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A population-based eight-year trend of distal radial fractures in adults in Taiwan

New title: A population-based study on trend in incidence of distal radial fractures in adults in Taiwan in 2000-2007

[1,2.]Chun-Hao Tsai, MD, [3,4.]Chih-Hsin Muo, Ms, [1,2] Yi-Chin Fong, MS, [2]Wan-Yu Lo, PhD, [1]Yen-Jen Chen, MD, [1.] Horng-Chang Hsu, MD, [3,4*]Fung-Chang Sung, PhD, MPH

[1.] Department of Orthopedics, China Medical University and Hospital, Taichung 404, Taiwan;
[2]. Graduate Institute of Integrated Medicine, China Medical University and Hospital, Taichung, Taiwan
[3]Management Office for Health Data, China Medical University and Hospital, Taichung 404, Taiwan;
[.4] Department of Public health, China Medical University and Hospital, Taichung 404, Taiwan;

* Horng-Chang Hsu and Fung-Chang Sung contributed equally to this work.

Address correspondence and reprint requests to:
Fung-Chang Sung, PhD, MPH
Professor and Dean
China Medical University and Hospital College of Public Health
91 Hsueh Shih Road,
Taichung 404, Taiwan
Phone: +884-4-2203-5740
Fax: +886-4-2201-9901
E-mail: ritsai8615@gmail.com; fcsung@mail.cmu.edu.tw

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Mini-abstract

This population-based study was conducted using claims data obtained from the National Health Insurance to investigate the trend in incidence of distal radial fractures in adults in Taiwan from 2000 to 2007. Our results revealed an increasing trend, particularly among women >50 years of age.

Abstract

This population-based study used insurance claims data from 2000 to 2007 obtained from the National Health Research Institute to investigate the longitudinal trend in distal radial fractures in adults ≥20 years in Taiwan. We estimated the age- and gender-specific annual incidence rates of distal radial fracture and compared the differences in distribution by sociodemographic status between patients with and those without distal radial fracture and the differences in incidence rates between 2000 and 2007. The incidence of fracture was higher in women than in men. The overall female-to-male rate ratios were 1.52 in 2000 (12.3 versus 8.06 per 10,000 persons) and 1.89 in 2007 (18.9 versus 10.0 per 10,000 persons). There was marked increase in age-specific incidence beginning in the 50-54-year age group, particularly among women. These results imply the need for more effective intervention for the prevention of subsequent fracture and disability, particularly for perimenopausal women.

Key words: chronological trend, distal radial fractures, retrospective cohort study, universal health insurance

Introduction

Fracture of the distal radius is one of the most common osteoporosis-related fractures. It is well known that previous wrist fracture is associated with a significantly increased risk of future fracture [1-5]. In addition, up to 30% of affected individuals may suffer from long-term complications [6-7]. Population-based studies have suggested that fracture is associated with an increased risk of subsequent hip fracture [8-9].

The epidemiological features of fracture vary among populations and are associated with race, socioeconomic status, culture, degree of urbanization, and other population characteristics [10-25]. The epidemiological features of distal forearm fracture have been reported in general population-based studies in Scandinavian countries, the UK, and North America.

Few epidemiological studies have investigated the chronological trend of distal forearm fracture using nation-wide data. Although data on the changes in incidence of distal radial fracture are available for some European populations [13, 16, 24], few studies on the changes in the trend in incidence of distal radial fractures have been conducted in Asian populations [26-27].

The aims of the present study were to report the annual chronological trend in incidence of distal forearm fracture during the period 2000 to 2007 in Taiwan, to explore the factors associated with the trend, and to compare our findings with recent data from other countries.

Materials and Methods

Data source

In March 1995, the Bureau of National Health Insurance, Taiwan Department of Health, consolidated all of the health insurance systems into a universal National Health Insurance system. By the end of 1996, this universal insurance system covered approximately 96% of the 23 million people living in Taiwan and contracted with 97% of the hospitals and clinics on the island. The National Health Research Institute (NHRI) of the Department of Health established several randomly selected claim files representative of the whole population for administrative use and research. We obtained insurance claims data of 1,000,000 persons randomly selected from all insured persons in Taiwan in 2000. The sex and age distributions were similar to those of the entire insured population registered with the Ministry of Interior. The database provided information on all medical services received by each individual from 1996 to 2007 as well as the characteristics of the patients, hospitals and physicians.

