.96%)	8146(50.29%)	559(63.16%)
10 min to 30 min	1025(6%)	967(5.97%)	58(6.55%)
30 min to 2 h	3425(20.05%)	3276(20.23%)	149(16.84%)
2 h to 4 h	1946(11.39%)	1876(11.58%)	70(7.91%)
More than 4 h	1981(11.6%)	1932(11.93%)	49(5.54%)
Activity_light			
Less than 10 min	2980(17.45%)	2769(17.1%)	211(23.84%)
10 min to 30 min	1650(9.66%)	1567(9.67%)	83(9.38%)
30 min to 2 h	6923(40.53%)	6574(40.59%)	349(39.44%)
2 h to 4 h	3199(18.73%)	3044(18.79%)	155(17.51%)
More than 4 h	2330(13.64%)	2243(13.85%)	87(9.83%)
Taking Chinese traditional medicine			
no	16,895(98.91%)	16,197(100%)	698(78.87%)
yes	187(1.09%)	0(0%)	187(21.13%)
Taking Western modern medicine			
no	16,541(96.83%)	16,197(100%)	344(38.87%)
yes	541(3.17%)	0(0%)	541(61.13%)
Physical therapy			
no	17,042(99.77%)	16,197(100%)	845(95.48%)
yes	40(0.23%)	0(0%)	40(4.52%)
Acupuncture and moxibustion			
no	17,013(99.6%)	16,197(100%)	816(92.2%)
yes	69(0.4%)	0(0%)	69(7.8%)
Occupational therapy			
no	17,037(99.74%)	16,197(100%)	840(94.92%)
yes	45(0.26%)	0(0%)	45(%)
Other treatments, please spcify			
no	16,997(99.5%)	16,197(100%)	800(90.4%)
yes	85(0.5%)	0(0%)	85(9.6%)

Table 1 (continued)

	All study participants ($n = 17{,}082$)	No stroke ($n = 16{,}197$)	Stroke ($n = 885$)
None treatment			
no	16,850(98.64%)	16,197(100%)	653(73.79%)
yes	232(1.36%)	0(0%)	232(26.21%)

was 26.44% (95% CI: 23.53–29.35) and 45.42% (95% CI: 42.14–48.71), respectively, and the difference was statistically significant ($p < 0.05$) (See appendix tables S1,S2). In addition, in different age groups, depressed and non-depressed people, the NP and LBP in the stroke population were still higher than those in the non-stroke population. The prevalence of post-stroke NP was higher in females (33.70%, 95% CI: 29.35–38.05) than in males (18.69%, 95% CI: 14.98–22.40). The prevalence of post-stroke LBP was higher in females (57.33%, 95% CI: 52.78–61.88) than in males (32.71%, 95% CI: 28.25–37.17). Significant between-sex differences in prevalence rates of post-stroke NP and LBP existed in all age groups. The rural residents had a lower prevalence of post-stroke NP (26.19%, 95% CI: 22.81–29.57) than the urban counterparts (27.16%, 95% CI: 21.39–32.92), although the rural residents had a higher prevalence of post-stroke LBP (46.40%, 95% CI: 42.57–50.24) as compared to the urban residents (42.67%, 95% CI: 36.26–49.08).

In addition, the prevalence of NP (35.36%, 95% CI: 30.52–40.19) and LBP (58.58%, 95% CI: 53.59–63.56) in the stroke population with depression was significantly higher than that in the non-depressed population (for NP: 19.76%, 95% CI 16.28–23.24; for LBP: 35.57%, 95% CI 31.39–39.76). The prevalence of NP and LBP was also significantly higher in the females with depression. Those with physical disability (30.35%, 95% CI: 24.69–36.01), comorbidities with other chronic diseases (33.20%, 95% CI: 27.36–39.04), short sleep duration (33.99%, 95% CI: 29.86–38.12), physical dysfunction (28.55%, 95% CI: 25.38–31.73), ADL impairment (32.63%, 95% CI: 27.87–37.38), and IADL impairment (30.50%, 95% CI: 26.27–34.73) had a high prevalence of post-stroke neck pain. Similar results were found in the post-stroke LBP population. The prevalence of neck pain (16.86%, 95% CI 12.29–21.43) and low back pain (32.18%, 95% CI 26.48–37.89) was significantly lower in the stroke population with higher education (secondary school and above; Table 2). The relationship between stroke participants' different levels of education, different residential areas, and depression status and their NP or LBP status is detailed in Tables S3, S4, and S5 in the Appendix.

The significant factors associated with NP in the stroke participants identified by logistic regression modeling are shown in Fig. 2. Female (OR = 1.76, 95% CI: 1.14–2.74), sleep duration of less than 6 h (OR = 2.15, 95% CI: 1.41–3.29), lunch breaks for more than 60 min (OR = 1.79, 95% CI: 1.03–3.13), physical dysfunction (OR = 2.31, 95% CI: 1.04–5.12), and depression (OR = 1.54, 95% CI: 1.07–2.23) were factors associated with the presence of NP in the stroke population. Sleeping less than 6 h (OR = 2.30, 95% CI: 1.29–4.08) and depression (OR = 1.75, 95% CI: 1.07–2.85) were factors associated with NP in the female stroke population. ADL disorder (OR = 2.42, 95% CI: 1.19–4.91) was an independent factor associated with NP in males with stroke, whereas high education level (junior high school and above; OR = 0.35, 95% CI: 0.14–0.87) was associated with less likelihood of having NP. The detailed results of subgroup multifactorial regression analyses based on the area of residence, number of comorbidities, depressive symptoms, and education level are presented in the Appendix (Figures S1–S4).

