ORIGINAL ARTICLE

Fragility fractures and imminent fracture risk in Hong Kong: one of the cities with longest life expectancies

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Abstract

Introduction Imminent fracture risk, or fractures within 2 years of an initial fracture, is a pressing issue worldwide. Hong Kong is a city with one of the longest life expectancies. The concern of fragility fractures and the imminent risk of a subsequent fracture is becoming a top priority. The objective of this study was to present the epidemiology of incident fragility fractures of all public acute hospitals and the imminent risk of a subsequent fracture in Hong Kong.

Methodology This was a retrospective population-based analysis. Patient records from all acute hospitals in Hong Kong from 1 January 2004 to 31 December 2018 were retrieved for patients ≥ 50 years of age with hip, distal radius, or proximal humerus fractures. Secondary fractures and falls were identified in the subsequent 5 years. Post hoc analysis in recent 2013–2018 period was performed. Overall survival (re-fracture incidence) on age subgroups using Kaplan survival analysis and variables was compared using the log-rank test. Cox proportional hazard regressions, obtaining the hazard ratios (HR) and their respective 95% confidence intervals (CI), were used.

Results There is an overall increasing trend of fragility fractures (hip, distal radius, proximal humerus) from 5596 in 2004 to 8465 in 2018. The average cumulative imminent risk of fractures from recent 5 years is 3.87% at 1 year and 6.50% at 2 years. 49.5% of the patients with a secondary fracture occurred within 2 years since the initial major fragility fracture. Post hoc analysis in recent 2013–2018 period ($N = 7039$) showed male patients were 1.21 times more likely to have further fractures with time (HR = 1.21 (1.02, 1.45), $p = 0.03$) compared with female patients. Patients over age 95 were 2.01 times higher than patients of age under 75 to have further fracture over time.

Conclusions Following an initial fracture, prompt treatment strategies should be adopted to avoid imminent risk of fractures. This window of opportunity in the first 2 years is a golden period to treat osteoporosis and prevent falls. Our post hoc analysis has shown that male patients and patients older than 95 are at even higher risk. Clinicians and allied healthcare professionals should be alert on these patients.

Keywords Imminent fracture risk · Osteoporotic fracture · Osteoporosis · Fragility fractures · Sarcopenia

Introduction

Imminent fracture risk, or fractures within 2 years of an initial fracture, is a pressing issue worldwide [1, 2]. In fact, a recent

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study from the Swedish database has shown that the cumulative subsequent fracture incidence at 12 months was 7.1% and at 24 months was 12.0% [3]. Johansson et al. also showed that at 1 year after a major osteoporotic fracture, the risk of a second fracture was 2.7-fold higher than population risk compared with 1.4-fold at 10 years [2]. These findings highlight the importance of early intervention after an initial fracture with dedicated and coordinated services. Currently, an estimated 200 million people are affected by osteoporosis and the lifetime fracture risk reaches up to 40% [4, 5]. With the aging population, the incidence of fragility fractures is expected to increase yearly, posing a significant healthcare burden to our society. In fact, 9 million osteoporotic fractures occurred

worldwide in year 2000 [6], but a large healthcare gap still exists leading to imminent risk of further fractures. In a previous study of 905 women and 337 men with an initial fracture, it was shown that 41% of women and 52% of men had an imminent fracture within 2 years [7]. It has also been reported that secondary fractures cost 1.6–6.2 times higher with costs ranging from USD 3844 to USD 27,730 compared with those without a prior fracture [8]. This implies the healthcare costs of a secondary fracture are mainly concentrated during this window period. It is therefore important to increase awareness and enhance international network alliances to further improve current public and health policies.

Hong Kong is a city with one of the longest life expectancies worldwide. In 2017, the life expectancy for males is 81.9 years of age and for females 87.6 years of age, increasing steadily [9]. The concern of fragility fractures and the imminent risk of a subsequent fracture is becoming a top priority. The current cost of a single hip fracture in Hong Kong is USD 8831.9, with projected direct cost of USD 84.7 million in total in 2018 [10]. It is well established that the single most predictive factor of a secondary fracture is a previous one [1]. Apart from osteoporosis, evidence has also shown that patients with fragility fractures often have low muscle mass and function as well, which has been postulated as a cause of further falls [11]. Major pitfalls in the healthcare system include low rates of bone mineral density (BMD) testing, low drug initiation, poor drug compliance, and low follow-up rates leading to falls and fractures. Therefore, establishment of Fracture Liaison Services (FLS) to improve patient outcomes has been adopted in many countries [12], but is still not yet available in many hospitals. Thus, the rate of imminent fractures remains high currently. In a recent study in the USA, it was shown that among 337,561 women, cumulative risk of subsequent fractures was 10% and 18% at 1 and 2 years, respectively [13].

The risk of a secondary fracture decreases over time [2], and therefore capturing imminent fractures in the first 2 years provides a window of opportunity in preventing a large number of secondary fractures. It is well known that osteoporotic fractures lead to high morbidity and mortality [14] and therefore a call-to-action worldwide is needed to stop further risk. Currently, there is a lack of published data in Asian cities on imminent risk of fractures. Presenting the imminent fracture risk in regions with long life expectancies and in Asia would prove to be important in strengthening the knowledge of this global threat. It is also crucial for representative parties internationally to share and provide treatment goals and strategies for our patients.

