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ORIGINAL PAPER

Demographic and socioeconomic factors influencing the incidence of clavicle fractures, a national population-based survey of five hundred and twelve thousand, one hundred and eighty seven individuals

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Abstract

Background This study aims to investigate the population-based incidence of clavicle fracture and the related risk factors in China.

Methods All the data on clavicle fractures were available from the China National Fracture Survey (CNFS) database performed in 2015. In the CNFS, all eligible household members were sampled from eight provinces, 24 urban cities, and 24 rural counties in China, using stratified random sampling and the probability proportional to size method. Questionnaires were sent to every participant for data collection. Information on age, gender, height, weight, ethnic group, education, professional, smoking, alcohol consumption, sleeping time per day, dietary habits, and others was collected. Fracture case was identified by patients' self report and further confirmation by medical data.

Results A total of 512,187 valid questionnaires were collected, and relevant data were extracted and analyzed. There were 89 patients with 89 clavicle fractures in 2014, indicating that the incidence was 17.4 (95%CI, 13.8–21.0) per 100,000 person-years. Traffic accidents and falls were the most predominant cause for clavicle factures, leading to 91.0% of all the injuries. Over 85% of them occurred on the road and at home. Age of 45–64, average sleep time < seven hours/day, smoking, alcohol consumption and history of previous fracture were identified as independent risk factors for clavicle fracture. Overweight (BMI, 24.0–27.9) was a significant protective factor, which was estimated to reduce 72% of the clavicle fractures, compared to normal BMI (18.5–23.9).

Conclusions Public health policies focusing on decreasing alcohol consumption, smoking cessation, and encouraging individuals to obtain sufficient sleep should be implemented. Middle-aged individuals with previous history of fracture should strengthen the awareness of prevention and health care and decrease risky activities to reduce the clavicle fractures.

Keywords Clavicle fracture · Incidence · National survey · Epidemiology

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Introduction

The incidence of clavicle fractures in general population was reported in a great variety, ranging from 6 to 91/100,000 person-years [1–5]. In department of emergency or orthopedics, clavicle fracture was also a common injury, constituting 2.6–10% of all fractures and 35–44% of all shoulder girdle injuries [5–8]. Approximately 70–80% of the fractures were located in the middle third of the clavicular shaft [6, 9] because it was the weakest part in biomechanics [10]. Direct fall on the shoulder is the most frequent injury mechanism [4]. In addition, we could find the obvious bimodal age distribution in males (< 30 and > 70 years) and a unimodal age distribution in older females [11]. However, most of these epidemiologic studies only focused on a single hospital, a subgroup of patients, or a certain region [1, 3, 4, 12]. By far, the epidemiological data of national level on clavicle fracture are scarce. Furthermore, very few studies attempted to identify the socioeconomic factors and individual lifestyles influencing the incidence of clavicle fractures.

With the largest population of over 1.36 billion worldwide, China had substantial diversity in terms of economic development, cultural practices, and lifestyles among different regions and ethnic groups. Currently, the Chinese National Health Services Survey (CNHSS) is the sole epidemiologic database of national level for collection of data on self-reported fractures at two weeks before the surgery. Therefore, some less-severe fractures treated by conservative methods might be missed out. In addition, this national survey system only collected the basic data on fractures (e.g., age, gender, and fracture occurrence timing), but without any information on type of fracture, body site, injury mechanisms, and related potential risk factor (geographical location, socioeconomic, and lifestyles).

China National Fracture Study (CNFS) was the first comprehensive and up-to-date national dataset of traumatic fracture through China, which was accomplished in the year 2015. In this dataset, the incidence rates, injury mechanism, demographic, and socioeconomic factors for all traumatic fractures were retrospectively documented via the questionnaire survey. Using data on clavicle fractures available from the CNFS dataset in this study, our purpose was (1) to report the population-based incidence of clavicle fracture in China and (2) to explore the demographic and socioeconomic factors and individual lifestyles influencing the clavicle fracture.