The significant factors associated with LBP in participants with stroke identified by the logistic regression model are shown in Fig. 3. Female (OR = 2.48, 95% CI: 1.71–3.59), comorbidities of two or more chronic diseases (OR = 2.08, 95% CI: 1.38–3.12), physical dysfunction (OR = 3.52, 95% CI: 1.79–6.95), and depression (OR = 2.33, 95% CI: 1.66–3.30) were factors associated with the presence of LBP in the stroke population. The subgroup of sex showed that physical dysfunction (OR = 4.22, 95% CI: 1.27– 14.01), depression (OR = 3.40, 95% CI: 2.16–5.36), and IADL disorder (OR = 1.87, 95% CI: 1.07–3.25) were factors associated with LBP in female participants with stroke. Comorbidities with two or more chronic diseases (OR = 3.03, 95% CI: 1.65–5.58), physical dysfunction (OR = 3.04, 95% CI: 1.36–6.77), depression (OR = 1.81, 95% CI: 1.08–3.02), and ADL disorder (OR = 2.70, 95% CI: 1.35–5.42) were factors associated with the presence of LBP in the male stroke population. The results of the subgroup multifactorial regression analyses based on the area of residence, number of comorbid chronic diseases, depressive symptoms, and education level are displayed in Figures S5–S8 in the Appendix.

The factors associated with NP and LBP in the non-stroke population are detailed in Appendix Figures S9–S18.

Table 2 Prevalence of neck and low back pain by gender in the general Chinese population aged 45 years and above

	Non-stroke Neck pain						Non-stroke Low back pain					
	Overall		Female		Male		Overall		Female		Male	
	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)
	16,197	17.80%(17.21–18.39)	8567	23.43%(22.53–24.32)	7630	11.48%(10.77–12.20)	16,197	37.22%(36.47–37.96)	8567	43.75%(42.70–44.80)	7630	29.88%(28.85–30.91)
Age, years												
45–54	4270	18.03%(16.88–19.19)	2401	42.40%(40.42–44.38)	1869	29.59%(27.52–31.66)	4270	36.79%(35.34–38.24)	2401	42.40%(40.42–44.38)	1869	29.59%(27.52–31.66)
55–64	5535	18.68%(17.65–19.71)	2880	42.92%(41.11–44.73)	2655	30.02%(28.27–31.76)	5535	36.73%(35.46–38.00)	2880	42.92%(41.11–44.73)	2655	30.02%(28.27–31.76)
65–74	4332	17.84%(16.70–18.98)	2211	45.77%(43.69–47.85)	2121	30.08%(28.13–32.03)	4332	38.09%(36.64–39.54)	2211	45.77%(43.69–47.85)	2121	30.08%(28.13–32.03)
≥ 75	2060	14.85%(13.32–16.39)	1075	44.84%(41.86–47.81)	985	29.64%(26.79–32.50)	2060	37.57%(35.48–39.67)	1075	44.84%(41.86–47.81)	985	29.64%(26.79–32.50)
p value		0.002		0.079		0.983		0.491		0.079		0.983
Residence												
rural	12,424	17.85%(17.18–18.53)	6575	45.23%(44.03–46.44)	5849	31.49%(30.30–32.68)	12,424	38.76%(37.91–39.62)	6575	45.23%(44.03–46.44)	5849	31.49%(30.30–32.68)