The information we used for this study included claims data with dates of outpatient and inpatient services. Individuals included in this study were followed up until the end of 2007 or until being censored because of death, loss to follow-up, or withdraw from the insurance system. Patients with fracture diagnosed during the period 1996-2000 were excluded.

Selected study population and Statistical analysis

We identified a total of 6,906 patients aged ≥20 years with newly diagnosed distal radial fractures during the period 2000-2007. To ensure that all patients were identified, we monitored all inpatient and outpatient services to search for patients with evidence of incident distal fracture. We used the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code 813.4 to capture the cases. Individuals with fracture before 2000 and those with repeat fracture were not included in the analyses. For each patient, four controls were randomly selected from among people aged ≥ 20 years without a history of distal radial fracture.

Data analyses consisted of two parts. One used the entire patient population to show the overall trend in distal radial fracture during the study period. The other compared only data in 2000 with data in 2007 in order to differentiate change in fracture incidence between these two periods (Table 3). We first calculated the annual incidence rates of fracture by gender and calculated the female–to–male rate ratios. Annual incidence rates were also estimated by age

and gender. Linear regression analysis was performed to examine the chronological trend in incidence of distal radial fracture. The incidence rates and confidence intervals (CI 95%) were estimated with Poisson regression.

Distributions of sociodemographic factors by sex, age, urbanization level, occupation, and income were compared between patients with fracture and those without fracture. The odds ratio (OR) and 95% CI were estimated using logistic regression models with and without controlling for sociodemographic factors. Model 1 shows the univariate analyses and model 2 shows the multivariable logistical regression analyses controlling for sex, age, urbanization, occupation, and income. We calculated the population density (persons/km^2) of each township or district where the patient or control subject resided. Areas with a population density in the highest quartile were classified as high urbanization areas, those in the second quartile were classified as moderate urbanization areas, and those in the third and fourth quartiles were classified as low urbanization areas.

We also calculated the age- and sex-specific incidence rates and 95% confidence intervals in 2000 and in 2007. Patients were stratified into 12 five-year age groups ranging from 20 years to ≥70 years of age (Table 3). Female-to-male rate ratios and 95% confidence intervals were also calculated separately for each age group in 2000 and in 2007. The 2007-to-2000 rate ratios were also measured. Statistical analyses were performed by the SAS

statistical package (version 9.1; SAS Institute, Cary, NC). A p value <0.05 was considered to represent statistical significance.

Results

The majority of the 6,906 patients with distal radial fracture identified during the period 2000-2007 were women (N=4,323, 62.6%). Female patients tended to be older than male patients (61.3 ± 15.3 vs. 47.3 ± 18.1; data not shown) and more likely to be blue-collar workers, living in lower urbanized areas, and to have lower income.

The annual age- and sex-specific incidence rates of distal radial fracture increased with age in both genders during the study period (Figure 1). There was a greater incremental increase in incidence among women than among men, particularly among women in the older age groups. The average annual incidence among men aged ≥70 years was 2.02 times greater than that among men in the youngest age group. The corresponding ratio was 17.7 times in women. The average incidence in the ≥ 60-year age group was approximately 3.4 times higher among women than that among men. The average overall incidence was 14.5 per 10,000 persons during the study period, and was higher among women than among men (18.9 verse 10.0 per 10,000 persons in 2007) (Table 1). The overall incidence increased by 42.2% in the 8-year period, from 10.2 to 14.5 per 10,000 persons (p for trend < 0.0001). The annual female-to-male rate ratios ranged from 1.52 (95% CI 1.31- 1.78) to 1.89 (95% CI 1.31- 1.78).

Logistic regression analyses revealed that patients in the 30-39-year age group were at the lowest risk of fracture (Table 2). Multivariate analysis (model 2) showed that the risk of distal radial fracture for women dropped slightly. Relative to patients 30-39 years of age, risk of fracture increased significantly with age to an OR of 7.19 (95% CI 6.43-8.04) for those in >70 years of age. In addition, patients in the 20-29-year age group were also at higher risk.

We compared 679 patients with distal radial fracture in 2000 with 1,030 patients with the fracture in 2007 (Table 3). Most of the age- and sex-specific incidence rates in 2007 were greater than those in 2000 for both genders with an overall rate ratio of 1.42. The women-to-men rate ratio increased as age increased and ranged from 3 to 10 starting at 50 years of age. Figure 2 shows that the incidence rate increased markedly in men aged 45 to 64 years and in women aged 45 to ≥ 84 years.

