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# Epidemiological Investigation of Elderly Patients with Severe Burns at a Major Burn Center in Southwest China

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**Background:** The treatment of elderly patients with severe burns is difficult and the mortality rate is high. The aim of this study was to investigate the epidemiological features of elderly patients with severe burns.


**Material/Methods:** Data from 109 elderly patients with severe burns between January 2009 and December 2018 were retrospectively analyzed. Demographic data, clinical characteristics, treatments, and outcomes were statistically analyzed.

**Results:** Among the 109 elderly patients with severe burns, the male-to-female ratio was 1.73: 1.0. The median age of the elderly patients was 67 years, and the median total body surface area (TBSA) burned was 42%. Notably, 67.9% of burns occurred at home and most frequently occurred in summer (38.5%) and winter (28.4%); flame and flash burns predominated (83.4%). The incidence of inhalation injury was 35.8%, and pre-existing comorbidities were observed in approximately 51.4% of the patients. The median length of stay in the hospital per TBSA burned was 0.4 days. The mortality rate in the elderly patients was 24.8%, and the mortality rates in the  $\geq 70\%$  TBSA group, inhalation injury group, and patients with 3 or more pre-existing comorbidities were significantly higher than in the other groups. The risk of death increased with an increase in the number of pre-existing comorbidities (odds ratio: 2.222; 95% confidence interval: 1.174–4.205).

**Conclusions:** At a major burn center in Southwest China, the incidence and mortality of elderly patients with severe burns displayed no downward trend. There are etiological characteristics of these age groups that should be considered for prevention. Meanwhile, multidisciplinary treatment in a hospital and an increase in the social support for the elderly population might improve outcomes.

**MeSH Keywords:** **Accident Prevention • Burns • Epidemiology • Frail Elderly**

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## Background

Burns are a common form of trauma in production and in life, with high morbidity and mortality rates. According to the Global Burden of Diseases Study (GBD), the number of burn injuries worldwide was as high as 360 000 in 2017 [1]. As the population ages, the elderly population is growing rapidly. At the same time, the elderly often display characteristics such as slowness of movement, loss of vision and sensation, and thin skin, and are more vulnerable to burns [2,3]. In the past few decades, significant progress has been made in reducing the incidence and mortality of burns in children and adults, with the exception of the elderly population [3,4]. Some scholars have predicted that in the near future, the treatment model for burns will also change as the number of elderly patients with burns increases [3].

Although “the burns in the elderly population are more aggressive” is not a new claim, the discussion is still relatively limited. As an accidental injury, burns are preventable. Once we understand the cause and eliminate the hidden dangers, the sources of burns will be reduced or avoided. An investigation of burn epidemics can reflect the basic situation of burn prevention and management in different periods and provide a theoretical basis for prevention and research. Some countries and regions have made substantial progress in reducing the incidence and mortality of burns by implementing measures related to prevention and treatment [5–7]. Therefore, an analysis of the epidemiological characteristics of elderly patients with burns, particularly elderly patients with severe burns, is of great significance for prevention and treatment.

As the largest burn center in Southwest China, more than 1500 hospitalized patients with burns are treated at the Institute of Burns Research of Southwest Hospital annually, providing us the unique opportunity to investigate the epidemiological characteristics and trends of elderly patients with severe burns. Thus, the present study retrospectively analyzed the etiology, clinical characteristics and therapeutic efficiency in elderly patients with severe burns who were admitted to and treated at the burn center from January 2009 to December 2018, providing experience to improve preventative measures and treatment for elderly patients with severe burns.

## Material and Methods

### Patients

Data were collected from 109 elderly patients with severe burns who were admitted to the Institute of Burn Research, Southwest Hospital, the Third Military Medical University between January 2009 and December 2018. A severe burn is

defined as a total burn area of no less than 30% of the total body surface area (TBSA), and elderly patients are defined as aged greater than or equal to 60 years. The study protocol was approved by the Ethics Committee of Southwest Hospital, Third Military Medical University.

### Data collection

The following factors were considered in the statistical analysis: 1) demographic data, including sex, age at burn, and residence; 2) general information about the burn, including the location, etiology, and time of burn; 3) clinical characteristics, including the total burn area, third degree burn area, severity score for the burn, inhalation injury, time of admission after the burn and complications before the burn; and 4) treatment methods and prognosis, mainly including operations, hospitalization days (length of stay, LOS), main causes of death and outcomes of disease. The abbreviated burn severity index (ABSI) score [8], the modified Baux score [9] and the burn index (BI) score [10] were calculated for each patient as follows: ABSI=sex (female=1 and male=0)+age (0–20 years=1, 21–40 years=2, 41–60 years=3, 61–80 years=4, and 80–100 years=5)+inhalation injury (yes=1 and no=0)+full-thickness burns (yes=1 and no=0)+TBSA (1–10%=1, 11–20%=2, 21–30%=3, 31–40%=4, 41–50%=5, 51–60%=6, 61–70%=7, 71–80%=8, 81–90%=9, and 91–100%=10). The modified Baux score=age+%TBSA+17×(inhalation injury, 1=yes and 0=no). BI=%TBSA of the full-thickness burn+1/2×%TBSA of the deep partial thickness burn.

