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Original Article

Traumatic brain injury among civilian inpatients in Southwest China military hospitals, 2008-2012: an epidemiologic survey

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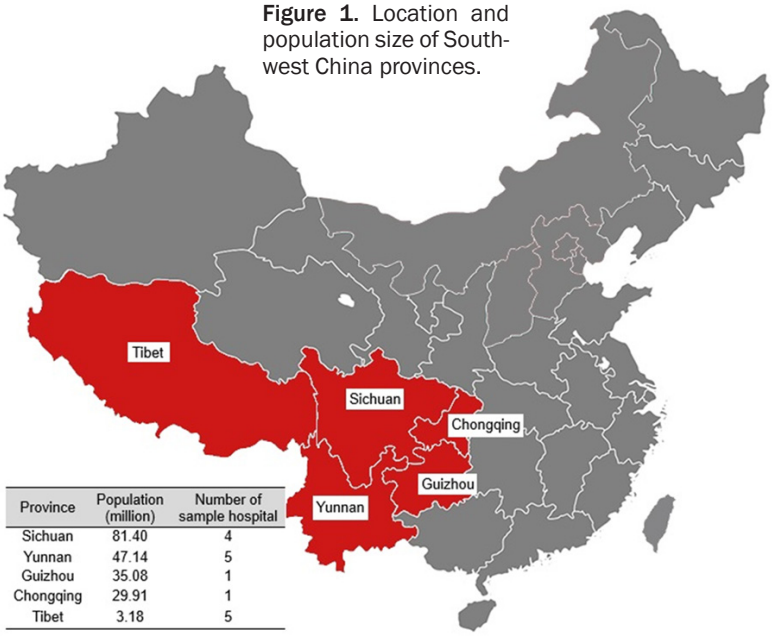
Abstract: Traumatic brain injury (TBI) poses a serious global public health concern. Recent studies on TBI epidemiology have been conducted in China and East China. Southwest China is economically underdeveloped, and data on TBI in this region are scarce. The present study aimed to evaluate the characteristics of TBI inpatients from military hospitals in Southwest China. We used data from the Chinese Trauma Database (CTD), which contained information on diagnosis and treatment of trauma patients hospitalized in more than 200 military hospitals in China. Based on the ICD-10 code for TBI, we retrieved information on civilian inpatients with TBI at 16 military hospitals in Southwest China between January 2008 and December 2012 and performed a comprehensive analysis of demographics, cause of injury, severity of injury, length of stay (days), inpatient costs, and mortality rate in patients with TBI. In total, data of 36,413 TBI inpatients were included. Hospital admissions grew at an average annual rate of 5.32%. The mean patient age was 35.29±17.39 years (76.23% men, 23.77% women). Motor vehicle traffic (MVT) accidents (45.92%), falls (25.41%), and assaults (18.09%) were the 3 leading causes of TBI. According to the Abbreviated Injury Scale (AIS) score, 60.40% of TBI cases were of mild, 24.02% were of moderate, and 15.58% were of severe intensity. The mean length of stay was 13.83±19.08 days, median inpatient cost was USD 735, and mortality rate was 2.54%. In conclusion, TBI is an important public health problem in Southwest China. A governmental initiative is expediently needed to establish a TBI monitoring system that covers the southwest region to develop more effective and targeted measures for TBI prevention, treatment, and rehabilitation.

Keywords: Traumatic brain injury, Southwest China, cause of injury, severity of injury

Introduction

Traumatic brain injury (TBI) is a major cause of trauma-related death and long-term disability, and poses a serious global public health concern [1]. TBI-related complications are difficult to detect because of potentially overlapping cognitive, sensory, and emotional disorders, all of which make TBI a "silent epidemic" [2, 3]. The United States and other developed countries have imbued great importance to epidemiological studies to further understand the epidemiological patterns in gender, age, as well as cause and severity of injury in patients with TBI and more importantly, to guide the development of effective measures for TBI prevention, treatment, and rehabilitation [4-7]. With rapid economic development, especially the rapid rise in motor vehicle accidents, TBI is becoming a serious concern in China [8] and has become the leading cause of both trauma-related death and death in adults younger than 40 [9, 10]. However, despite the substantial TBI-related economic burden and familial tragedy, many developing countries and economically underdeveloped regions have yet to devote sufficient attention to TBI.

