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Original Article

Deaths caused by osteoporotic fractures in Japan: An epidemiological study

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ABSTRACT

Background: Osteoporosis is a global issue with a worldwide prevalence of 18.3%, and the presence of coexisting fragility fractures can reduce the survival rate by approximately 20%. In Japan, the prevalence of osteoporosis is estimated to be 12.8 million, and the annual occurrence of hip fractures is approximately 193,400. Remarkably, coexisting hip or spinal fragility fractures caused by slight external force meet the Japanese diagnostic criterion for osteoporosis regardless of bone mineral density. However, only 191 deaths due to osteoporosis were published in 2021 in Japan. With the concern that some cases of hip and spinal fragility fractures were assigned an underlying cause of death of traumatic fracture instead of osteoporosis, this study aimed to elucidate the actual number of deaths due to osteoporosis in Japan.

Methods: We used the data from Japan in 2018. First, the number of deaths due to osteoporosis and hip or spinal fractures was reviewed using published vital statistics. Second, we calculated the number of elderly deaths (age ≥80 years) resulting from hip or spinal fractures caused by falls on the same level using data from approximately 1.4 million annual individual death certificates. Combining the above data, the actual number of deaths due to osteoporosis was estimated.

Results: Only 190 deaths due to osteoporosis were reported in the published data. The individual certificate data revealed 3437 elderly deaths due to hip or spinal fractures caused by falls on the same level, which could meet the criteria of osteoporotic fragility fractures. Accordingly, the estimated number of deaths caused by osteoporosis was calculated as 3,627, approximately 19 times the published value.

Conclusions: After researching the individual death certificate data focusing on the coexisting hip or spinal fragility fracture, it was implied that osteoporosis may have a higher mortality rate in Japan than what is published.

1. Introduction

Osteoporosis is a significant public health concern [1–3]. Its global prevalence is reported to be 18.3% according to a systematic review of 86 meta-analyses [1]; furthermore, some cohort studies have reported that the occurrence of lumbar vertebral fractures or hip fractures in patients with osteoporosis can lead to a deterioration in the 5-year survival rate by approximately ≥20% [2,3]. In Japan, it is estimated that there are 12.8 million osteoporosis patients [4], which accounts for approximately 10% of the total population, and approximately 193,400 hip fractures occur annually [5]. Another study reported that 79.5% of such cases were caused by falls from standing height or a bed [6]. Hip fractures due to falls from standing height or a bed are included in the definition of "fragility fractures [7,8] " hence, we predicted that a significant

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number of osteoporosis-related deaths must have been recorded. However, vital statistics from Japan in 2021 indicate that only 191 (0.013%) out of 1,439,856 annual deaths were attributed to osteoporosis as the cause of death [9]. Although we understand that the purpose of statistics for public health differs from that of clinical practice, the registered number of deaths due to osteoporosis is very small.

Registering deaths due to osteoporosis requires three complex processes. First, the definition of osteoporosis is unique. Osteoporosis is defined as a disease characterized by low bone mass and microarchitectural deterioration of bone tissue that leads to enhanced bone fragility and, thus, an increase in fracture risk [7,10]. Hence, osteoporosis is recognized as a morbid process that causes fractures as complications. Second, the diagnostic criteria of osteoporosis in Japan are as follows [4]: 1) patients with a fragility fracture of the vertebrae or proximal femur, irrespective of their bone density value and 2) patients with a bone density of $\leq$70% of the young adult mean value. The United States also has similar diagnostic criteria [11,12]. The World Health Organization (WHO) defines a fragility fracture as one caused by a slight external force, equivalent to falling from a standing position or lower [8]. Hence, the presence or absence of fractures and the mechanism of injury need to be the focus when diagnosing osteoporosis, as well as the evaluation of bone pathology.

Finally, the process of selecting the underlying cause of death may confuse physicians. The WHO has established that only one disease or injury should be chosen as the underlying cause of death even if many diseases or injuries are written on the death certificate; this is considered the point that should have been targeted to stop the series of conditions that led to the death, according to the rules of the International Classification of Disease (ICD) [13]. Further, a confusing aspect of this system is that the external cause of the injury is registered as the underlying cause of death, rather than the injury itself. Consequently, vital statistics publish plenty of data regarding disease types and external causes of injury, but do not describe in detail the relationship between each injury and its external cause. For example, in the cases where osteoporosis was selected as the cause of death on the individual death certificate, the disease types were subdivided into "*osteoporosis with fracture (M80: assigned ICD-10 code)*" and "*osteoporosis without fracture (M81)*" for registration (Fig. 1). However, once a fracture is tentatively selected as the cause of death, the applicable external force, such as "*falls on the same level (W01)*" or "*pedestrian injured in collision with a car (V03)*", is recorded as the underlying cause of death on vital statistics. In some cases of hip and spinal fragility fractures, osteoporosis might not be considered as the underlying cause of death; instead, other traumatic fractures may be considered as underlying causes of death.