Methods

Sampling method

The CNFS survey was designed as retrospective and performed between January and May in 2015. All participants were sampled using optimum allocation and random stratified and probability proportionate to size (PPS) method. Firstly, eight provinces (municipalities) were initially selected from 31 provinces (municipalities or autonomous regions) in mainland China based on socioeconomic development and geographical environment in each province. These included Jilin, Hebei, Gansu, Shanghai, Hubei, Sichuan, Guangdong, and Yunnan provinces. And in this phrase, stratified random sampling method was used. During the second phrase, sampling was done separately in urban and rural areas of each targeted province (municipalities), and the optimum allocation and random stratified and probability proportional to size method was mainly used.

For urban areas, we selected a certain number of streets ranging from one to six in each sampled city, and a range from one to ten neighborhood communities from each chosen street, based on the geographical location from west to east on the electronic map. The total number of families in each neighborhood community was determined by the average number of household members according to the latest official census data of China. All members of eligible families to be invited to participate in this study must live in their current residence for at least six months.

For rural areas, we sampled one to five counties in each selected province and then one to eight towns were selected in each county. In each town, one to 14 administrative villages were sampled. In each village, households were calculated and selected based on probability proportional to size principles. Similarly as urban areas, all members of eligible families to be invited to participate in this study must live in their current residence for at least six months.

Participants and survey

In principle, eligible household members must be personally interviewed by our trained research team members. However, for preschool and primary school children, their information should be provided by their guardians in order to insure data accuracy. For participants who remained noncontactable after repeated visits, telephone surveys had to be used. For selected household members who refused to participate, an alternative household was randomly selected from the list.

A standardized questionnaire was administered by trained research teams for data collection. The detailed information included age, sex, Chinese ethnic nationality, marital status, and residence, income status, occupation, lifestyles (smoking, alcohol drinking, tea, coffee, carbonate beverages and daily consumption of meat, protein product, dairy products) for all participants. Only for women, information on age of menopause and the number of children to give birth was provided. Individuals who had clavicle fractures between January 1 and December 31, 2014, then must answer a more detailed accessory questionnaire regarding the fracture occurrence date and place, fracture site (distal, middle, or proximal), and injury

mechanism. In addition, they were asked to provide medical data on clavicle fractures, including radiographs, diagnostic reports, and medical reports. And if these data were not available, the survey team paid for individual participants to obtain a new radiograph of the clavicle at a local hospital.

Eight quality control teams were established (one per province) to check for the quality of related data collection. The CNFS was approved by the Institutional Review Board of the Third Hospital of Hebei Medical University, and written informed consent was obtained from all participants before data collection.

Definition of variables of interest

The individual was divided into Han ethnicity and others (all the national minority ethnicity). The body mass index (BMI) was divided into four groups: underweight, < 18.5; normal, 18.5–23.9; overweight, 24–27.9; obesity, ≥ 28 [13, 14]. Daily diet including meat and products, bean products, milk and dairy products, coffee, tea, and carbonate beverages was divided into five groups based on frequency of consumption: never, always (at least 1 per day), often (1/day–1/week), occasionally (1/week–1/month), and seldom (< 1/month). Calcium or vitamin D supplement was defined as positive if participants acknowledged they received calcium or vitamin D-related medicine or nourishment for at least one month before the clavicle fracture occurrence. Urbanization was divided into two groups: (1) rural area (village) and (2) urban areas (other than village).

Statistical analysis

Incidence rates for clavicle fractures were estimated for the overall population and for subgroups such as age, occupation, and education, stratified by gender. For unordered categorical variables such as occupation, regions, and ethnic origin, the chi-square test was used to test the difference in incidence of clavicle fracture. For ordered categorical variables such as age and education level, we entered the related data as a continuous variable into a univariate logistic regression model to test the difference in incidence of clavicle fractures.

Then, univariate chi-square test was used to investigate the potential correlations between clavicle fractures and various factors of interest. Case group were defined as patients with adult clavicle fractures in the year 2014, and control group was defined as those without fractures of any site in the year 2014.

