ORIGINAL CONTRIBUTION

Prevalence of Vertebral Fractures in a Rural Japanese Population

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To clarify the prevalence of vertebral fractures (VFs) of Japanese, a population survey was conducted in a small village in Japan. To measure bone mineral density, 50 males and 50 females in each of four age strata (40-49, 50-59, 60-69, 70-79), totaling 400 individuals were recruited almost randomly from a cohort of 1543 residents (716 men and 827 women) set up based on the resident registration as of 1988. Three hundred and ninety of the participants agreed to undergo routine two dimensional X-ray examinations. Diagnosis of VF was performed by four orthopedic surgeons according to the criteria established by the Ministry of Health and Welfare. The prevalence rates having one or more VFs by sex and age in 40's, 50's, 60's and 70's were shown as follows; for males, 4.3, 14.6, 22.0 and 24.5% and for females, 2.1, 10.2, 14.0 and 44.9% respectively. There was little difference between 60's and 70's in males. To the contrary, in females, 70's has almost twice higher prevalence than 60's. Among persons with VF, one third of them had two or more VFs. Regarding shapes and sites of VF, wedge was the most common shape of VF, and there were found most frequently fractured were in the thoraco-lumbar transition zone (25.5% Th12 and 23.4% L1 in fractured males, and 19.7% Th12 and 14.8% L1 in fractured females). *J Epidemiol*, 1995; 5: 171-175.

prevalence, vertebral fracture, osteoporosis, general population

According to increasing proportion of elderly people in the population, vertebral fracture (VF) due to osteoporosis become to remarkable health problem. As the first step in an epidemiological investigation, it is important to describe the frequency and distribution of the target disease. However, as VFs often occur with slight or no symptoms, all patients do not always visit hospitals. In the case of VF, the true incidence and prevalence can only be obtained from X-ray survey of a representative sample of the population. As such surveys are difficult to perform, only a few reports¹⁾⁻⁷⁾ regarding prevalence of VFs based on the population survey were submitted. That was especially in Asia.

The purpose of this study was to determine the frequency and distribution of VF by sex and age in a mountainous village as a defined population in Japan.

METHODS

Epidemiologic research based on population can be conducted in Miyama village, Wakayama prefecture, Japan (Fig. 1). As a detail profile of Miyama cohort has been described elsewhere^{8,9)}, we repeat here briefly. In this village, a list of inhabitants aged 40 to 79 was compiled based on the resident registration as of December 1988. As a result, 1543 residents consisting 716 males and 827 females were identified. From this list, a total of 400 people consisting 200 males and 200 females were recruited for the purpose of measuring bone mass density. Most (about 75%) were recruited from a community called "Sogawa," and the remainder came from nearby areas, to give 50 people in each of eight age-sex groups (age strata; 40-49, 50-59, 60-69, 70-79). This community has a medical

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Figure 1. Location of Miyama village

Table 1. Number of participants within inhabitants by sex and age.

Age	Male		Female	
	Inhabitants	Participants	Inhabitants	Participants
Total	716	194 (27.1)	827	196 (23.7)
40-49	130	47 (36.2)	135	48 (35.6)
50-59	252	48 (19.0)	254	49 (19.3)
60-69	224	50 (22.3)	276	50 (18.1)
70-79	110	49 (44.5)	162	49 (30.2)

% in parenthesis

clinic, and they could easily come to this clinic and undergo bone mass examinations. Among 400 people, 390 participants were performed routine two-dimensional radiographs. All of them were contacted and agreed to participate for this study. The number of inhabitants and participants for this study by sex and age is shown in Table 1.

Lateral spinal radiographs were examined for the presence of one or more vertebral compression between Th1 and L5, using the criteria assessed by measuring the anterior, middle and posterior heights on lateral radiographs of the thoracic or lumbar spine. Ratios of the dimensions defined anterior wedge, biconcave and compound of the vertebral body according to the previously published algorithm (Fig. 2). These criteria issued by the Ministry of Health and Welfare is very popular and used nationwide in Japan.

X-ray films were examined by three orthopedic surgeons independently according to the criteria; in case of disagreement, a fourth physician adjudicated.