urban	3773	17.63%(16.41–18.84)	1992	38.86%(36.71–41.00)	1781	24.59%(22.59–26.59)	3773	32.12%(30.63–33.61)	1992	38.86%(36.71–41.00)	1781	24.59%(22.59–26.59)
p value		0.749		0		0		0		0		0
Education												
illiterate	3795	20.66%(19.37–21.95)	3024	45.21%(43.43–46.98)	771	33.07%(29.75–36.40)	3795	42.74%(41.17–44.32)	3024	45.21%(43.43–46.98)	771	33.07%(29.75–36.40)
elementary school or below	6982	18.30%(17.40–19.21)	3440	45.64%(43.97–47.30)	3542	32.92%(31.37–34.47)	6982	39.19%(38.04–40.33)	3440	45.64%(43.97–47.30)	3542	32.92%(31.37–34.47)
secondary school and above	5420	15.15%(14.19–16.10)	2103	38.56%(36.48–40.65)	3317	25.90%(24.41–27.39)	5420	30.81%(29.58–32.04)	2103	38.56%(36.48–40.65)	3317	25.90%(24.41–27.39)
p value		0		0		0		0		0		0
Disability												
no	14,356	16.50%(15.89–17.11)	7590	42.00%(40.89–43.11)	6766	28.26%(27.19–29.33)	14,356	35.53%(34.74–36.31)	7590	42.00%(40.89–43.11)	6766	28.26%(27.19–29.33)
yes	1841	27.92%(25.87–29.97)	977	57.32%(54.21–60.43)	864	42.59%(39.29–45.90)	1841	50.41%(48.12–52.69)	977	57.32%(54.21–60.43)	864	42.59%(39.29–45.90)
p value		0		0		0		0		0		0
Chronic Disease												
0	9643	14.03%(13.34–14.72)	5044	37.67%(36.33–39.01)	4599	25.20%(23.95–26.46)	9643	31.72%(30.79–32.65)	5044	37.67%(36.33–39.01)	4599	25.20%(23.95–26.46)
1	4355	20.48%(19.28–21.68)	2315	50.19%(48.16–52.23)	2040	34.02%(31.96–36.08)	4355	42.62%(41.15–44.09)	2315	50.19%(48.16–52.23)	2040	34.02%(31.96–36.08)
2	2199	29.01%(27.11–30.91)	1208	56.79%(53.99–59.59)	991	43.09%(40.00–46.18)	2199	50.61%(48.52–52.71)	1208	56.79%(53.99–59.59)	991	43.09%(40.00–46.18)
p value		0		0		0		0		0		0
Sleep Time												
≤ 6 h	8838	22.22%(21.36–23.09)	4952	49.41%(48.02–50.81)	3886	34.82%(33.32–36.32)	8838	43.00%(41.96–44.03)	4952	49.41%(48.02–50.81)	3886	34.82%(33.32–36.32)
6-8 h	5821	12.61%(11.76–13.46)	2799	36.26%(34.48–38.05)	3022	24.95%(23.41–26.49)	5821	30.39%(29.21–31.57)	2799	36.26%(34.48–38.05)	3022	24.95%(23.41–26.49)
≥ 8 h	1538	12.03%(10.40–13.66)	816	35.05%(31.77–38.33)	722	23.96%(20.84–27.08)	1538	29.84%(27.55–32.13)	816	35.05%(31.77–38.33)	722	23.96%(20.84–27.08)
p value		0		0		0		0		0		0
Nap Time												
≤ 30 min	9039	19.04%(18.23–19.85)	5185	45.36%(44.01–46.72)	3854	31.16%(29.70–32.63)	9039	39.31%(38.30–40.31)	5185	45.36%(44.01–46.72)	3854	31.16%(29.70–32.63)
31-60 min	4087	17.37%(16.21–18.53)	1995	42.16%(39.99–44.32)	2092	28.06%(26.13–29.99)	4087	34.94%(33.48–36.40)	1995	42.16%(39.99–44.32)	2092	28.06%(26.13–29.99)
≥ 61 min	3071	14.72%(13.46–15.97)	1387	40.01%(37.43–42.60)	1684	29.22%(27.04–31.39)	3071	34.09%(32.42–35.77)	1387	40.01%(37.43–42.60)	1684	29.22%(27.04–31.39)
p value		0		0.001		0.035		0		0.001		0.035