Finally, all the potential factors associated with clavicle fracture were entered into multivariable analysis model using stepwise logistic regression (backward selection) to identify the independent factors for clavicle fractures. Odds ratio (OR) values and corresponding 95% confidence interval (95%CI) were used to indicate the correlation intension of risk factor. The Hosmer–Lemeshow test was used to examine goodness-of-fit of the final model and a P value > 0.05 suggested an acceptable fitness. SPSS 19.0 was used to perform all the analyses (SPSS Inc., Chicago, IL, USA).

Results

The CNFS lasted from January to May in 2015; questionnaires from 23,649 (4%) individuals were ultimately excluded due to missing items, insufficient responses, or logical errors; and finally, a total of 512,187 valid questionnaires were collected, and relevant data were abstracted and analyzed. There were 259,649 (51%) boys and men and 252,538 (49%) girls and women, with the M/F ratio of 1.03/1. Through the year 2014, 1763 patients sustained traumatic fractures (1833 fractures). Of them, 89 patients with 89 cases of clavicle fractures were included, indicating the incidence rate of traumatic clavicle fracture in China was 17.4 (95%CI, 13.8–21.0) per 100,000 person-years (Table 1).

There were 32 female and 57 male patients, and their average age was 47.9 years (standard deviation, 6.3). Traffic accidents and fall and were the most predominant cause for clavicle factures, leading to 91.0% of all the injuries (Table 2). Most of the clavicle fractures occurred on the road and at home, accounting for 86.5% (77/89) of all the injuries (Table 3).

Table 1 presents the population-based incidence rates of clavicle fractures by individual characteristics for overall populations, males and females. There was no significant difference in incidence between those of Han ethnicity and all other ethnicities combined, nor was there any significant difference according to geographical region, urbanization, either for overall population or either gender. Stratified by occupation, farmers had the highest incidence rates in males, females, and overall individuals, and that was 43.1, 27.7, and 34.7 per 100,000 person-years, respectively. Population aged 45–64 had the highest incidence rate of clavicle fractures in overall individuals (37.5; 95% CI, 27.3–47.7), males (49.2; 95% CI, 32.7–65.7) and females (25.9; 95% CI, 14.0–37.9), and the difference among respective subgroup was statistically significant ($P = 0.009, < 0.001, 0.002$). Stratified by education level, in males, illiterate and less-educated people had the higher incidence rate of clavicle fractures, compared to those with education of high level and the trend test for difference showed the significant result ($P = 0.008$). However, this tendency for difference was not obvious in females ($P = 0.333$), although illiterate individuals had the highest incidence rate (27.2; 95% CI, 11.1–43.2).

Table 4 presents the detailed results of univariate analysis using chi-square test for adults (≥ 15 years). We could find that there were significant correlation between clavicle fracture and gender, age, education level, occupation, cigarette

Table 1 National incidence of clavicle fractures among Chinese population by demographic, socioeconomic, and geographic factors in 2014

