**Table 6.** Vertebral fracture according to steroid and MTX therapy

| Steroid | MTX | No. | Age ± SD (years) | Prevalence of fracture | |
|---|---|---|---|---|---|
| | | | | 1998 | 2002 |
| + | + | 24 | 58.6 ± 4.2 | 7 (29%) | 15 (63%) |
| + | – | 31 | 59.1 ± 4.8 | 11 (35%) | 14 (45%) |
| – | + | 22 | 58.7 ± 4.5 | 1 (5%) | 3 (14%) |
| – | – | 35 | 56.2 ± 4.5 | 4 (11%) | 10 (29%) |

MTX, methotrexate

was 7 (29%) in 1998 and 15 (63%) in 2002. In steroid (+) MTX (–) patients, the prevalence was 11 (35%) in 1998 and 14 (45%) in 2002; in steroid (–), MTX (+) patients, the prevalence was 1 (4.5%) in 1998 and 3 (14%) in 2002; in steroid (–) MTX (–) patients, the prevalence was 4 (11%) in 1998 and 10 (29%) in 2002 (Table 5). New vertebral fracture during the 4-year period showed a significant excess in steroid (+) MTX (+) patients above the occurrence in steroid (–) MTX (+) and MTX (–) steroid (–) patients ($P < 0.05$). Steroid (+) MTX (–) patients also showed an excess over the two steroid (–) groups ($P < 0.05$), which did not differ between MTX (+) and MTX (–).

*Urinary NTx in RA patients with or without fracture*

Urinary NTx in RA patients with any vertebral fracture in 2002 was 66.6 ± 28.6 nmol BCE/mmpl·Cr, while in RA patients with no vertebral fracture in 2002 it was 66.8 ± 32.0 nmol BCE/mmpl·Cr. Thus, urinary NTx was high in RA patients with or with no fracture, with no difference between fracture-defined groups.

## Discussion

This study sought to identify the risk factors for vertebral fracture in menopausal and postmenopausal Japanese women with RA. The cross-sectional part of our study indicated a prevalence of vertebral fracture of 21%, which was considerably higher than in age-matched healthy women without RA (5%, $P < 0.05$). As for steroid treatment, 33% of RA patients with corticosteroid administration had vertebral fracture, which is higher than that seen without steroid administration; this implicated corticosteroid therapy as a risk factor for fracture (see Table 1). In this study, the steroid-related odds ratio for vertebral fracture compared with RA patients without steroid administration was 3.82 (95% CI, 3.01–4.85), indicating an increased risk of developing vertebral fracture in patients treated with corticosteroid. This finding is in agreement with data reported by de Nijs et al. [13] (odds ratio 2.34; 95% CI, 1.39–3.93). Their study included 410 patients with RA, half of whom were treated with corticosteroid; the mean age was 65. The 148 women in this study included 91 postmenopausal women. The dose of prednisolone appeared to be related to the vertebral fracture risk. Steroid-treated patients in our current study showed an odds ratio of 3.80 (95% CI, 3.03–4.76) for vertebral fracture for a daily dose of prednisolone of 5 mg or higher vs. a dose of less than 5 mg. This increased to 4.34 (95% CI, 3.21–5.86) for a daily prednisolone dose of 7.5 mg or higher vs. a dose of less than 7.5 mg. The Japanese Society for Bone and Mineral Research has suggested starting treatment at a dose of 5 mg/day or higher for prednisolone or an equivalent dose of another corticosteroid [18].

Fracture rates also increased with advancing age. In primary osteoporosis, the occurrence of fracture becomes high in Japanese women aged 75 years or older [14,15]. However, vertebral fracture showed an earlier increase in RA patients, beginning at approximately 60 years; patients 60–64 years old receiving no steroid showed a prevalence of 19% with fractures and this in 1998, increased to 33% in 2002. For 28 patients at this age receiving an oral steroid, the prevalence was 43% in 1998 and 75% in 2002 (see Table 2). Fracture rate also was analyzed in terms of age as a variable in RA patients in whom the cut-off age was 59 years (see Fig. 1). An age of 60 years or more was thus identified as a risk factor for vertebral fracture in patients with RA.

A previous history of vertebral fracture was reported to increase the risk of another [19]. Over the 4 years of follow-up in this study, new vertebral fractures occurred in eight patients with a previous fracture. As all eight patients were treated with corticosteroids, this also implicates corticosteroids in compounding the risk of vertebral fracture ($P < 0.05$, Table 3).

Cohen et al. [20] reported that during 12 months of follow-up in 77 patients receiving more than 7.5 mg of prednisolone per day (given for RA in 31 patients), 20.8% (5/24) of all postmenopausal patients in their study group sustained a vertebral fracture. Similarly, Reid et al. [21] found that in 96 patients given over 7.5 mg of prednisolone per day (for RA in 39), 15% (9/60) had a vertebral fracture during a 12-month interval. The importance of BMD in patients with glucocorticoid treatment was questioned by these authors, who suggested that the relationship between BMD and vertebral fracture was tenuous. A working committee of the Japanese Society for Bone and Mineral Research concerned with the development of diagnostic criteria for osteoporosis suggested a BMD/YAM below 70% as a diagnostic criterion for primary osteoporosis in Japanese women [17]. Among our RA patients with a BMD/YAM less than 70%, those treated with prednisolone (5.6 ± 1.9 mg daily) had a 70% prevalence of vertebral fracture at the second evaluation after 4 years; even without steroid therapy the prevalence was 38%. Thus, in RA patients, a BMD/YAM below 70% indicates a risk for vertebral fracture, as was proposed for primary osteoporosis. Among patients with a BMD/YAM between 70% and 80%, some 38% of patients receiving prednisolone (4.6 ± 0.88 mg daily) had a vertebral fracture after 4 years, while 18% of our patients with a BMD/YAM in the same range, but without steroid treatment, had vertebral fractures in 2002. RA patients who had both steroid therapy and a BMD/YAM from 70% to 80% were at increased risk of vertebral fracture. Finally, however, when BMD/YAM was at least 80% in RA

patients receiving prednisolone at 5.7 ± 1.9 mg daily, the risk of vertebral fracture did not appear to be excessive. The fracture rate during a 4-year interval was also analyzed in terms of BMD/YAM (%) as a variable in patients treated with corticosteroid. The cut-off BMD/YAM value that best separated fracture and nonfracture in RA patients was 73%–74% (see Fig. 2); the Japanese Society for Bone and Mineral Research similarly reported a cut-off value for BMD of 73.6% [18]. This suggests that RA patients with a BMD/YAM between 70% and 80% who receive corticosteroid treatment, and all patients with a BMD/YAM below 70%, should undergo treatment for the prevention of vertebral fracture.

We previously compared the structural characteristics of bone loss in iliac biopsy specimens between RA and primary osteoporosis, including a node–strut analysis [1]. Briefly, in RA, trabecular thickness and wall thickness showed a decline with age that was accelerated by glucocorticoid treatment. Decreased connectivity between trabeculae was more prominent than a disappearance of nodes. The connectivity of cortical bone to nodes and the cortical thickness decreased significantly with age, especially in RA patients not treated with corticosteroid. Corticosteroid therapy accelerated the loss of connections between trabeculae and the disappearance of nodes. In this study, fractures were increased in patients aged 60 years or older, while corticosteroid therapy accelerated, the occurrence of fracture. However, the clinical risk of vertebral fracture incidence in menopausal or postmenopausal RA patients treated without a corticosteroid did not clearly differ from that in controls. A 50-year-old patient whose BMD/YAM was 98% and a 63-year-old patient whose BMD/YAM was 95% received no corticosteroid but still sustained vertebral fracture during the 4-year follow-up interval. However, these fractures might conceivably be related to the RA itself. Ørstavik et al. [3] demonstrated vertebral deformity in 141 of 249 female RA patients in Oslo, compared with 51 in 249 control subjects matched for age, sex, and area of residence. A diagnosis of RA and low BMD were both significantly associated with vertebral deformities. In their study, the relative risk with these factors was 1.95 (95% CI, 1.30–2.76) and 1.53 (95% CI, 1.30–1.81), respectively, after controlling for age, body mass index, and use of estrogens or bisphosphonate. When long-term corticosteroid use was added to this analysis, the association between RA and vertebral deformities was weaker, and the relative risk was 1.47 (95% CI, 1.03–2.31). They concluded that a diagnosis of RA was associated with vertebral deformities independently of BMD and long-term corticosteroid use.