We hypothesized that the actual number of death cases due to osteoporosis is more than the registered value in the vital statistics. Therefore, this study aimed to elucidate the actual number of deaths due to osteoporosis in Japan, with a focus on deaths due to hip or spinal fractures caused by a slight external force.

2. Methods

First, using Japan's government-published vital statistics data from 2018 (designated as "published data" in this study), which follows the ICD-10 [9], we counted "*osteoporosis with fracture (M80)*" and "*osteoporosis without fracture (M81)*" as deaths due to osteoporosis, while "*femoral neck fracture (S72.0)*", "*trochanteric fracture (S72.1)*", and "*subtrochanteric fracture (S72.2)*" were counted as deaths due to hip fractures, and "*fractures of the cervical spine (S12)*", "*fractures of the thoracic vertebra (S22.0)*", "*multiple fractures*

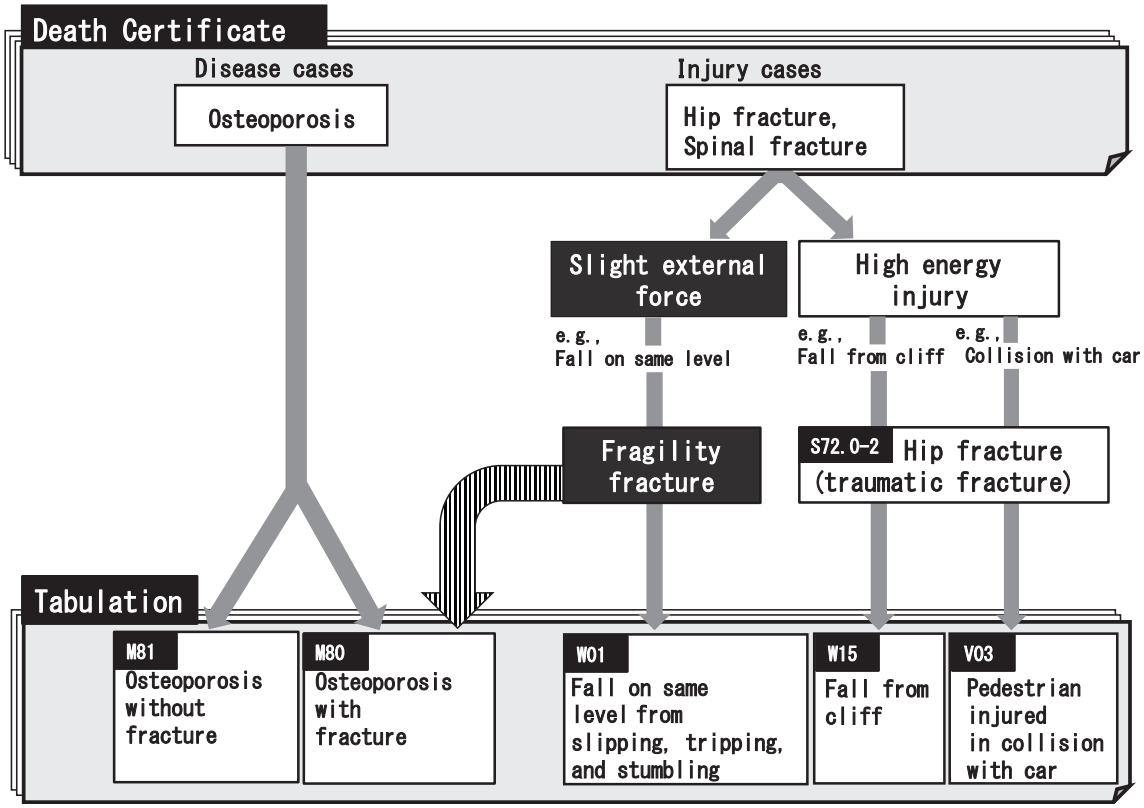

Fig. 1. Tree diagram for reconsidering the underlying cause of death regarding fragility fracture according to the ICD rule We considered that hip and spinal fractures due to *falls on the same level* should be categorized into not "*fall from the same level (W01)*" as a trauma but "*Osteoporosis with fracture (M80)*" as a disease, indicated by the striped arrow.

of the thoracic spine (S22.1)", and "*fractures of the lumbar vertebra (S32.0)*" were counted as deaths due to spinal fractures.

