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Socioeconomic factors and individual lifestyles influencing the incidence of patella fractures: a national population-based survey in China

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Abstract

Background We aimed to do a national survey on the population-based incidence of patella fractures and related risk factors fracture in China.

Methods All the data on patella fractures were available from the China National Fracture Survey (CNFS) between January and May in 2015. And in the CNFS, all eligible household members were selected from 24 urban cities and 24 rural counties of eight provinces of China, with stratified random sampling and the probability proportional to size method used. Questionnaire was sent to every participant for data collection and quality control was accomplished by our research team members.

Results A total of 512,187 valid questionnaires were collected, and relevant data were abstracted. There were a total of 69 patients with 69 patella fractures that occurred in 2014, indicating that the incidence was 13.5 (95% CI, 10.3–16.7))/100,000 person-years. Slip, trip, or fall from standing height was the most common cause, leading to 69.6% (48/69) of patella factures, followed by traffic accidents (18.8%, 13/69). Home and road were the first two most common places, where 86.9% of the overall injuries occurred. Age of 45–64 and 65–74 years, alcohol consumption and previous history of fractures were identified as independent risk factors for patella fracture.

Conclusions Specific public health policies focusing on decreasing alcohol consumption should be implemented. Individuals aged 45–64 and 65–74 should pay more attention to bone mass density and prevention of falls, especially those with previous history of fracture.

Keywords Patella fracture · Epidemiology · Risk factors · Population-based · Questionnaire survey

Yanbin Zhu and Song Liu contributed equally to this work.

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Introduction

Patella fracture is uncommon in department of emergency or orthopaedics and was reported to account for approximately 1% of fractures in children and adolescents [1, 2] and 1–2.6% in adults [3–5]. Generally, there was obvious bimodal distribution about its incidence rate, with peaks at children of ten–19 years and the elderly above 60 years, and in adults, there was an increase trend with ages [6]. By far, several studies have reported the population-based incidence of patella fracture, but with a great variation among countries and regions, ranging from 4.0 to 26.0/100000 person-years [5–9]. Despite this, the overall trend of incidence of patella fracture was rising during the past 60 years [6–10].

Methodologically, the study design, sample size, and patient groups were primarily responsible for the inconsistent results. In some studies, authors selected one single hospital in a certain region as study objects [5, 6], and in others, authors selected a certain subgroup such as elderly, children, and adolescent as study subjects [9, 11], both of which might provide skewed results and did not accurately and precisely reflect the overall level of this injury. From macroscopic perspective, the predominant cause for great variation in incidence of patella fracture might lie in the differences in geographical location, developmental level in economics, cultural practices, recreational activities, and individual lifestyles, among countries and regions. Therefore, extrapolation of conclusions obtained from these studies to our Chinese population and implementation in our routine clinical evaluation might not be valid. Furthermore, we have not found any previous studies that aimed to investigate the socioeconomic risk factors associated with patella fractures.

Currently, China National Fracture Study (CNFS) was the largest epidemiologic survey with use of the form of on-site questionnaire, to investigate the population-based incidence of traumatic fracture of the trunk, arms, or legs and associated socioeconomic risk factors and individual lifestyles. The overall results including incidences for overall population and subgroups and related risk factors have been published recently [12]. In this study, we extracted related data on patella fractures from the CNFS database and aimed (1) to report the national population-based incidence of patella fracture in China and (2) to explore the associated risk factors in term of demographics, socioeconomics, and individual lifestyles.

Methods

Sampling method

The CNFS is registered with the Chinese Clinical Trial Registry, number ChiCTR-EPR-15005878. The entire sampling process of CNFS was completed with combined use of optimum allocation and random stratified and probability proportionate to size (PPS) sampling method. During the first phase, eight provinces (municipalities) were initially selected from 31 provinces (municipalities or autonomous regions) in mainland China based on socioeconomic development and climate, using stratified random sampling method. And within each targeted province (municipalities), sampling was done separately in urban and rural areas.

For urban areas, using the optimum allocation and random stratified and probability proportional to size method, we selected a certain number of streets ranging from one to six in each sampled city, and a certain number ranging 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 in 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 in each county, one to eight towns were selected. In each town, one–14 administrative villages were sampled. The sampling process was completed using the probability proportional to size method. 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 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 any member in selected household who refused to participate, an alternative household was randomly selected from the candidate list.