### Statistical analyses

All data are presented as medians and interquartile ranges (IQR) or proportions, as appropriate. All statistical analyses were performed using SPSS 20.0 software (SPSS, Inc., Chicago, IL, USA). Categorical variables were compared using the chi-square test or Fisher's exact test, and continuous non-parametric variables were compared using the Mann-Whitney U-test or the Kruskal-Wallis test. The associations between mortality and demographic and clinical characteristics variables were assessed using a univariate analysis (Table 1). After univariate analysis, variables with  $P<0.05$  (including inhalation injury, pre-existing comorbidities, TBSA, and full-thickness burns) were included in a multivariate logistic regression model (forward: LR method, entry:  $P=0.05$ ; removal:  $P=0.10$ ) to screen the independent risk factors for mortality.  $P<0.05$  was considered statistically significant.

**Table 1.** Comparison of characteristics between survivors and non-survivors among elderly patients with severe burns.

Parameter		Survivors (n=82)		Non-survivors (n=27)		P-value
Male: Female	n: n	53: 29		16: 11		0.615
Age	Years	67.0	(62.0–71.0)	71.0	(64.0–76.0)	0.110
Rural residence	n (%)	69	(84.1)	21	(77.8)	0.643
Admission within 6 hours after injury	n (%)	33	(40.2)	9	(33.3)	0.522
With pre-existing comorbidities (no ≥3)	n (%)	6	(7.3)	9	(33.3)	0.002*
Inhalation injury	n (%)	24	(29.3)	15	(55.6)	0.013*
With full-thickness burns	n (%)	57	(69.5)	26	(96.3)	0.005*
Full-thickness burns	%TBSA	25.0	(8.5–36.0)	24.5	(15.8–44.3)	0.261
TBSA	%	40.0	(34.8–47.3)	45.0	(40.0–68.0)	0.040*
ABSI score	/18	10.0	(9.0–11.0)	11.0	(10.0–12.0)	0.006*
Baux score		115.0	(102.8–127.5)	129.0	(115.0–143.0)	0.001*
Burn index		23.3	(9.9–37.5)	31.0	(27.5–55.5)	0.004*
Patients treated surgically	n (%)	43	(52.4)	14	(51.9)	0.958

All values are presented as medians with inter-quartile ranges (IQR), or numbers and percentages in parentheses. TBSA – total body surface area; ABSI – abbreviated burn severity index. \*  $P < 0.05$ .

## Results

### Demographic characteristics

The 109 elderly patients with severe burns included 69 males (63.3%) and 40 females (36.7%); the male-to-female ratio was approximately 1.73: 1.0. In the same period, 1268 patients with severe burns and 697 elderly patients with burns were admitted to and treated in the same department. The proportions of elderly patients with severe burns among the total patients with severe burns and elderly patients with any burn showed large variations in different years (Figure 1A, 1B). All elderly patients were aged from 60 to 89 years, with a median age of 67.0 years (range, 62.5 to 72.5 years); the median ages of both males and females were 67 years. The age range with the highest burn incidence was 60–69 years (n=68, 62.4%), followed by 70–79 years (n=32, 29.4%), and 80–89 years had the lowest incidence (n=9, 8.2%). No elderly patients with severe burns were aged greater than 90 years (Figure 1C).

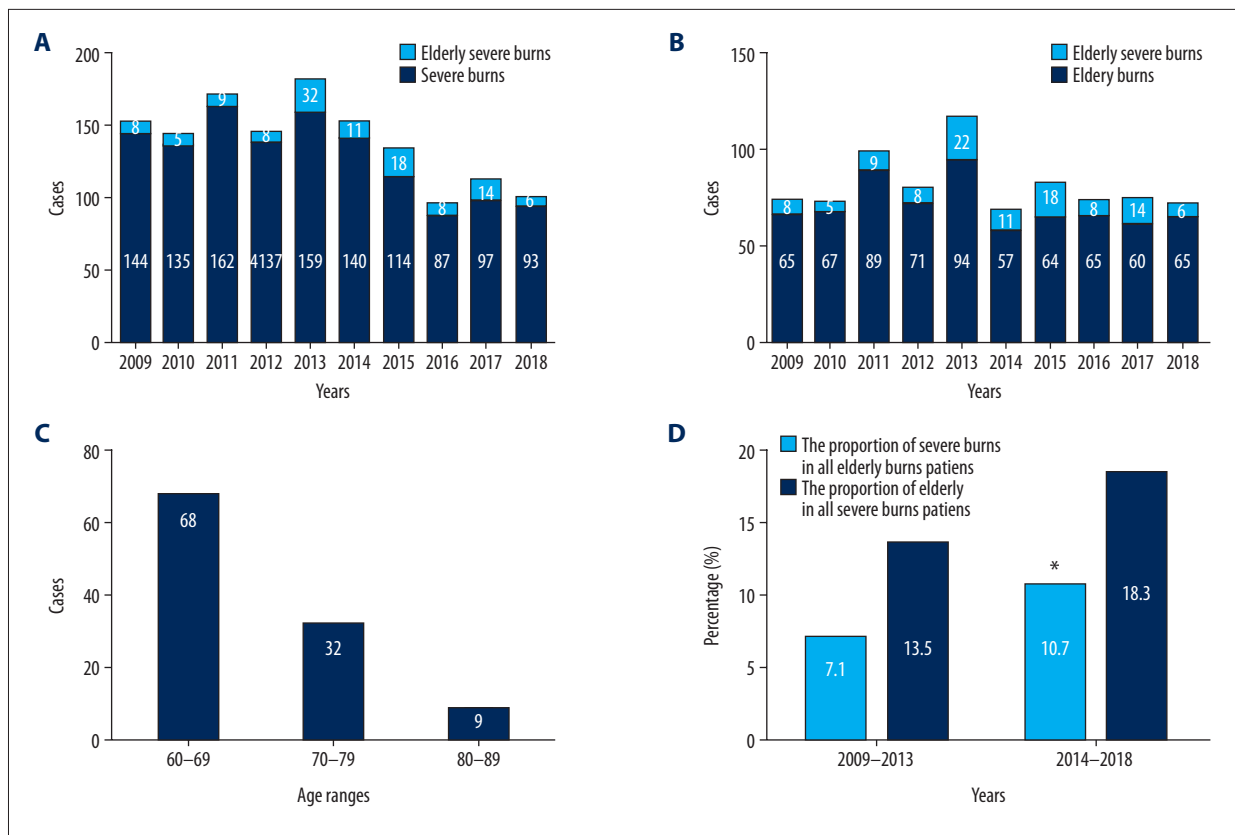
In addition, the 109 patients were divided into 2 periods (2009–2013 and 2014–2018) according to the time of admission. In the 2014–2018 cohort, the elderly patients accounted for 10.7% of all patients with severe burns in the same period, and the proportion was significantly higher than the value of 7.1% observed in the previous 2009–2013 cohort ( $P < 0.05$ ). The incidence of severe burns in all elderly patients with burns who