The objective of this study was to present the epidemiology of incident fractures and the imminent risk of a subsequent fracture in Hong Kong. This is the first study representing imminent fracture data from a Chinese population.

Methods

Study design

This was a retrospective population-based analysis. Patient records from all acute hospitals in Hong Kong from 1 January 2004 to 31 December 2018 were retrieved from the Hospital Authority Clinical Data Analysis and Reporting System (CDARS, Hospital Authority, Hong Kong) [15, 16]. Patients ≥ 50 years of age with hip, distal radius, or proximal humerus fractures (major osteoporotic fractures) were identified using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes for hip fracture (820.02, 820.3, 820.8, 820.9, 820.12, 820.20, 820.22, 820.32), proximal humerus fracture (812.02, 812.03, 812.09, 812.12, 812.13, 812.19), and distal radius fracture (13.41, 813.42, 813.44, 813.52, 813.54). Patients with motor vehicle accident or pathological fractures were excluded. In Hong Kong, hip, distal radius, and proximal humerus fractures are well captured in the database. The public hospital system in Hong Kong uses the Clinical Management System (CMS) and the diagnosis is entered. This allows retrieval of all records through the CDARS regardless of in-patient or out-patient [15, 16], and more than 90% of the Hong Kong population is captured [17]. The positive predictive value (PPV) in using ICD-9 does for CDARS database search has also been shown to be 100% for fracture hip, wrist, and humerus [17]. However, although 98% of hip fractures are admitted to public hospitals instead of private hospitals and captured [10], there is currently no available data on the sensitivity and completeness in capturing all distal radius and proximal humerus fractures in Hong Kong.

Vertebral fractures were not retrieved initially because it is well documented that approximately two-thirds are not diagnosed and therefore, diagnostic coding would strongly underestimate the prevalence and thereby be inaccurate [18, 19]. Incident fracture, mean age, gender, and length of stay in acute hospital were recorded for 15 years (2004 to 2018). Secondary fractures and falls and deaths of patients were further identified from each year from 2004 to 2013 (follow-up of 5 years each year) projecting up to 5 years using the Hospital Authority CDARS. A 5-year follow-up is used as it is a common time-point in fracture studies [20]. Imminent fractures were defined as the first 2 years. To eliminate risk of double counting, secondary fracture was excluded if it was at the same site as the initial fracture [2]. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines were used in preparation of this manuscript.

Data analysis

Descriptive statistics were presented in numbers and percentages. Secondary fractures and falls and deaths of patients were

identified from each year from 2004 to 2013 (follow-up of 5 years each year) to better represent the average imminent fracture risk over 10 years. The more recent data over 5 from 2008 to 2013 was also calculated. Post hoc analysis of imminent fracture risk in Hong Kong was performed in year 2013 as it is the most recent 5 years (since fracture in 2013, and follow-up to 2018) and is therefore most representative of recent data. We determined and compared the overall survival (re-fracture incidence) on age subgroups using the Kaplan–Meier product-limit method and variables were compared using the log-rank test. Cox proportional hazard regressions, obtaining the hazard ratios (HR) and their respective 95% confidence intervals (CI), were used to show the strength of estimated relative risk, which were applied to model the relationship between potential covariates (sex and age groups) and fracture incidence. Comparisons of percentage cumulative fractured rates happened between the 1st and 2nd year and 3rd to 5th years were performed after stratifying for age groups. p value of < 0.05 was regarded as statistical significance.

Results

Incidence of fragility fractures, characteristics, and length of hospital stay from 2004 to 2018

There is an overall increasing trend of fragility fractures (hip, distal radius, proximal humerus) from 5596 in 2004 to 8465 in 2018 (Fig. 1 and Table 2). Hip fractures have the highest incidence for fragility fractures in Hong Kong, with 4002 in 2004 to 5241 in 2018. The mean age is 81.4 ± 9.0 years old, with a

female to male ratio of 2:1. The average length of hospital stay is 15.5 days. The mean age of distal radius fractures is 67.6 ± 11.9 years old, which is earliest to occur. The female to male ratio is 3:1, and average length of hospital stay is 3.7 days. Proximal humerus fractures occur at a mean age of 73.5 ± 11.7 years old, with a female to male ratio of 3.7:1. The average length of hospital stay is 5.7 days (refer to Table 1).

Mortality of fragility fracture patients from 2004 to 2013

The mortality of fragility fracture patients from 2004 to 2013 at 1 year on average is 401 and at 2 years 357. The absolute number has a steady increasing trend over the years due to the increase in fragility fracture incidence. An average mortality of 6.3% of all fragility fracture patients occurs each year after an initial fracture (refer to Table 6). Hip fractures on average had an 8.49%, 15.8%, and 34.8% cumulative mortality rate at 1, 2, and 5 years, respectively. Distal radius on average had a 1.80%, 3.96%, and 10.6% cumulative mortality rate at 1, 2, and 5 years, respectively. Proximal humerus on average had a 4.56%, 9.90%, and 17.4% cumulative mortality rate at 1, 2, and 5 years, respectively (refer to Table 9 and 10).