Previous studies in China have provided data on TBI in civilians across the Eastern regions. In



Province	Population (million)	Number of sample hospital
Sichuan	81.40	4
Yunnan	47.14	5
Guizhou	35.08	1
Chongqing	29.91	1
Tibet	3.18	5

Figure 1. Location and population size of Southwest China provinces.

the early 1980s, Wang *et al.* conducted 2 large household surveys in 6 Chinese cities and their results showed that the incidence of TBI was 55.4 to 64.1 cases per 100,000 persons, and the mortality rate was 6.3 to 9.7 deaths per 100,000 persons [11, 12]. In 2004, Wu *et al.* conducted a prospective epidemiological study of TBI in East China, demonstrating that adolescent boys and young adults were more vulnerable to TBI; and moreover, traffic accidents, assaults, and falls were the leading causes of TBI [10]. In 2015, Li *et al.* completed a survey of the characteristics of inpatients with TBI at Chinese military hospitals and showed that motor vehicle traffic (MVT) accidents, falls, and assaults were the 3 leading causes of TBI, and the mortality rate of inpatients with was 4.14% [8]. On the other hand, the relevant data in the Southwest China is scarce.

Southwest China is one of the seven geographical regions of China, including 5 provincial-level administrative regions (Yunnan, Guizhou, Sichuan, Tibet, and Chongqing) with a total population of 196.71 million, which accounts for 14.38% of the total Chinese population (**Figure 1**). The terrain is complex with 3 geographical areas: the Sichuan Basin and surrounding mountains, the Yunnan-Guizhou Plateau and alpine hilly area, and the Qinghai-Tibet Plateau and alpine mountain region (average altitude > 3000 meters). Historically, it has always been economically underdeveloped. Southwest China is also home to more than 30 ethnic groups, including the Han, Tibetan, Bai, and Yi. In recent years, although some epidemiological studies on TBI have been conducted in East China [8, 10-13], relevant data on TBI remain scarce for Southwest China.

To date, hospital information systems (HIS) have been established in tertiary-care Chinese (≥ 200 bed) hospitals. However, because standards for the health information industry have not been established, HIS data are not easily exchangeable between different medical institutions [14]. Therefore, it becomes unfeasible to build a national monitoring network of TBI in the short term. In 2006, researchers at the Third Military Medical University developed a Chinese Trauma Database (CTD) [8, 15] to collect diagnostic and treatment information of patients hospitalized for trauma in over 200 military hospitals in China, thereby forming a large nationwide trauma database. In 2015, we retrieved CTD information on all TBI cases admitted to Chinese military hospitals and conducted an epidemiological study of TBI [8]. In this study, we reviewed the epidemiology of TBI and investigated demographic characteristics, cause of injury, severity of injury, length of stay (days), inpatient costs, and treatment outcomes of inpatients with TBI at military hospitals in Southwest China to obtain data necessary to support the development of effective measures for TBI prevention, treatment, and rehabilitation.

Materials and methods

This study was approved by the Chengdu Military General Hospital of People's Liberation Army (PLA), and all patients with TBI were anonymized before data analysis.

Data sources

Since 2008, Chinese military hospitals (comprehensive hospitals opened to the general

Table 1. ICD-10 codes and number of TBI inpatients in Southwest China military hospitals between 2008 and 2012

Description	ICD-10 codes	n (%)
Total		36413
Open wound of the head	S01.0-S01.9	3811 (10.47)
Fracture of the skull and facial bones	S02.0, S02.1, S02.3, S02.7-S02.9	4342 (11.92)
Injury to optic nerve and pathways	S04.0	349 (0.96)
Intracranial injury	S06.0-S06.9	22367 (61.43)
Crushing injury of head	S07.0, S07.1, S07.8, S07.9	82 (0.23)
Other unspecified head injuries	S09.7-S09.9	3906 (10.73)
Open wounds involving head with neck	T01.0	973 (2.67)
Fractures involving head with neck	T02.0	158 (0.43)
Crushing injuries involving head with neck	T04.0	88 (0.24)
Injuries of brain and cranial nerves with injuries of nerves and spinal cord at neck level	T06.0	5 (0.01)
Sequelae of injuries of head	T90.1, T90.2, T90.4, T90.5, T90.8, T90.9	332 (0.91)