Item	Sample size	Male		Female		Total	
		Case	Incidence (1/100,000)	Case	Incidence (1/100,000)	Case	Incidence (1/100,000)
Overall	512,187	57	22.0 (16.3–27.7)	32	12.7 (8.3–17.1)	89	17.4 (13.8–21.0)
Age (years)							
0–14	81,166	2	4.5	2	5.4	4	4.9 (0.1–9.7)
15–44	236,206	18	15.2 (8.2–22.3)	8	6.8 (2.1–11.5)	26	11.0 (6.8–15.2)
45–64	138,533	34	49.2 (32.7–65.7)	18	25.9 (14.0–37.9)	52	37.5 (27.3–47.7)
65+	48,020	3	10.7	4	14.2 (2.9–28.1)	7	12.4 (3.2–21.7)
P value for trend test	512,187	< 0.001		0.002		0.009	
Ethnicity							
Han nationality	477,508	49	20.2 (14.6–25.9)	31	13.2 (8.5–17.8)	80	16.9 (13.1–20.4)
Other nationalities	34,679	8	45.4 (14.0–76.9)	1	5.9	9	26.0 (9.0–42.9)
P value for difference test	512,187	0.056		0.722		0.210	
Region							
East	232,998	21	17.6 (10.1–25.1)	12	10.6 (4.6–16.5)	33	14.2 (9.3–19.0)
Central	99,109	9	18.1 (6.3–29.9)	7	14.2 (3.7–24.7)	16	16.1 (8.2–24.1)
West	180,080	27	29.9 (18.6–41.1)	13	14.5 (6.6–22.4)	40	22.2 (15.3–29.1)
P value for difference test	512,187	0.139		0.695		0.143	
Urbanization							
Urban area	203,101	23	22.4 (13.3–31.6)	8	8.0 (2.5–13.5)	31	15.3 (9.9–20.6)
Rural area	309,086	34	21.7 (14.4–28.9)	24	15.8 (9.5–22.1)	58	18.8 (13.9–23.6)
P value for difference test	512,187	0.088		0.352		0.894	
Occupation							
Office worker	61,919	8	24.4 (7.5–41.3)	4	13.7 (2.8–27.2)	12	19.4 (8.4–30.3)
Farmer	106,484	21	43.1 (24.7–61.5)	16	27.7 (14.1–41.3)	37	34.7 (23.6–45.9)
Manual worker	148,650	20	24.2 (13.6–34.8)	4	6.1 (0.1–12.0)	24	16.1 (9.7–22.6)
Retired	30,366	3	20.2	1	6.4	4	13.2 (2.6–26.1)
Unemployed	32,770	2	4.7	4	10.5 (0.2–20.8)	6	7.5 (1.5–13.4)
Others	15,974	3	7.8	3	6.5	6	7.1 (1.4–12.8)
P value for difference test	512,187	0.002		0.012		< 0.001	
Education (preschool children and students were excluded)							
Illiterate	74,937	14	40.6 (19.3–61.9)	11	27.2 (11.1–43.2)	25	33.4 (20.3–46.4)
Primary school	158,970	28	34.9 (22.0–47.8)	7	8.9 (2.3–15.5)	35	22.0 (14.7–29.3)
Junior high school	121,415	10	16.3 (6.2–26.3)	9	15.0 (5.2–24.8)	19	15.6 (8.6–22.7)
Senior high school or above	40,841	3	13.9	3	15.6	6	14.7 (2.9–26.4)
P value for trend test	396,163	0.008		0.333		0.009	

smoking, alcohol consumption, reduced sleep time (< 7 h/day), and history of previous fracture. For other variables, there was no significant correlation identified in this univariate analysis model.

Table 5 summarizes independent risk factors for clavicle fractures in adults (≥ 15 years). People aged 45–64 years had the significantly increased risk of clavicle fractures and the corresponding OR value was 2.68 (95% CI, 1.64–4.38), compared to those of 14–44 years. Compared to those having enough sleep time (≥ 7 hours/day), average sleep time < seven hours/day increased the risk of clavicle fracture by 1.98 times (95% CI, 1.28–3.06). In addition, current smoking, alcohol consumption, and history of previous fracture were also identified as significantly independent risk factors for occurrence of clavicle fractures. Overweight (BMI, 24.0–27.9) was a significant protective factor for occurrence of clavicle fracture and was estimated to reduce 72% of the cases, with reference of normal BMI (18.5–23.9).

In the final multivariate logistic regression model, the results of Hosmer–Lemeshow test showed the adequate fitness ($X^2 = 4.846$, $P = 0.774$).

Table 2 The causal mechanisms for clavicle fractures in China in 2014 (*n*, %)

Injury mechanism	Children (0–14 years)	Adult (≥ 15 years)		Total
		Male	Female	
Traffic accident	1(25.0)	25 (45.5)	11 (36.7)	37 (41.6)
Slip, trip, or fall	2 (50.0)	26 (47.2)	16 (53.3)	44 (49.4)
Fall from heights	[a]	3 (5.5)	1(3.3)	4 (4.5)
Crushing injury	1 (25.0)	1 (1.8)	2 (6.7)	4 (4.5)
Sum	4 (2.6)	55 (61.8)	30 (33.7)	89 (100.0)

[a] No fracture cases observed in this subgroup

Discussion

Regarding the epidemiology of clavicle fractures, the studies were in a large amount and the reported incidences were in a great variation. However, very few of them were population-based survey of national level. In the present study, we used the data from CNFS database of traumatic fractures and the results showed that the incidence rate of clavicle fracture was 17.4/100,000 person-years in 2014. In addition, results showed traffic accidents and fall and were the most common injury mechanism, leading to 91.0% of injuries. Over 85% of the injuries occurred on the road and at home. In adults, age of 45–64 years, smoking, alcohol consumption, average sleep time < seven hours/day, history of previous fracture were identified as independent risk factors for clavicle fractures. Compared to normal BMI (18.5–23.9), overweight (BMI, 24–27.9) was a significant protective factor and was estimated to reduce 72% of the clavicle fracture.