Next, using the data of approximately 1.4 million individual death certificates from 2018, we calculated hip and spinal fractures caused by "*falls on the same level (W01)*". Although Japan's diagnostic criteria for osteoporosis do not include consideration for the patient's age, we strictly defined the criteria for death due to osteoporotic fragility fracture as "*deaths in elderly individuals aged ≥80 years due to hip or spinal fractures caused by a fall on the same level*", as it is recognized that the prevalence of osteoporosis increases with age [8,12]. For reference, we also counted deaths due to *"cervical cord injury (14.1)"* and *"head injury (S00-09)"*. Additionally, we calculated the number of deaths due to each injury that was caused by "*transport accidents (V01-99)*", as these are typical examples of high-impact injuries.

Subsequently, in combining the number of deaths in the published data with the calculated values of those cases that met our criteria for death due to osteoporosis in the individual data, the actual value was estimated.

3. Results

In the published data for 2018, osteoporosis was identified as the underlying cause of death in 190 cases (Table 1). Deaths due to hip and spinal fractures accounted for 2827 and 1121 cases, respectively.

The analysis of the death certificate data revealed that the number of deaths due to hip and spinal fractures caused by "*falls on the same level (W01)* was 2737 and 939, respectively, giving a total of 3,676 cases (Table 2). These values accounted for 96.8%, 83.8%, and 93.1% of hip fracture deaths, spinal fracture deaths, and the total of both categories of deaths in the published data, respectively.

Focusing on the elderly, the numbers of deaths due to hip and spinal fractures caused by *"falls on the same level (W01)*" were 2563 and 874 (3437 cases in total), respectively, which were equal to 90.7% and 78.0% (in total 87.1%) of published hip and spinal fracture deaths, respectively. These met the criteria of fragility fractures that were assumed to be attributed to osteoporosis. When those 3,437 cases were added to 190 cases of deaths due to osteoporosis in the published data, the actual number of deaths caused by osteoporosis was estimated to be 3,627, which was approximately 19 times the published value (Fig. 2).

Regarding the cases involving victims of "*transport accidents (V01-99)*", 41 *"cervical spinal fractures (S12)"* were counted, while other fractures accounted for <10 of these cases. For reference, deaths due to *"cervical cord injury (14.1)"* and *"head injury (S00-09)"* comprised 141 cases caused by "*falls on the same level (W01)*" and 174 cases involving "transport *accidents (V01-99)*", accounting for 15.1% and 18.6% of the total 933 cases from the published data, respectively. Deaths due to head injury included 2299 cases involving "*falls on the same level (W01)*" and 1967 cases involving traffic accidents, accounting for 21.7% and 18.6% of the total 10,577 cases from the published data, respectively.

Regarding deaths resulting from hip and spinal fractures, except for cervical spine fractures, "*falls from the same level (W01)*" in the elderly accounted for ≥85% of the published value in each fracture site, while those caused by transport accidents were rare. In contrast, only approximately 20% of deaths due to cervical cord and

Table 1
Five-year trends in deaths due to osteoporosis, hip fracture, and spinal fracture in published data.

		ICD-10 code	2017	2018	2019	2020	2021	Mean	SD
Osteoporosis	with fracture	M80	48	53	26	40	49	43.2	10.71
	without fracture	M81	121	137	123	117	142	128.0	10.86
	total		169	190	149	157	191	171.2	19.01
Hip fracture	femoral neck fracture	S72.0	1519	1545	1515	1541	1633	1550.6	15.19
	trochanteric fracture	S72.1	1087	1204	1237	1316	1530	1274.8	95.09
	subtrochanteric fracture	S72.2	54	78	74	73	70	69.8	10.72
	total		2660	2827	2826	2930	3233	2895.2	212.18
Spinal fracture	fracture of cervical spine	S12	203	220	238	229	257	229.4	20.13
	fracture of thoracic spine	S22.0, S22.1	294	307	311	306	385	320.6	36.56
	fracture of lumbar spine	S32.0	543	594	601	633	723	618.8	66.59
	total		1040	1121	1150	1168	1365	1168.8	120.13

Table 2
The relationship between each injury and its external cause.