Figure 2. Diagnostic criteria of vertebral fracture in Japan.

Table 2. Prevalence of vertebral fractures by age and number of fractured vertebra.

Male	Age	40-49	50-59	60-69	70-79
Total	32 (16.5)	2 (4.3)	7 (14.6)	11 (22.0)	12 (24.5)
Single	23 (11.9)	2 (4.3)	4 (8.3)	8 (16.0)	9 (18.4)
Multiple	9 (4.7)	0 (0.0)	3 (6.3)	3 (6.0)	3 (6.1)
Female	Age	40-49	50-59	60-69	70-79
Total	35 (17.9)	1 (2.1)	5 (10.2)	7 (14.0)	22 (44.9)
Single	23 (11.7)	1 (2.1)	5 (10.2)	7 (14.0)	10 (20.4)
Multiple	12 (6.1)	0 (0.0)	0 (0.0)	0 (0.0)	12 (24.5)

(): prevalence %

RESULTS

Sixty-seven persons (32 males, 35 females) were diagnosed as having one or more VFs. The prevalence rates having one or more VFs at overall age were 16.5% for males and 17.9% for females. Prevalence per cent rates at 40's, 50's, 60's and 70's for both sexes was shown in Table 2. Although the prevalence increased with age in both sexes, age specific differences were observed by sex. Namely, in the age group younger than 60's the prevalence was higher in males, however in 70's almost twice higher in females.

Cases with two or more (multiple) VFs were observed in one-third of whole cases. Also markedly age specific

difference was observed by sex. Among males, the prevalence with multiple VFs accounted for none in 40's, and 6% in each 50's, 60's and 70's. On the other hand, among females, no cases with multiple VFs were observed in 40's, 50's and 60's. In women older than 70 years, however, there were 12 individuals with multiple fractures comparable 10 those with single fracture.

Table 3 shows the prevalence of vertebral fracture by sex classified by site and shape. The result revealed that upper thoracic vertebrae and lower lumbar vertebrae were the areas where were commonly suffered by fractures in both males and females (25.5% Th12 and 23.4% L1 in fractured males, and 19.7% Th12 and 14.8% L1 in fractured females). The most common shape of fracture was wedge, followed by compound and biconcave.

Table 3. Prevalence of vertebral fractures classified by site and shape.

Male	Th5	6	7	8	9	10	11	12	L1	2	3	4	5
Total	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	3 (1.5)	3 (1.5)	12 (6.2)	11 (5.7)	9 (4.6)	5 (2.6)	2 (1.0)	0 (0.0)
Wedge	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.0)	2 (1.0)	12 (6.2)	11 (5.7)	9 (4.6)	4 (2.1)	2 (1.0)	0 (0.0)
Biconcave	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)
Compound	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	1 (0.5)	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Female	Th5	6	7	8	9	10	11	12	L1	2	3	4	5
Total	2 (1.0)	2 (1.0)	3 (1.5)	7 (3.6)	5 (2.5)	3 (1.5)	7 (3.6)	12 (6.1)	9 (4.6)	4 (2.0)	3 (1.5)	3 (1.5)	1 (0.5)
Wedge	1 (0.5)	2 (1.0)	3 (1.5)	5 (2.6)	3 (1.5)	2 (1.0)	7 (3.6)	12 (6.1)	7 (3.6)	2 (1.0)	2 (1.0)	0 (0.0)	0 (0.0)
Biconcave	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	2 (1.0)	1 (0.5)	1 (0.5)	0 (0.0)
Compound	1 (0.5)	0 (0.0)	0 (0.0)	2 (1.0)	2 (1.0)	1 (0.5)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)	2 (1.0)	1 (0.5)

(): prevalence %

DISCUSSION

The epidemiological survey of VF has been difficult to conduct because radiographic criteria for the diagnosis of these fractures are uncertain, and they appear with slight or no symptoms. The criteria used for this study was authorized by the committee of Japanese Health and Welfare. On X-ray films, both anterior and posterior heights from Th4 to L5 vertebra, totaling 1400 vertebra, were measured. The committee members determined the normal height range of each vertebra¹⁰. After that, they concluded the wedge type vertebral fracture was assessed by the 75% lower in anterior height than in posterior height. These criteria are used nation-widely in Japan.