The incidence rate of clavicle fractures reported in this study was relatively lower than those of previous literature [1, 3, 4, 7]. The highest incidence rate of clavicle fractures was reported by Hsiao and his colleagues [1], who reported 91/100,000 person-years in US military, using the Defense Medical Epidemiology Database. There was no surprise that young males in predominance and occupation-specific tasks contributed majorly to the injury, for military personnel. The lowest incidence rate was reported in one of the earliest studies in Sweden, wherein authors calculated the age- and gender-specific incidences in 2035 cases of clavicle fractures between 1952 and 1987 [3]. And they reported an annual incidence rate of 6/1,000,000 person-years. In addition, Nowak et al. [4] and Robinson et al. [5] reported the median incidence rates of clavicle fractures, which were 50 and 29/100,000 person-years based on population in Sweden and Scotland, respectively. The differences among these studies might predominantly be associated with geographic location, social-economic development, individual lifestyles, and recreational activities among different countries. Primary prevention including home prevention remains the major task for reduction of clavicle fractures, because over 85% of the injuries were found to occur at home or on the road around in this study.

Table 3 The place of clavicle fracture occurrence in 2014 (n, %)

Place of fracture occurrence	Children	Adult (≥ 15 year)		Total
		Male	Female	
Home	2 (50.0)	9 (16.4)	10 (33.3)	21 (23.6)
Work unit	[a]	2 (3.6)	1 (3.3)	3 (3.4)
Building site	1	1 (1.8)	1 (3.3)	3 (3.4)
Road	1 (25.0)	39 (70.9)	16 (53.3)	56 (62.9)
Others	0	4 (7.3)	2 (6.7)	6 (6.7)
Sum	4 (4.5)	55 (61.8)	30 (33.7)	89 (100)

[a] No fracture cases observed in this subgroup

Middle-aged individual aged 45–64 years was identified as an independent risk factor for clavicle fracture. And in this age group, the incidence rate was 37.5/100,000 person-years, which was three to seven times higher than those in other age groups. This result was not accidental. Herteleer and his colleagues [12] retrospectively analyzed 667 patients with clavicle fractures and found the peak in middle-aged males (41–50 years). This age trend has also been reported in the Scandinavian population [15, 16], and they attributed this to the more active lifestyles in this age group. The mechanism was supported by Herteleer et al. [12], who reported 60.3% of clavicle fractures in patients of 51–60 years were caused by bicycle and motorbike injuries. The association between BMI and fracture risk was known to be complex. Lower BMI is a well-established risk factor for fracture, especially hip fracture. However, BMI > 25 kg/m^2 was previously reported to decrease the fracture risk [17]. Furthermore, recent data showed the association between BMI and fracture differed based on fracture site [18–20]. In this study, we found overweight (BMI, 24.0–27.9) was identified as a protective factor and could reduce approximately a half of the clavicle fracture, compared to those with BMI of 18.5–23.9. The mechanisms whereby BMI may influence risk could be multifactorial and at least in part was associated with bone mineral density, muscle strength and pattern of falls, the protective response to falling and the presence of soft tissue pudding [21, 22].