Title		ICD-10 code	By all types of external cause (published data)	By falls on the same level (W01)				By transport accidents (V01-99)			
				all ages		≥80 years		all ages		≥80 years	
Hip fracture	femoral neck	S72.0,	1545	1486	(96.2%)	1382	(89.4%)	–		–	
	trochanteric	S72.1	1204	1176	(97.7%)	1112	(92.4%)	–		–	
	subtrochanteric	S72.2	78	75	(96.2%)	69	(88.5%)	–		–	
	subtotal		2827	2737	(96.8%)	2563	(90.7%)	N/A		N/A	
Spinal fracture	cervical spine	S12	220	81	(36.8%)	68	(30.9%)	41	(18.6%)	18	(8.2%)
	thoracic spine	S22.0, 22.1	307	288	(93.8%)	270	(87.9%)	–		–	
	lumbar spine	S32.0	594	570	(96.0%)	536	(90.2%)	–		–	
	subtotal		1121	939	(83.8%)	874	(78.0%)	N/A		N/A	
Total of hip and spinal fracture			3948	3676	(93.1%)	3437	(87.1%)	N/A		N/A	
Cervical cord injury		S14.1	933	141	(15.1%)	73	(7.8%)	174	(18.6%)	45	(4.8%)
Head injury		S00-09	10,577	2299	(21.7%)	1336	(12.6%)	1967	(18.6%)	444	(4.2%)
Total fatalities of injury and poisoning (published value)[a]		S00-T98	69,096	7596				4595			

"-" indicates not available number because they are under 10, which could be personally identifiable information.
"N/A" indicates not available or incalculable due to deficiency of each cell's data. Round bracket shows the percentage of each number compared to the value of "By all types of external cause (published value)."
[a] Values in this row are extracted from Japan's government-published vital statistics data [9].

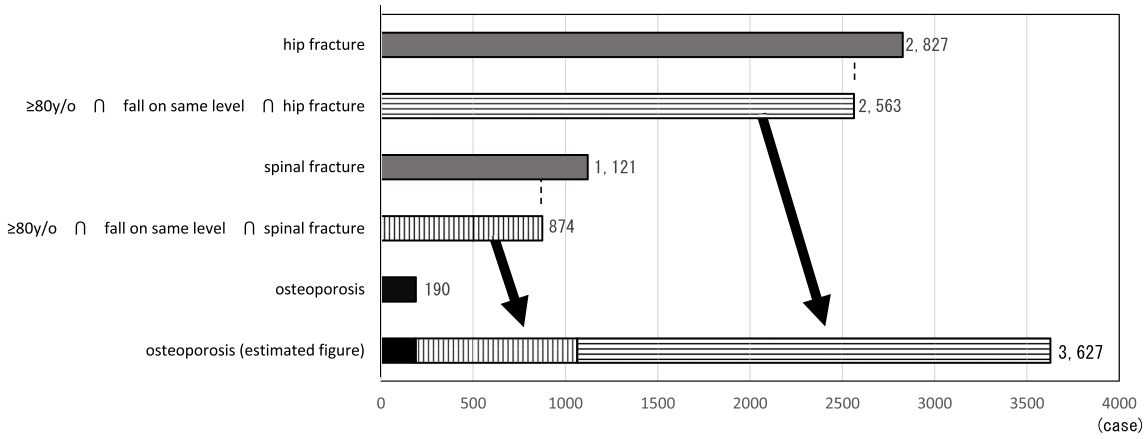

Fig. 2. Estimated actual number of deaths due to osteoporosis Hip and spinal fracture deaths adapted to the fragility fracture criteria were 2,563 and 874 cases, indicated by the striped bars, respectively. When added to the published number for osteoporosis (190), indicated by the black arrows, the estimated number was 3,627.

head injuries in the published data were caused by "*falls on the same level (W01)*"; a similar percentage to those caused by transport accidents.