In children receiving antineoplastic chemotherapy for up to 5 years, high-dose MTX has been identified as a short- and long-term risk factor for osteoporosis [22,23]. In addition, some case reports have described pathological fractures related to osteoporosis occurring in adult patients who had been treated long-term with low-dose MTX for RA or psoriatic arthritis [24–27]. However Buckley et al. [28], Minaur et al. [29], and Mazzantini et al. [10] found no effect of MTX on BMD. In our study, fracture prevalence was high in patients receiving MTX when given with corticosteroids. No adverse effect on vertebral fracture of low-dose MTX alone was found in RA.

In general, osteoclastic activation, as opposed to the suppression of bone formation, has been suggested as the dominant process leading to bone loss in patients with RA [30–32]. Assessing bone resorption markers in patients with RA may therefore improve our understanding of the pathogenesis of bone loss with bone resorption in RA. Urinary cross-linked N-telopeptides of type I collagen (NTx) serve as a bone resorption marker that was previously reported to be significantly higher in women with RA than in age-matched controls; the RA-related increase in urinary NTx was suggested to be associated with physical inactivity and increased RA activity [33]. In the present study, urinary NTx was high in RA patients, as previously reported, but no difference was seen between patients with and without a new fracture after 4 years. Since urinary NTx is generally elevated in RA patients, increases in urinary NTx resulting from vertebral fracture may have been masked. Another reason for the lack of difference may involve the variability in the duration of intervals from the occurrence of vertebral fracture to the measurement of urinary NTx.

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ORIGINAL ARTICLE

# Secular change of the incidence of four fracture types associated with senile osteoporosis in Sado, Japan: the results of a 3-year survey

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**Abstract** We conducted a three-year survey of fracture incidences associated with senile osteoporosis—compression fractures of the spine, femoral neck fractures, distal radius fractures, and fractures of the proximal end of the humerus—to examine secular change. The survey was conducted between 2004 and 2006 on patients in Sado City. We calculated the incidence of each fracture based on the population of Sado City (per 100,000 person-years). Only clinical or incident fractures were diagnosed as new fractures for compression fractures of the spine. Incidence of compression fracture of the spine was the highest, followed by femoral neck fracture, distal radius fracture, and fracture of the proximal end of the humerus. The incidence of femoral neck fracture increased annually from 2004 to 2006, significantly among the elderly in their 80s ($P < 0.05$). Compression fracture of the spine also increased but not significantly. The incidences of distal radius fracture and fracture of the proximal end of the humerus did not increase. This increase in incidence of femoral neck fractures associated with senile osteoporosis will become an important issue for an aging society such as Japan.

**Keywords** Fracture · Osteoporosis · Incidence

Data represented in the Journal of Bone and Mineral Metabolism [2] are included in a table and figures in this article, to examine secular change from 2004.

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## Introduction

Japan has an increasingly aging society which is expected to experience an increasing number of fractures associated with senile osteoporosis; namely, compression fracture of the spine, femoral neck fracture, distal radius fracture, and fracture of the proximal end of the humerus. In fact, the incidence of femoral neck fractures is reportedly on the rise [1, 2]. However, the incidences of other fracture types are not entirely clear, nor are the relationships among these fracture types. Moreover, there are currently few reports on any consecutive surveys of the incidence of four kinds of fractures associated with senile osteoporosis which were conducted simultaneously and in a defined geographic area. Therefore, we conducted a survey on the incidences of four fracture types associated with senile osteoporosis in the city of Sado, Japan for three consecutive years.

## Patients and methods

We conducted a survey of patients at Sado General Hospital (inpatients and outpatients) between 2004 and 2006 for compression fractures of the spine, femoral neck fractures, distal radius fractures, and fractures of the proximal end of the humerus. Sado General Hospital is the only hospital on Sado Island capable of treating fractures and manages 95% of all such cases in Sado. In 2004, a few

other medical institutions in Sado City were included in this study, but as they contributed only a small percentage of all cases, these were eliminated from the study in 2005. All fractures were examined by X-ray. Diagnosis of compression fractures was based on dimensions of the vertebral body and diagnostic criteria issued by The Japanese Society for Bone and Mineral Research, used widely in Japan [3]. We diagnosed clinical or incident fractures as new fractures. These were found in patients who visited the hospital for symptoms such as back pain and were judged by the orthopedic doctor based on X-ray and physical examination to have a new vertebral fracture. Prevalent fractures and asymptomatic older fractures observed accidentally by X-ray were excluded from the analysis.

We first counted the number of patients with each fracture type for each year and then calculated the incidences based on the Sado City population for each year (per 100,000 person-years). We also calculated the incidences in 2004 adjusted to the population structure of Japan in 2005. Patients were divided into groups according to age (10-year intervals). The incidence of each fracture type per age group per study year was calculated according to the population of each age group in Sado City for a given study year (per 100, 000 person-years). We focused on patients who resided in Sado, an island, as it is unlikely that patients would go elsewhere for treatment, and thus would remain on the island for the duration of the survey. We excluded any fractures experienced by tourists to Sado. The population of Sado was 70,011 in 2004, 68,045 in 2005, and 66,592 in 2006. At the same time, the aging rate (ratio of population $\geq$65 years relative to total population) for these three years was 34.0, 34.7, and 35.2%, respectively (Table 1). The fracture incidences surveyed in 2004 were reported in a previous paper [4]; however, these are also included in this report in order to illustrate changes over three consecutive years, from 2004 to 2006 in Sado City.

### Statistical analysis

Chi-square test followed by Tukey's multiple comparison was used to compare the incidence of each fracture across all observation years.

## Results

The combined number of compression fractures of the spine, femoral neck fractures, distal radius fractures, and fractures of the proximal end of the humerus was 350 patients in 2004, 369 in 2005, and 405 in 2006. The incidence per 100,000 people was 499.9 in 2004, 542.3 in 2005, and 608.2 in 2006. Therefore, both the number of fractures and incidence increased every year from 2004 to 2006 (Table 1) (N.S.). We analyzed the result by classifying the incidences for the four fracture types by year and by age.

### Compression fractures of the spine

The incidence per 100,000 was 232.8 in 2004, 246.9 in 2005, and 282.3 in 2006, indicating an annual increase (N.S.). In age group analysis the annual increase in incidences from 2004 to 2006 was shown in octogenarian patients (N.S.) (Fig. 1).

### Femoral neck fractures

The incidence per 100,000 was 121.4 in 2004, 141.1 in 2005, and 177.2 in 2006, also indicating an annual increase (N.S.). In particular, there was a significant increase in incidence of femoral neck fractures among octogenarian patients between 2004 and 2006 ($P < 0.05$) (Fig. 2).