Imminent risk of fractures and falls

The average cumulative imminent risk of fractures from 2004 to 2013 at 1 year is 3.41% and at 2 years is 5.77%. This amounts to an average of 325 imminent fractures in 2 years. In the more recent 2009–2013, the average cumulative imminent risk of fractures at 1 year is 3.87% and at 2 years is 6.50%. Projecting to year 2018 with an incidence of 8465
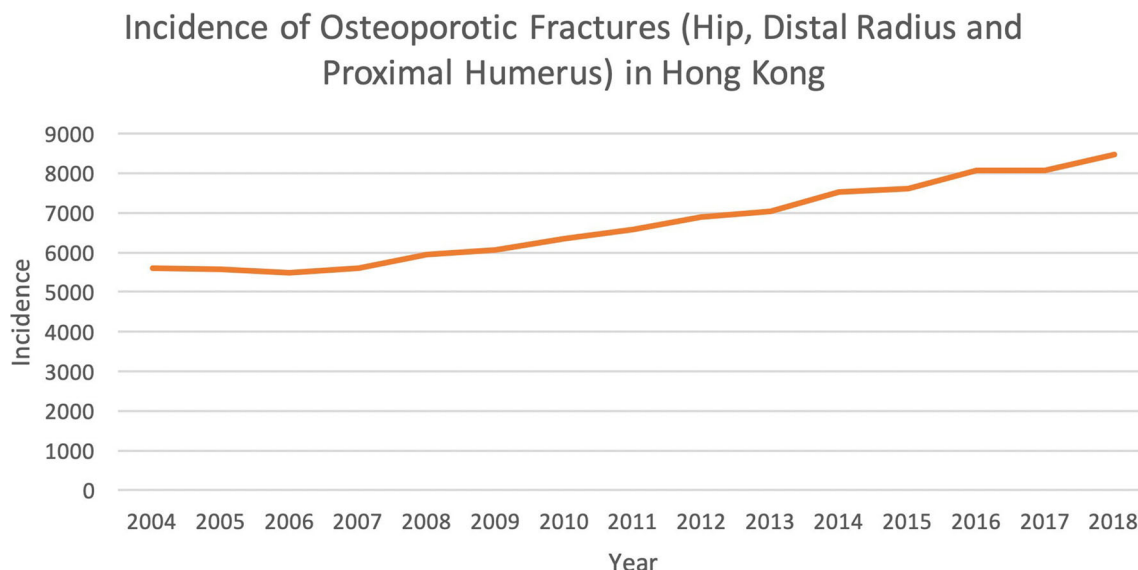

Fig. 1 Incidence of osteoporotic fractures (hip, distal radius, and proximal humerus) from 2004 to 2018

Table 1 Mean age, sex ratio, and mean length of hospital stay of osteoporotic fractures (hip, distal radius, and proximal humerus) from 2004 to 2018

Fracture type	Mean age (years) ± SD	F:M ratio	Mean length of hospital stay (days)
Distal radius	67.6 ± 11.9	3:1	3.7 (median 2; IQR 4)
Proximal humerus	73.5 ± 11.7	3.7:1	5.7 (median 3; IQR 5)
Hip	81.4 ± 9.0	2:1	15.5 (median 12; IQR 12)

fragility fractures, imminent fractures would reach 550 in 2 years (Table 2). Cumulative secondary fractures at the 3rd, 4th, and 5th years from 2004 to 2013 are 7.67%, 9.57%, and 11.1%, respectively. This amounts to an average of 258 secondary fractures from the 3rd to 5th years. The results show that an average of 55% of secondary fractures occurs in the first 2 years in a 5-year period (refer to Table 11). Corresponding to the imminent risk of fractures, mean fall rates from 2004 to 2013 at 1 year are 3.61% and at 2 years is 6.60%. At the 3rd, 4th, and 5th years, cumulative fall rates are 9.27%, 11.79%, and 13.97%, respectively (refer to Table 12).

Table 2 Yearly incidence of distal radius, proximal humerus, and hip fractures from 2004 to 2018 and age/sex distribution of fractures

Year	Fracture incidence	Distal radius fracture			Humerus fracture			Hip fracture		
2004	5596	1449	F	1101	145	F	123	4002	F	2752
			M	348		M	22		M	1250
2005	5562	1469	F	1146	123	F	99	3970	F	2727
			M	323		M	24		M	1243
2006	5485	1451	F	1085	120	F	92	3914	F	2664
			M	366		M	28		M	1250
2007	5590	1402	F	1040	114	F	92	4074	F	2790
			M	362		M	22		M	1284
2008	5941	1480	F	1102	125	F	97	4336	F	2918
			M	378		M	28		M	1418
2009	6065	1701	F	1276	122	F	88	4272	F	2951
			M	425		M	34		M	1321
2010	6351	1780	F	1328	158	F	125	4413	F	3002
			M	452		M	33		M	1411
2011	6585	1807	F	1357	161	F	134	4617	F	3096
			M	450		M	27		M	1521
2012	6890	2164	F	1611	194	F	146	4532	F	3021
			M	553		M	46		M	1511
2013	7039	2256	F	1669	214	F	156	4569	F	3066
			M	587		M	58		M	1503
2014	7532	2396	F	1772	191	F	150	4945	F	3254
			M	624		M	41		M	1691
2015	7621	2550	F	1901	230	F	184	4841	F	3258
			M	649		M	46		M	1583
2016	8069	2718	F	2025	209	F	163	5142	F	3461
			M	693		M	46		M	1681
2017	8074	2787	F	2087	270	F	209	5017	F	3306
			M	700		M	61		M	1711
2018	8465	2945	F	2233	279	F	236	5241	F	3519
			M	712		M	43		M	1722