A standardized questionnaire was administered by our trained research team for data collection. The detailed information included age, sex, Chinese ethnic nationality, marital status, and residence, occupation, lifestyles (smoking, alcohol drinking, tea, coffee, carbonate beverages, and daily consumption of meat, protein product, dairy products) for women and men, age of menopause, and the number of births additionally for women. Individuals who sustained patella fractures between January 1 and December 31, 2014 must answer a more detailed accessory questionnaire regarding the fracture occurrence date and place and injury mechanism. In addition, they were asked to provide medical records of the index

injury, including radiographs, diagnostic reports, and medical reports. If these data were not available, the survey team paid for individual participants to obtain a new radiograph of their reported injured knee at a local hospital for reappraisal.

Eight quality control teams were established (one per province) to check for the quality of the collected data. The CNFS was approved by the Institutional Review Board of the 3rd Hospital of Hebei Medical University, and written informed consent was obtained from each participant before data collection.

Definition of variables of interest

Ethnicity origin was divided into Han ethnicity and others (all the national minority ethnicity). The body mass index (BMI) was calculated as weight divided by the square of height and was grouped based the reference criteria suited to Chinese people: underweight, < 18.5; normal, 18.5–23.9; overweight, 24–27.9; and obesity, ≥ 28 [12, 13]. Daily diet and drinking including meat and products, bean products, milk and dairy products, tea, and carbonate beverages were divided into five groups based on frequency of consumption: never, always (at least 1/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 or both related medicine or nourishment at least one month before the fracture occurrence. Urbanization was divided into twogroups: (1) rural area (village) and (2) urban areas (cities of levels).

Statistical analysis

Incidence rates for patella fractures were estimated for the overall population and for subgroups such as age, ethnics, region, education level, and urbanization level, stratified by gender. For unordered categorical variables such as region, urbanization, and ethnics, the chi-square test was used to test the difference. 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 assess the incidence trend.

Case group was defined as adult patients sustaining patella fractures in 2014, and control group was defined as adult individuals without any fracture in 2014. Chi-square test was used to investigate the potential correlations between patella fractures and variables of interest. Finally, multivariate logistic regression model was used to explore the independent risk factors associated with patella fractures. $P < 0.05$ was set as the statistical significance level. Odds ratio (OR) values and corresponding 95% confidence interval (95% CI) were used to indicate the strength of correlation. The Hosmer–Lemeshow test was used to examine goodness-of-ft of the final model, and a P value > 0.05 indicated an acceptable fitness. SPSS 19.0 was used to perform all the analyses (SPSS Inc., Chicago, IL, USA).

Results

During the survey, a total of 512,187 valid questionnaires were collected and relevant data were abstracted and analyzed. Through the year 2014, 69 patients sustained patella fractures (69 fractures), indicating that the incidence rate was 13.5 (95% CI 10.3–16.7) per 100,000 person-years (Table 1). There were 35 male patients with their median age 50 years, and the corresponding incidence rate was 13.5 (95% CI 9.0–17.9) per 100,000 person-years; there were 34 females sustaining patella fractures with median age of 56.5 years, and the corresponding incidence was 13.5 (95% CI 8.9–18.0) per 100,000 person-years.

Slip, trip, or fall from standing height was the most common cause and lead to 69.6% (48/69) of patella factures, followed by traffic accidents (18.8%, 13/69), fall from height (8.7%, 6/69), and crushing injuries (2.9%, 2/69) (Table 2). In terms of occurrence place, home and road were the first two most common places and accounted for 86.9% of the overall injuries (Table 3).

Table 1 presents the population-based incidence rates of patella fractures for overall populations and subgroups, based on democratic and socioeconomic characteristics, stratified by gender. There was no significant difference in incidence rate between those of Han ethnicity and all other ethnicities combined, nor was there any significant difference according to geographical region or urbanization, for overall population and any gender (Table 1). Stratified by age, males of 65–74 years and females ≥ 75 years had the highest incidence rate (36.1 and 34.4 per 100,000 person-years), respectively. The trend difference of incidence rate by occupation in males and overall population approached to significance ($P < 0.001$; $P < 0.001$) but was nonsignificant in females ($P = 0.198$). Stratified by education level, males receiving no education (illiterate) and females with the primary school education had the highest incidence in respective subgroup, and the trend difference test demonstrated the significant result in males ($P = 0.003$) but not in males ($P = 0.258$).