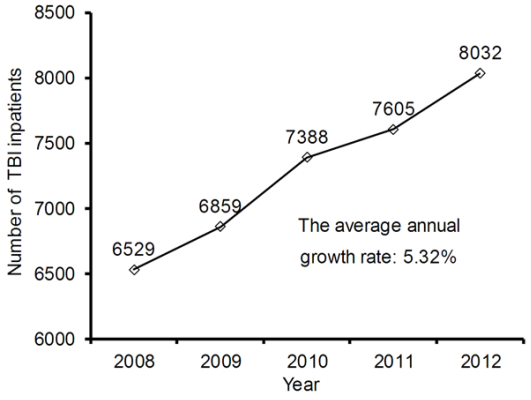


Figure 2. Numbers of TBI inpatients in Southwest China military hospitals between 2008 and 2012.

public) have upgraded to the International Classification of Diseases version 10 (ICD-10) for disease coding [8]. As such, to ensure a representative study sample and consistent data, the study population comprised inpatients with TBI who were diagnosed and treated in all military hospitals (16 military hospitals in total) in the southwestern region between January 2008 and December 2012. Military hospitals, such as the Chengdu Military General Hospital of PLA, the Kunming General Hospital of Chengdu Military Region of PLA, and the Lhasa General Hospital of Chengdu Military Region of PLA, are at the cutting edge with regard to diagnosis and treatment of TBI in Southwest China. We reviewed TBI studies in the United States [2] and used ICD-10 coding (**Table 1**) to retrieve CTD information on inpatients with TBI in military hospitals in Southwest China, including their medical record number, date of birth, gender, ethnicity, altitude of the hospital, length of hospital stay, diagnosis at discharge, ICD-10 coding, E-coding of the cause of injury, inpatient costs, and treatment outcomes.

Cause of injury

E-coding of the cause of injury from epidemiological studies of TBI in the United States were used to code and group etiology of TBI [2, 4, 16], and included MVT (E810-E819), fall (E880-E886, E888, E987), assaults (E960-E969), struck by and against (E916, E917), and others.

Abbreviated injury scale

The CTD contains information on all types of trauma but lacks information about TBI-specific Glasgow Coma Scale (GCS) scores. Thus, in this study, we used the Abbreviated Injury Scale (AIS) score to evaluate the severity of TBI in hospitalized patients [9, 17, 18]. The AIS score can be calculated from the ICD-10 coding of the diagnosis of TBI cases at discharge [19, 20] and interpreted as: 1-2 points: mild injury; 3 points: moderate injury; and 4-6 points: severe injury [17, 21].

Data analysis

Categorical variables were expressed as the frequency and percentage; quantitative variables were expressed as the mean ± standard

Table 2. Demographic characteristics of TBI inpatients in Southwest China military hospitals between 2008 and 2012

	Total	Male	Female	χ^2/t	*P*
Total	36413	27757 (76.23)	8656 (23.77)		
Age (years)	35.29±17.39	34.48±16.34	37.9±20.18	15.996[a]	< 0.001
Age group (years)				944.626[b]	< 0.001
< 5	1423 (3.91)	924 (3.33)	499 (5.76)		
5-14	2342 (6.43)	1660 (5.98)	682 (7.88)		
15-24	7967 (21.88)	6632 (23.89)	1335 (15.42)		
25-34	7114 (19.54)	5717 (20.60)	1397 (16.14)		
35-44	8565 (23.52)	6623 (23.86)	1942 (22.44)		
45-54	4444 (12.20)	3295 (11.87)	1149 (13.27)		
55-64	2433 (6.68)	1701 (6.13)	732 (8.46)		
65-74	1279 (3.51)	751 (2.71)	528 (6.10)		
≥ 75	846 (2.32)	454 (1.64)	392 (4.53)		
Ethnicity				42.120[b]	< 0.001
Han	27031 (74.23)	20,530 (73.96)	6501 (75.10)		
Tibetan	3627 (9.96)	2857 (10.29)	770 (8.90)		
Bai	2320 (6.37)	1686 (6.07)	634 (7.32)		
Yi	1367 (3.75)	1041 (3.75)	326 (3.77)		
Other	2068 (5.68)	1643 (5.92)	425 (4.91)		
Hospital altitude (m)				24.230[b]	< 0.001
< 3000	26218 (72.00)	19806 (71.35)	6412 (74.08)		
≥ 3000	10195 (28.00)	7951 (28.65)	2244 (25.92)		

a: the *t* value of the independent two-sample *t* test. b: the χ^2 value of Pearson chi-square test.

deviation; and quantitative variables with non-normal distribution were described as median and quartiles. A Kolmogorov-Smirnov test was conducted to analyze the normal distribution of the quantitative variables. A Pearson chi-square test was performed for between-group comparisons of categorical variables. An independent two-sample *t* test or the Mann-Whitney *U* test was performed for between-group comparisons of quantitative variables. A one-way analysis of variance (ANOVA) or the Kruskal-Wallis *H* test was performed to compare data from more than 2 groups. SPSS 16.0 was used for statistical analysis, and $P < 0.05$ was considered indicative of statistical significance.