In the current studies, unhealthy lifestyles as smoking, alcohol consumption, and sleeping time less than seven hours per day were identified as independent risk factor for clavicle fractures for adults. Alcohol consumption as a recognized risk factor for traumatic fracture had been identified in the literature [23, 24]. And the underlying mechanism might be metabolic effects, drunken gait-related falls, and alcohol-related unconsciousness while driving [24]. Stone et al. [25] reported that women who slept for five hours or less or five to seven hours had the higher risk of frequent falls, compared to those with adequate sleep (7–8 h/day). And Holmberg et al. [26] got the similar findings in males that sleep disturbances contributed to

Table 4 Detailed results of univariate analysis for variables of interest

Variables	Case, $n = 85$ (%)	Control, $n = 429{,}375$ (%)	P
Gender			0.007
Male	55 (64.7)	214,501 (49.9)	
Female	30 (35.3)	214,874 (50.1)	
Age (years)			< 0.001
15–44	26 (30.6)	235,657 (54.9)	
45–64	52 (61.2)	137,779 (32.1)	
≥ 65	7 (8.2)	55,939 (13.0)	
Region			
Eastern	30 (35.3)	193,223 (45.0)	
Middle	16 (18.8)	85,630 (19.9)	
Western	39 (45.9)	150,522 (35.1)	
Ethnicity			0.583
Han	77 (90.6)	400,874 (93.4)	
Other	8 (9.4)	28,501 (6.6)	
Urbanization			0.286
Rural area	56 (65.9)	258,563 (60.2)	
Urban area	29 (34.1)	170,812 (39.8)	
BMI			0.367
18.5–23.9	61 (71.8)	282,433 (65.8)	
< 18.5	7 (8.2)	26,248 (6.1)	
24–27.9	14 (16.5)	102,964 (24.0)	
≥ 28	3 (3.5)	17,730 (4.1)	
Education			0.008
Illiterate	25 (29.4)	74,774 (17.4)	
Primary school	35(41.2)	162,924 (37.9)	
Junior high school	19 (22.4)	134,891 (31.4)	
Senior high school or above	6 (7.1)	56,786 (13.2)	
Occupation			0.001
Office worker	12 (14.1)	61,747 (14.4)	
Manual worker	24 (28.2)	148,165 (34.5)	
Farmer	37 (43.5)	105,960 (24.7)	
Retired	4 (4.7)	30,197 (7.0)	
Unemployed	6 (7.1)	32,590 (7.6)	
Other	2 (2.4)	60,716 (11.8)	
Meat and product			0.138
Never	0	2552 (0.6)	
Always	36 (42.4)	216,500 (50.4)	
Often	33 (38.8)	130,155 (30.3)	
Occasionally	9 (10.6)	60,720 (14.1)	
Seldom	7 (8.2)	19,448 (4.5)	
Dairy and product			0.502
Never	39 (45.9)	169,492 (39.5)	
Always	14 (16.5)	69,907 (16.3)	
Often	12 (14.1)	76,218 (17.8)	
Occasionally	10 (11.8)	72,971 (17.0)	
Seldom	10 (11.8)	40,787 (9.5)	
Bean product			0.777
Never	1 (1.2)	2644 (0.6)	
Always	12 (14.1)	80,682 (18.8)	
Often	40 (47.1)	200,433 (46.7)	
Occasionally	22 (25.9)	100,335 (23.4)	
Seldom	10 (11.8)	45,281 (10.5)	
Cigarette smoking			< 0.001
No	42 (49.4)	324,652 (75.6)	
Yes	43 (50.6)	104,723 (24.4)	
Alcohol consumption			< 0.001
No	33 (38.8)	289,344 (67.4)	
Yes	52 (61.2)	140,031 (32.6)	
Living alone			0.175
No	84 (98.8)	427,953 (99.7)	
Yes	1 (1.2)	1422 (0.3)	
Carbonate beverages			0.649
Never	51 (60.0)	254,003 (59.2)	
Always	1 (1.2)	4766 (1.1)	
Often	7 (8.2)	58,481 (13.6)	
Occasionally	13 (15.3)	55,964 (13.0)	
Seldom	13 (15.3)	56,161 (13.1)	
Coffee			0.626
No	83 (97.6)	401,055 (93.4)	
Yes	2 (2.4)	28,320 (6.6)	
Tea			0.385
Never	41 (48.2)	236,467 (55.1)	
Always	25 (29.4)	103,425 (24.1)	
Often	6 (7.1)	41,056 (9.6)	
Occasionally	9 (10.6)	28,914 (6.7)	
Seldom	4 (4.7)	19,513 (4.5)	
Living circumstance			0.097
Single-storey house	41 (48.2)	170,315 (39.7)	
House ≤ 7 storey	42 (49.4)	227,535 (53.0)	
House > 7 storey	2 (2.4)	31,525 (7.3)	
Calcium or vitamin D supplement			0.345
No	78 (91.8)	404,323 (94.2)	
Yes	7 (8.2)	25,052 (5.8)	
Average sleep time (hours) per day			< 0.001
≥ 7	39 (45.9)	280,212 (65.3)	
< 7	46 (54.1)	149,163 (34.7)	
Previous history of fracture			0.003
No	79 (92.9)	419,666 (97.7)	
Yes	6 (7.1)	9709 (2.3)	