**Table 1** Number and incidence of each fracture in Sado

| Year | 2004 | | 2005 | | | 2006 | |
|---|---|---|---|---|---|---|---|
| Total population | 70,011 | | 68,045 | | | 66,592 | |
| Aging rate | 34.00% | | 34.70% | | | 35.20% | |
| | 2004 | | 2005 | | | 2006 | |
| | Number | Incidence | Incidence adjusted for Japanese population | Number | Incidence | Number | Incidence |
| Spine | 163 | 232.8 | 138.4 | 168 | 246.9 | 188 | 282.3 |
| Femoral neck | 85 | 121.4 | 69.8 | 96 | 141.1 | 118 | 177.2 |
| Distal radius | 76 | 108.6 | 76.9 | 84 | 123.4 | 74 | 111.1 |
| Proximal end of humerus | 26 | 37.1 | 37.3 | 21 | 30.9 | 25 | 37.5 |
| Total | 350 | 499.9 | 322.4 | 369 | 542.3 | 405 | 608.2 |

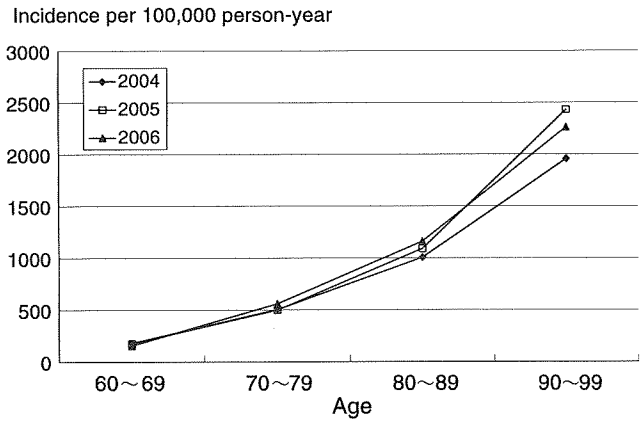


**Fig. 1** Incidence of compression fractures of spine

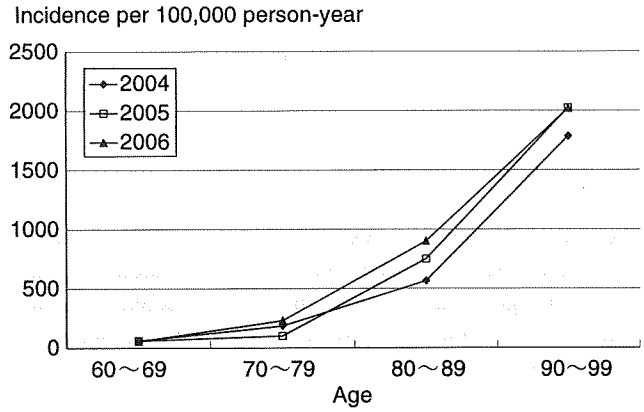


**Fig. 2** Incidence of femoral neck fractures

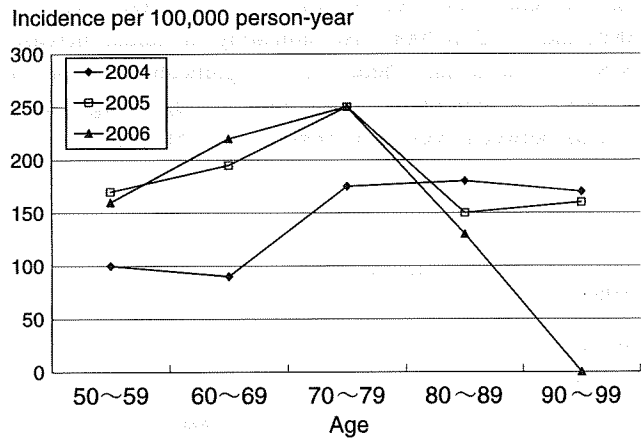


**Fig. 3** Incidence of distal radius fractures

Distal radius fractures

The incidence per 100,000 was 108.6 in 2004, 123.4 in 2005, and 111.1 in 2006, indicating a plateau. The incidence was highest among septuagenarian patients each year (Fig. 3).

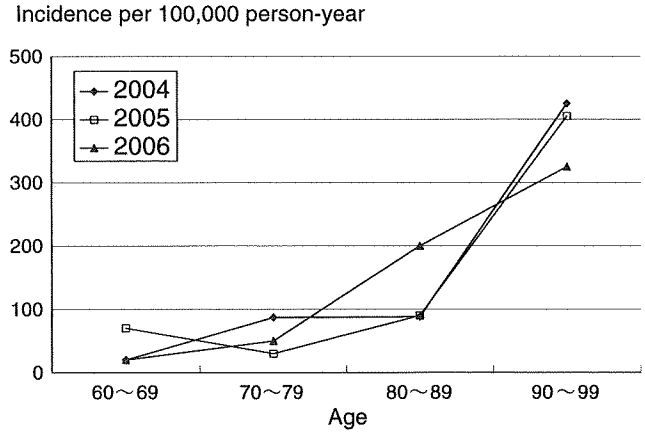


**Fig. 4** Incidence of proximal end of humerus fractures

There was no significant age-dependent difference in incidence across all years.

Fractures of the proximal end of the humerus

The incidence per 100,000 was 37.1 in 2004, 30.9 in 2005 and 37.5 in 2006, also indicating a plateau. Nonagenarian patients had the highest incidence each year (Fig. 4).

There was no significant age-dependent difference in incidence across all years.

## Discussion

Sado is an island city whose residents attend the Sado General Hospital, which allows us to conduct a complete survey of four types of fractures associated with senile osteoporosis within the same location and at the same time. Furthermore, since Sado has a high aging rate of 35%, we believe that it represents a good indication of future trends in Japan.

The incidence of compression fractures of the spine and femoral neck fractures increased most markedly among octogenarian patients, particularly in 2006 ($P < 0.05$; between 2004 and 2006 on femoral neck fracture).

One reason for the increased hip fracture incidence may be that the elderly population over 80 years of age in Sado grew by approximately 300 people each year, despite a decline in the total population from 2004 to 2006. Other studies reported similar increases in hip fracture with time [1, 2, 5–7]. In the current study, the incidence increased 1.46-fold in 3 years—a steep increase rate compared to the 1.4-fold increase observed in other Asian regions in a recent decade [6]. In addition, pre-existing compression fractures of the spine have been suggested as risk factors for femoral neck fractures [8]. Eighty percent of patients with femoral neck fractures reportedly have a history of

compression fractures of the spine, and femoral neck fractures are thought to occur 3–5 years after patients have been diagnosed with a compression fracture [9, 10]. We are therefore confident that the increase in compression fractures of the spine is associated with later increases in femoral neck fractures. Osteoporosis patients should be educated and enlightened about these issues, and we recommend that physicians also take this into consideration in their treatment of such patients.

Studies from Northern Europe and North America have reported that fracture incidences have decreased in recent years. Initially, these regions had higher incidences than Japan, but these have since declined, most likely as a result of proper osteoporosis diagnoses and the use of osteoporosis drugs [11, 12].

This survey revealed that distal radius fractures have a different incidence pattern compared to compression fractures of the spine and femoral neck fractures. The incidence of distal radius fractures did not increase by age or by year. Hagino et al. [5] reported that the fracture of upper extremities increased significantly with time in their study of 1986–1995, but in the current study we did not observe such an obvious increase (Table 1, Figs. 3, 4). It is possible that the shorter observation period and fewer fractures in upper extremities contributed to this discrepancy.

Some studies report that while the elderly must remain sufficiently active in order to prevent distal radius fractures by using their hands during a fall, it may not be possible to prevent the other types of fractures [5, 13]. Unmistakably, one of the contributing factors, other than an increasingly aging population, is reduced physical ability, as seen in individuals who are unable to use their hands during a fall to prevent fractures or those who fall while being transferred onto a bed or a wheelchair. The elderly who are over 80 years of age clearly have a lower physical activity level and, therefore, a decreased ability to walk and an increased likelihood to stumble or fall, a condition which necessitates assistance [5, 13].

A survey conducted in 2004 reported that patients who suffered femoral neck fractures reported low levels of serum vitamin 25(OH)D and albumin [9, 10]. A drop in serum vitamin 25(OH)D levels generally suggests reduced torso flexibility [14] and, therefore, an increased risk of falling [15], which can also be related to dementia [16]. Levels of 25(OH)D are significantly related to vitamin D levels, and also correlate with low levels of albumin, indicating the important role of nutrition among the elderly, particularly those over 80 years of age. We believe that decreased activity and poor nutrition may have contributed to the increased incidence of fractures.