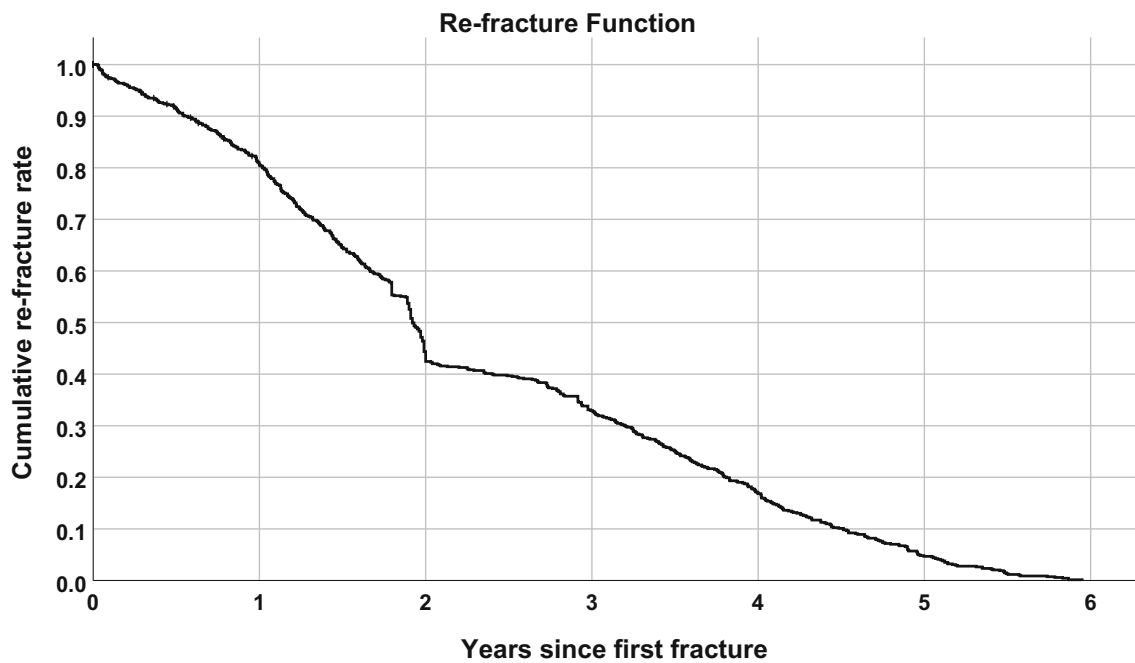|		Distal radius fracture	Humerus fracture	Hip fracture
≥ 95	F	0.8%	1.4%	4.1%
	M	0.1%	0.1%	0.9%
	Total	0.8%	1.5%	5.1%
85–94	F	8.0%	15.1%	27.3%
	M	1.4%	2.9%	10.0%
	Total	9.4%	18.0%	37.3%
75–84	F	17.4%	26.6%	25.8%
	M	3.7%	6.3%	13.6%
	Total	21.1%	32.9%	39.4%
< 75	F	48.8%	35.8%	10.3%
	M	19.9%	11.8%	8.0%
	Total	68.7%	47.6%	18.3%

Re-fracture Function

Fig. 2 Survival curve for all patients with secondary fracture event from year 2013–2018 ($N = 7039$)