Results

Number of patients discharged and diagnosis at discharge

From January 2008 to December 2012, 36,413 patients with TBI were treated at the hospitals included in this study. The number of inpatients increased each year (average annual growth rate: 5.32%; **Figure 2**). **Table 1** shows the number and percentage of patients in each TBI group: intracranial injuries: 61.43%; fractures of the skull and facial bones: 11.92%; other unspecified head injuries: 10.73%; and open wound of the head: 10.47%.

Demographic characteristics

Table 2 shows the demographic characteristics of this study population. There were 27,757 (76.23%) men and 8,656 (23.77%) women (male-to-female ratio: 3.21:1). The average age was 35.29±17.39 years, with men appeared to be younger than women (t=15.996, $P < 0.001$). Inpatients of 15 to 44 year-old accounted for 64.94% of the study population, children younger 5 years accounted for 3.91%, and those ≥ 65 years old accounted for 5.83%. In total, 68.35% of the men were in the 15 to 44 year-old group, which was greater than women subjects in the same age group (54.00%). Patients of Han ethnicity accounted for 74.23% of the patients, whereas those from Tibetan, Bai, Yi, and other ethnicities accounted for 9.96%, 6.37%, 3.75%,

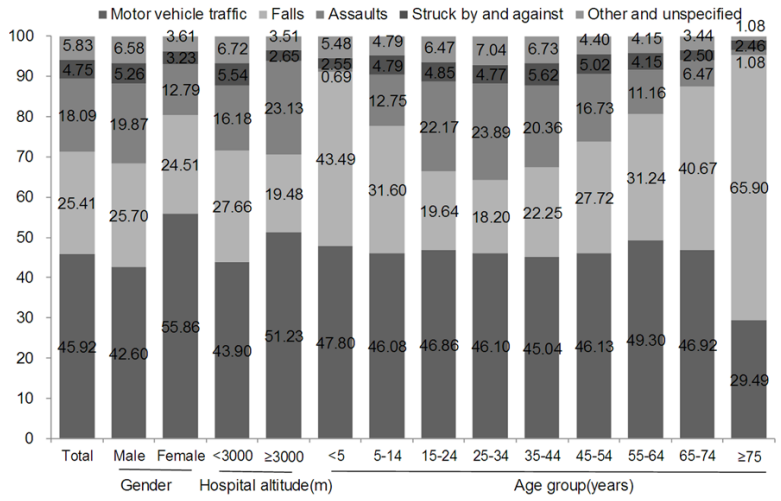


Figure 3. Percentage bar charts for external causes of TBI inpatients in Southwest China military hospitals between 2008 and 2012.

and 5.68%, respectively. Moreover, 28.00% of the patients were admitted into hospitals situated at an altitude of ≥ 3000 m, with a male-to-female ratio of 3.54:1. This ratio was significantly higher than that for hospitals situated at altitudes < 3000 m (3.09:1) (χ^2=24.230, P < 0.001).

Causes of injury

Figure 3 shows the causes of injury in patients with TBI. MVT, falls, and assaults were the top 3 causes of injury (total: 89.42%) in the southwestern region, accounting for 45.92%, 25.41%, and 18.09% of all TBI cases, respectively. A gender difference was also observed with regard to cause of TBI (χ^2=440.633, P < 0.001): MVT accounted for 55.86% of TBI cases in women, which was significantly higher than that in men (42.60%); assaults accounted for 19.87% of TBI cases in men, which was higher than that in women (12.79%). Cause of injury in patients with TBI who were admitted in hospitals situated at an altitude ≥ 3000 m differed to those at an altitude of < 3000 m (χ^2=518.771, P < 0.001). MVT and assaults accounted for 51.23% and 23.13% of all TBI cases admitted in hospitals situated at an altitude ≥ 3000 m, respectively, which was both higher than those in hospitals situated at an altitude < 3000 m. A difference was also observed in the cause of injury among different age groups (χ^2=1648.952, P < 0.001): MVT was the leading cause of injury in patients younger than 75, whereas falls were the leading cause of injury in patients 75 or older. Falls accounted for 43.49%, 40.67%, and 65.90% of all TBI cases in patients aged < 5, 65-74, and ≥ 75, respectively. Moreover, a higher percentage of TBIs was caused by assaults in patients aged 15 to 44 compared to other age groups.