were admitted to our burn center also increased (18.3% versus 13.5%), although the difference was not significant (Figure 1D). The clinical characteristics, treatments, and outcomes of elderly patients with severe burns were not significantly different between the 2 periods, except for a higher proportion of full-thickness burns in the 2014–2018 cohort ( $P < 0.05$ ) (Table 2).

### Location, etiology, and time of admission of burns

In our study, 74 burns (67.9%) occurred at home, and 35 burns (32.1%) occurred outside the home, for a 2.1: 1 ratio (Figure 2A). Flame and flash burns predominated (83.4%), followed by explosion burns (Figure 2B). Severe burns could occur in elderly individuals at any time of the year. Nevertheless, the incidence in summer (38.5%) and winter (28.4%) increased compared to the incidence in autumn (19.3%) or spring (13.8%) (Figure 2C). The time of admission to the hospital ranged from 2 hours to 30 days after injury. Only 42 patients (38.5%) were transported to our burn center for treatment within 6 hours after injury (Figure 2D). In addition, in a more detailed investigation of the month of injury, the 3 months in which burns frequently occurred were July (17.4%), August (11.9%), and December (10.1%) (Figure 3).

In an analysis stratified according to geographic characteristics, differences in the burn parameters mentioned above were not observed between the rural and urban areas (Table 3).



**Figure 1.** The proportions of elderly patients with severe burns among patients with severe burns (A) and elderly patients with burns (B) in different years. Distribution of elderly patients with severe burns in different age groups (C). The proportion of elderly patients with severe burns among all patients with severe burns and all elderly patients with burns in the 2009–2013 and 2014–2018 cohorts (D). \*  $P < 0.05$  compared with the 2009–2013 cohort.

**Severity of burns and pre-existing comorbidities**

The median burn area was 42% (35–52%) TBSA (range: 30–92% TBSA). Patients with TBSAs of 30–49%, 50–69%, and  $\geq 70\%$  accounted for 72.5%, 19.3%, and 8.3% of all cases, respectively. The majority of these patients had full-thickness burns (76.1%). The associations between the sex, age, and burn severity are presented in Table 4. The ABSI scores for females were significantly higher than those of males ( $P < 0.01$ ). Female also had higher TBSAs, Baux scores and BIs, but the differences were not significant. The Baux score was significantly increased with age in the age groups of 60–69 years, 70–79 years, and 80–89 years ( $P < 0.01$ ). No significant differences in the TBSAs, ABSIs, and BIs were detected in the 3 age groups.

In our study, 39 patients (35.8%) were complicated with inhalation injuries. Fifty-six patients (51.4%) who were elderly patients with severe burn had at least 1 of 24 pre-existing comorbidities, and the most common pre-existing comorbidities were hypertension (25.7%), diabetes mellitus (11.1%), ischemic heart disease (8.3%), and chronic obstructive pulmonary disease (8.3%) (Figure 4).

**Treatment in the hospital**

The median LOS and LOS/TBSA of the 109 patients were 19.0 days (range 5.5–49.5 days) and 0.4 days (range 0.1–1.2), respectively. Table 5 illustrates the distribution of the LOS, LOS/TBSA, and outcomes of disease in groups stratified by sex, age, and TBSA. Males had higher LOS, LOS/TBSA, and cure rate, as well as a lower mortality rate, but the differences were not significant. The enthusiasm for treatment reflected in the LOS, LOS/TBSA, and cure rate among the age groups of 60–69 years, 70–79 years, and 80–89 years inversely correlated with age ( $P < 0.05$  or  $P < 0.01$ ). When patients were stratified into burn size groups (30–49% TBSA, 50–69% TBSA, and  $\geq 70\%$  TBSA), marked reductions in LOS, LOS/TBSA, and the cure rate were observed in the 30–49% TBSA and  $\geq 70\%$  TBSA groups ( $P < 0.05$  or  $P < 0.01$ ).

Approximately equal numbers of patients underwent surgical treatment ( $n = 57$ ) with excision and skin grafting compared to non-surgical management ( $n = 52$ ), as summarized in Table 6. Patients who did not undergo surgery were significantly older ( $P < 0.01$ ), had a higher proportion of pre-existing comorbidities ( $P < 0.05$ ) and a lower proportion of full-thickness

**Table 2.** A Comparison of the characteristics of elderly patients with severe burns between the 2009–2013 and 2014–2018 cohorts.