Post hoc analysis of imminent risk of fractures during period of 2013–2018

A total of 4891 of the 7039 patients were female (69.5%). Four hundred twenty-six (57.0%) of the patients with a secondary fracture occurred within 2 years since the initial major fragility fracture. The overall Kaplan–Meier survival curve is shown in Fig. 2. Subgroup analyses on age and sex groups are graphically represented in Figs. 3 and 4, respectively (Table 6, 7, and 8). Both show statistical significance.
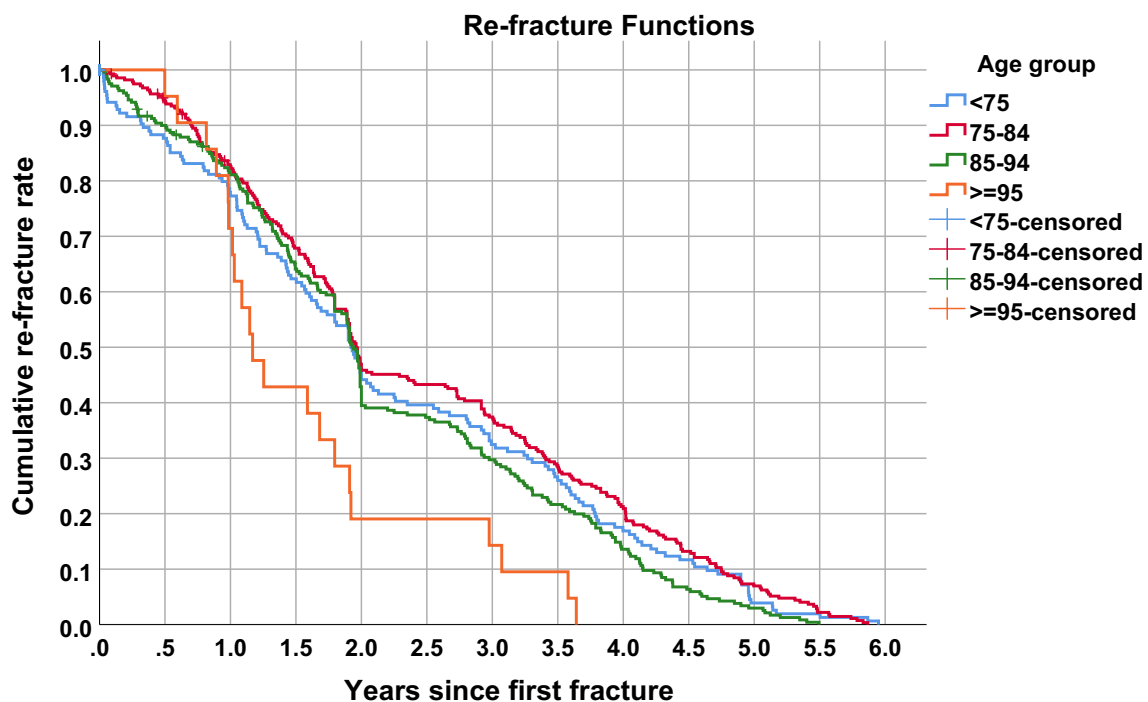
Re-fracture Functions

Fig. 3 Kaplan–Meier survival curves of all patients divided by age groups from year 2013–2018. Subgroup analyses on age (log-rank test = 0.001) show statistical significance
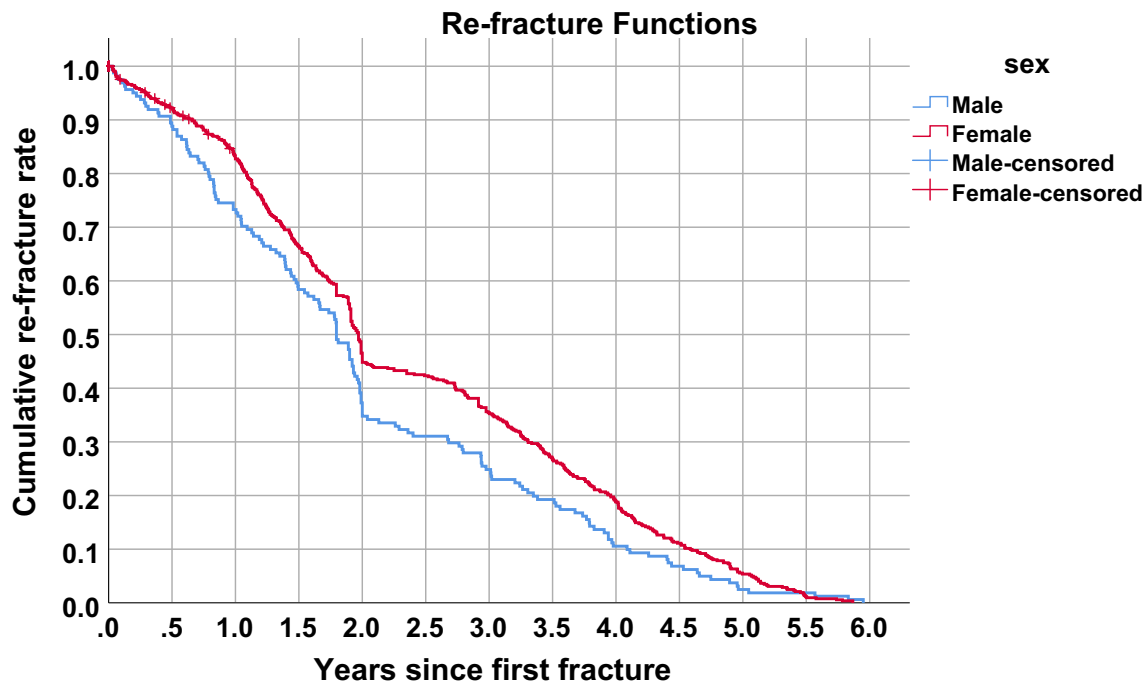
Fig. 4 Kaplan–Meier survival curves of all patients divided by sex from year 2013–2018. Survival curve. Subgroup analyses on sex (log-rank test = 0.033) show statistical significance