Table 4 presents the detailed results of univariate chi-square test between case and control group in adults (≥ 15 years). We could find that there were significant differences between patella fractures and controls in terms of age ($P < 0.001$), BMI ($P < 0.001$), education level ($P = 0.001$), occupation ($P < 0.001$), cigarette smoking status ($P = 0.048$), alcohol consumption ($P = 0.003$), sleep time per day ($P = 0.002$), calcium or vitamin D supplement or both ($P = 0.029$), and history of fracture ($P = 0.004$). And in other variables, we did not observe the significant differences, such as gender and region.

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

Items	Total			Male		Female	
	Sample size	Case	Incidence (1/100,000)	Case	Incidence (1/100,000)	Case	Incidence (1/100,000)
Total	512,187	69	13.5 (10.3–16.7)	35	13.5 (9.0–17.9)	34	13.5 (8.9–18.0)
Age (years)							
0–14	81,166	3	3.7	1	2.3	2	5.4
15–44	236,206	19	8 (4.4–11.7)	13	11 (5–17)	6	5.1 (1–9.1)
45–64	138,533	30	21.7 (13.9–29.4)	13	18.8 (8.6–29)	17	24.5 (12.9–36.1)
65–74	38,745	14	36.1 (17.2–55.1)	8	41.4 (12.7–70.1)	6	30.9 (6.2–55.6)
75+	17,537	3	17.1	0	0	3	34.4
P value for trend test	512,187	< 0.001		0.001		< 0.001	
Ethnicity							
Han nationality	477,508	65	13.6 (10.3–16.9)	32	13.2 (8.6–17.8)	33	14 (9.2–18.8)
Other nationalities	34,679	4	11.5 (0.2–22.8)	3	17	1	5.9
P value for difference test	512,187	0.748		0.674		0.727	
Region							
East	232,998	32	13.7 (9–18.5)	11	9.2 (3.8–14.7)	21	18.5 (10.6–26.4)
Central	99,109	11	11.1 (4.5–17.7)	6	12 (2.4–21.7)	5	10.1 (1.3–19)
West	180,080	26	14.4 (8.9–20)	18	19.9 (10.7–29.1)	8	8.9 (2.7–15.1)
P value for difference test	512,187	0.759		0.108		0.142	
Urbanization							
Urban area	203,101	30	14.8 (9.5–20.1)	15	14.6 (7.2–22)	15	14.9 (7.4–22.5)
Rural area	309,086	39	12.6 (8.7–16.6)	20	12.7 (7.2–18.3)	19	12.5 (6.9–18.1)
P value for difference test	512,187	0.516		0.687		0.605	
Occupation							
Office worker	61,919	7	11.3 (2.9–19.7)	5	15.3 (1.9–28.6)	2	6.9
Farmer	106,484	18	16.9 (9.1–24.7)	10	20.5 (7.8–33.2)	8	13.8 (4.3–23.4)
Manual worker	148,650	14	9.4 (4.5–14.4)	7	8.5 (2.2–14.7)	7	10.6 (2.8–18.5)
Retired	30,366	6	19.8 (4–35.6)	2	13.5	4	25.8 (0.5–51)
Unemployed	32,770	15	45.8 (22.6–68.9)	8	82.8 (25.4–140.1)	7	30.3 (7.9–52.7)
Students	80,443	5	6.2 (0.8–11.7)	1	2.4	4	10.5 (0.2–20.8)
Other	15,974	4	25 (0.5–49.6)	2	7	2	8.7
P value for difference test	476,606	< 0.001		< 0.001		0.198	
Education							
Illiterate	74,937	17	22.7 (11.9–33.5)	10	29 (11–47)	7	17.3 (4.5–30.1)
Primary school	158,970	36	22.6 (15.2–30)	19	23.7 (13–34.3)	17	21.6 (11.3–31.9)
Junior high school	121,415	14	11.5 (5.5–17.6)	5	8.1 (1–15.3)	9	15 (5.2–24.8)
Senior high school or above	40,841	2	4.9	1	4.6	1	5.2
P value for trend test	396,163	0.004		0.003		0.258	

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

Injury mechanism	Children (0–14 years)	Adult (≥ 15 years)		Total
		Male	Female	
Traffic accident	0	6 (17.6)	7 (21.9)	13 (18.8)
Slip, trip, or fall	2 (66.7)	26 (76.5)	20 (62.5)	48 (69.6)
Fall from heights	1 (33.3)	1 (2.9)	4 (12.5)	6 (8.7)
Crushing injury	0	1 (2.9)	1 (3.1)	2 (2.9)
Sum	3 (4.3)	34 (49.3)	32 (46.4)	69 (100.0)