4. Discussion

In this study, we aimed to elucidate the actual number of deaths due to osteoporosis in Japan. The findings of this study revealed that a considerable number of deaths in elderly individuals due to hip or spinal fractures caused by slight external forces could have met the criteria of fragility fracture. In contrast, relatively fewer deaths resulting from hip or spinal fractures were caused by traffic accidents, implying that deaths due to hip or spinal fractures had a limited number of cases resulting from high-impact external force. Therefore, we consider that the actual number of deaths due to osteoporosis may be much greater than the published value. Briefly, the mean value of annual deaths due to osteoporosis was 171.2, and the trend over the years showed nearly no change in the last 5 years. In contrast, the trends of the number of deaths due to hip and spinal fractures at the same time showed slight increases, and the mean number of deaths due to hip and spinal fractures annually were 2895.2 and 1168.8, respectively (Table 1, Fig. 3). Therefore, the propensity of results of the present study in 2018 was predicted to be nearly the same as in other years.

Based on the published vital statistics from 2018 in other countries, the mortality rates of osteoporosis in the United Kingdom, Australia, United States, and Japan were calculated to be 1.17, 0.74, 0.20, and 0.15, respectively (Table 3) [9,14–17]. At first glance, Japan's mortality rate due to osteoporosis was the smallest. However, considering that Japan has the highest elderly population rate (28.9%) and the highest mortality rate due to "*falls on the same level (W01)*" (59.90%), we suspect that the death cases registered as "*falls on the same level (W01)*" in Japan may have included a considerable number of fragility fracture cases.

Notably, Nelly et al. reported the number of deaths due to osteoporosis using individual death certificates as a novel methodology. In their study, 46,421 deaths due to osteoporotic fractures were detected out of 2,625,743 death cases from 2000 to 2004 in France by analyzing various anatomical sites of fractures, mechanisms of external cause, ages, and sexes [18]. Compared with this report, the estimated number of additional deaths due to osteoporosis in our study was smaller. This difference can be attributed to the fact that we researched only hip and spinal cases due to "*falls on the same level (W01)*", while Nelly et al. investigated fractures on various anatomical sites caused by various types of slight external force.

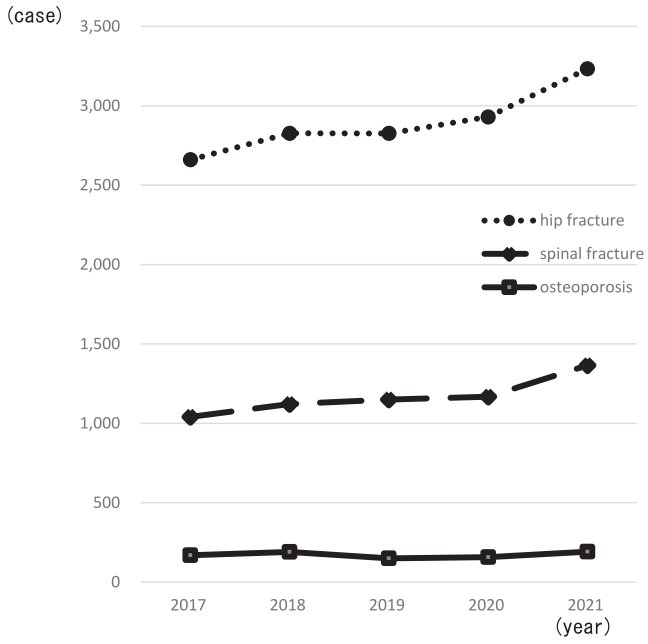

Fig. 3. Changes in the number of cases with osteoporosis, hip fracture, and spinal fracture as underlying causes of death based on published data Deaths due to hip and spinal fractures show a slight upward slope, but osteoporosis shows almost no change in 5 years. Therefore, the propensity of results of the present study in 2018 was predicted to be almost the same during this time.

Therefore, we might have detected more concealed death cases due to osteoporosis if the included causes had been expanded.

We considered that these unexpected results in our present study may be attributed to a synergic effect of some specific conditions in the diagnostic criteria for osteoporosis, as mentioned above, and the statistical systems for classifying deaths. First, it is eccentric for clinicians to assess the external force that caused the comorbid fracture in order to diagnose patients with osteoporosis because diseases, such as osteoporosis, are usually diagnosed with more conventional modalities, such as laboratory studies and imaging. Therefore, some clinicians could be unfamiliar with investigating the underlying mechanism of an injury. Second, the current mortality statistics system mandates that only one cause of death must be selected among several causes on the death certificate. Moreover, further information on the form that was not selected as the cause of death could have been omitted.