Table 2 (continued)

	Non-stroke Neck pain						Non-stroke Low back pain					
	Overall		Female		Male		Overall		Female		Male	
	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)
Dyspraxia												
no	4986	7.44%(6.71–8.17)	1903	19.65%(17.87–21.44)	3083	16.67%(15.36–17.99)	4986	17.81%(16.75–18.87)	1903	19.65%(17.87–21.44)	3083	16.67%(15.36–17.99)
yes	11,211	22.41%(21.63–23.18)	6664	50.63%(49.43–51.83)	4547	38.84%(37.42–40.26)	11,211	45.85%(44.93–46.77)	6664	50.63%(49.43–51.83)	4547	38.84%(37.42–40.26)
p value		0		0		0		0		0		0
Depressive												
no	10,762	12.70%(12.07–13.33)	5170	35.16%(33.86–36.47)	5592	24.46%(23.34–25.59)	10,762	29.60%(28.74–30.47)	5170	35.16%(33.86–36.47)	5592	24.46%(23.34–25.59)
yes	5435	27.89%(26.70–29.09)	3397	56.81%(55.15–58.48)	2038	44.75%(42.59–46.91)	5435	52.29%(50.96–53.62)	3397	56.81%(55.15–58.48)	2038	44.75%(42.59–46.91)
p value		0		0		0		0		0		0
Drink												
no	10,683	19.67%(18.91–20.42)	7362	43.10%(41.97–44.23)	3321	30.08%(28.52–31.64)	10,683	39.05%(38.13–39.98)	7362	43.10%(41.97–44.23)	3321	30.08%(28.52–31.64)
yes	5514	14.18%(13.26–15.10)	1205	47.72%(44.89–50.54)	4309	29.73%(28.36–31.09)	5514	33.66%(32.41–34.91)	1205	47.72%(44.89–50.54)	4309	29.73%(28.36–31.09)
p value		0		0.003		0.739		0		0.003		0.739
ADL												
no	13,397	14.50%(13.90–15.09)	6780	38.19%(37.03–39.34)	6617	26.82%(25.76–27.89)	13,397	32.57%(31.78–33.37)	6780	38.19%(37.03–39.34)	6617	26.82%(25.76–27.89)
yes	2800	33.61%(31.86–35.36)	1787	64.86%(62.64–67.07)	1013	49.85%(46.77–52.94)	2800	59.43%(57.61–61.25)	1787	64.86%(62.64–67.07)	1013	49.85%(46.77–52.94)
p value		0		0		0		0		0		0
ADL_ins												
no	12,561	14.44%(13.83–15.06)	6205	37.60%(36.39–38.80)	6356	26.83%(25.74–27.91)	12,561	32.15%(31.33–32.96)	6205	37.60%(36.39–38.80)	6356	26.83%(25.74–27.91)
yes	3636	29.40%(27.92–30.88)	2362	59.91%(57.93–61.88)	1274	45.13%(42.40–47.87)	3636	54.73%(53.11–56.35)	2362	59.91%(57.93–61.88)	1274	45.13%(42.40–47.87)
p value		0		0		0		0		0		0
Activity_intensive												
less than 10 min	10,895	17.66%(16.94–18.38)	6223	41.68%(40.46–42.91)	4672	26.84%(25.57–28.11)	10,895	35.32%(34.42–36.22)	6223	41.68%(40.46–42.91)	4672	26.84%(25.57–28.11)
More than 10 min	5302	18.09%(17.05–19.12)	2344	49.23%(47.21–51.26)	2958	34.69%(32.97–36.40)	5302	41.12%(39.79–42.44)	2344	49.23%(47.21–51.26)	2958	34.69%(32.97–36.40)
p value		0.504		0		0		0		0		0
Activity_moderate												
less than 10 min	8146	15.39%(14.61–16.18)	3882	41.19%(39.64–42.74)	4264	28.68%(27.32–30.04)	8146	34.64%(33.61–35.68)	3882	41.19%(39.64–42.74)	4264	28.68%(27.32–30.04)
More than 10 min	8051	20.23%(19.36–21.11)	4685	45.87%(44.44–47.30)	3366	31.40%(29.83–32.97)	8051	39.82%(38.75–40.89)	4685	45.87%(44.44–47.30)	3366	31.40%(29.83–32.97)
p value		0		0		0.001		0		0		0.01
Activity_light												
less than 10 min	2769	16.90%(15.50–18.30)	1479	44.62%(42.09–47.16)	1290	27.83%(25.38–30.28)	2769	36.80%(35.00–38.60)	1479	44.62%(42.09–47.16)	1290	27.83%(25.38–30.28)
More than 10 min	13,428	17.98%(17.34–18.63)	7088	43.57%(42.41–44.72)	6340	30.30%(29.17–31.43)	13,428	37.30%(36.48–38.12)	7088	43.57%(42.41–44.72)	6340	30.30%(29.17–31.43)
p value		0.175		0.456		0.077		0.619		0.456		0.077
Treatments for Stroke												
no	16,197		8567		7630		16,197		8567		7630	
yes	0		0		0		0		0		0	
p value												

Table 2 (continued)