Discussion

This population-based epidemiological study on adult distal forearm fracture demonstrated that the incidence of this type of fracture increased annually during the period 2000-2007 in Taiwan. Women were at greater risk than men during the 8-year study period with average incidence rates of 15.1 per 10 000 persons in women and 9.5 per 10 000 persons in men. The incidence in Taiwan is lower than that in Northern European countries and America [10-25].

Relative to the Japanese population [26], the age-adjusted incidence rates in the Taiwanese population are lower in women but quite similar in men.

Our results are in agreement with other studies that have shown that the incidence in women increased dramatically with age beginning in the perimenopausal period until 79 years of age (Figure 2). The age-specific incidence rate in men, however, increased at a slower pace. The increasing trend in age-specific incidence of fracture in women in Taiwan is similar to that in women in Scandinavian countries [13, 22] and in the UK [18, 25]. However, in Taiwan, the rate rose slowly in the mid-sixth decade of life rather than leveling off as in those countries [12, 26]. Studies conducted in Denmark [23] and Norway [16] have shown that the incidence rates decrease after 75 years of age.

Our study also showed the mean age for wrist fracture in men was over a decade younger than that in women. Further analysis revealed there were more incident traumatic wrist fractures associated with fall or slip than with traffic accidents (52.1 vs. 39.0%; data not shown), mainly because of the number of fractures in women. The incidence of fracture sustained in motor vehicle accidents among all accident-related fractures was higher in men than in women (44.2 vs. 34.9%; data not shown). We also found that the risk of fracture was higher in June and July than in other months in a year (data not shown), a finding that contradicts that reported in the UK by O'Neill et al. in which the highest incidence of fracture occurred in winter [18]. Typhoons, which commonly occur in the summer months in Taiwan,

may increase the risk of fractures associated with fall and slip. The demographics of fracture strongly suggest that men are less likely to incur osteoporosis-related fractures.

Oinuma and Sakuma recently reported that the combined incidence of compression fractures of the spine, femoral neck fractures, distal radial fractures, and fractures of the proximal end of the humerus increased from 499.9 in 2004 to 542.3 in 2005 and to 608.2 in 2006 per 100,000 population [30]. They reported that this increase was associated with senile osteoporosis. Wigg et al. also reported that by 2021 there will be an 81% increase in the incidence of distal forearm fractures in the Australian population aged ≥ 50 years mainly due to the aging population in that country [13]. These findings are in line with our results, which demonstrate that the incidence of adult distal radial fracture increased by 5% yearly during the 8-year study period, especially in women ≥ 60 years of age.

A few studies have reported that the increasing incidence of hip fracture in Taiwan can be explained by the aging population and also by lifestyle changes [28,31]. Similar reasons may explain the chronological trend in incidence of distal radial fracture found in the present study. For example, we found that the proportion of elderly patients in our study population increased from 8.3% in 2000 to 10.5% in 2007. Another explanation for the chronological trend is the increased prevalence of osteoporosis. We found that the prevalence of osteoporosis among patients with distal radial fracture was higher among older patients. Further analysis revealed that the mean prevalence of osteoporosis measured during the

period 2005-2007 was 24.7% higher than that during the period 2000-2002 (data not shown). This increase in prevalence of osteoporosis may be associated with lifestyle changes such as those associated with lower dietary intake of calcium [29]. However, further analyses showed that the increased utilization of the universal insurance program for osteopathic care might have contributed to the annual increase. The number of medications prescribed for osteoporosis increased 2.45% annually during the study period (data not shown). This may explain the dramatic increase in number of patients diagnosed with and treated for distal radial fracture in Taiwan. Unfortunately, DXA scan data were not available in the reimbursement claims records. In the present study, the overall female-to-male incidence ratio of distal radial fracture was about 1.73 in 2007. This ratio is lower than the corresponding ratio in populations in other countries [16, 18, 20, 26, 32-33]

This study depicted an 8-year incident trend of distal radial fractures among a population enrolled in a universal insurance system during the period 2000 to 2007 in Taiwan. To the best of our knowledge, this is the first national population-based report for this Asian population. We found that during the study period, there was an increasing trend in distal radial fractures, and that the increase was greater in women than in men, particularly in those aged ≥50 years.