Severity of injury

Table 3 shows the severity of injury of patients with TBI. The AIS score was successfully converted from ICD-10 coding in 32,089 patients with TBI, but the conversion failed in 4324 patients (11.87%). According to the AIS score, 60.40%, 24.02%, and 15.58% of TBI cases in the southwestern region were of mild, moderate, and severe grading, respectively. The Mann-Whitney U test showed that TBI was more severe in men than in women (Z=12.732, P < 0.001). The Kruskal-Wallis H test showed a significant difference in TBI severity in patients from different age groups, ethnicities, and causes of injury (P < 0.001). A higher percentage of patients with severe TBI was found in age group < 15 and ≥ 65 compared to other age groups. We also observed a higher percentage of Tibetans with severe TBI than other ethnic groups and a higher percentage of patients with severe TBI due to fall than other causes.

Length of stay

Table 4 shows the length of stay (in days) of patients with TBI. The average length of stay was 13.83±19.08 days (median and quartiles: 8 [4, 16] days). The Mann-Whitney U test showed that the median length of stay was longer in men than in women (Z=6.379, P < 0.001) and was shorter in patients admitted to hospitals at an altitude ≥ 3000 m than those at altitudes < 3000 m (Z=18.358, P < 0.001). The Kruskal-Wallis H test showed a significant difference in the median length of stay among patients with TBI of different age groups (χ^2=314.180, P < 0.001). The average length of

Table 3. Abbreviated injury scale (AIS) scores of TBI inpatients in Southwest China military hospitals between 2008 and 2012

	AIS group			χ^2/Z	*P*
	1-2	3	≥ 4		
Total	19383 (60.40)	7707 (24.02)	4999 (15.58)		
Gender				12.732[a]	< 0.001
Male	14296 (58.26)	6307 (25.71)	3934 (16.03)		
Female	5087 (67.36)	1400 (18.54)	1065 (14.10)		
Age group (years)				59.099[b]	< 0.001
< 5	858 (65.55)	193 (14.74)	258 (19.71)		
5-14	1272 (60.60)	422 (20.10)	405 (19.29)		
15-24	3996 (56.74)	2162 (30.70)	885 (12.57)		
25-34	3606 (58.14)	1752 (28.25)	844 (13.61)		
35-44	4412 (59.47)	1890 (25.48)	1117 (15.06)		
45-54	2477 (62.77)	770 (19.51)	699 (17.71)		
55-64	1471 (68.20)	293 (13.58)	393 (18.22)		
65-74	777 (66.81)	144 (12.38)	242 (20.81)		
≥ 75	514 (68.44)	81 (10.79)	156 (20.77)		
Ethnicity				133.531[b]	< 0.001
Han	13934 (59.70)	5837 (25.01)	3570 (15.29)		
Tibetan	1857 (56.67)	644 (19.65)	776 (23.68)		
Bai	1511 (66.53)	498 (21.93)	262 (11.54)		
Yi	844 (66.77)	285 (22.55)	135 (10.68)		
Other	1237 (63.89)	443 (22.88)	256 (13.22)		
Hospital altitude (m)				0.458[a]	0.647
< 3000	13600 (60.24)	5494 (24.33)	3484 (15.43)		
≥ 3000	5783 (60.80)	2213 (23.27)	1515 (15.93)		
External cause of injury				349.055[b]	< 0.001
Motor vehicle traffic	7403 (68.51)	1738 (16.08)	1665 (15.41)		
Falls	3794 (62.41)	954 (15.69)	1331 (21.90)		
Assaults	2528 (62.13)	1172 (28.80)	369 (9.07)		
Struck by and against	627 (58.43)	286 (26.65)	160 (14.91)		
Other and unspecified	464 (36.14)	694 (54.05)	126 (9.81)		

a: the *Z* value of the Mann-Whitney *U* test. b: the χ^2 value of the Kruskal-Wallis *H* test.

stay was longer in patients of Han and Yi ethnicity than in patients of other ethnicities (χ^2=118.658, $P < 0.001$). A higher AIS score was associated with a longer length of stay (median) of patients with TBI (χ^2=317.845, $P < 0.001$). Moreover, a significant difference was observed in the median length of stay between patients with TBI associated with different causes of injury (χ^2=435.045, $P < 0.001$). Hospital stay was the longest in patients with fall-induced TBI.