Upon stratification, the cumulative secondary fractures in the first 2 years were significantly higher compared with the 3rd to 5th year after the initial fracture in all age groups, 85–94 and ≥ 95 ($p < 0.01$) (Tables 3 and 4). The largest difference was observed in the age group ≥ 95 (79.2% in the first 2 years vs. 20.8% in the 3rd to 5th years). Mortality is shown in Table 5. Using sex (ref: female) and age groups (ref: age < 75), we show that male patients were 1.21 times more likely to have further fractures with time (HR = 1.21 (1.02, 1.45), $p = 0.03$) compared with female patients. Patients over age 95 were 2.01 times higher than patients of age under 75 to have further fracture over time (Table 6). Age group- and sex-specific analyses showed statistical significances in both male age over 95 (HR = 8.04 (1.06, 61.03)) and female patients age 85–94 (HR = 1.29 (1.01, 1.64), $p = 0.04$)), and over 95 (HR = 2.25 (1.38, 3.66), $p < 0.01$)), when both compared with "age < 75" group (Table 7). When controlling for sex, patients over age

95 were 2.15 times more likely to have second fracture compared with patients younger than 75 (HR = 2.15 (1.36, 3.42), $p < 0.01$) (Table 8).

Table 4   Analysis of imminent fractures compared with remaining years by age groups (period of 2013–2018)

Time	N re-fractured	% re-fracture rate within the period	p value
Age < 75 ($N = 2631$)			
Fractured with the first 2 years	94	56.7	0.08
Fractured between the 3rd and 5th years	72	43.3	
Age 75–84 ($N = 2108$)			
Fractured with the first 2 years	160	53.5	0.21
Fractured between the 3rd and 5th years	139	46.5	
Age 85–94 ($N = 2041$)			
Fractured with the first 2 years	153	59.3	< 0.01
Fractured between the 3rd and 5th years	105	40.7	
Age ≥ 95 ($N = 259$)			
Fractured with the first 2 years	19	79.2	< 0.01
Fractured between the 3rd and 5th years	5	20.8	

*Chi-square test

Table 3   Analysis of imminent fractures compared with remaining years (period of 2013–2018)

Time	N re-fractured	% re-fracture rate within the period	p value
Re-fractured with the first 2 years	426	57.0	< 0.01
Fractured between the 3rd and 5th years	321	43.0	

Table 5 Follow-up of mortality for 2013 patients (N = 7039) for 5 years (2013–2018)

Year	Age group	Deaths	Remaining patients	% cumulative death
2014	≥ 95	59	296	19.9%
	85–94	215	2002	10.7%
	75–84	164	1985	8.3%
	< 75	52	2266	2.3%
2015	≥ 95	43	359	31.9%
	85–94	198	1931	21.0%
	75–84	106	1763	14.3%
	< 75	29	2120	3.7%
2016	≥ 95	50	397	44.5%
	85–94	186	1860	31.0%
	75–84	104	1538	21.0%
	< 75	32	2005	5.26%
2017	≥ 95	42	445	53.9%
	85–94	183	1734	41.5%
	75–84	85	1380	27.2%
	< 75	37	1894	7.21%
2018	≥ 95	25	505	58.9%
	85–94	151	1647	50.7%
	75–84	89	1218	34.5%
	< 75	30	1788	8.9%

Discussion

The risk of an imminent fracture after an initial fracture is a major threat in our aging population. Our results show nearly half of all patients with secondary fractures occurring in the first 2 years. Resources should be allocated to prevent the high risk to save healthcare costs. Our results concur with other studies on imminent fractures in the USA, Sweden, and Iceland as secondary fractures significantly decrease after the first 2 years [2, 3, 13]. Compared with the study in the USA and Sweden, the risk of imminent fractures is lower in Hong Kong and Iceland. The differences seen would likely correlate with

Table 6 Univariate Cox regression analysis of sex or age for secondary fracture within 5 years from 2013 (period of 2013–2018)

Covariate	p value	HR	95% CI Lower	Upper
Sex (ref: female)				
Male	0.03	1.21	1.02	1.45
Age (ref: < 75)				
75–84	0.44	0.93	0.76	1.13
85–94	0.19	1.15	0.94	1.41
≥ 95	0.00	2.01	1.27	3.17

Table 7 Univariate Cox regression analysis of age for secondary fracture within 5 years from 2013 (period of 2013–2018)

Covariate	p value	HR	95% CI Lower	Upper
Male only (ref: < 75)				
75–84	0.24	0.80	0.56	1.16
85–94	0.68	0.92	0.61	1.38
≥ 95	0.04	8.04	1.06	61.03
Female only (ref: < 75)				
75–84	0.93	1.01	0.80	1.29
85–94	0.04	1.29	1.01	1.64
≥ 95	< 0.01	2.25	1.38	3.66

the demographics and general health status of patients in different countries. Furthermore, in countries including the USA, insurance coverage may allow follow-ups with increased detection of secondary fractures including vertebral compression fractures. However, all studies are consistent in highlighting the importance of intervening rapidly after a fragility fracture. Although Hong Kong is a small city, it has one of the longest life expectancies worldwide and the risk of imminent fractures is still substantial. At an imminent fracture rate of 6.50% at 2 years based on the average in years 2009–2013, costs of secondary fractures are a major burden. A systematic review and meta-regression analysis have shown that the estimated cost for a single hip fracture is USD 10,075 for index hospitalization, and health and social care costs at 1 year are USD 43,669 [21]. Furthermore, secondary fractures have higher costs ranging from USD 3844 to USD 27,730 compared with those without a prior fracture [8]. The excess costs are due to hospital admissions, long-term care, and outpatient visits [8] that may result from further complications. With the majority of secondary fractures in the first 2 years, decreasing imminent fractures should be a national priority.