The increase in bone fractures among the elderly is an important concern for Japan's aging society, and indicates a disparity between long life expectancy and a high quality of life. The decline in activity and the rise in assisted living increase the risk of falls and are linked to increased rates of bone fractures. The increase in bone fractures, especially femoral neck fractures, indicates the need for increased care. Moreover, it is reported that only 55% of patients with femoral neck fractures return home after leaving the hospital [4], which creates a large burden of medical care expenses.

The results of our survey on the incidence of fractures associated with senile osteoporosis, particularly among the elderly over 80 years old, should serve as a warning to our society. A national survey on femoral neck fractures also indicates increasing incidence of bone fractures among those 80 years and older [17]. We believe that it is critical to implement comprehensive bone fracture prevention programs, including fall prevention, nutrition, and the appropriate use of osteoporosis therapy drugs to rehabilitate the current generation.

We conclude that reducing the risk of falls among the elderly will have a significant impact on the incidence of fractures associated with senile osteoporosis.

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# Epidemiology of cervical and trochanteric fractures of the proximal femur in 1994 in Tangshan, China

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**Abstract:** The purpose of this study was to determine the incidence of cervical and trochanteric fractures of the proximal femur in 1994 in Tangshan City, China. There are many reports on hip fracture incidence in many countries, suggesting that there are many factors affecting hip fractures. We visited 15 hospitals with an orthopaedic department within Tangshan City, and reviewed the medical records and radiographs of all patients with hip fractures occurring between January 1 and December 31, 1994. The population of Tangshan in 1994 was determined to be 1454543 (746015 males and 708528 females). The population of those over 65 years of age was 88490 (41519 males and 46971 females), representing 6.08% of the total population. This study detected 184 cervical and trochanteric fractures of the proximal femur in 1994 in Tangshan (127 men and 57 women). The overall incidence or rate of the combined number of cervical and trochanteric fractures was 25 fractures per 100000 population per year for men and 12 for women. There were a total of 147 cervical fractures (80%) and 37 trochanteric fractures (20%). The incidence of the combined number of cervical and trochanteric fractures in patients over 70 years of age increased to 108 for men and 156 for women. The incidence of hip fractures increased with age in both sex groups, especially in women over 65. Severe trauma fractures happened more often in younger groups, and mainly occurred in men, which may be a result of the particular composition of the population in Tangshan, which is young and male dominated. In addition, because Tangshan is an industrial city, many of its citizens are involved in occupations requiring a high level of physical activity.

**Key words:** epidemiology, cervical femoral fracture, trochanteric femoral fracture, hip fracture, Tangshan, China

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## Introduction

The incidence of hip fractures is increasing worldwide because of the growth of the elderly population [1–11] and impaired physical activity [12]. The rate of increase differs from country to country, and also among different races; especially, it is reported that there are large differences between Asian and European populations [13]. Osteoporosis has become one of the major health problems confronting the elderly population. The incidence of fractures of the proximal femur is one of the indicators reflecting bone fragility in the elderly population. Most previous epidemiological studies of hip fractures were performed in certain periods and to compare with results with other areas. More recently, it has been reported that the incidence of hip fractures has increased with year and time in the same area [14,15]. There are many factors affecting hip fractures. The aims of this study were to determine the age-specific incidence of cervical and trochanteric fractures of the proximal femur in Tangshan City, and to compare this rate with the incidence of these fractures as detected in other areas, in Asia and in Western countries.

## Materials and methods

This study was carried out in the city of Tangshan, which is located in the north of China, 240km east of Beijing, and at a latitude of 38° north (Fig. 1). Data included the patients' age and sex, the type of hip fracture, and the date on which the patient sustained hip fracture. We visited 15 hospitals with an orthopaedic department in Tangshan. The medical records and radiographs of all patients who sustained a hip fracture between January 1 and December 31, 1994, were reviewed. The remaining 12 hospitals in Tangshan City did not have an orthopaedic department. The type of hip fracture was categorized as either cervical or trochanteric. Patients with


**Fig. 1.** Location of Tangshan City, China

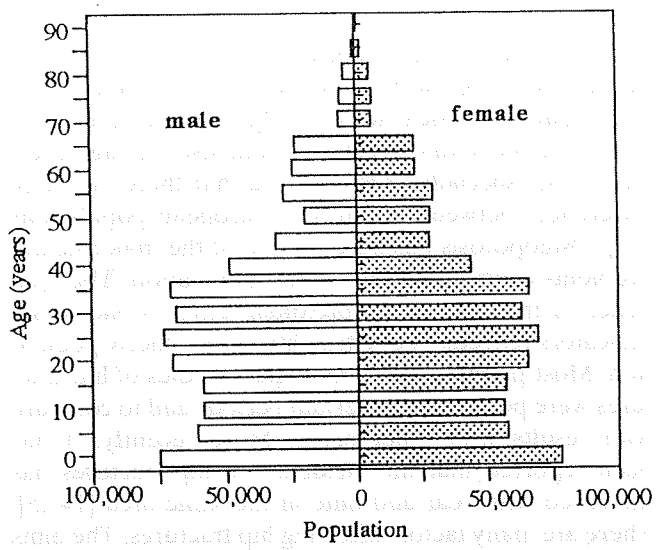


**Fig. 2.** Population pyramid in Tangshan City, based on sex and age in 1994

subtrochanteric or pathological fractures, residents of other cities, and patients under the age of 20 years were excluded from the study. Each patient with a fracture was given a personal code to ensure that every fracture was recorded only once in the study.

Demographic information for 1994 was obtained from the census office in Tangshan. The population of Tangshan in 1994 was determined to be 1454543 (746015 males and 708528 females). The population of those over 65 years of age was 88490 (41519 men and 46971 women), representing 6.08% of the total population (Fig. 2).

The population in this study was divided into four 5-year age groups, ranging from 50–54 years to 65–69 years. Individuals aged 49 years or less and those 70 years and older formed two additional groups. We determined the age-specific incidence of cervical and trochanteric fractures of the proximal femur in Tangshan in 1994. Fracture incidence or rate was expressed as the number of cervical or trochanteric fractures per 100000 population per year, and was computed for each of the age groups.

## Results

*Incidence of cervical and trochanteric fractures in 1994*

The population pyramid of the city of Tangshan, based on age and sex, is shown in Fig. 2. Approximately 240000 residents died in Tangshan because of an earthquake in 1976. Because Tangshan is an industrial center, the population is young and male dominated. The ratio of males to females was nearly 1 to 1. Women over the age of 65 comprised only 6.62% of the total female population.

In Tangshan in 1994, 184 cervical and trochanteric fractures of the proximal femur occurred, with 127 in males and 57 in females (male-to-female ratio, 2.2:1). The average age at the time of fracture was 56.1 years for men and 62.8 years for women. The age-specific number and incidence of cervical and trochanteric fractures are shown in Table 1. There were 35 fractures in men over 65 years of age, and 34 in women in the same age range. The overall incidence of the combined number of cervical and trochanteric fractures was 25 per 100000 population per year for men and 12 for women. In the range of 50 to 55 years, the incidence of hip fracture is higher in men than in women. However, the incidence of these fractures in patients over 70 years of age increased to 108 for men and 156 for women. The incidence of the combined number of cervical and trochanteric fractures increased in both males and females with increasing age (Fig. 3).

There were 147 cervical fractures (80%) and 37 trochanteric fractures (20%). The ratio of cervical to trochanteric fractures was 4.0 to 1 (Table 2). There were 104 cervical fractures and 23 trochanteric fractures in men, and 43 cervical fractures and 14 trochanteric fractures in women. The percentage of trochanteric fractures was greater in men under 65 years of age compared to females in the same age range. However, above the age of 65 years, the percentage of trochanteric fractures in women was higher than in men.