Inpatient costs

Table 4 shows inpatient costs of TBI (average USD 2, 088±4,238, median and quartiles: USD 735 [329, 1,993]). The Mann-Whitney *U* test showed that the median inpatient cost was higher in men than in women (Z=12.318, $P < 0.001$) and was lower for inpatients at hospitals situated ≥ 3000 m than for those in hospitals situated < 3000 m (Z=25.395, $P < 0.001$). The Kruskal-Wallis *H* test showed a significant difference in median inpatient costs between patients of TBI belonging to different age groups (χ^2=1117.095, $P < 0.001$), and the median inpatient costs increased with age. Similarly, a significant difference was observed in median inpatient costs between patients of different ethnicities (χ^2=191.667, $P < 0.001$). A higher AIS score was associated with higher

Table 4. Length of stay, hospitalization costs, and outcome of TBI inpatients in Southwest China military hospitals between 2008 and 2012

	Length of stay (days)			Hospitalization costs(USD)			Outcomes	
	Mean ± SD	Median (P25, P75)	*P*	Mean ± SD	Median (P25, P75)	*P*	Death n (%)	*P*
Total	13.83±19.08	8 (4, 16)		2088±4238	735 (329, 1993)		926 (2.54)	
Gender			< 0.001			< 0.001		0.538
Male	14.04±19.18	9 (4, 16)		2199±4409	769 (343, 2152)		698 (2.51)	
Female	13.18±18.75	8 (4, 15)		1734±3615	636 (297, 1547)		228 (2.63)	
Age group (years)			< 0.001			< 0.001		< 0.001
< 5	9.54±11.33	6 (3, 12)		772±1198	349 (166, 817)		28 (1.97)	
5-14	11.63±14.15	8 (4, 14)		1400±2652	518 (249, 1333)		31 (1.32)	
15-24	12.82±18.15	8 (4, 15)		1892±4106	648 (297, 1733)		105 (1.32)	
25-34	13.34±18.87	8 (4, 15)		2002±4140	689 (316, 1849)		146 (2.05)	
35-44	14.79±20.05	9 (4, 17)		2258±4357	810 (363, 2234)		203 (2.37)	
45-54	16.12±22.30	10 (5, 18)		2641±5246	955 (433, 2655)		158 (3.56)	
55-64	15.57±18.82	9 (5, 19)		2662±4692	1020 (452, 2650)		120 (4.93)	
65-74	14.50±21.39	9 (4, 17)		2315±4236	912 (417, 2309)		59 (4.61)	
≥ 75	13.12±17.88	8 (3.75, 15)		2163±3720	933 (432, 2126)		76 (8.98)	
Ethnicity			< 0.001			< 0.001		0.001
Han	14.39±20.52	8 (4, 16)		2242±4542	759 (332, 2151)		732 (2.71)	
Tibetan	10.30±11.00	8 (4, 13)		1442±2110	716 (332, 1661)		93 (2.56)	
Bai	12.66±15.12	8 (4, 16)		1356±2908	520 (282, 1099)		44 (1.90)	
Yi	14.49±16.22	9 (5, 18)		2067±3646	772 (358, 2223)		18 (1.32)	
Other	13.65±15.45	9 (5, 16)		2043±4358	788 (343, 1921)		39 (1.89)	
Hospital altitude (m)			< 0.001			< 0.001		0.002
< 3000	14.91±20.86	9 (4, 17)		2372±4709	819 (359, 2343)		709 (2.70)	
≥ 3000	11.08±13.10	7 (3, 14)		1358±2529	564 (274, 1331)		217 (2.13)	
AIS group			< 0.001			< 0.001		< 0.001
1-2	11.19±13.68	8 (5, 13)		1648±3621	603 (313, 1323)		189 (0.98)	
3	14.66±20.20	9 (4, 17)		2375±4623	813 (345, 2391)		264 (3.43)	
≥ 4	17.16±22.95	11 (6, 20)		2516±4656	1219 (489, 2713)		443 (8.86)	
External cause of injury			< 0.001			< 0.001		< 0.001
MVT	15.93±21.86	9 (4, 19)		2373±4500	833 (373, 2323)		469 (3.93)	
Falls	16.69±23.96	10 (5, 20)		2400±4915	883 (381, 2425)		198 (3.00)	
Assaults	9.70±11.88	7 (3, 12)		1011±2038	464 (238, 923)		27 (0.57)	
Struck	14.30±20.36	9 (4, 16)		2516±6462	818 (342, 2429)		21 (1.70)	
Other	14.62±20.88	9 (5, 16)		2454±4746	852 (358, 2395)		23 (1.52)	