Parameter		2009–2013 (n=52)		2014–2018 (n=57)		P-value
Male	n (%)	30	(57.7)	39	(68.4)	0.246
Age	Years	69.0	(63.0–72.8)	67.0	(62.0–73.5)	0.310
Rural residence	n (%)	45	(86.5)	45	(78.9)	0.297
Admission within 6 h after injury	n (%)	20	(38.5)	22	(38.6)	0.988
With a pre-existing comorbidity	n (%)	26	(50.0)	32	(56.1)	0.521
With full-thickness burns	n (%)	35	(67.3)	48	(84.2)	0.039*
Inhalation injury	n (%)	19	(36.5)	20	(35.1)	0.875
TBSA	%	41.5	(35.0–55.0)	42.0	(34.0–51.5)	0.600
ABSI score	/18	10.0	(9.0–11.8)	10.0	(9.0–12.0)	0.664
Baux score		121.0	(105.3–131.0)	117.0	(102.5–129.0)	0.397
Burn index		29.3	(9.0–41.4)	28.0	(15.0–37.3)	0.860
Patients treated surgically	n (%)	24	(46.2)	33	(57.9)	0.220
LOS survivors	Days	16.5	(7.0–55.0)	31.5	(7.5–55.8)	0.577
LOS survivors/TBSA	Days	0.4	(0.1–1.4)	0.8	(0.1–1.6)	0.561
Cure rate	n (%)	17	(32.7)	24	(42.1)	0.311
Mortality rate	n (%)	12	(23.1)	15	(26.3)	0.696

All values are presented as medians with inter-quartile ranges (IQR), or numbers and percentages in parentheses. h – hours; TBSA – total body surface area; ABSI – abbreviated burn severity index; LOS – length of stay. \*  $P < 0.05$ .

burns ( $P < 0.01$ ), and had significantly lower LOS, LOS/TBSA, and cure rates ( $P < 0.01$ ).

### The outcomes, mortality rates and clinical characteristics of death

Twenty-seven deaths were recorded among the 109 patients, including 16 males and 11 females. The overall mortality rate was 24.8%. Non-survivors had a significantly larger overall TBSA, and a greater proportion presented with 3 or more pre-existing comorbidities, sustained full-thickness burns and inhalation injury compared to the survivors ( $P < 0.05$  or  $P < 0.01$ ) (Table 1).

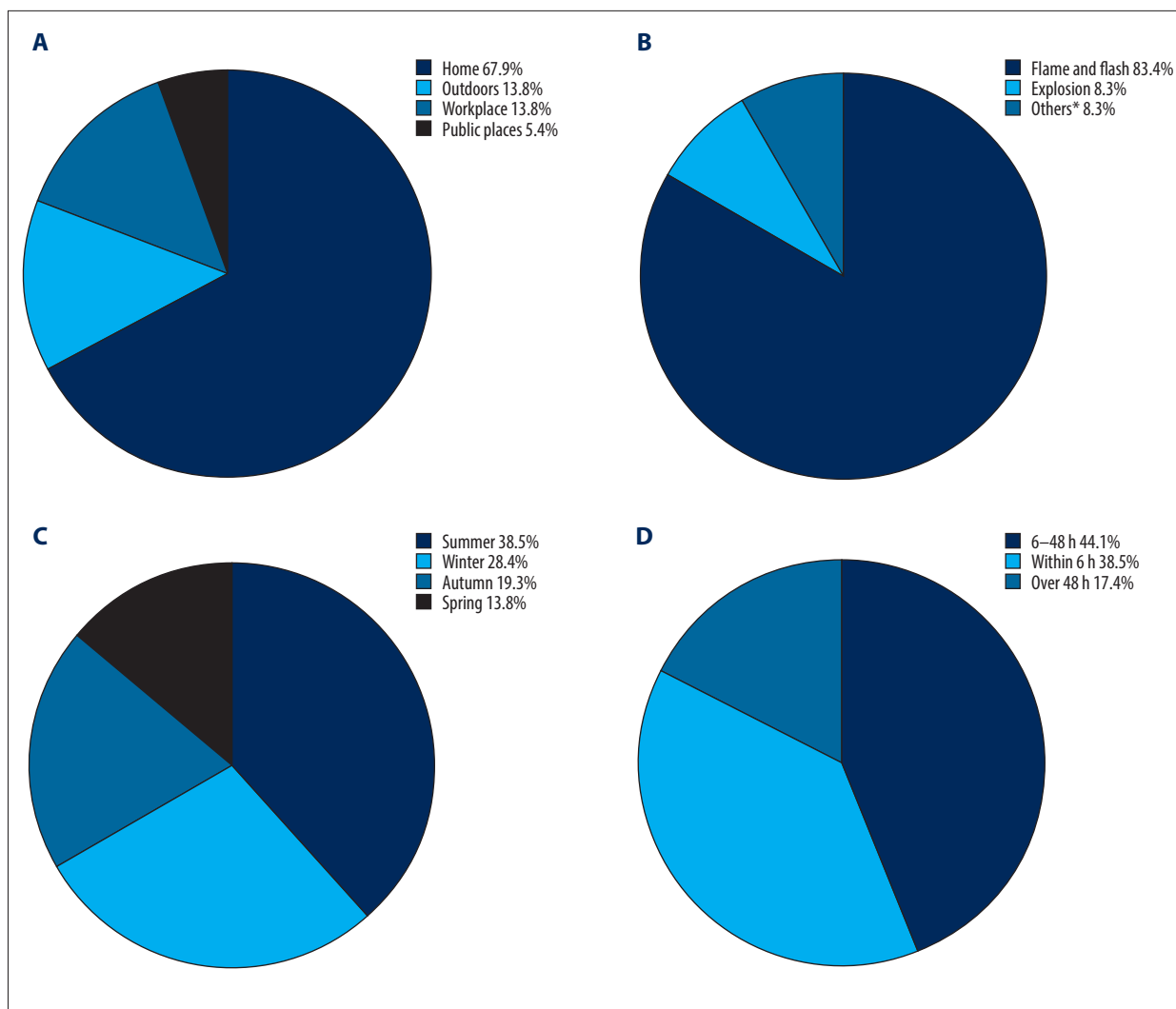
When stratified into burn size groups, marked increases in mortality were observed in the  $\geq 70\%$  TBSA group ( $P < 0.05$ ). However, no differences were observed in mortality in groups stratified by sex and age (Table 5). A higher mortality rate was observed in the inhalation injury group (38.5%) than in the non-inhalation injury group (17.1%,  $P < 0.05$ ) (Figure 5A). Furthermore, the mortality rate of the patients with 3 or more pre-existing comorbidities was as high as 60%, compared with a mortality rate of 18.9% in patients without pre-existing comorbidities ( $P < 0.05$ ) (Figure 5B). An association between a greater