## Discussion

The incidence of hip fractures is related to a society's economy, industrial structure, geographic location, and composition of its population, as well as the occurrence of global traumas such as earthquakes, and the presence

**Table 1.** Number and age-specific incidence of cervical and trochanteric fractures of the proximal femur, and the percentage of trochanteric fractures, in 1994 in Tangshan

| Age | Male | | | | | | | Female | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cervical fractures | | Trochanteric fractures | | Combined | | Trochanteric fractures (%) | Cervical fractures | | Trochanteric fractures | | Combined | | Trochanteric fractures (%) |
| | Cases | Rate | Cases | Rate | Cases | Rate | | Cases | Rate | Cases | Rate | Cases | Rate | |
| –49 | 49 | | 4 | | 53 | | 8 | 2 | | 0 | | 2 | | 0 |
| 50–54 | 5 | 24.8 | 2 | 9.9 | 7 | 34.8 | 28 | 4 | 14 | 0 | 0 | 4 | 14 | 0 |
| 55–59 | 14 | 49.5 | 3 | 10.6 | 17 | 60 | 17 | 6 | 20 | 0 | 0 | 6 | 20 | 0 |
| 60–64 | 11 | 44.3 | 4 | 16.1 | 15 | 60.5 | 26 | 10 | 43.3 | 2 | 8.6 | 12 | 51.9 | 16 |
| 65–69 | 13 | 65.3 | 4 | 5 | 17 | 70.3 | 23 | 11 | 60 | 4 | 21.8 | 15 | 82.6 | 36 |
| 70+ | 12 | 72 | 6 | 36 | 18 | 108 | 35 | 10 | 82 | 9 | 74.5 | 19 | 156 | 64 |
| Total | 104 | 21.2 | 23 | 4.7 | 127 | 25.8 | 18 | 43 | 9.4 | 14 | 14.5 | 57 | 12.4 | 24 |

Fracture incidence or rate is expressed as the number of fractures per 100000 population per annum, computed over each age interval

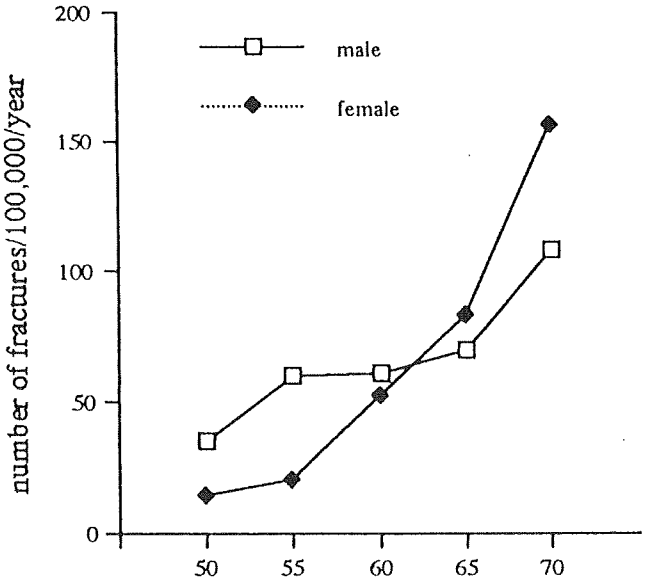


**Fig. 3.** Age-specific incidence of the combined number of cervical and trochanteric fractures of the proximal femur in female and male residents of Tangshan in 1994

**Table 2.** Summary of proximal femur fractures in Tangshan City in 1994

| | |
|---|---|
| Number of fractures | 184 |
| Male/female ratio | 2.2:1 |
| Average age | |
| Males | 56.1 |
| Females | 62.8 |
| Cervical/trochanteric ratio | 4.0:1 |

of osteopenia. Osteopenia, in turn, depends upon genetics, as well as a society's climate, lifestyle, food intake, and the level of physical activity of its people. This is the first report of the incidence of hip fractures in the city of Tangshan, which is a large coal industrial center in China. This preliminary study provides an understanding of the trends and the reasons for hip fractures in Tangshan.

### *Changes in the trend of incidence of cervical and trochanteric fractures in Tangshan*

It is very interesting to find that in the age range from 50 to 55 years the incidence in men is higher than that in women. This phenomenon may indicate that in this age group the male mainly has severe force fractures related to occupation. Further, this variation may be related to more than the trauma degree of fracture; old women often fall in their home, but men more often fall in public places or places of work. After 65 years of age, the incidence of hip fractures in women was higher than

in men, which could be explained by fractures related more to the decline of estrogen secretion in women and osteoporosis. Also, it is related to the loss of bone mass and a slighter force, as mainly occurred in hip fractures of women.

*Characteristics of cervical and trochanteric fractures in Tangshan*

Most of the cervical and trochanteric fractures of the proximal femur that occurred in the adult males in this study were caused by severe traumatic situations. Females tended to be injured by a simple fall and most fractures occurred indoors, whereas males tended to be injured by more severe traumatic occurrences. Traffic accidents and high-energy traumatic events accounted for most of the cervical and trochanteric fractures in the adult men. The highest age-specific incidence of fractures in this study occurred in women over 70 years of age, reflecting the fact that hip fractures are closely related to the presence of osteoporosis.

*Characteristics of lifestyle in Tangshan may cause the lower incidence of fractures*

There are several factors for the lower incidence of fractures in Tangshan: physical activity, nutrition and food intake, body weight, and living habits. Each of these factors is discussed here.

A number of epidemiological studies have indicated that lack of physical activity is a risk factor for osteoporotic fractures [15,16]. These studies also found that physical activity in early life is a significant factor in the development of peak bone mass [17,18]. Because Tangshan is the biggest coal industry center of China, most people in Tangshan are engaged in occupations related to coal or the steel industry, and perform physically intense work daily. Most women have a job, even after retirement. Some of them also have a second job, perform physical activities in the morning such as Chinese dance, or provide care for their grandchildren. They also frequently travel from place to place by walking or bicycling. This higher level of physical activity may be mainly responsible for slowing the onset of osteoporosis.

People in Tangshan consume many coarse cereals and have meals that include beans. Their food intake is very similar to that in Daqing, China [9], where a low incidence of hip fractures has also been reported. Accelerated bone loss from a deficient diet does not appear to be a problem.

Body weight may be an important determinant of bone loss [19,20]. Alcoholism is a recognized cause of osteoporosis [21,22]. One study reported that even modest alcohol consumption may have an adverse effect on bone mass [23]. Tobacco consumption is also a risk factor for osteoporosis [24,25]. A recent study reported that smokers not only have a lower bone mass but also a greater rate of bone loss [26]. In Tangshan, very few women smoke or drink alcohol. Also, most postmenopausal females tend to gain body weight, compared to their younger years. These factors most likely influence the low incidence of hip fractures in Tangshan.

*Comparison of incidence of fractures in Tangshan and other areas*

The incidence of cervical and trochanteric fractures is considered to be related to osteoporosis or aging, races and other factors [1–3,6,12–14,19]. The incidencf@of cervical and trochanteric fractures in Tangshan was lower than that reported for other prefectures in Japan such as Niigata, Tottori, and Nagasaki in Asia, as well as in Rochester, MN, in the United States [6–8,10–15]. In addition, this incidence was also lower than that reported in Taiwan [27]. The possible reason may be the particular composition of the population, which is young and male dominant; also, people in Tangshan have needed to maintain a high level of physical activity [12,27].

From this preliminary study, it was found that some patients with a suspected hip fracture present to a hospital outside the city of Tangshan and are not transferred to a hospital in Tangshan because of mental problems. By checking surgical and outpatient records in one hospital outside Tangshan City, it was estimated that the current study was able to detect approximately 80% of those with hip fractures. As previously mentioned, the incidence of hip fractures is affected by many factors. Because it is difficult to predict changes in these factors from only a single epidemiological study, more detailed studies are required.

In summary, this study detected a low incidence of cervical and trochanteric fractures of the proximal femur in Tangshan. This low incidence may result from the particular composition of the population, which is young and male dominant, and to the fact that many people have industrial-related occupations requiring a high level of physical activity.