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

Place of fracture occurrence	Children (0–14 years)	Adult (≥ 15 year)		Total
		Male	Female	
Home	1 (33.3)	12 (35.3)	16 (50.0)	29 (42.0)
Work unit	0	1 (2.9)	0	1 (1.4)
Building site	0	1 (2.9)	1 (3.1)	2 (2.9)
Road	2 (66.7)	17 (50.0)	12 (37.5)	31 (44.9)
Recreation site	0	1 (2.9)	0	1 (1.4)
Others	0	2 (5.9)	3 (9.4)	5 (7.2)
Sum	3 (4.3)	34 (49.3)	32 (46.4)	69 (100.0)

Table 5 summarizes independent risk factors for patella fractures in adults, after adjustment for confounding variables. Populations of 45–64 and 65–74 had the increased 1.97 and 2.98-time risk of patella fracture, compared to those of 15–44 years. Patients with previous history of fracture had an increased risk of patella fracture by 2.51-time (95% CI 1.01–6.27). In addition, alcohol consumption was identified as a significant risk factor and corresponding OR was 2.25 (95% CI 1.37–3.68).

In the final multivariate logistic regression model, the Hosmer–Lemeshow test demonstrated the adequate fitness ($X^2 = 2.597$, $P = 0.957$).

Discussion

In the present study, we used the data from CNFS database to investigate the epidemiologic characteristics of patella fractures and the results showed its incidence rate was 13.5/100,000 person-years, similarly in males and females. Skip, trip, or fall was the most frequent cause of patella fracture, resulting in 70% of the injuries. Over 85% of the injuries occurred at home and on the road. In adults, age of 65–74 and 75+, alcohol consumption and previous history of fracture were identified as independent risks for patella fractures.

Studies focusing on investigation of population-based incidence of patella fractures were scarce. Larsen and his colleague [6] conducted a retrospective review of clinical and radiological records of 756 patella fractures at a university hospital in Denmark and reported that the incidence of patella fracture was 13.1/100,000/year, between 2005 and 2014. In addition, authors observed the increase trend of incidence rate with increasing age and AO type 34-C3 (25%) and C1 (23%) as the most common fracture type [6]. Before this, Pasco and her colleagues [10] conducted a study to determine age- and sex-specific fracture incidence rate in Australia in 2006–2007. Pasco et al. [10] used the radiology reports to identify the incidence rate of patella fracture in males and females which were 22 and 23/100,000 person-years, with peaks in males aged ≤ 20 years and females ≥ 50 years. Court-Brown et al. [5] reviewed 5953 cases of fractures in patients ≥ 12 years in Royal Infirmary of Edinburgh and found an incidence of 10.7/100000 person-years in patella fractures. In this study, we used population-based questionnaire survey to find a median incidence rate (13.5/100,000 person-years) among reported figures in previous studies (4.0–26.0/100,000 person-years) [5–9]. In addition, we also observed the increase trend of incidence of patella fracture with age, wherein males of 65–74 years and females of 75+ years had the highest incidence rate. In the multivariate logistic regression model, we also identified the age of 45–64 and 65–74 were independent risk factor for patella fracture. In a study from UK [5], authors attributed this phenomenon to the prevalence of osteoporosis and suggested 14 different fractures including patella fractures should be considered to be osteoporosis-related. Regarding the injury mechanism, 70% of the patella fractures were caused by low-energy trauma in this study, which indirectly verified the viewpoint by Court-Brown et al. [5]. In addition, increased social engagement activities and reduced physical exercises at this age group should be also a consideration.

A relatively good education and a stable work might contribute to the reduced incidence of patella fracture. In this study, unemployed people had the highest incidence rate of patella fracture, either for males (82.8/100,000 person-years) or females (30.3/100,000 person-years). Similarly, illiterate individuals and those receiving only education of primary school had the first and second highest incidence of patella fracture, both in males and females. We attributed this finding to the more active and risky activities that were involved in those individuals especially in males, which could be also be used to explain the nonsignificance among females, either for education level ($P = 0.198$) or for occupation ($P = 0.258$). On the other hand, after adjustment for confounding factors we did not find either lower education level or unemployment was independently related to the patella fractures ($P > 0.05$). Therefore, the more active and risky activities involved in