number of pre-existing comorbidities and the mortality rate was observed with the multivariate model, with an odds ratio (OR) of 2.222 (95% confidence interval [CI]: 1.174–4.205,  $P < 0.05$ ) (Table 7).

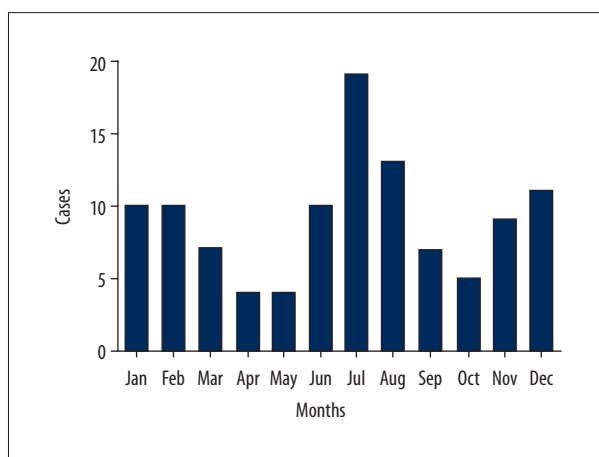
After investigating the medical notes regarding the cause of death in more detail, sepsis, major burns and acute renal failure were the most common causes of death (Table 8). The median time of death was 14 days (range 3–35 days) after injury, and the most common time of death was within 7 days after injury (40.7%) (Figure 5C).

### Discussion

Although the overall incidence of burns is decreasing [11], some studies have reported increasing trends of burn admissions or burn incidence rates in the elderly population [12–15]. The results of our study also revealed a similar increasing trend. The proportion of elderly patients with severe burns among all patients with severe burns (10.7% versus 7.1%) was higher in the second 5-year cohort (2014–2018) than in the previous 5-year cohort (2009–2013). As a result, the rapid growth



**Figure 2.** Distribution of the location (A), etiology (B), seasons (C), and time to hospitalization (D) in elderly patients with severe burns from 2009 to 2018. \* Scald, electricity, and contact burns.



**Figure 3.** Monthly distribution of elderly patients with severe burns.

of the elderly population and the vulnerability of this population to injury led to an increase in the number of elderly patients with severe burns [12,16].

Most of the elderly patients with severe burns in this study were aged 60 to 69 years old, which was similar to other reports [2]. Some studies reported a higher risk of burns in older women [12,14,17,18]. However, most of the patients included in this study were male. This discrepancy may be related to the differences in sex distribution among different countries and regions and the different divisions of labor between males and females within the family [2,12]. In the present study, the majority of burns occurred at home, were relatively common in summer and winter, and flame and flash burns were the major risk factors for elderly patients. These findings are consistent with previous reports [2,12,14,18–20]. Therefore, strengthening the investigation of burn hazards in the homes

**Table 3.** Comparison of burn parameters between rural and urban areas.

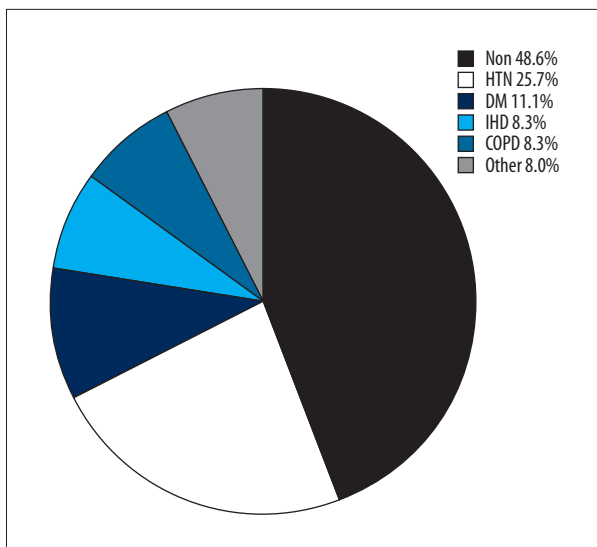
Parameter		Rural areas (n=90)	Urban areas (n=19)	P-value
<b>Location of burns</b>				
Home	n (%)	62 (68.9)	12 (63.2)	0.627
Outdoors	n (%)	14 (15.6)	1 (5.2)	
Workplace	n (%)	12 (13.3)	3 (15.8)	
Public places	n (%)	2 (2.2)	3 (15.8)	
<b>Etiology of burns</b>				
Flame and flash	n (%)	73 (81.1)	18 (94.7)	0.236
Explosion	n (%)	9 (10.0)	0	
Others*	n (%)	8 (8.9)	1 (5.3)	
<b>Seasonal distribution of burns</b>				
Spring	n (%)	11 (12.2)	4 (21.1)	
Summer	n (%)	34 (37.8)	8 (42.1)	0.725
Autumn	n (%)	19 (21.1)	2 (10.5)	
Winter	n (%)	26 (28.9)	5 (26.3)	
<b>Time to hospitalization</b>				
within 6 hours	n (%)	33 (36.7)	9 (47.4)	0.384
6–48 hours	n (%)	41 (45.5)	7 (36.8)	
Over 48 hours	n (%)	16 (17.8)	3 (15.8)	

All values are presented as numbers and percentages in parentheses. \* Scald, electricity, and contact burns.