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# Epidemiology of cervical and trochanteric fractures of the proximal femur in 1996 in Kaohsiung City, Taiwan

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**Abstract:** The goal of this study was to determine the incidence of cervical and trochanteric fractures of the proximal femur in 1996 in Kaohsiung City, Taiwan. Kaohsiung City is the industrial and commercial center of southern Taiwan, with a population of 1433621 in 1996. The number of individuals over 65 years of age accounted for 6.2% of the total population. Data from the archives of reimbursement of the National Health Insurance program were used to investigate the incidence of fractures of the proximal femur. This study detected 580 cervical and trochanteric fractures (40.5 fractures per 100000 population per year) in 261 males (35.8 fractures per 100000 men per year) and 319 females (45.3 fractures per 100000 women per year), with 420 (72%) of these fractures occurring in individuals over 65 years of age. The age-specific incidences of cervical and trochanteric fractures increased exponentially with age in both genders. The overall ratio of cervical to trochanteric fractures was 1:1.04. The mean ages of women with cervical or trochanteric fractures (71.6 and 74.0 years, respectively) were significantly higher than those of males (59.9 and 64.8 years, respectively; $P < 0.01$). The age-adjusted incidences of fractures of the proximal femur in Kaohsiung City were higher than in other Asian countries, but were lower than in Western countries such as the United States and Norway. The urban lifestyle and low daily calcium intake may be responsible for this increased incidence of proximal femoral fractures in Kaohsiung City.

**Key words:** epidemiology, cervical femoral fracture, trochanteric femoral fracture, Kaohsiung, Taiwan

## Introduction

Previous epidemiological studies [1–4] have reported that the incidence of fractures of the proximal femur varies with geographic location and race. These fractures frequently occur in elderly individuals, and are thought to be closely related to senile osteoporosis. It has been found that the incidence of fractures of the proximal femur is lower in Oriental countries [5–8] compared to countries in the West [9–12]. Factors affecting the incidence of these fractures include gender, nutrition, activity level, occupation, genetics, weather, and the morphology of the proximal femur [1,7,9,13,14]. Several studies [11,15] have reported a gradual increase in the incidence of these fractures over time. The devastating complications associated with fractures of the proximal femur create medical and financial burdens to society. Because the percentage of elderly people in the population of Taiwan is increasing, there will likely be more cases with fractures of the proximal femur occurring in the future. However, there is little available information about the epidemiology of these fractures in Taiwan. This study was undertaken to investigate the incidence of cervical and trochanteric fractures of the proximal femur occurring in Kaohsiung City, Taiwan, in 1996, and to compare this finding with the incidences in other Asian and Western countries.

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## Materials and methods

This survey of proximal femoral fractures was carried out in Kaohsiung City, which is the center of industry and commerce of southern Taiwan; it is also the second largest city and has the largest harbor in Taiwan (Fig. 1). The majority of the population of Kaohsiung City is made up of Taiwanese. The National Health Insurance program in Taiwan was established in March 1995, which is a single-pipe public insurance system for all citizens of Taiwan and is operated by the Bureau of National Health Insurance. The benefits coverage of this insurance program includes all medical care related to fractures of the proximal femur. Up to 95% of the residents of Kaohsiung City are enrolled in the National Health Insurance program. Cases of fractures of the

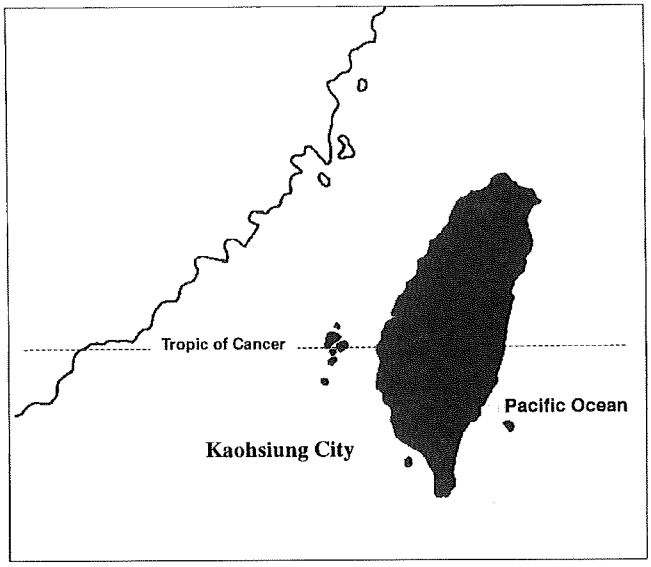


**Fig. 1.** Location of Kaohsiung City, Taiwan

proximal femur were identified from the reimbursement archives for hospital discharges from the Kao-Ping Branch of the Bureau of National Health Insurance, which manages the medical insurance of the medical institutes in Kaohsiung City and its two neighboring prefectures, Kaohsiung Prefecture and Pingtung Prefecture.

To be eligible for this study, patients with proximal femoral fractures had to satisfy the following inclusion criteria: (1) the patient had to present to the medical institute with their fracture between January 1 and December 31, 1996; (2) the patient had to be a registered resident of Kaohsiung City during the study period; and (3) the proximal femoral fracture had to be identified by codes 820.0 through 820.9 of the ninth revision of the International Classification of Diseases—Clinical Modification (ICD-9-CM) [16] in any of the five diagnostic fields of the discharge record. Cervical fractures (femoral neck fractures) were indicated by codes 820.0, 820.1, 820.8, 820.9, or their five-digit subclassification, whereas trochanteric fractures were identified by codes 820.2, 820.20, 820.21, 820.3, 820.30, or 820.31. Additional information such as patient age and identification number, and the other related diagnostic and procedure ICD-9-CM codes, was also provided by this database. Although one or more medical records (including emergency, admission, or transfer between hospitals) existed for each patient, we were able to identify a given patient in the records by their identification number. In Taiwan, the first numeral of the identification number indicates the patient's gender, "1" for male and "2" for female.

Major associated traumatic injuries (concussion, pneumothorax, other fractures, and internal organ injuries) were identified by the corresponding ICD-9-CM diagnostic codes. Patients with subtrochanterical fractures (codes 820.22 and 820.32), pathological fractures (codes 733.14 and 733.15), and late complications of fractures of the proximal femur (e.g., revision of a hip prosthesis, procedure code 81.53) were excluded from this study.

According to the census of the Bureau of Civil Affairs, the adult population of Kaohsiung City at the end of 1996 was 1433621 (729813 males and 703808 females) [17]. The population of residents over 65 years of age (defined as "elderly" in this study) was 88885, or 6.2% of the total population. The population of residents over 75 years of age (defined as "advanced aged" in this study) was 24372, or 1.7% of the total population.

*Data analysis*

Fracture incidence was expressed as the number of cervical and/or trochanteric fractures per 100000 population per year, and was computed as a function of gender and age interval. Patients were categorized into either the 0–49 years of age group or into 5-year intervals after 50 years of age. The differences in mean age between males and females with either cervical or trochanteric fractures were compared using the two-sample Student's *t*-test. *P* values less than 0.05 were considered to be significant. When comparing the incidence of fractures in Kaohsiung City with those in other countries, the age-adjusted incidences in the other countries were calculated by the population of Kaohsiung City in 1996.

## Results

A total of 580 residents of Kaohsiung City sustained cervical or trochanteric fractures in 1996 (Table 1). Of these patients, 261 were males and 319 were females, and none of them was a foreigner. As shown in Table 1, the age-specific incidences of fractures of the proximal femur increased exponentially with age in both males and females; 420 of these cervical and trochanteric fractures (72%) occurred in the elderly population (older than 65 years of age), whereas 240 fractures (41%) occurred in those of advanced age (older than 75 years of age).