Table 3
Comparison of the osteoporosis mortality rates of different countries.

Country	Annual total deaths	*Osteoporosis (M80, 81)* (mortality rate[a])		*Fall on the same level (W01)* (mortality rate)		Total population (million)[b]	Elderly population rate[b]
United Kingdom[c]	541,589	779	(1.17)	156	(2.35)	66.46	18.3
Australia[c]	158,493	185	(0.74)	361	(14.46)	24.97	15.7
United States[c]	2,839,205	645	(0.20)	778	(2.38)	326.84	15.4
Japan[c]	1,362,470	190	(0.15)	7596	(59.90)	126.81	28.9

[a] Mortality rate indicates the number of deaths per 1,000,000 people in the population.
[b] The total population and elderly population of each country are based on the World Bank Open Data [17].
[c] The demographic data from 2018 of the United Kingdom, Australia, United States, and Japan are taken from the Nomis data [14], Australian Bureau of Statistics [15], CDC data [16], and e-stat [9], respectively.

The ICD-10 instruction manual [13] describes the careful handling of osteoporosis and fragility fractures as follows: "When a disease of bone density is reported as the cause of a fracture, the fracture should be considered not traumatic and coded as "*osteoporosis with fracture (M80)*". This perspective is the basis of the ICD-11 instruction manual [19]. Hence, on the death certificate where fracture was selected as the cause of death, only if "osteoporosis" had been precisely written in the proper column by clinicians, "*osteoporosis with fracture (M80)*" would have been ultimately selected as the underlying cause of death. Nelly et al. remarked on the need for greater awareness concerning the significant impact of osteoporotic low-impact fractures on mortality rate when filling out death certificates [18]. In Japan, though the death certificate is a formal and dignified medical and legal attestation, clinicians may not realize that the certificate will eventually become an important document under the Statistics Act. Additionally, they must prepare the death certificate immediately after judging the patient's death in the hospital before the body is transported for burial. Therefore, in Japan, we would also like clinicians to be counseled to write down precisely "osteoporosis" on the certificate if fragility fracture is the cause of death; this is important for both public health and correct diagnosis in the clinical setting.

The present study analyzed diseases and injuries designated as the single cause of death according to the ICD's rule. However, a single cause may not fully represent all the conditions involved in the death certificate, not just for death cases due to osteoporosis. Therefore, the analysis of multiple causes of death [16,20] may sometimes be required, especially in cases of death due to osteoporosis accompanied by fragility fracture. Even if osteoporosis is adopted as the underlying cause of death, the fracture should be selected as another cause of death as it is the primary treatment target for stopping the series of conditions leading to death. We expect that increased discussions among experts, such as epidemiologists and health information managers, will resolve this issue. Further, in the present study, only individual data from 2018 was assessed because it was the latest death certificate dataset available at the commencement of this research (October 2021 to June 2022). In the next study, we wish to expand candidate years to provide further evidence of the practical value of osteoporosis as a cause of death.

In conclusion, the results of the present study implied that the actual number of deaths due to osteoporosis might be much higher than the published value. We hope that this study will act as a basis for further discussion regarding the actual number of deaths due to osteoporosis and re-education for the clinicians to record the precise cause of death on the death certificate.

Ethical statement

This study was not a clinical trial and did not involve any human subjects or animal experimentation. As no identifiable human material or data was used, informed consent was not required, and the Declaration of Helsinki and Directive 2010/63/EU are not applicable. This research has been approved by the institutional review board of the authors' affiliated institutions. The manuscript has been prepared in accordance with the Uniform Requirements for Manuscripts Submitted to Biomedical Journals.

This research was conducted with the permission of the Statistics Bureau, in line with the Statistics Act of Japan enforced in 2009. However, the estimated number of deaths due to osteoporosis was obtained by the authors' calculations using the individual data.

Declaration of competing interest

The authors declare no conflicts of interest associated with this study.