**Table 4.** Burn severity analysis.

Parameter	TBSA median (IQR)	ABSI median (IQR)	Baux score median (IQR)	Burn Index Median (IQR)
<b>Sex</b>				
Male	40.0 (35.0–52.0)	10.0 (9.0–11.0)	103.0(97.0–117.0)	27.5 (12.8–37.5)
Female	45.0 (32.3–54.3)	11.0 (10.0–12.0)	106.3(98.1–118.5)	29.5 (10.4–44.4)
P-value	0.940	0.002*	0.945	0.676
<b>Age (years)</b>				
60–69	45.0 (35.0–54.8)	10.0 (9.0–11.8)	114.0(101.3–127.0)	27.3 (11.5–39.6)
70–79	40.0 (34.0–55.0)	10.0 (9.0–11.8)	126.5(107.0–138.5)	28.8 (16.3–42.9)
80–89	40.0 (37.5–44.0)	11.0 (9.5–12.0)	127.0(123.0–142.5)	32.5 (20.0–37.3)
P-value	0.708	0.500	0.002*	0.792

All values are presented as medians and inter-quartile ranges (IQR) in parentheses. \*  $P < 0.05$ . TBSA – total body surface area; ABSI – abbreviated burn severity index.



**Figure 4.** The most common pre-existing comorbidities. HTN – hypertension; DM – diabetes mellitus; IHD – ischemic heart disease; COPD – chronic obstructive pulmonary disease.

of elderly patients with burns and increasing preventive measures, such as installing smoke alarms and improving wire quality, are important measures to prevent burns in the elderly population [21]. In addition, differences in the occurrence and

prognosis of burns have been reported in elderly patients residing in rural and urban households [22,23]. However, no significant differences were observed between rural and urban households in the present study. Thus, with the increase in rural urbanization construction and the development of the social economy in China, burn-related lifestyle factors were relatively similar between rural and urban residents.

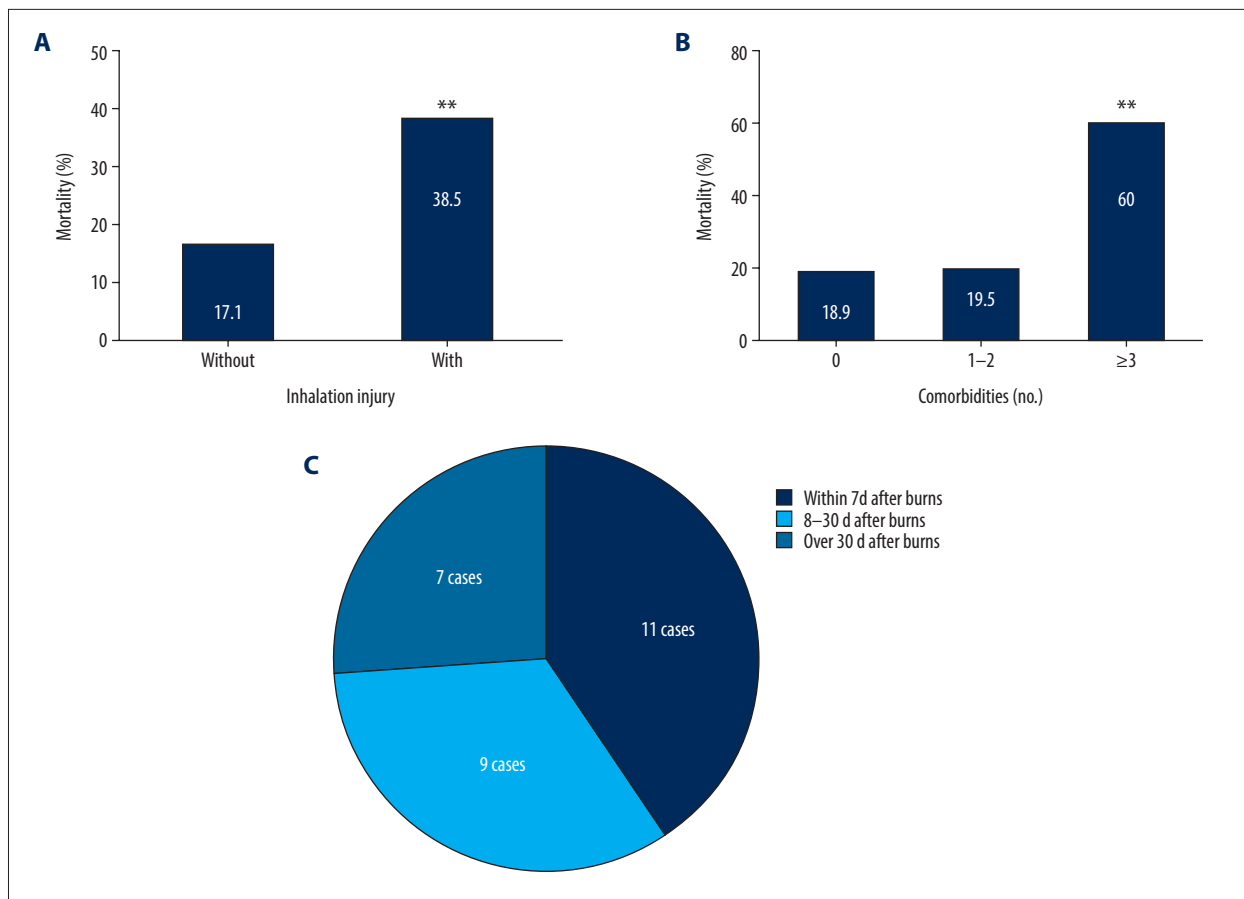
Elderly people often live alone, and flame burns are common; thin skin, a limited ability to escape harm and other factors easily lead to deeper burns [24]. Cheng et al. [14] observed that compared with children and middle-aged and young patients, the highest incidence of full-thickness burns was observed in elderly patients. In the present study, the proportion of elderly patients presenting with full-thickness burns was 76.1%. In addition, females appeared to have more severe burns and higher mortality rates than males, although the differences were not significant. Chang et al. [25] reported that although a lower burn severity was observed in women than in men, the number of deaths was the same, indicating that women had worse outcomes after burns. However, we did not observe any difference in the severity of burns among different age ranges. This finding differs from the results of some studies [26–28] and might be related to the small sample size and the insufficient numbers of patients in each age range in the present study.