Table 4 Univariate analysis for variables of interest between patella fractureand non-fracture group in adults

Variables	Case, $n = 66$ (%)	Control, $n = 429{,}375$ (%)	P
Gender			
Male	34 (51.5)	214,501 (50)	0.800
Female	32 (48.5)	214,874 (50)	
Age (years)			< 0.001
15–44	19 (28.8)	235,657 (54.9)	
45–64	30 (45.5)	137,779 (32.1)	
65–74	14 (21.2)	38,514 (9.0)	
≥ 75	3 (4.5)	17,425 (4.1)	
Region			0.617
Eastern	31 (47)	193,223 (45)	
Middle	10 (15.2)	85,630 (19.9)	
Western	25 (37.9)	150,522 (35.1)	
Urbanization			0.852
Rural area	27 (40.9)	258,563 (60.2)	
Urban area	39 (59.1)	170,812 (39.8)	
Bean product			0.822
Never	0 (0)	2644 (0.6)	
Always	13 (19.7)	80,682 (18.8)	
Often	34 (51.5)	200,433 (46.7)	
Occasionally	12 (18.2)	100,335 (23.4)	
Seldom	7 (10.6)	45,281 (10.5)	
Ethnicity			0.851
Han	62 (93.9)	400,874 (93.4)	
Other	4 (6.1)	28,501 (6.6)	
BMI			< 0.001
18.5–23.9	33 (50)	282,433 (65.8)	
24–27.9	25 (37.9)	102,964 (24)	
≥ 28	4 (6.1)	17,730 (4.1)	
< 18.5	4 (6.1)	26,248 (6.1)	
Education			0.001
Illiterate	17 (25.8)	74,774 (17.4)	
Primary school	35 (53)	162,924 (37.9)	
Junior high school	12 (18.2)	134,891 (31.4)	
Senior high school or above	2 (3)	56,786 (13.2)	
Occupation			< 0.001
Unemployed	15 (22.7)	32,590 (7.6)	
Office worker	7 (10.6)	61,747 (14.4)	
Manual worker	14 (21.2)	148,165 (34.5)	
Farmer	18 (27.3)	105,960 (24.7)	
Retired	6 (9.1)	30,197 (7)	
Students	2 (3)	34,833 (8.1)	
Other	4 (6.1)	15,883 (3.7)	
Meat and product			0.912
Never	0 (0)	2552 (0.6)	
Always	31 (47)	216,500 (50.4)	
Often	21 (31.8)	130,155 (30.3)	
Occasionally	10 (15.2)	60,720 (14.1)	
Seldom	4 (6.1)	19,448 (4.5)	
Dairy and product			0.404
Never	33 (50)	169,492 (39.5)	
Always	9 (13.6)	69,907 (16.3)	
Often	11 (16.7)	76,218 (17.8)	
Occasionally	10 (15.2)	72,971 (17)	
Seldom	3 (4.5)	40,787 (9.5)	
Cigarette smoking			
No	43 (65.2)	324,652 (75.6)	0.048
Yes	23 (34.8)	104,723 (24.4)	
Alcohol consumption			0.003
No	33 (50)	289,344 (67.4)	
Yes	33 (50)	140,031 (32.6)	
Living alone			0.094
No	65 (98.5)	427,953 (99.7)	
Yes	1 (1.5)	1422 (0.3)	
Carbonate beverages			0.088
Never	49 (74.2)	254,003 (59.2)	
Always	0 (0)	4766 (1.1)	

Table 4 (continued)

Variables	Case, $n = 66$ (%)	Control, $n = 429{,}375$ (%)	P
Often	3 (4.5)	58,481 (13.6)	
Occasionally	6 (9.1)	55,964 (13)	
Seldom	8 (12.1)	56,161 (13.1)	
Coffee			0.096
No	65 (98.5)	401,055 (93.4)	
Yes	1 (1.5)	28,320 (6.6)	
Tea			0.190
Never	38 (57.6)	236,467 (55.1)	
Always	21 (31.8)	103,425 (24.1)	
Often	3 (4.5)	41,056 (9.6)	
Occasionally	1 (1.5)	28,914 (6.7)	
Seldom	3 (4.5)	19,513 (4.5)	
Living circumstance			0.463
Single-storey house	30 (45.5)	170,315 (39.7)	
House ≤ 7 storey	30 (45.5)	227,535 (53)	
House > 7 storey	6 (9.1)	31,525 (7.3)	
Housing facing the sun			0.390
No	4749 (1.1)	0	
Yes	424,626 (98.9)	66	
Calcium or vitamin D supplement			0.029
No	58 (87.9)	404,323 (94.2)	
Yes	8 (12.1)	25,052 (5.8)	
Average sleep time (h) per day			0.002
≥ 7	31 (47)	280,212 (65.3)	
< 7	35 (53)	149,163 (34.7)	
Previous history of fracture			0.004
No	61 (92.4)	419,666 (97.7)	
Yes	5 (7.6)	9709 (2.3)	

those individuals rather than education or employed work per se were more likely to contribute to the increased incidence of patella fracture.