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Table 1. Gender-specific annual numbers and incidence rates of distal radial fracture in Taiwan, 2000-2007

	Total				Women			Men				
Year	N	n	IR	(95% CI)	n	IR	(95% CI)	n	IR	(95% CI)	Rate ratio	(95% CI)
2000	668,987	679	10.15	(9.41-10.9)	406	12.29	(11.2-13.5)	273	8.06	(7.16-9.08)	1.52	(1.31-1.78)
2001	673,933	748	11.10	(10.3-11.9)	460	13.76	(12.6-15.1)	288	8.48	(7.55-9.52)	1.62	(1.40-1.88)
2002	678,468	777	11.45	(10.7-12.3)	467	13.86	(12.7-15.2)	310	9.08	(8.12-10.2)	1.53	(1.32-1.76)
2003	684,486	787	11.50	(10.7-12.3)	489	14.36	(13.1-15.7)	298	8.66	(7.73-9.70)	1.66	(1.44-1.91)
2004	691,534	902	13.04	(12.2-13.9)	580	16.84	(15.5-18.3)	322	9.28	(8.32-10.4)	1.82	(1.58-2.08)
2005	699,583	968	13.84	(12.9-14.7)	620	17.76	(16.4-19.2)	348	9.93	(8.94-11.0)	1.79	(1.57-2.04)
2006	705,575	1,015	14.39	(13.5-15.3)	626	18.25	(16.9-19.7)	389	11.03	(9.99-12.2)	1.65	(1.46-1.88)
2007	710,757	1,030	14.49	(13.6-15.4)	675	18.94	(17.6-20.4)	355	10.02	(9.03-11.1)	1.89	(1.66-2.15)
P for trend	<0.0001				<0.0001			0.003				

IR: Incidence rate per 10,000 person-years

Rate ratio: women-to-men

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Table 2. Comparison of socio-demographic characteristics and type of accident occurred between patients with distal radial fracture and those without fracture

Variable	Distal radial fracture				Model 1		Model 2	
	No N=27,624		Yes N=6,906					
	n	(%)	n	(%)	OR	(95% CI)	OR	(95% CI)
Sex								
Female	13,783	(49.9)	4,323	(62.6)	1.68	(1.59-1.77)	1.45	(1.38-1.55)
Male	13,841	(50.1)	2,583	(37.4)	1.00	(reference)	1.00	(reference)
Age, years								
20-29	6,489	(23.5)	811	(11.7)	1.37	(1.23-1.54)	1.34	(1.20-1.51)
30-39	6,192	(22.4)	564	(8.2)	1.00	(reference)	1.00	(reference)
40-49	6,202	(22.5)	977	(14.2)	1.73	(1.55-1.93)	1.70	(1.52-1.90)
50-59	3,933	(14.2)	1,485	(21.5)	4.14	(3.73-4.60)	3.96	(3.56-4.40)
60-69	2,470	(8.9)	1,374	(19.9)	6.11	(5.48-6.81)	4.49	(4.91-6.14)
≥70	2,338	(8.5)	1,695	(24.5)	7.96	(7.15-8.85)	7.19	(6.43-8.04)
Urbanization								
Low	3,377	(12.2)	1,094	(15.8)	1.44	(1.34-1.56)	1.08	(0.99-1.17)
Moderate	5,732	(20.5)	1,649	(23.9)	1.28	(1.20-1.36)	1.16	(1.09-1.25)
High	18,515	(67.0)	4,163	(60.3)	1.00	(reference)	1.00	(reference)
Occupation								
White collar	15,197	(55.0)	2,999	(43.4)	1.00	(reference)	1.00	(reference)
Blue collar	8,580	(31.1)	2,912	(42.2)	1.72	(1.63-1.82)	1.08	(0.99-1.16)
Others	3,847	(13.9)	995	(14.4)	1.31	(1.21-1.42)	0.95	(0.86-1.04)
Income (NTD)								
≤ 9,999	9,501	(34.4)	2,630	(38.1)	1.67	(1.55-1.80)	1.12	(1.03-1.23)
10,000-19,999	10,003	(36.2)	2,930	(42.4)	1.77	(1.65-1.90)	1.16	(1.07-1.27)
≥20,000	8,120	(29.4)	1,346	(19.5)	1.00	(reference)	1.00	(reference)

Logistic regression: Model 1 for univariate analysis; Model 2 for mutivariable analysis.
NTD: New Taiwan Dolar, 1.0 USD is about 32.0-34.0 NTD.