**Table 5.** LOS and outcome distributions.

	LOS (days) median (IQR)	LOS/TBSA (days) median (IQR)	Cured n (%)	Died n (%)
<b>Sex</b>				
Male	24.0 (7.5–51.0)	0.6 (0.1–1.2)	29 (42.0)	16 (23.2)
Female	12.0 (2.3–40.8)	0.3 (0.1–1.4)	12 (30.0)	11 (27.5)
<i>P</i> -value	0.174	0.265	0.211	0.615
<b>Age (years)</b>				
60–69	34.0 (8.5–58.8)	0.7 (0.2–1.4)	32 (47.1)	13 (19.1)
70–79	11.5 (4.0–30.8)	0.2 (0.1–0.8)	9 (28.1)	11 (34.4)
80–89	3.0 (1.0–12.5)	0.1 (0–0.4)	0	3 (33.3)
<i>P</i> -value	0.001*	0.004*	0.010*	0.212
<b>TBSA (%)</b>				
30–49	28.0 (8.0–53.0)	0.7 (0.2–1.4)	37 (46.8)	17 (21.5)
50–70	8.0 (3.5–20.5)	0.1 (0.1–0.4)	3 (14.3)	4 (19.0)
≥70	12.0 (1.0–47.0)	0.1 (0–0.7)	1 (11.1)	6 (66.7)
<i>P</i> -value	0.047*	0.002*	0.005*	0.010*

All values are presented as medians with inter-quartile ranges (IQR), or numbers and percentage in parentheses. TBSA – total body surface area; LOS – length of stay. \*  $P < 0.05$ .





**Figure 5.** Mortality rates of elderly patients with severe burns presenting with and without inhalation injury (A). Mortality rates of elderly patients with severe burns stratified according to the number of pre-existing comorbidities (B). Distribution of the time of death after burns in elderly patients with severe burns (C). \*  $P < 0.05$  compared with patients without inhalation injury and \*\*  $P < 0.05$  compared patients with 0 and 1–2 comorbidities.

The prevalence of pre-existing comorbidities is a unique feature of the elderly population and increases the vulnerability and mortality of burns in the elderly population [29–31]. In the present study, approximately half of the patients had at least one pre-existing comorbidity, which is less than the reported 69–82.4% rate in the literature [18,32,33]. The major pre-existing comorbidities were hypertension, diabetes mellitus, ischemic heart disease, and chronic obstructive pulmonary disease, similar to some previous findings [2,34,35]. Currently, researchers generally believe that burns further exacerbate the pre-existing comorbidities, and the underlying diseases existing in the elderly before injury might in turn affect the recovery from burns. The interaction between the 2 would prolong the hospital stay, consume more medical resources and result in a poor prognosis [36,37]. For instance, Lara et al. [30] observed that in elderly patients with the same severity of burns, patients with dementia were hospitalized for twice as long as patients without dementia, the 30-day mortality rate was 3 times higher than patients without dementia, and more medical resources were consumed.

Since Janzekovic [38] first proposed the concept of early excision and skin grafting in 1970, this technique has been shown to reduce the hospitalization time and mortality of children and adults [39]. Half of the patients in the present study underwent surgical treatment, and older patients with pre-existing comorbidities were more likely to choose conservative treatment. However, surgical treatment did not improve the number of hospitalization days and mortality rates in elderly patients, which may be related to more complications after surgery [40]. Elderly patients with burns are often characterized by a pre-existing comorbidity, critical conditions, numerous complications and a weak wound healing ability [3]. Therefore, the hospitalization time should exceed the overall hospitalization time of patients with burns. However, the median hospitalization period for the patients included in this study was only 0.4 days/% TBSA, which was lower than the usual hospitalization period (1 day/%) for the total burn population [41], and much lower than the rate of 2.4 days/% TBSA for elderly patients with burns in some countries, such as the UK [32]. In the present study, the treatment received by elderly patients with