Despite the strong evidence and need to prevent imminent fractures, there remains a large healthcare gap. Our recent study showed that only 23% of hip patients in Hong Kong are prescribed with anti-osteoporotic

Table 8 Multivariate Cox regression analysis of age for secondary fracture within 5 years from 2013 (period of 2013–2018)

Covariate	Confounding factor controlled	p value	HR	95% CI Lower	Upper
Age (ref: < 75)	Sex				
75–84		0.57	0.94	0.77	1.15
85–94		0.11	1.18	0.96	1.45
≥ 95		0.00	2.15	1.36	3.42

Table 9   Mortality of fragility fracture patients from 2004 to 2013

Year	Incident fragility fractures	Number of mortality (1st year)	Cumulative mortality % (1st year)	Number of mortality (2nd year)	Cumulative mortality % (2nd year)	Number of mortality (3rd year)	Cumulative mortality % (3rd year)	Number of mortality (4th year)	Cumulative mortality % (4th year)	Number of mortality (5th year)	Cumulative mortality % (5th year)
2004	5596	394	7.04	315	13.10	299	19.21	295	25.64	235	31.12
2005	5562	318	5.72	319	11.80	321	18.32	307	24.99	271	31.29
2006	5485	317	5.78	377	13.07	302	19.38	298	26.02	233	31.58
2007	5590	422	7.55	326	13.86	300	20.05	270	26.00	278	32.51
2008	5941	402	6.77	382	13.66	344	20.33	314	26.86	260	32.64
2009	6065	405	6.68	313	12.21	335	18.47	275	23.96	300	30.29
2010	6351	398	6.27	373	12.53	359	18.97	319	25.08	303	31.26
2011	6585	432	6.56	395	12.98	383	19.63	356	26.25	333	32.89
2012	6890	432	6.27	396	12.40	398	18.97	329	24.78	280	30.02
2013	7039	490	6.96	376	12.70	372	18.73	347	24.71	295	30.12
Mean cumulative mortality (first 2 years after initial fracture) (%) from 2004 to 2013										*12.8*	
Mean cumulative mortality (5 years after initial fracture) (%) from 2004 to 2013										*31.4*	

medications, excluding calcium and vitamin D supplements [22]. In the USA, Canada, and UK, only 9–50% of patients proceed for bone health assessment after a fragility fracture [23]. Systematic reviews have shown that the prevention of secondary fractures with Fracture Liaison Services to be cost-effective [24]. In fact, a recent meta-analysis of 74 studies showed that Fracture Liaison Service programs improved outcomes of fracture patients with significant increase in BMD assessment (48.0% vs 23.5%), treatment initiation (38.0% vs 17.2%), compliance (57.0% vs 34.1%), secondary fracture (6.4% vs 13.4%), and mortality (10.4% vs 15.8%) (Tables 9, 10, 11, and 12) [12].

Given the high risk in the first 2 years for imminent fractures, a call-to-action with international alliances should be made. Expert groups and stakeholders should have consensus and guidelines in the allocation of resources and treatment in managing imminent risk of fractures in an effective manner. Although FLS appear to be a promising solution, only 10–25% of public hospitals in Hong Kong have the existing service [25]. Likewise, only 9–20% of fragility fracture patients actually get treated for osteoporosis [26, 27]. Despite the evidence, difficulties in setting up FLS, lack of resources, and expertise in certain hospitals have still not been addressed. Recently, several organizations including the Fragility Fracture Network (FFN), the European Geriatric Medicine Society (EuGMS), the European Federation of National Associations of Orthopaedics and Traumatology (EFFORT), the International Collaboration of Orthopaedic Nursing (ICON), the International Geriatric Fracture Society (IGFS), and the International Osteoporosis Foundation (IOF) have stated the importance of acute multidisciplinary care for fragility fracture patients, rapid secondary prevention, and ongoing post-acute care [28]. However, given the current low treatment rates, it is still important to continue spreading the awareness of this imminent threat to our society.

The strengths of this study are that it includes public hospital data from the whole of Hong Kong, reflecting the situation across all territories in the city, thus reducing selection bias. To the knowledge of the authors, this is also the first study with data of imminent fractures from Asia. Furthermore, the locations of imminent fractures are also shown to further elaborate the epidemiological data. We have identified male patients to have further fractures with time (HR = 1.21 (1.02, 1.45), $p = 0.03$). Patients over age 95 were also 2.01 times higher than patients of age under 75 to have further fracture over time.