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References

[1] Salari N, Ghasemi H, Mohammadi L, Behzadi MH, Rabieenia E, Shohaimi S, et al. The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis. J Orthop Surg Res 2021 Oct;16(1):609.
[2] Cooper C, Atkinson EJ, Jacobsen SJ, O'Fallon WM, Melton 3rd LJ. Population-based study of survival after osteoporotic fractures. Am J Epidemiol 1993 May;137(9):1001–5.
[3] Bliuc D, Nguyen ND, Milch VE, Nguyen TV, Eisman JA, Center JR. Mortality risk associated with low-trauma osteoporotic fracture and subsequent fracture in men and women. JAMA 2009 Feb;301(5):513–21.
[4] Japan Osteoporosis Society. The Japanese society for bone and mineral research, and Japan osteoporosis foundation. Guidelines for prevention and treatment of osteoporosis 2015. Tokyo: Sanposha Publishing Co., Ltd; 2015 [in Japanese)].
[5] Takusari E, Sakata K, Hashimoto T, Fukushima Y, Nakamura T, Orimo H. Trends in hip fracture incidence in Japan: estimates based on nationwide hip fracture surveys from 1992 to 2017. JBMR Plus 2020 Nov;5(2):e10428.
[6] Hagino H, Endo N, Harada A, Iwamoto J, Mashiba T, Mori S, et al. Survey of hip fractures in Japan: recent trends in prevalence and treatment. J Orthop Sci 2017 Sep;22(5):909–14.
[7] Kanis JA on behalf of the World Health Organization Scientific Group. Assessment of osteoporosis at the primary health-care level. Technical report [internet] World health organization collaborating centre for metabolic bone diseases. UK: University of Sheffield; 2007. Available from: https://www.sheffield.ac.uk/FRAX/pdfs/WHO_Technical_Report.pdf.
[8] O'Flynn N. Risk assessment of fragility fracture: NICE guideline. Br J Gen Pract 2012 Dec;62(605):667–8.
[9] The National Statistics Center [Internet]. Stat Portal Site of Official Statistics of Japan. Vital Statistics, Final data General mortality3; 2018. table number 1-2 [cited 2023 Nov 10]. Available from: https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00450011&tstat=000001028897&cycle=7&year=20180&tclass1=000001053058&tclass2=000001053061&tclass3=000001053065&cycle_facet=tclass1&tclass4val=0&metadata=1&data=1.
[10] Consensus development conference: diagnosis, prophylaxis, and treatment of osteoporosis. Am J Med 1993 Jun;94(6):646–50.
[11] Siris ES, Adler R, Bilezikian J, Bolognese M, Dawson-Hughes B, Favus MJ, et al. The clinical diagnosis of osteoporosis: a position statement from the national

bone health alliance working group. Osteoporos Int 2014 May;25(5):1439–43.
[12] Camacho PM, Petak SM, Binkley N, Diab DL, Eldeiry LS, Farooki A, et al. American Association of Clinical Endocrinologists/American College of Endocrinology clinical practice guidelines for the diagnosis and treatment of postmenopausal osteoporosis—2020 update. Endocr Pract 2020 May;26(-Suppl 1):1–46.
[13] World Health Organization. International statistical classification of diseases and related health problems 10th revision Volume 2 Instruction manual. Geneva: World Health Organization; 2011 [cited 2023 Mar 1]. Available from: https://icd.who.int/browse10/Content/statichtml/ICD10Volume2_en_2016.pdf.
[14] Office for National Statistics. Nomis Mortality statistics - underlying cause, sex, and age. Available from: https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=161. [Accessed 25 March 2023].
[15] Australian Bureau of Statistics. Causes of death, Australia. Available from: https://www.abs.gov.au/statistics/health/causes-death/causes-death-australia/2018#data-downloads. [Accessed 3 June 2023].
[16] Centers for the Disease Control and Prevention, National Center for Health Statistics. Available from: https://www.cdc.gov/nchs/index.htm. [Accessed 1 March 2023].
[17] Population estimates and projections [Internet. World Bank Open Data; 2017. – [cited 2023 Mar 30]. Available from: https://databank.worldbank.org/reports.aspx?source=Health Nutrition and Population Statistics: Population estimates and projections.
[18] Ziadé Nelly, Jougla Eric, Coste Joël. Using vital statistics to estimate the population-level impact of osteoporotic fractures on mortality based on death certificates, with an application to France (2000-2004). BMC Publ Health 2009 Sep;9:344.
[19] World Health Organization. International classification of disease eleventh revision (ICD-11). Geneva: World Health Organization; 2022 [cited 2023 Mar 5]. Available from: https://icdcdn.who.int/icd11referenceguide/en/html/index.html.
[20] Kiadaliri AA, Rosengren BE, Englund M. Fracture-related mortality in southern Sweden: a multiple cause of death analysis, 1998-2014. Injury 2018 Feb;49(2):236–42.