The incidences of the combined numbers of cervical and trochanteric fractures were 35.8 fractures per 100000 men per year, 45.3 fractures per 100000 women per year, and 40.5 fractures per 100000 population per year for both sexes (Table 1). The incidences of the combined numbers of cervical and trochanteric fractures in the elderly population were 320.4 fractures per 100000 men per year and 677.8 fractures per 100000

**Table 1.** Age-specific incidences[a] of the combined numbers of cervical and trochanteric fractures of the proximal femur in Kaohsiung City, Taiwan in 1996

| | Males | | Females | | Total | | Relative risk[b] |
|---|---|---|---|---|---|---|---|
| Age (years) | Cases | Incidence | Cases | Incidence | Cases | Incidence | (female/male ratio) |
| 0–49 | 53 | 8.8 | 14 | 2.4 | 67 | 5.6 | 0.27 |
| 50–54 | 12 | 40.9 | 9 | 31.3 | 21 | 36.1 | 0.76 |
| 55–59 | 11 | 42.8 | 15 | 55.2 | 26 | 49.2 | 1.29 |
| 60–64 | 23 | 111.6 | 23 | 114.6 | 46 | 113.1 | 1.03 |
| 65–69 | 37 | 167.5 | 27 | 176.7 | 64 | 171.3 | 1.06 |
| 70–74 | 46 | 289.3 | 70 | 632.9 | 116 | 430.3 | 2.19 |
| 75–79 | 39 | 486.1 | 67 | 1034.1 | 106 | 730.9 | 2.13 |
| 80+ | 40 | 878.5 | 94 | 1791.2 | 134 | 1367.2 | 2.04 |
| Total | 261 | 35.8 | 319 | 45.3 | 580 | 40.5 | 1.27 |
| ≥65 | 162 | 320.4 | 258 | 677.8 | 420 | 473.9 | 2.12 |
| Percent | 62% | | 81% | | 72% | | |
| ≥75 | 79 | 628.2 | 161 | 1372.9 | 240 | 987.5 | 2.19 |
| Percent | 30% | | 50% | | 41% | | |

[a] Fracture incidence is exxpressed as the numbers of fractures per 100000 population per year, and is computed over each age interval
[b] Female/male ratio is expressed as the fracrture incidence for females divided by the incidence for males

**Table 2.** Overall mean patient age and number of cervical and trochanteric fractures for males and females, and the incidences of these fractures in those over 65 years of age

| | Cervical fractures | | Trochanteric fractures | | Total | |
|---|---|---|---|---|---|---|
| | Cases | Mean age | Cases | Mean age | Cases | Mean age |
| Male | 105 | 59.9[a,b] | 156 | 64.8[a,b] | 261 | 62.8[a] |
| Female | 180 | 71.6[a] | 139 | 74.0* | 319 | 72.6[a] |
| Total | 285 | 67.3 | 295 | 69.1 | 580 | 68.2 |
| ≥65 years | Incidence[c] | | Incidence[c] | | T/C ratio[d] | |
| Males | 112.7 | | 207.6 | | 1.8 | |
| Females | 370.4 | | 307.4 | | 0.8 | |
| Overall cervical to trochanteric ratio | 1:1.04 | | | | | |

[a] Significant difference in age between males and females ($P < 0.01$)
[b] Significant difference in age between those with cervical fractures and those with trochanteric fractures ($P < 0.05$)
[c] Fracture incidence is expressed as the number of cervical or trochanteric fractures per 100000 population per year
[d] Trochanteric/cervical (T/C) ratio is expressed as the incidence of trochanteric fractures divided by the incidence of cervical fractures

women per year. These incidences in the advanced aged group were 628.2 fractures per 100000 men per year and 1372.9 fractures per 100000 women per year. The comparison of the relative incidences of the combined numbers of cervical and trochanteric fractures in females and males, or the relative risk, varied from 0.27 to 2.19 in the different age intervals in Table 1. The incidences for males were higher than for females less than 55 years of age. However, after 70 years of age, the incidences for women were much higher than for men and the relative risks were greater than 2.0.

In the 580 fractures of the proximal femur, there were 285 cervical fractures and 295 trochanteric fractures, and the ratio of the overall number of cervical fractures to the number of trochanteric fractures was 1:1.04 (Table 2). In both types of fractures, the mean age of the female patients was significantly higher than the mean age of the males ($P < 0.01$). The mean age of the male patients with trochanteric fractures was significantly higher than that of males with cervical fractures ($P < 0.05$), but this difference was not significant for females. The relative risks of both subtypes of fractures of the proximal femur varied with age and gender. In the elderly population, there were more fractures in women than in men in each fracture type. The ratio of the incidence of trochanteric fractures to cervical fractures (TC) was higher in males (T/C ratio of 1.8) than in females (T/C ratio of 0.8) (Table 2).

Of the 580 cervical and trochanteric fractures, 81 fractures were associated with another major trauma. These fractures were not caused by just a simple fall. The percentages of these fractures associated with other trauma, as a function of age interval and gender, are shown in Fig. 2. Before 50 years of age, both males and

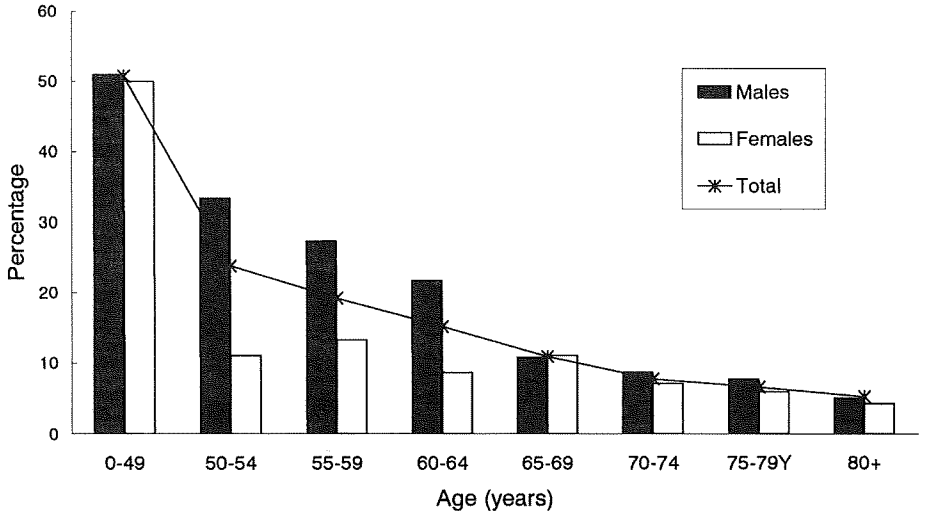


**Fig. 2.** Percentage of patients with associated major injuries, as a function of age intervals and gender

females had similar high percentages of associated injuries. The percentages of associated injuries for women decreased after age 50, but male patients continued to have a higher percentage of associated injuries until 65 years of age.

## Discussion

To our knowledge, this is the first survey of cervical and trochanteric fractures of the proximal femur in Kaohsiung City. It has been mandatory since 1995 that all citizens in Taiwan participate in the National Health Insurance program. To manage the payment system, the Bureau of National Health Insurance examines the applications of reimbursements by well-trained specialists and experienced physicians. Qualified personnel enter codes of the International Classification of Diseases (ICD) into all medical records in medical institutes. We collected eligible cases of cervical and trochanteric fractures of the proximal femur from medical institutions in Kaohsiung City and its two neighboring prefectures by the corresponding ICD codes. These facts guaranteed the completeness of this study.

Epidemiological studies of fractures of the proximal femur have been performed in many countries [5–12]. The results of this present study follow the same general trends as in these previous reports. In younger people, fractures of the proximal femur are not common, and usually occur as a result of major trauma (Fig. 2). However, the number of these fractures increases exponentially with age in both men and women. This fact suggests that fractures of the proximal femur are closely related to aging, accompanied by senile osteoporosis and impaired physical activity.

Comparison of the age-specific incidences of fractures of the proximal femur for both men and women shows that the incidences detected in the present study were higher than the incidence reported in Italy [18], and lower than those reported in the United States [8] and central Norway [9] (Fig. 3). The age-specific incidences in our study are much higher than in equivalent surveys in Niigata, Japan [5] and in Singapore [6], and slightly higher than the incidence reported in Hong Kong [7]. As compared to the age-adjusted incidences after age 50 years (Table 3), the results are still the same as the trend mentioned.