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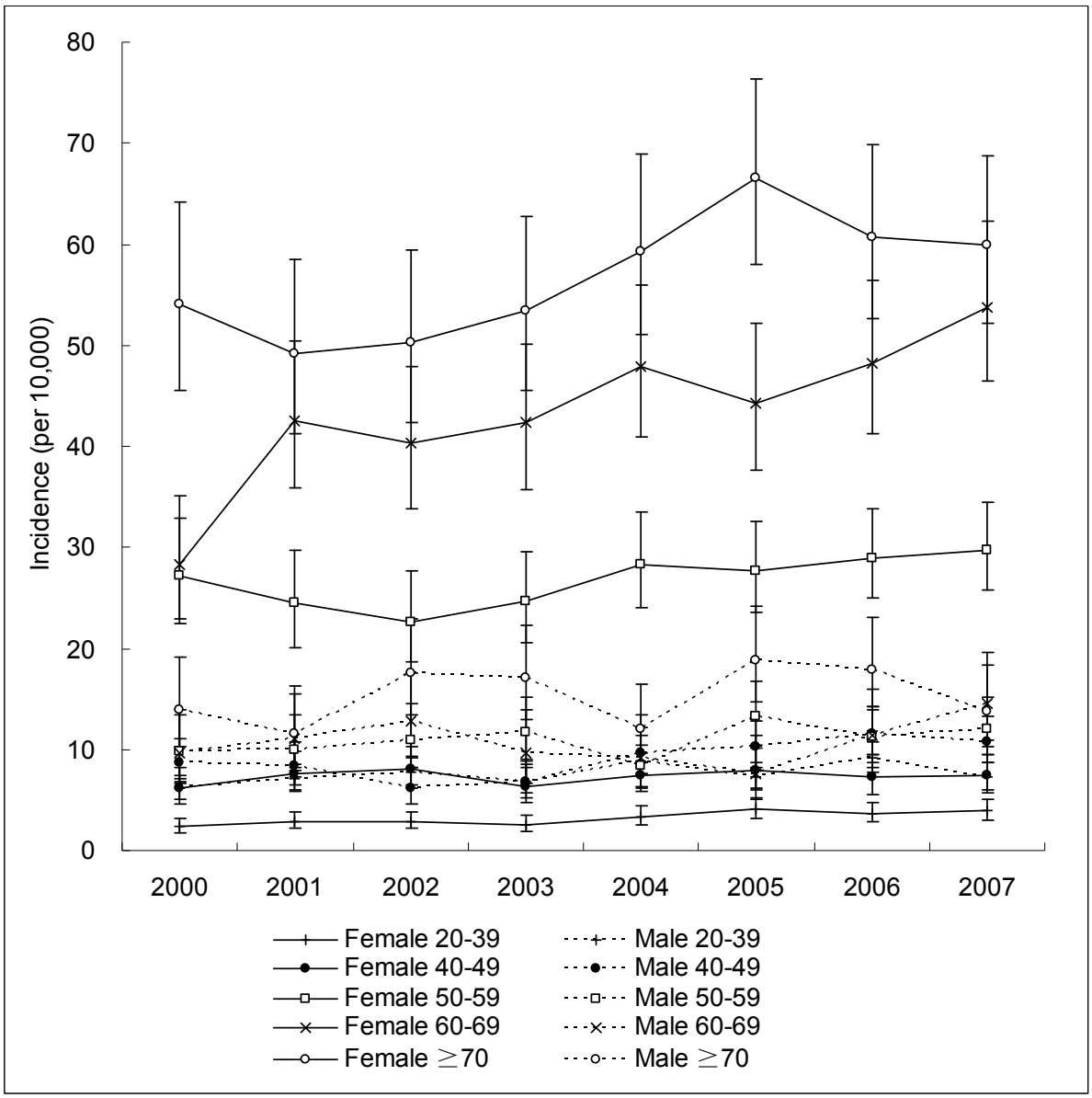

Figure 1. Age- and sex-specific incidence rates of distal radial fracture in 2000-2007, Taiwan.