To estimate prevalence of the target disease in the population, random sampling method is the most important. In the present study, samples were selected from the inhabitants living near the clinic so that the subjects could easily attend X-ray examinations. Therefore, this study sample did not employ a truly "random sample," in the strict sense of the word. However, this sampling procedure is similar to random sampling. To clarify the representative of these participants in the population, as authors have described previously^{8,9}, we compared the results of basic factors such as life-style and biological characteristics for participants who underwent X-ray examination with those of the entire community using data undertaken other health related projects in Miyama village. Behavioral pattern consistent with a healthy life-style in the study population were reasonably good agreement when compared with those in the overall population in Miyama village. The mean of height, weight and body mass index, rates of smokers and drinkers, prevalence of hypertension and the mean of blood chemical analysis (e.g., GOT, GPT, BUN, T-CHO, ALP) among the study population was almost identical with those of the overall community and the nationwide surveys¹¹.

In the present study, we clarified the prevalence of VF in females older than 70 years was by far the highest and the majority of the individuals with fracture had multiple VFs. We measured bone mineral density in the same study population and reported that the bone mineral density reached the lowest level in individuals older than 60 years. We insisted on the significance of starting preventive care for fracture and osteoporosis before the age of 60⁹. The present study revealed the prevalence of VF has become extremely high within several years since elderly people's bone mineral densities reached to the lowest level. In addition, this study showed an immediate necessity to begin carrying out preventive care at the younger age.

VF is considered to be occurred due to development of osteoporosis. There are very few epidemiological reports on prevalence based on population survey in Asia.

Fujiwara et al.⁷ reported that the VF prevalence in males was 1.6% in their sixties and 7.3% in their seventies. Furthermore, the VF prevalence in females was 7.6% in their sixties while 20.1% in their seventies. These rates were considerably lower than those in our study. The difference of the two cohorts might be explained by the difference of diagnosis method. In Fujiwara's study, measurement of vertebral height was performed using a digitizer by a technician at the evaluation of X-ray films. In our study, the diagnosis was made on X-ray films by clinical orthopedic surgeons. Measurement using a digitizer is useful because of objective values. However, in Japan, VF is generally diagnosed by evaluating X-ray films by clinical orthopedic surgeons. In our study, X-ray films were evaluated by four orthopedics who were not given any information in advance, but the accordance rate was very high (86.3%). This suggests the diagnosis is reliable. The present findings more markedly reflect the actual prevalence of VF in Japan.

Melton et al.¹ examined a random sampling in Rochester, Minnesota, and reported that the prevalence of VF in women in each 50-59, 60-69, 70-79 age groups were 6.5%, 17.6% and 27.5% respectively. Since there may be some differences in the diagnostic criteria between theirs and ours, we cannot compare the results directly. It, however, seems that prevalence of VFs in our study in Japan would not be lower than that of Caucasians. Ross et al.¹² suggested that the prevalence of the VFs was similar in both Caucasians and Japanese-American. This result contradicts with the finding that the incidence of femoral neck fracture in Japanese is lower than in Caucasians¹³⁻¹⁵. It has been suggested that the low incidence of hip fracture among Japanese despite their lower bone mass than Caucasians¹⁶ might be attributable to the shorter stature, which means the lower energy of the fall.

For the comparison of prevalence between different population, it is indispensable to use the same method and criteria. In the present study, the diagnostic method for the criteria was criticized because the same criteria applied to each vertebra. However, the criteria were devised to be used easily for not only orthopedic surgeons but doctors in the other speciality, and it is used nation-widely in Japan. Several workers¹⁷⁻²¹ have recommended that vertebra-specific dimension criteria must be used to define the VFs. Also, a diagnostic technique for VF the computer is being promoted to minimize observer's error and make the diagnostic procedure more objective²². We will be able to compare it in different races diagnosed by the objective method in future.

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