the increased risk in most fractures, including clavicle fractures. The direct relationship between smoking and clavicle fracture occurrence has not been identified and reported in literature, as

Table 5 Results of multivariate logistic regression of risk factors for clavicle fractures

Variables	Exp (B)	95% CI		*P*
		Lower limit	Upper limit	
Age				
14–44	Reference			
45–64	2.68	1.64	4.38	< 0.001
≥ 65	0.79	0.33	1.89	0.596
BMI				
18.5–23.9	Reference			
< 18.5	1.68	0.76	3.68	0.199
24.0–27.9	0.51	0.28	0.91	0.022
≥ 28.0	0.63	.020	2.02	0.438
Smoking				
No	Reference			
Yes	2.14	1.33	3.43	0.002
Alcohol consumption				
No	Reference			
Yes	2.27	1.40	3.68	0.001
Sleep time				
≥ 7 h/day	Reference			
< 7 h/day	1.98	1.28	3.06	0.002
History of previous fracture				
No	Reference			
Yes	2.38	1.03	5.50	0.042

far as we know. But in some studies, smoking was identified to be significantly associated with nonunion or after surgical or conservative treatment of clavicle fractures [27–29]. We can infer smoking could have significant negative effect on the metabolism of clavicle bone development and growth. Therefore, it can be suggested that public health interventions should be implemented to encourage individuals to improve their sleep quality and duration and modify the unhealthy lifestyles to help reduce the risk of clavicle fractures.

Previous history of fracture was an independent risk factor for adults and increased 2.38-time risk of clavicle fracture in this study, and similar findings were also observed in previous studies. Holmberg and colleagues [26] reported that previous low-energy fractures strongly increased the risk of subsequent fracture in middle-aged women. Another study by Robinson et al. [30] showed that middle-aged and elderly patients with prior fracture had increased risk of subsequent fracture by 3.89, 5.55, and 2.94 for overall, males, and females, respectively. Similarly, Kanis and colleagues [31] conducted a meta-analysis and confirmed the strong association between the history of fracture and subsequent fracture risk (RR = 1.86). However, most of these previous did specify osteoporosis-related fracture like hip, ankle, proximal humerus, vertebra fractures, or overall fractures as index injury. Therefore, in this study, previous fracture as risk factor for subsequent clavicle fracture was firstly reported, and the conclusion should be confirmed by the future studies.

This study had some potential limitations that should be mentioned. Firstly, the retrospective nature of this study had its intrinsic weakness in accuracy of data collection. Secondly, patients' self-report on fracture occurrence and individual lifestyles might be affected more or less by some individual reasons. Thirdly, patients died from severe concurrent visceral injury in clavicle fracture could not be captured. Therefore, overall, the incidence rate of clavicle fracture was underestimated.

In summary, the current study provided detailed information about the national population-based incidence, characteristics, and related risk factors of clavicle fractures. The overall incidence rate of clavicle fracture was slightly lower than reported data. Specific public health policies focusing on decreasing alcohol consumption, smoking cessation, and encouraging individuals to obtain sufficient sleep should be implemented. Middle-aged individuals with previous history of fracture should strengthen the awareness of prevention and health care and decrease risky activities to reduce the clavicle fractures.

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Compliance with ethical standards

Conflict of authors' statement The authors declare that they have no conflict of interest.

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