Risk factors have been identified that contribute to the incidence of fractures of the proximal femur [19]. Some studies [9,20] have reported that the incidence of proximal femoral fractures was higher in urban areas than in rural areas. The incidence of fractures of the proximal femur rose threefold between 1970 and 1989 in Hong Kong [7], which paralleled the dramatic urbanization that occurred in Hong Kong during that same time period. In Asian areas, the age-specific incidences of proximal femoral fractures in Hong Kong in 1989 and in Kaohsiung City in 1996 are higher than in Niigata, Japan [5] and in Singapore [6]. Kaohsiung City is similar to Hong Kong in that both cities have undergone rapid urbanization in the past 20 years. It is hypothesized that the urban lifestyle, with its decrease in available space for activity, would lead to an increase in the incidence of osteoporosis, with a subsequent higher incidence of fractures of the proximal femur.

Some previous studies support the notion that adequate dietary calcium intake protects against hip fractures [7,14,21]. Low calcium content is a common feature of Oriental diets. The average daily calcium intake in Taiwan was estimated in 1981 to be approximately 400 mg for adult men and women of all ages [22]. However, a recent survey has reported that the daily calcium intake has increased to 640 ± 240 mg/day (mean ± SD) [23]. The cohort effect of calcium intake

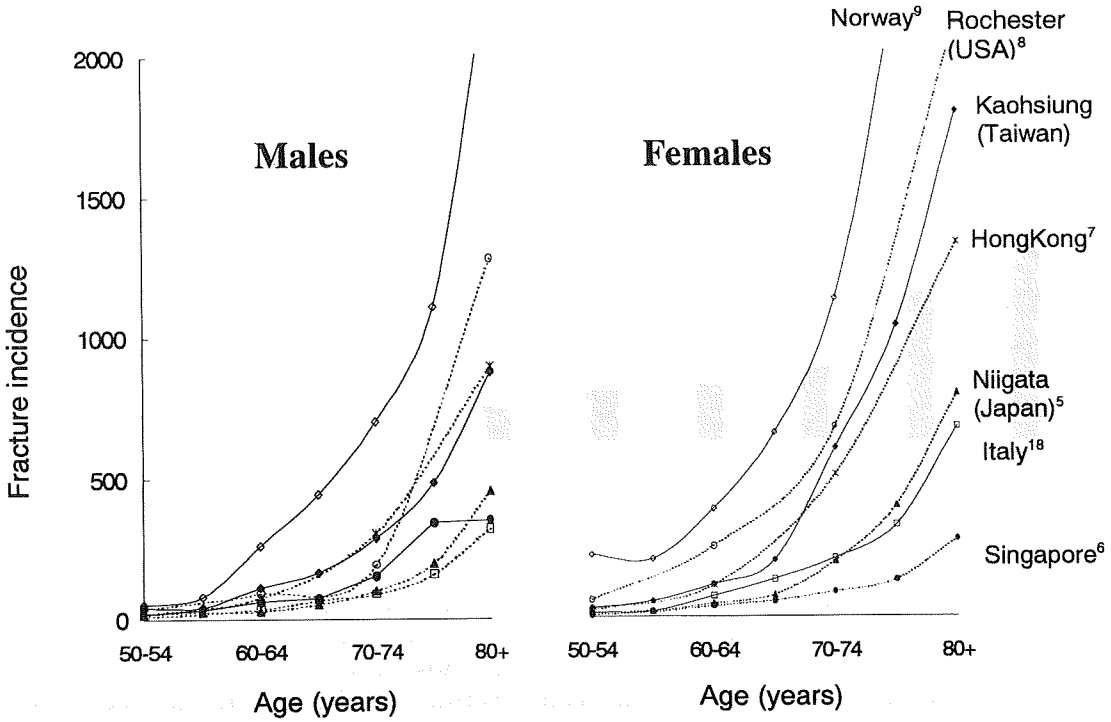


**Fig. 3.** Age-specific incidences of cervical and trochanteric fractures of the proximal femur (fractures per 100000 population per year) in patients more than 50 years of age from various studies

**Table 3.** Age-adjusted incidences[a] of cervical and trochanteric fractures of the proximal femur in patients over age 50 years of age from various epidemiological studies

| | Year | Males | Females | Total | F/M ratio[b] |
|---|---|---|---|---|---|
| Singapore[6] | 1955–1962 | 87.7 | 48.1 | 68.9 | 0.5 |
| Niigata (Japan)[5] | 1994 | 67.1 | 113.1 | 88.9 | 1.7 |
| Italy[18] | 1990 | 61.6 | 122.5 | 90.5 | 2.0 |
| Hong Kong[7] | 1989 | 125.8 | 185.9 | 154.4 | 1.0 |
| Rochester (USA)[8] | 1965–1974 | 130.2 | 308.5 | 214.8 | 2.4 |
| Central Norway[9] | 1972–1973, 1989–1984 | 414.0 | 741.9 | 569.7 | 1.8 |
| Kaohsiung (Taiwan) | 1996 | 164.8 | 267.3 | 213.5 | 1.6 |

[a] Fracture incidences in these other countries were adjusted by the population of Kaohsiung City in 1996

[b] Female/male (F/M) ratio is expressed as the fracture incidence for females divided by the incidence for males

deficiency would be another risk factor responsible for the higher incidence of fractures of the proximal femur in Kaohsiung City.

Bone mineral density has been used to predict the future risk of hip fractures [24,25]. Tsai et al. [13] demonstrated that the bone mineral density of the proximal femora of Chinese subjects in Taiwan was 10%–15% lower than that of Caucasian subjects, although the lower bone mineral density in the Taiwanese may be accounted for by the relative smaller body size of the Taiwanese people [26]. However, Johnell et al. [19] reported that low body mass index was one of significant risk factors for hip fractures in their study. Thus, the relationship between the bone mineral density of the proximal femur and body stature may represent a potential risk factor for fractures of the proximal femur in Chinese subjects in Kaohsiung City.

In this study, the overall age-specific incidences of proximal femoral fractures were slightly higher for females than for males (female/male ratio, 1.27:1). Comparison of the relative age-specific incidences of females to males showed that women had 2.04 to 2.19 times more fractures than males after age 65 (see Table 1). This trend is in agreement with other studies [8,12], which have

reported that women are more susceptible to hip fractures than men in the elderly and advanced aged populations. However, this pattern in our study occurred 10 to 15 years later in life than with Caucasian subjects. In Taiwan, many women of labor worker status retire from their jobs at about 50 years of age, whereas Taiwanese men are typically still employed until they retire at age 65. Figure 2 illustrates that the percentage of associated injuries in women decreases after age 50, and that there is a higher percentage of associated injuries in men than in women between ages 50 and 65. The possible reason for this finding is that men have a higher possibility of injuries as workers than do women in the role of homemaker. The relative age-specific incidences of females to males of the proximal femoral fractures are low before age 55 (Table 1), which may be due to the lower trauma incidence in females than in males. However, proximal femoral fracture incidence in women increases dramatically after age 55, which represents the close relation of the proximal femoral fractures with postmenopausal osteoporosis in females.

In our patients over 65 years of age, the number of trochanteric fractures was less than that of cervical fractures in women and more than that of cervical fractures in men (Table 2). This result is in agreement with Tsai et al. [13], who surveyed the bone densitometry of the proximal femur in 709 Taiwanese men and women. They reported that trochanteric bone area increased in women with increasing age, but not in men, and that the femoral neck bone area increased in men with increasing age, but not in women. These structural and geometrical changes of the proximal femur may explain, in part, the difference in the incidence of cervical and trochanteric fractures between men and women in the elderly population of our present study.

It is well known that senile osteoporosis is an important factor in the occurrence of fractures of the proximal femur. However, the reported incidences of these fractures, as a function of gender and fracture type, have been found to vary with race and geographic location. In this study, the incidence of fractures of the proximal femur in Kaohsiung City was higher than that reported in other Asian countries. The urban lifestyle and low daily calcium intake may be responsible for this finding. Because of the future increase in the elderly population in Kaohsiung City, further epidemiological surveys are necessary to monitor the incidence of fractures of the proximal femur and to elucidate the risk factors associated with these fractures.

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