**Table 6.** Comparison of elderly patients with severe burns treated with and without surgical management.

Parameter		Surgical management (n=57)		Non-surgical management (n=52)		P-value
Male: Female	n: n	41: 16		28: 24		0.050
Age	Years	66.0	(62.0–70.0)	69.0	(65.3–77.8)	0.005*
Rural residence	n (%)	46	(80.7)	44	(84.6)	0.591
With a pre-existing comorbidity	n (%)	23	(40.4)	33	(63.5)	0.016*
With full-thickness burns	n (%)	51	(89.5)	32	(61.5)	0.001*
Inhalation injury	n (%)	22	(38.6)	17	(32.7)	0.521
TBSA	%	40	(35–53)	43	(35–52)	0.708
Full-thickness burns	%TBSA	18.0	(6.0–32.5)	6.0	(0–34.5)	0.103
ABSI score	/18	10.0	(9.0–11.0)	10.5	(9.0–12.0)	0.696
Baux score		115.0	(103.0–129.0)	122.0	(105.3–133.3)	0.250
Burn index		29.5	(18.0–38.0)	25.3	(8.6–40.8)	0.113
LOS	Days	37.0	(13.0–63.5)	7.0	(1.0–22.3)	<0.01*
LOS/TBSA	Days	0.9	(0.3–1.8)	0.15	(0–0.58)	<0.01*
Cured	n (%)	29	(50.9)	12	(23.1)	0.003*
Died	n (%)	14	(24.6)	13	(25.0)	0.958

All values are presented as medians and inter-quartile ranges (IQR), or numbers and percentages in parentheses. TBSA – total body surface area; ABSI – abbreviated burn severity index; LOS – length of stay. \*  $P < 0.05$ .

**Table 7.** Independent risk factors for mortality of elderly patients with severe burns.

Factors	B	OR	95% CI	P-value
Pre-existing comorbidities (no.) <sup>#</sup>	0.799	2.222	1.174–4.205	0.014*
Full-thickness burns (%TBSA)	0.034	1.035	1.010–1.060	0.006*

<sup>#</sup> According to the number of pre-existing comorbidities, it is divided into 0, 1–2 and  $\geq 3$ , respectively. \*  $P < 0.05$ . OR – odds ratio; CI – confidence interval; TBSA – total body surface area.

**Table 8.** The reported causes of death in elderly severe burns patients with severe burns from 2009 to 2018.

Primary cause of death	Number	Primary cause of death	Number
Sepsis	7	Respiratory failure	1
Major burns	5	Stroke	1
Acute renal failure	3	Cardiac failure	1
Pneumonia	3	Myocardial infarction	1
Multiple organ failure	2	Upper alimentary tract hemorrhaging	1
Unknown	2		

severe burns was obviously insufficient, and with aging and an increase in the burn area, the enthusiasm for treatment was lower. Similarly, studies by Cheng et al. [14] and Tang et al. [42]

also reported this phenomenon. Tang et al. [42] reported a proportion of elderly patients with severe burns who refused treatment and were discharged as high as 57.3%, whereas

the proportion of young and middle-aged patients was only 7.8%; the reason why the elderly patients refused treatment was mainly insufficient funds.

The mortality rate is the focus of epidemiological investigations. Even with the same degree of burns, the prognosis of the elderly is often worse [3]. The literature published over the last decade reports a mortality rate of burns in the elderly ranging from 8% to 67%, and the average is approximately 15–20% in most reports [14,18–20,32,34,35]. In the present study, the mortality rate of the elderly patients with severe burns was 24.8%. However, when comparing the data from the same institute from 1999 to 2006, the mortality rate of the elderly patients in both the 30–50% TBSA group and the >50% group increased [22]. Meanwhile, the mortality rate of the last 5-year cohort (2014–2018) was also higher than the previous 5-year cohort (2009–2013) (26.3% versus 23.1%) in this study, although this increase had no statistically significant. Undoubtedly, the treatment of burns is improving. Why is the mortality rate of the elderly patients with severe burns not declining? This topic deserves additional consideration and further research. In addition, regarding the mortality rate of elderly patients with burns, the actual number of deaths caused by burns might be higher than reported in the literature because most studies only analyzed the mortality rate during hospitalization, and a certain proportion of the injured patients died at the scene of the burn or outside the hospital after completing treatment [43]. Duke et al. [37] also observed an increase in the long-term mortality of elderly patients associated with burns, and the true mortality rate associated with burns would be underestimated if the rate only relies on hospital death data.

The mortality rate of patients with burns is mainly affected by age, the burn area and inhalation injury [2,12,19,22,39,44]. In the present study, the mortality rate did not increase with age and burn area, which might be related to the insufficient sample size. However, we observed a significantly higher mortality rate in patients with inhalation injury (38.5% versus 17.1%), consistent with previous reports [19,20]. Meanwhile, significant difference in the mortality rates was not observed between patients without a pre-existing comorbidity and patients with 1 or 2 pre-existing comorbidities (18.9% versus 19.5%); however, when older patients had 3 or more pre-existing comorbidities, the mortality rate was significantly higher, up to 60%. The multivariate regression analysis also showed that the number of pre-existing comorbidities was an independent risk factor for death, similar to results reported by Stylianou et al. [45]. In addition, the causes of death in elderly patients with severe burns were sepsis, major burns, acute renal failure and pneumonia in previous studies, and the median time of death was 14 days after injury [12,32,46]. We obtained similar results in the present study.

## Conclusions

In this study, the incidence and mortality of severe burns in the elderly in our department have no sign of declining. Men aged 60–69 years are the key populations to target preventative measures for burns in the elderly. Most elderly patients with severe burns experienced flame and flash burns, and burns frequently occurred in summer and winter. Meanwhile, multidisciplinary treatment in a hospital and an increase in the social support for the elderly population may improve outcomes.

## Conflict of interest

None.

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