median inpatient costs of TBI (χ^2=583.754, P < 0.001), and a significant difference was observed in median inpatient costs between patients with TBI associated with different causes of injury (χ^2=435.045, P < 0.001).

Treatment outcomes

Table 4 also shows treatment outcomes for study subjects. The mortality rate was 2.54% for inpatients with TBI. No significant difference was observed in mortality between male and female patients with TBI (χ^2=0.379, P=0.538). However, mortality rates differed significantly between patients of TBI from different age groups (χ^2=310.256, P < 0.001). Except in patients aged < 5, the mortality rate generally increased with age. The mortality rate was also higher in subjects of Han or Tibetan ethnicity than in those from other ethnic groups (χ^2=18.785, P=0.001). Further, the mortality rate was lower in patients who were admitted to hospitals at an altitude of ≥ 3000 m than in those who were admitted into hospitals at an altitude of < 3,000 meters (χ^2=9.818, P=0.002). As expected, a higher AIS score was also found associated with a higher mortality rate (χ^2=925.677, P < 0.001). The mortality

rate was 8.86% in patients with severe TBI (AIS score ≥ 4). A significant difference was observed in the mortality rate between patients with TBI associated with different causes of injury ($P < 0.001$). The mortality rate was highest (3.93%) for MVT-induced TBI and lowest for assault-induced TBI (0.57%).

Discussion

This study is the first epidemiological study of TBI in Southwest China. Based on ICD-10 coding, we retrieved CTD information for patients with TBI admitted to 16 military hospitals in the southwestern region and performed a comprehensive analysis of demographics, cause of injury, severity of injury, length of stay, inpatient costs, and mortality of patients with TBI. The results showed that military hospital admissions of TBI cases increased annually, and intracranial injury as well as skull and facial bone fractures comprised the main types of TBI. Patients were, on average, 35.29±17.39 years old, with a male preponderance. MVT, falls, and assaults were the 3 leading causes of TBI, accounting for 89.42% of all TBI cases. According to the AIS score, 60.40% of TBI cases were mild, 24.02% were moderate, and 15.58% were of severe intensity. The average length of stay of patients with TBI was 13.83±19.08 days, median inpatient cost was USD 735, and the mortality rate was 2.54%. These characteristics of patients with TBI provide data necessary to support developmental measures for TBI prevention and treatment in Southwest China.

The male preponderance of patients with TBI (male-to-female ratio: 3.21:1) was consistent with the findings of previous Chinese studies on TBI. Wu *et al.* conducted a study among 14,948 patients with TBI from 77 hospitals in East China and found that the male-to-female ratio was 3.27:1 [10]. Yuan *et al.* conducted a study among 13,007 patients with TBI from 80 hospitals in East China and found that the male-to-female ratio was 3.20:1 [22]. Li *et al*. conducted a study among 203,553 patients with TBI from more than 200 military hospitals in China and found that the male-to-female ratio was 2.98:1 [8]. Foreign studies on TBI have reported similarly high male-to-female ratios: 3.5:1 in Brazil [23], 3.33:1 in India [24], and 1.93:1 in the United States [16], In addition, the results also showed that young men (15-44 years) were more vulnerable to TBI, probably attributable to the lifestyle choices and behaviours in young males such as higher alcohol intake [25], dangerous driving, poorer risk judgement, violence and impulsiveness characteristic of males in this age group [26]. Moreover, gender differences on TBI causes were also demonstrated in this study. Females tended to have different TBI causes with a much lower proportion in assault caused TBI, leading to a slightly higher proportion of TBI caused by MVT.