	Stroke Neck pain						Stroke Low back pain					
	Overall		Female		Male		Overall		Female		Male	
	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)
	885	26.44% (23.53–29.35)	457	33.70%(29.35–38.05)	428	18.69%(14.98–22.40)	885	45.42% (42.14–48.71)	457	57.33%(52.78–61.88)	428	32.71%(28.25–37.17)
Age, years												
45–54	82	29.27%(19.21–39.33)	40	40%(24.13–55.87)	42	19.05%(6.66–31.43)	82	47.56%(36.52–58.60)	40	55%(38.89–71.13)	42	40.48%(24.99–55.96)
55–64	260	25%(19.70–30.30)	126	30.95%(22.77–39.14)	134	19.40%(12.62–26.19)	260	46.15%(40.05–52.25)	126	61.11%(52.48–69.74)	134	32.09%(24.08–40.10)
65–74	351	28.77%(24.02–33.53)	196	35.71%(28.95–42.48)	155	20%(13.63–26.37)	351	45.58%(40.35–50.82)	196	57.65%(50.67–64.63)	155	30.32%(23.01–37.64)
≥75	192	22.92%(16.92–28.92)	95	30.53%(21.10–39.96)	97	15.46%(8.14–22.79)	192	43.23%(36.16–50.30)	95	52.63%(42.41–62.86)	97	34.02%(24.42–43.62)
p value		0.421		0.591		0.83		0.901		0.641		0.65
Residence												
rural	653	26.19%(22.81–29.57)	338	32.84%(27.81–37.87)	315	19.05%(14.69–23.41)	653	46.40%(42.57–50.24)	338	57.69%(52.40–62.99)	315	34.29%(29.02–39.56)
urban	232	27.16%(21.39–32.92)	119	36.13%(27.38–44.89)	113	17.70%(10.55–24.84)	232	42.67%(36.26–49.08)	119	56.30%(47.26–65.34)	113	28.32%(19.88–36.75)
p value		0.774		0.514		0.753		0.328		0.793		0.247
Education												
illiterate	245	28.98%(23.26–34.70)	185	29.73%(23.08–36.38)	60	26.67%(15.15–38.19)	245	53.47%(47.18–59.76)	185	58.38%(51.21–65.55)	60	38.33%(25.67–51.00)
elementary school or below	379	31.40%(26.70–36.09)	190	40%(32.97–47.03)	189	22.75%(16.72–28.78)	379	49.34%(44.28–54.40)	190	61.05%(54.06–68.05)	189	37.57%(30.60–44.53)
secondary school and above	261	16.86%(12.29–21.43)	82	28.05%(18.12–37.98)	179	11.73(6.97–16.49)	261	32.18%(26.48–37.89)	82	46.34%(35.32–57.37)	179	25.70%(19.24–32.16)
p value		0		0.054		0.006		0		0.074		0.032
Disability												
no	628	24.84%(21.45–28.23)	325	31.69%(26.61–36.78)	303	17.49%(13.19–21.79)	628	44.11%(40.21–48.00)	325	55.08%(49.64–60.51)	303	32.34%(27.05–37.64)
yes	257	30.35%(24.69–36.01)	132	38.64%(30.22–47.05)	125	21.60%(14.29–28.91)	257	48.64%(42.49–54.79)	132	62.88%(54.53–71.22)	125	33.60%(25.20–42.00)
p value		0.092		0.155		0.323		0.22		0.127		0.802
Chronic Disease												
0	350	21.43%(17.11–25.75)	177	29.38%(22.60–36.15)	173	13.29%(8.18–18.40)	350	38.57%(33.45–43.70)	177	53.11%(45.68–60.53)	173	23.70%(17.30–30.10)
1	282	26.60%(21.41–31.78)	146	34.93%(27.11–42.76)	136	17.65%(11.16–24.14)	282	43.97%(38.14–49.80)	146	54.11%(45.93–62.29)	136	33.09%(25.08–41.10)
2	253	33.20%(27.36–39.04)	134	38.06%(29.73–46.39)	119	27.73%(19.57–35.89)	253	56.52%(50.37–62.67)	134	66.42%(58.32–74.52)	119	45.38%(36.30–54.45)
p value		0.005		0.258		0.007		0		0.04		0.001
Sleep Time												
≤6 h	509	33.99%(29.86–38.12)	289	41.87%(36.15–47.59)	220	23.64%(17.98–29.29)	509	50.29%(45.93–54.65)	289	59.86%(54.18–65.55)	220	37.73%(31.27–44.18)
6-8 h	275	16.36%(11.96–20.76)	126	20.63%(13.47–27.80)	149	12.75%(7.33–18.17)	275	38.18%(32.40–43.96)	126	52.38%(43.54–61.22)	149	26.17%(19.03–33.31)
≥8 h	101	15.84%(8.60–23.09)	42	16.67%(4.91–28.42)	59	15.25%(5.80–24.70)	101	40.59%(30.85–50.33)	42	54.76%(39.06–70.46)	59	30.51%(18.41–42.61)
p value		0		0		0.024		0.003		0.346		0.063
Nap Time												
≤30 min	455	30.11%(25.88–34.34)	258	36.82%(30.90–42.75)	197	21.32%(15.55–27.09)	455	49.67%(45.06–54.28)	258	58.53%(52.48–64.58)	197	38.07%(31.23–44.91)
31-60 min	200	19.50%(13.96–25.04)	102	26.47%(17.76–35.18)	98	12.24%(5.64–18.85)	200	44.00%(37.06–50.94)	102	62.75%(53.20–72.29)	98	24.49%(15.82–33.16)
≥61 min	230	25.22%(19.56–30.87)	97	32.99%(23.46–42.52)	133	19.55%(12.72–26.38)	230	38.26%(31.93–44.59)	97	48.45%(38.33–58.58)	133	30.83%(22.88–38.78)
p value		0.016		0.172		0.163		0.016		0.106		0.055

Table 2 (continued)