In the current studies, alcohol consumption was identified as an independent risk factor for patella fractures in adults. Alcohol consumption as a risk factor for traumatic fracture had been well recognized in the literature [14–16], although it has been not specifically identified as an independent risk factor for patella fractures. Scholes et al. [14] suggested consuming more than eight units of alcohol for men or more than six units for women in the past week increased the 1.65-time and 2.07-time risk of fractures in individuals ≥ 55 years. In a twin study investigating effects of alcohol consumption on the BMD, Williams and his colleagues [17] found the opposite conclusion and suggested moderate alcohol consumption was not harmful to bone health and may even be beneficial. Seeman [18] did not draw a definite conclusion on the risk of fracture and BMD by moderate alcohol consumption in his book and attributed the inconsistent results in literature to the concomitant lifestyle or socioeconomic factors in individuals. Although the relationship between moderate alcohol consumption and BMD remains further investigation, the alcohol-related falls is a well-established risk factor for fractures [14, 15]. Therefore, avoidance of heavy alcohol

Table 5 Risk factors for patella fractures in adults after multivariate logistic regression analysis

Variables	Exp (B)	95% CI		P
		Lower limit	Upper limit	
Age (years)				
15–44	Reference			
45–64	1.97	1.05	3.69	0.034
65–74	2.98	1.30	6.86	0.010
≥ 75	1.43	0.38	5.35	0.598
Alcohol consumption	2.25	1.37	3.68	0.001
History of previous fracture	2.51	1.01	6.27	0.049

consumption and reduction of related falls remain the primary task for prevention of patella fractures.

History of previous fracture as a risk factor for the subsequent fracture had been well identified in literature [16, 19, 20] and was reidentified in this study. In a meta-analysis by Klotzbuecher et al. [20], they concluded that history of prior fracture at any site was an important risk factor for future fractures and the risk of future fractures appeared to increase with the number of prior fractures. Kanis et al. [21] drew the similar conclusion in a meta-analysis that previous history of fracture conferred an increased 1.86-time risk of subsequent fracture of any site beyond that explanation by measurement of BMD. Huntjens and his colleagues [22] suggested the combination of bone- and fall-related risk factors play the important role in the short-term subsequent fracture after index fractures. Therefore, education on the prevention of secondary fractures should be strengthened among individuals with a previous fracture history. Even, Gunnes et al. [23] suggested appliance of information on previous fractures to select at-risk patients for evaluation and intervention against osteoporosis. In addition, implementation of preventive measures for falls and home and behavioral modifications will also be helpful to reduce the risk of secondary fractures.

Although this is currently the largest epidemiologic study for patella fractures, some potential limitations must be considered. Firstly, the retrospective nature of this study had its intrinsic weakness in accuracy of collected data, which might incur recall biases. Secondly, patients' self-report on individual lifestyles might be affected more or less by manners or customs in some minority ethnic groups. Thirdly, we could not capture data on the individual who had died in this index injury or coexisting diseases or complications, which might lead to the underestimation of the incidence rate.

In summary, the current study provided detailed information about the national population-based incidence, characteristics, and related risk factors for patella fractures, which could be used as reference data for healthcare policy makers and bone health consultation, and fracture prevention for individuals. Specific public health policies focusing on decreasing alcohol consumption should be implemented. Measures that keep a healthy bone mass and prevent low-energy falls should be initiated in those of 45–74 years, especially with previous history of fracture, to reduce the incident patella fractures.

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Author contributions Yingze Zhang designed the study; Wei Chen and Lin Wang searched relevant studies; Xiaolin Zhang analyzed and interpreted the data; Yanbin Zhu and Song Liu wrote the manuscript; and Yingze Zhang approved the final version of the manuscript.

Compliance with ethical standards

Competing interests The authors declare that they have no conflict of interest.

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