We found MVT, falls, and assaults were the 3 leading causes of TBI, and studies conducted in East China and Chinese military hospitals have reported similar findings, suggesting that MVT as the leading cause of injury correlated with the rapid increase in motor vehicles in recent years in China [8, 10, 22]. Meanwhile, studies in the United States (falls: 32%, MVT: 19%) [27], Finland (falls: 51.8%, MVT: 16.6%) [28], Switzerland (falls: 58%, MVT: 16%) [29], and Austria (falls: 80%, MVT: 7%) [5] have shown that falls were the leading cause of TBI, which may be associated with geographic location, study population, and the method used to determine the cause of injury. Moreover, this study showed that MVT was the leading cause of injury in patients aged < 75, whereas falls were the leading cause of injury in patients aged ≥ 75. Furthermore, Wu *et al*. showed that MVT was the leading cause of injury in patients with TBI aged < 75 in East China [10]. Feigin *et al*. reported that falls were the leading cause of injury in patients with TBI aged ≥ 65 [30]. More importantly, a previous report by Coronado *et al.* demonstrated a significant reduction in MVT-caused TBI along with legislation [4], which indicate the importance of legislation in reducing incidence of TBI nationwide.

The AIS scores showed that, in Southwest China, 60.40%, 24.02%, and 15.58% of TBI cases were of mild, moderate, and severe intensity, respectively. Wu *et al.* surveyed the epidemiological characteristics of patients with TBI in East China, and the GCS score showed that 62%, 18%, and 20% of TBI cases were of mild, moderate, and severe intensity, respectively [10]. Gururaj conducted a study in India using GCS score and found that 70% of TBI cases were mild, 14% were moderate, and 16% were of severe intensity [24]. These results sug-

gested that mild injury is the most common injury intensity among patients with TBI. Moreover, the use of different measurements for severity may affect the classification of TBI severity in epidemiology studies.

Furthermore, this study showed that the median hospital stay was 8 days for patients with TBI in Southwest China, which was shorter than that in East China (11 days) [22] and longer than the average hospital stay (5.5 days) in Brazil [23]. In this study, the median inpatient cost was USD 735, considerably less than in East China (USD 879) [22] and higher than that for Brazil (USD 568) [23]. This regional variation in China may be attributable to economic conditions because Southwest China generally lags behind that of East China. This study showed that, in Southwest China, the mortality rate of patients with TBI was 2.54%, which was lower than the mortality with TBI for East China and developed countries such as Austria [5, 10, 22].

This study has some limitations. Because a nationwide monitoring network for TBI has not yet been established in China, we only had access to data from 16 military hospitals in Southwest China. Therefore, inevitably, a number of TBI cases were not included in this study. The results of this study could not reflect the epidemiology of TBI in the entire region of Southwest China. Moreover, this study did not include information about patients with TBI who visited private clinics, received emergency medical attention, or those who did not visit the hospital. Furthermore, although this study covered all military hospitals in Southwest China, these hospitals operated at different levels, which may have resulted in certain biases in the results. Moreover, the lack of confirmation of TBI diagnosis is another of our limitations. The ICD-10 coding used in this study for inclusion might miss other TBIs complicated by other types of trauma not identified under ICD-10. Additionally, in this study, the ICD-10 coding of disease was converted to an AIS score to evaluate the severity of injury; thus, coding errors may have led to misclassification of the severity of TBI.

In Southwest China, young men were more vulnerable to TBI and MVT, falls, and assaults were the 3 leading causes of TBI. MVT was the leading cause of injury in patients with TBI younger than 75, whereas falls were the leading cause of injury in patients with TBI aged 75 or older. AIS score demonstrated that 60.40% of TBI cases were mild, 24.02% were moderate, and 15.58% were severe. The median hospital stay of patients with TBI in Southwest China was 8 days, median inpatient cost was USD 735, and mortality rate was 2.54%. Nevertheless, this study only provides preliminary data for the characteristics of patients with TBI in Southwest China. The gender proportion, major causes, and severity of TBI were all similar to those from East China. However, the hospital stay was shorter and medical expenses were lower than those for East China. Based on the limitation of this study, it is important to establish an accessible and reliable clinical database in China to monitor and evaluate the epidemiological characteristics of TBI in Southwest China, which will help health authorities to develop effective prevention, treatment, and rehabilitative strategies. More importantly, governmental agencies should take appropriate measures (e.g., strict regulations on the use of seat belts by drivers and passengers in motor vehicles, strengthening of the regulation of driver's tests, and safety education) to prevent and reduce TBI, especially MVT-caused TBI.

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Disclosure of conflict of interest

None.

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