	Stroke Neck pain						Stroke Low back pain					
	Overall		Female		Male		Overall		Female		Male	
	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)	n	Prevalence (95%CI)
Dyspraxia												
no	104	10.58%(4.57–16.59)	26	11.54%(-1.62–24.70)	78	10.26%(3.37–17.14)	104	18.27%(10.72–25.82)	26	26.92%(8.65–45.19)	78	15.38%(7.20–23.57)
yes	781	28.55%(25.38–31.73)	431	35.03%(30.51–39.56)	350	20.57%(16.32–24.83)	781	49.04%(45.53–52.55)	431	59.16%(54.51–63.82)	350	36.57%(31.50–41.64)
p value		0		0.014		0.035		0		0.001		0
Depressive												
no	506	19.76%(16.28–23.24)	231	24.68%(19.07–30.28)	275	15.64%(11.32–19.96)	506	35.57%(31.39–39.76)	231	45.89%(39.41–52.36)	275	26.91%(21.63–32.18)
yes	379	35.36%(30.52–40.19)	226	42..92%(36.42–49.42)	153	24.18%(17.32–31.04)	379	58.58%(53.59–63.56)	226	69.03%(62.95–75.10)	153	43.14%(35.20–51.07)
p value		0		0		0.03		0		0		0.001
Drink												
no	683	28.26%(24.87–31.64)	417	32.85%(28.33–37.38)	266	21.05%(16.12–25.98)	683	46.71%(42.95–50.46)	417	55.88%(51.09–60.67)	266	32.33%(26.67–37.99)
yes	202	20.30%(14.70–25.89)	40	42.50%(26.49–58.51)	162	14.81%(9.29–20.34)	202	41.09%(34.25–47.93)	40	72.50%(58.04–86.96)	162	33.33%(26.00–40.67)
p value		0.024		0.219		0.109		0.159		0.042		0.831
ADL												
no	508	21.85%(18.24–25.46)	229	30.57%(24.56–36.58)	279	14.70%(10.52–18.88)	508	39.57%(35.30–43.83)	229	55.46%(48.97–61.94)	279	26.52%(21.31–31.74)
yes	377	32.63%(27.87–37.38)	228	36.84%(30.53–43.15)	149	26.17%(19.03–33.31)	377	53.32%(48.26–58.37)	228	59.21%(52.78–65.64)	149	44.30%(36.23–52.36)
p value		0		0.157		0.004		0		0.419		0
ADL_ins												
no	426	22.07%(18.11–26.02)	183	28.96%(22.33–35.60)	243	16.87%(12.13–21.61)	426	38.03%(33.40–42.66)	183	48.63%(41.32–55.94)	243	30.04%(24.24–35.85)
yes	459	30.50%(26.27–34.73)	274	36.86%(31.11–42.61)	185	21.08%(15.15–27.01)	459	52.29%(47.70–56.87)	274	63.14%(57.39–68.89)	185	36.22%(29.23–43.21)
p value		0.004		0.08		0.27		0		0.002		0.178
Activity_intensive												
less than 10 min	705	25.11%(21.90–28.32)	376	31.91%(27.18–36.65)	329	17.33%(13.21–21.44)	705	43.55%(39.88–47.21)	376	55.32%(50.27–60.37)	329	30.09%(25.11–35.07)
More than 10 min	180	31.67%(24.81–38.53)	81	41.98%(30.99–52.96)	99	23.23%(14.77–31.70)	180	52.78%(45.41–60.14)	81	66.67%(56.18–77.16)	99	41.41%(31.54–51.29)
p value		0.075		0.083		0.187		0.15		0.061		0.035
Activity_moderate												
less than 10 min	559	24.87%(21.27–28.46)	267	31.84%(26.21–37.46)	292	18.49%(14.01–22.97)	559	42.75%(38.64–46.87)	267	55.81%(49.81–61.80)	292	30.82%(25.49–36.15)
More than 10 min	326	29.14%(24.18–34.10)	190	36.32%(29.42–43.22)	136	19.12%(12.42–25.81)	326	50%(44.54–55.46)	190	59.47%(52.43–66.52)	136	36.76%(28.56–44.97)
p value		0.165		0.319		0.878		0.037		0.436		0.223
Activity_light												
less than 10 min	211	24.17%(18.35–29.99)	132	28.03%(20.27–35.79)	79	17.72%(9.11–26.33)	211	47.39%(40.60–54.19)	132	54.55%(45.94–63.15)	79	35.44%(24.66–46.23)
More than 10 min	674	27.15%(23.79–30.52)	325	36%(30.75–41.25)	349	18.91%(14.78–23.04)	674	44.81%(41.04–48.57)	325	58.46%(53.08–63.85)	349	32.09%(27.17–37.01)
p value		0.392		0.103		0.807		0.511		0.444		0.568
Treatments for Stroke												
no	232	22.41%(17.01–27.82)	124	29.84%(21.67–38.01)	108	13.89%(7.26–20.52)	232	43.10%(36.68–49.52)	124	52.42%(43.51–61.33)	108	32.41%(23.44–41.38)
yes	653	27.87%(24.42–31.32)	333	35.14%(29.98–40.29)	320	20.31%(15.88–24.74)	653	46.25%(42.41–50.08)	333	59.16%(53.85–64.47)	320	32.81%(27.64–37.98)
p value		0.106		0.288		0.139		0.409		0.196		0.938

One-way ANOVA was used to compare the differences in prevalence rates between different groups, with the test level $\alpha = 0.05$, and $p < 0.05$ indicating that the differences were statistically significant