Falls are the major cause of fractures [29]. Our data suggests the rates of falls are similar to the fractures especially in the first 2 years of imminent risk of fractures. Effective fall prevention and programs are therefore an essential step. Multidisciplinary approach with physiotherapists and

Table 10   Mortality rates after hip, distal radius, and proximal humerus fracture

Fracture type	Distal radius fracture (%)	Hip fracture (%)	Proximal humerus fracture (%)
1 year	1.80	8.49	4.56
2 years	3.96	15.83	9.90
5 years	10.59	34.84	17.43

Table 11 Risk of secondary fractures from 2004 to 2013

Year	Incident fragility fractures	Number of secondary fractures (1st year—imminent risk)	Cumulative per 1000 person-years (1st year)	Number of secondary fractures (2nd year—imminent risk)	Cumulative per 1000 person-years (2nd year)	Number of secondary fractures (3rd year)	Cumulative per 1000 person-years (3rd year)	Number of secondary fractures (4th year)	Cumulative per 1000 person-years (4th year)	Number of secondary fractures (5th year)	Cumulative per 1000 person-years (5th year)
2004	5596	163	31	87	49	83	66	67	82	58	96
2005	5562	140	27	104	48	80	65	74	82	81	10
2006	5485	132	26	89	44	103	66	75	84	56	97
2007	5590	142	28	97	48	107	70	100	93	76	112
2008	5941	199	36	145	64	83	80	80	98	64	113
2009	6065	241	43	138	68	121	91	89	110	68	125
2010	6351	232	39	138	64	96	81	92	100	74	116
2011	6585	228	37	145	62	112	82	103	102	73	118
2012	6890	241	37	160	64	109	82	112	103	83	119
2013	7039	247	38	179	67	92	82	102	100	73	114

Mean cumulative imminent risk of fractures (first 2 years) (%; per 1000 person-years) from 2004 to 2013　5.8%; 58 per 1000 person

Mean cumulative imminent risk of fractures (first 2 years) (%; per 1000 person-years) from 2008 to 2013　6.5%; 65 per 1000 person

occupational therapists is important and exercise programs have been shown to be successful [30]. More importantly, recent studies have shown a high prevalence of sarcopenia in patients with fragility fractures [11, 31]. Sarcopenia is an age-related decline in muscle mass and function [32] and studies have postulated the occurrence of the condition due to the loss of muscle bulk during in-patient periods [11]. Our previous systematic review further showed that the prevalence of sarcopenia in elderly patients with fragility fracture is high, especially in men [11]. This corresponds to the current observation of male patients more likely to have a secondary fracture with time. Further studies investigating an imminent risk of sarcopenia after a fracture should be conducted. As sarcopenia is associated with an increased risk of falls, it should therefore be treated promptly. Exercise and nutrition should be optimized after a fragility fracture with Fracture Liaison Services.

The limitations of the study include that the study was retrospective data. Vertebral fractures for initial fractures were not collected due to the fact that it is well documented that approximately two-thirds are not diagnosed and therefore diagnostic coding would strongly underestimate the prevalence and thereby be inaccurate [18, 19]. Furthermore, fracture patients may have gone to the private setting, which would not be captured. In fact, although 98% of hip fractures are admitted to public hospitals instead of private hospitals [10], there is currently no available data on the sensitivity and completeness in capturing distal radius and proximal humerus fractures in Hong Kong. With the lower incidence of distal radius and proximal humerus fractures in this study compared with other epidemiological studies [33, 34], it is suggestive that the current data source is unable to detect the majority of these 2 fractures, thereby underestimating the overall incidence of major osteoporotic fractures in Hong Kong. Mortality can also be a factor of underestimating the actual total number of re-fractures. Medical risk factors of patients were not analyzed in this study as the purpose was solely to identify the number of secondary fractures and the significance of imminent fractures. Patient loss to follow-up is also a limitation as the CDARS database does provide this data.

In conclusion, following an initial fracture, prompt treatment strategies should be adopted to avoid imminent risk of fractures. This window of opportunity in the first 2 years is a golden period to treat osteoporosis and prevent falls. This would not only save costs but also decrease morbidity and mortality for the patients. Furthermore, our post hoc analysis has shown that male patients and patients older than 95 are at even higher risk. Clinicians and allied healthcare professionals should be alert on these patients.

Table 12   Risk of secondary falls from 2004 to 2013

Year	Number of secondary falls (1st year)	Cumulative per 1000 person-years (1st year)	Number of secondary falls (2nd year)	Cumulative per 1000 person-years (2nd year)	Number of secondary falls (3rd year)	Cumulative per 1000 person-years (3rd year)	Number of secondary falls (4th year)	Cumulative per 1000 person-years (4th year)	Number of secondary falls (5th year)	Cumulative per 1000 person-years (5th year)
2004	181	35	126	61	106	84	98	107	92	129
2005	166	32	132	58	101	80	116	107	109	134
2006	132	27	112	50	124	78	105	103	84	124
2007	172	33	135	61	150	94	112	120	93	144
2008	228	41	198	80	135	108	114	133	94	155
2009	269	48	174	80	156	111	115	135	103	159
2010	252	42	163	72	130	96	121	121	104	144
2011	168	27	181	59	139	85	153	115	89	134
2012	265	41	193	73	150	99	131	124	100	144
2013	231	35	197	67	141	91	120	113	88	131

Mean cumulative imminent risk of falls (first 2 years) (%; per 1000 person-years) from 2004 to 2013	*6.6%*; *66* per 1000 person
Mean cumulative imminent risk of falls (first 2 years) (%; per 1000 person-years) from 2008 to 2013	*7.0%*; *70* per 1000 person

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