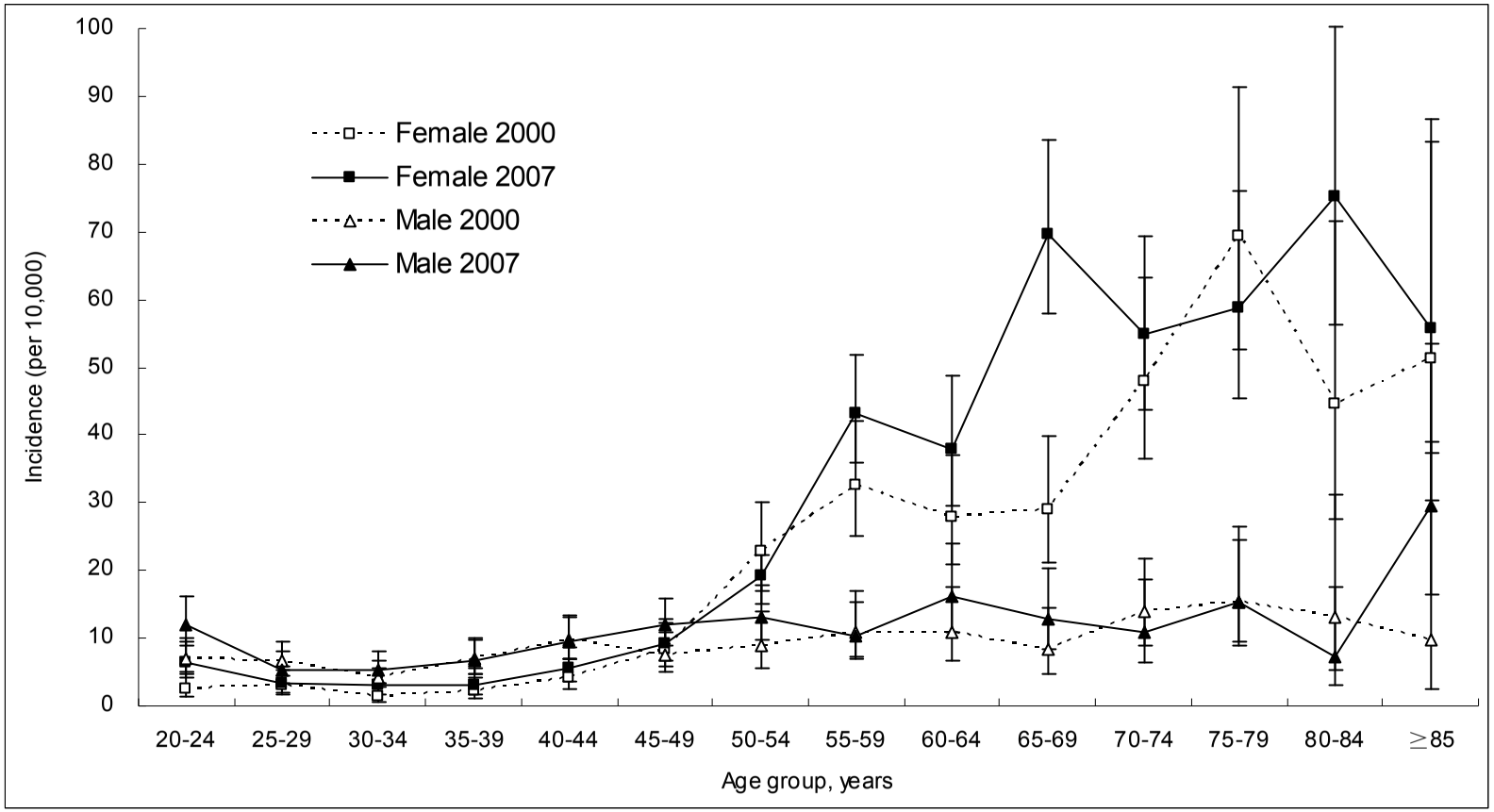

Figure 2. Age- and sex-specific incidence rates of distal radial fracture for the population in 2000 and 2007, Taiwan.

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Table 3. Age-specific numbers and incidence rates of distal radial fracture by gender in 2000 and 2007,Taiwan.