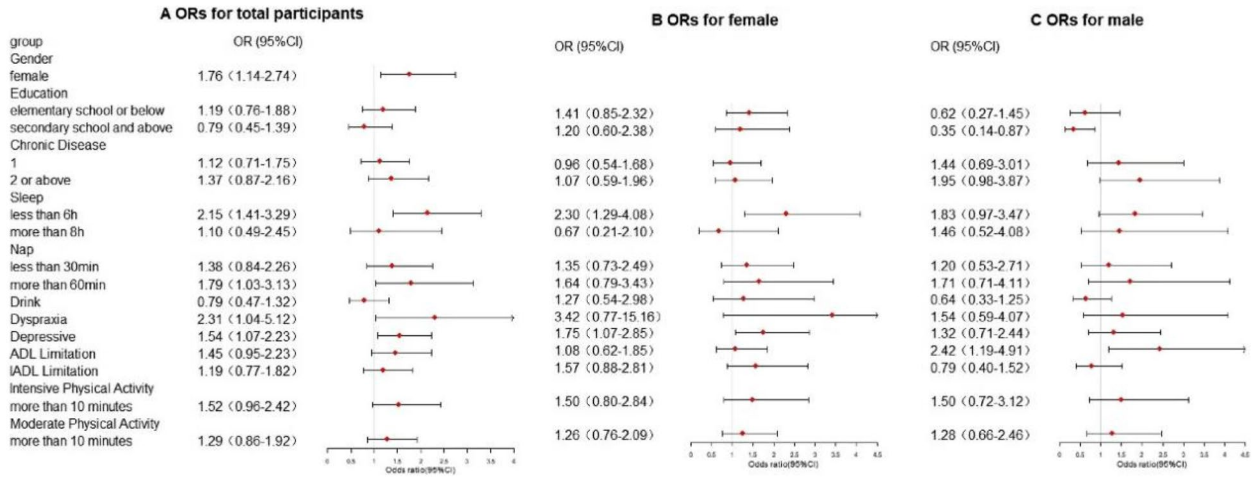

Fig. 2 Forest plot of risk factors for neck pain in the general Chinese population aged 45 years and above with stroke in China, 2018

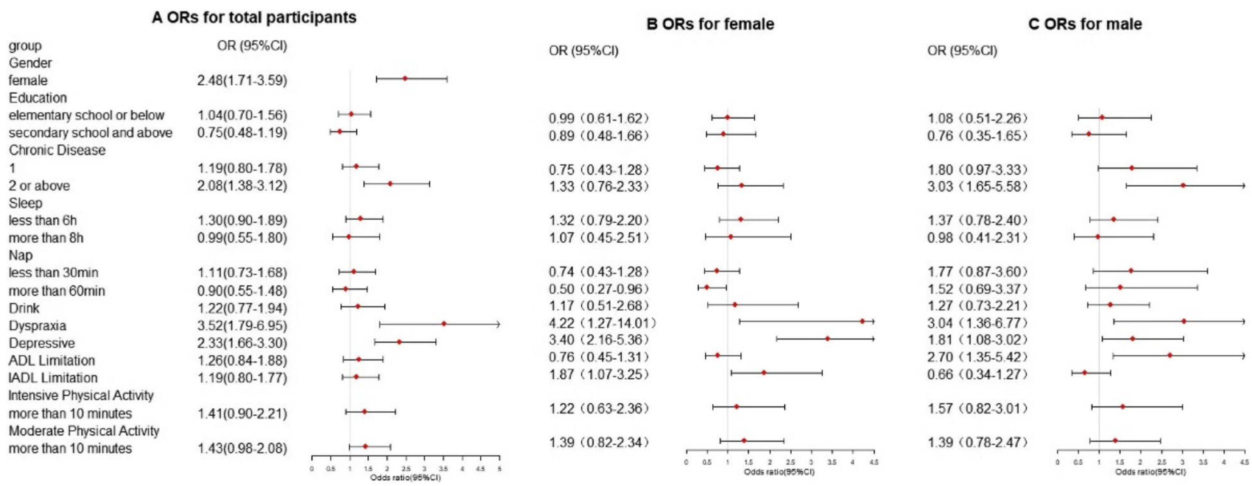

Fig. 3 Forest plot of risk factors for low back pain in the general Chinese population aged 45 years and above with stroke in China, 2018

Discussion

To our knowledge, this is the first and the largest survey on the prevalence of NP and LBP in Chinese stroke populations aged 45 years and above. Our results showed that 26.44% and 45.42% of middle-aged and older individuals with stroke in China experienced NP and LBP, reaching the epidemic level. Our findings revealed that female with stroke had significantly higher prevalence of NP and LBP than the male counterparts, which highlights the importance of paying more attention to post-stroke pain in females. Further, chronic diseases, sleep problem and depression are the major modifiable factors for NP and LBP among Chinese stroke survivors.

The current study found no significant association between medical insurance and NP or LBP in the stroke population. The lack of association may be related to the unique Chinese basic medical insurance system that covers the entire population in 2009. Statistical data indicated that the Chinese basic medical insurance coverage rate exceeded 95% in 2018, and it has remained unchanged till now [27]. This situation is consistent with the situation in the current study where nearly 98% of the participants with stroke had health insurance.

Females with stroke display a higher prevalence of NP and LBP than male counterparts, which concurred with previous studies [28–30]. This finding may be attributed to the fact that females have a higher pain sensitivity than males [31]. Our study also found that depression was associated with NP and LBP in the stroke population. This finding is consistent with prior studies [32, 33].

Two previous Japanese studies revealed that poor mental health is associated with severe pain [34, 35]. Although the current study cannot confirm the causal relationship, it underscores the importance of proper assessment and management psychological well-being in individuals with stroke, especially for those with pain, so that timely psychological counselling and advice can be provided. In addition, women with comorbid depression were more likely to experience NP and LBP. This result suggests that clinicians and relevant health authority should pay more attention to the psychological construction of the female stroke population. The high prevalence of depression (42.82%) in the stroke population found in the current study could be ascribed to the retrospective nature of the survey and the diagnosis of depression based on a self-reported questionnaire rather than the clinical diagnosis of depression by physicians. The connection between depression and pain is still unclear and requires further investigation.

Stroke participants with activity limitations resulting from physical dysfunction were two times more likely to experience frequent NP and almost three times more likely to experience frequent LBP as compared to those without activity limitations (Appendix). Limitations in movement caused by physical dysfunction are common clinical symptoms of stroke. Approximately 80% of patients with stroke experience motor dysfunction [36], while motor dysfunction is highly associated with post-stroke pain [37]. Suboptimal physical activity may be one of the possible causes of post-stroke pain, as shown in this study. Further, the presence of NP and LBP secondary to activity limitation or physical dysfunction was significantly higher in the stroke population in rural areas than in the stroke population in urban areas. A possible explanation is that people in rural areas have a low economic base and lack of systematic rehabilitation training, leading to increased physical dysfunction. Regular exercise has been proven to decrease pain intensity, improve independence from daily activities, and alleviate depression symptoms [38–40]. The current study showed that participation in physical activity of different intensity were related to the presence of NP and LBP in some stroke populations. Therefore, personalized physical activity programs are important in the pain management of individuals with stroke. Our study has also found that the presence of two or more chronic diseases are associated with the presence of LBP in the stroke populations, which may affect allostatic load and cause pain through the dysregulation of physiological mechanisms; however, these mechanisms remain to be confirmed [41]. The stroke populations with other chronic condition were likely to experience frequent NP or LBP due to the limited ability to perform ADL. This finding is consistent with the finding that activity limitation due to physical dysfunction is an explanatory factor for pain because the ADL scale represents mobility capacity. This finding emphasizes the importance of considering other chronic conditions in the pain management in individuals with stroke.

In the stroke population with higher education, the prevalence of NP was associated with female and sleep problem. These findings are similar to previous studies [42, 43]. In the current study, more educated participants were more likely to engage in sedentary lifestyles with concomitant psychological problems and sleep problem as compared to less educated participants. Further, females with a high level of education had a high prevalence of NP. This observation may be due to the sedentary lifestyle and poor posture contribute to the occurrence of NP [44]. Sleep problems are known to be linked to or increase musculoskeletal pain [45]. A cohort study in Northern Finland found that sleep deprivation is an independent risk factor for NP and LBP in women [46]. Both NP and LBP may increase due to increased pain sensitivity and pain-related biomarkers following sleep deprivation [47]. Interestingly, prolonged napping after lunch was associated with NP in our stroke population. Although speculative, it is possible that prolonged napping leads to delayed nighttime sleep, which impairs circadian rhythms and leads to sleep problem. Our study also reported a high prevalence of LBP in stroke populations with low education levels. Female, depression, and comorbidities with other chronic diseases may be important factors in the development of LBP in stroke populations with low levels of education. However, due to the limitations of cross-sectional studies, although an association exists among sleep duration, the female gender, and neck pain, the causal relationship remains unclear.

Strengths and limitations

This study has multiple strengths. First, it used the national CHARLS database, which contains big data. The strict sampling design and data screening process ensure the reliability and validity of our research results. Second, this study comprehensively analyzed the prevalence and factors associated with NP and LBP in the Chinese stroke population. Third, this study has laid the foundation for developing prevention and intervention strategies for NP and LBP in the Chinese stroke population.

However, our study had some limitations. First, the current cross-sectional study could not determine the causal relationships between post-stroke NP or LBP and their associated factors. Second, this work was based on retrospective reports from the participants, and the information might have been subject to recall bias. Third, the database did not distinguish between populations with different types and severity of stroke. Therefore, our findings study should be interpreted with caution and may not be generalized to the whole Chinese stroke population. In addition, the baseline survey of the database did not include residents of nursing homes. However, this is unlikely to cause a major problem because the proportion of nursing home residents is very small in China.

Conclusions

This is the first population-based study to investigate the prevalence of NP and LBP in the Chinese stroke population. Short sleep duration, prolonged napping after lunch, physical dysfunction, and depression were associated with the presence of NP in the stroke population. Comorbidities of two or more chronic diseases, physical dysfunction, and depression were associated with LBP in the stroke population. Additionally, clinicians should pay more attention to female stroke survivors because they are more vulnearable to experience NP and LBP. Our findings provide policy makers and clinicians with empirical data to formulate more effective prevention and management strategies of spinal pain in stroke survivors.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-024-19847-2.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

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Authors' contributions

"XQ W, SQ R, and X J had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. SQ R and X J contributed equally to this study. XQ W, SQ R, X J, AYLW, and X B contributed to the conception and design of the study. Statistical analysis: SQ R , X J , SY W and AY LW. Draft the original manuscript: SQ R and X J. All authors contributed to the edit of the manuscript."

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Availability of data and materials

The data that support the findings of this study are available from the China Longitudinal Study of Health and Retirement (CHARLS), subject to registration and application process. Further details can be found at http://charls.pku.edu.cn/pages/data/111/zh-cn.

Declarations

Ethics approval and consent to participate

Ethical approval for all the CHARLS waves was granted from the Institutional Review Board at Peking University(IRB00001052-11015). All participants signed informed consent forms before participating in the CHARLS study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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