	Total			Female			Male			Rate	2007/2000 ratio		
Age	n	IR	(95% CI)	n	IR	(95% CI)	n	IR	(95% CI)	ratio	Total	Female	Male
2000													
20-24	42	4.84	(3.58-6.55)	11	2.59	(1.43-4.67)	31	7.00	(4.93-9.96)	0.37			
25-29	40	4.84	(3.55-6.59)	13	3.11	(1.81-5.37)	27	6.59	(4.52-9.61)	0.47			
30-34	24	2.89	(1.94-4.32)	6	1.47	(0.66-3.27)	18	4.27	(2.69-6.78)	0.34			
35-39	38	4.58	(3.33-6.30)	9	2.22	(1.15-4.26)	29	6.85	(4.76-9.86)	0.32			
40-44	53	6.95	(5.31-9.10)	16	4.20	(2.57-6.86)	37	9.70	(7.03-13.4)	0.43			
45-49	53	7.90	(6.03-10.3)	28	8.40	(5.80-12.2)	25	7.40	(5.00-11.0)	1.14			
50-54	67	15.7	(12.4-20.0)	48	22.7	(17.1-30.1)	19	8.87	(5.66-13.9)	2.56			
55-59	77	21.8	(17.4-27.3)	58	32.5	(25.2-42.1)	19	10.9	(6.93-17.0)	2.98			
60-64	63	19.6	(15.3-25.1)	46	27.7	(20.8-37.1)	17	10.9	(6.80-17.6)	2.54			
65-69	51	18.3	(13.9-24.1)	39	29.1	(21.2-39.8)	12	8.30	(4.71-14.6)	3.51			
70-74	70	28.8	(22.8-36.4)	51	48.0	(36.5-63.1)	19	13.9	(8.87-21.8)	3.45			
75-79	63	40.3	(31.5-51.6)	50	69.3	(52.5-91.4)	13	15.4	(8.96-26.6)	4.50			
80-84	22	28.7	(18.9-43.5)	17	44.5	(27.7-71.6)	5	13.0	(5.40-31.1)	3.42			
≥85	16	33.4	(20.5-54.6)	14	51.2	(30.3-86.5)	2	9.75	(2.44-39.0)	5.25			
All	679	10.2	(9.41-10.9)	406	12.3	(11.2-13.6)	273	8.06	(7.16-9.08)	1.53			
2007													
20-24	66	9.19	(7.23-11.7)	22	6.30	(4.15-9.57)	44	11.9	(8.89-16.1)	0.53	1.90	2.43	1.70
25-29	36	4.36	(3.15-6.05)	14	3.44	(2.04-5.81)	22	5.26	(3.47-7.99)	0.65	0.90	1.11	0.80
30-34	32	4.20	(2.97-5.94)	12	3.14	(1.79-5.54)	20	5.26	(3.39-8.15)	0.60	1.45	2.14	1.23
35-39	38	4.98	(3.62-6.84)	12	3.15	(1.79-5.54)	26	6.80	(4.63-9.99)	0.46	1.09	1.42	0.99
40-44	59	7.57	(5.86-9.77)	22	5.63	(3.71-8.56)	37	9.51	(6.89-13.1)	0.59	1.09	1.34	0.98
45-49	80	10.5	(8.47-13.1)	35	9.16	(6.58-12.8)	45	12.0	(8.93-16.0)	0.76	1.33	1.09	1.62
50-54	110	16.3	(13.5-19.6)	66	19.3	(15.1-24.5)	44	13.2	(9.84-17.8)	1.46	1.04	0.85	1.49
55-59	142	27.0	(22.9-31.9)	115	43.2	(36.0-51.9)	27	10.4	(7.15-15.2)	4.15	1.24	1.33	0.95
60-64	87	27.3	(22.1-33.7)	62	37.9	(29.6-48.7)	25	16.1	(10.9-23.8)	2.35	1.39	1.37	1.48
65-69	134	42.9	(36.2-50.8)	115	69.5	(57.9-83.5)	19	12.9	(8.26-20.3)	5.39	2.34	2.39	1.55
70-74	85	34.0	(27.5-42.0)	72	55.0	(43.7-69.3)	13	10.9	(6.34-18.8)	5.05	1.18	1.15	0.78
75-79	75	35.8	(28.5-44.8)	58	58.8	(45.5-76.1)	17	15.3	(9.51-24.6)	3.84	0.89	0.85	0.99
80-84	51	39.3	(29.8-51.7)	46	75.2	(56.3-100)	5	7.28	(3.03-17.5)	10.33	1.37	1.69	0.56
≥85	35	43.7	(31.3-60.8)	24	55.7	(37.4-83.2)	11	29.6	(16.4-53.5)	1.88	1.31	1.09	3.04
All	1,030	14.5	(13.6-15.4)	675	18.9	(17.6-20.4)	355	10.0	(9.03-11.1)	1.89	1.42	1.54	1.24

IR: Incidence rate for 10,000 person-years

Rate ratio: females-to-males

2

1