Comparison of Osteoporosis and Calcium Intake between Japan and the United States

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Abstract. **The number of osteoporotic females in Japan with vertebral bone mineral density measured by dual energy x-ray absorptiometry, defined as less than −3 SD of the peak bone mass, is approximately 10,000,000, corresponding to 8% of the whole population of Japan. While this value approximately corresponds to the prevalence of low bone mineral density in the United States, the incidence of hip fracture appears to be much less in Japan than in the United States, 50,000 per 125,000,000 per year compared with 250,000 for a population twice as large. This seems to be paradoxical because of the lower bone mineral density and lower calcium intake in Japan, with 400–500 mg/day mainly as soybean products, small fish with bones, and vegetables. The difference in hip fracture incidence, however, may not actually be as wide as it seems when the larger number of bedridden elderly subjects in Japan is taken into consideration. In these bedridden subjects with severe immobilization osteoporosis, hip fracture is only prevented by the fact that they are not ambulatory. Life-style difference may also offer an explanation. Sitting on a tatami mattress on completely flexed knees with frequent standing up, along with other household work, in a narrow home space may ensure a marked development of hip musculature and also provide skill in balancing oneself to prevent fails. The difference in fracture incidence should be analyzed from various angles to obtain a firm ground for the future prevention of hip fracture due to osteoporosis.**

Although osteoporosis universally affects all races and nationalities, conspicuous differences may be encountered in the severity of its manifestations and complications. While the lower incidence of hip fracture in blacks than in whites may be explained by the higher bone mass in the former, the lower incidence of hip fracture in Orientals than in whites cannot be explained by the lower bone mass or lower calcium intake in the former. In order to analyze such differences in more detail, factors influencing osteoporosis were compared between Japan and the United States. [P.S.E.B.M. 1992, Vol 200]

Prevalence of Osteoporosis in Japan and the United States. The peak bone mass in the lumbar vertebrae (L_2-L_4) in Japanese, measured by dual energy x-ray absorptiometry, was 1.207 ± 0.108 g/cm^2 in males and 1.159 ± 0.092 g/cm^2 in females (mean ± SD). The prevalence of vertebral deformity, including wedging, loss of height, and compression fracture, rose along with the fall of bone mineral density. In subjects with bone mineral density between −2 and −3 SD of the peak bone mass, vertebral deformity was seen in 23%, whereas it rose to 40% in those with bone mineral density between −3 and −4 SD of the peak bone mass (1). When a fall of vertebral bone mineral density to less than −3 SD of the peak bone mass (less than 0.883 g/cm^2) was defined as osteoporosis or risk for osteoporosis, the number of subjects meeting this criterion reached 15% of the women, or 8% of the total population of Japan (Table I; Fig. 1).

This figure is comparable to the corresponding value in the United States, where approximately 25,000,000 osteoporotics are said to be found among a population of 250,000,000 (2, 3).

Since several epidemiologic studies indicated a lower incidence of hip fracture in Japan and the Orient than in the United States and Europe, a comprehensive national survey was carried out on total hip fracture

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Table I. Prevalence of Osteoporosis Reserve in Japan (% of Population)[a]

Age	Males	Females
0–39	0 (0%)	0 (0%)
40–49	0 (0%)	121,220 (1.2%)
50–59	0 (0%)	2,220,960 (28.1%)
60–69	0 (0%)	3,212,216 (51.4%)
70–79	1,353,600 (36.8%)	2,671,406 (68.3%)
80–		1,300,515 (72.2%)
Total	1,353,600 (2.2%)	9,526,317 (15.2%)
Grand total	10,879,917 (8.8%)	

[a] Prevalence of subjects at risk for osteoporosis defined by lumbar spine BMD less than −3 SD of the peak bone mass (less than 0.883 g/cm^2) (1). Estimated from the current population of Japan as actual number and percentage of the number of subjects in each group.

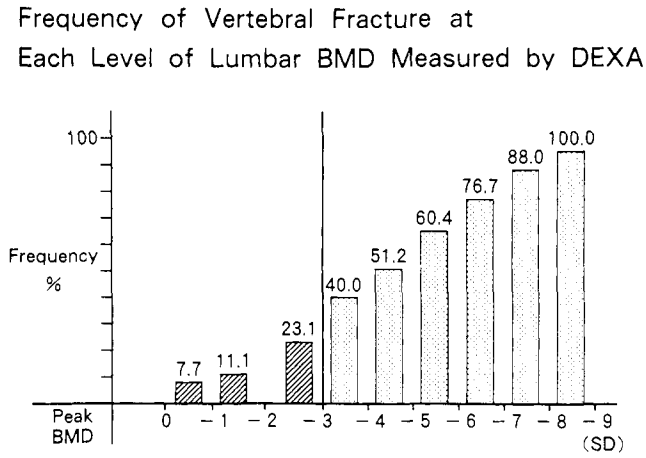

Figure 1. Lumbar bone mineral density (L_2-L_4) in Japanese females, measured by dual energy x-ray absorptiometry and expressed as the deviation from the peak bone mass, is plotted on the horizontal axis and frequency of vertebral fracture on the vertical axis. The fracture incidence shows an abrupt rise from 23.1 to 40.0, between SD of −2 to −3 and SD of −3 to −4.

incidence in Japan in 1987 (4). Questionnaires were sent to all hospitals with more than 200 beds, 1,357 in all of Japan, and 563 answers were obtained (41.5%). The number of new hip fracture patients in these hospitals, 11,105, was corrected for response rate to obtain 26,763 as the presumptive annual incidence of hip fracture patients in those hospitals with more than 200 beds. In order to assess the proportion of patients who sustained hip fracture and were seen in hospitals with more than 200 beds, a complete survey on all patients with hip fracture was also carried out in three prefectures: Aichi Prefecture, with Nagoya City (population 3,000,000) as an urban-type society; Tottori Prefecture, on the Japan Seaside; and Wakayama, on the Pacific side. Both Tottori and Wakayama were representative of countryside areas. In these areas, 40–60% of patients were seen in hospitals with more than 200 beds and the rest were presumably treated in smaller hospitals and clinics. Therefore, in order to assess the total annual incidence of hip fracture in Japan, 26,734 has to be doubled to obtain 53,426, or approximately 50,000. Women sustain hip fracture much more frequently than men, and this differences becomes more and more pronounced at a higher age (Fig. 2).

The corresponding hip fracture incidence in the United States is approximately 250,000, representing about 1% of osteoporotics or 0.01% of the whole population. This rate seems to be about 2–2.5 times higher than in Japan, where hip fracture seems to occur in 0.4–0.5% of osteoporotics or 0.004–0.005% of the whole population.

Why Is Hip Fracture More Frequent in the United States than in Japan?

First of all, the wide difference in hip fracture between the two countries may be more apparent than real. Many elderly people in Japan are bedridden under complete care of their attendants, mostly their daughters or daughters-in-law. A bold estimate goes so far as to say that 5% of the people above the age of 70 are bedridden. According to another estimate shown in Figure 3, 170,000 men and 230,000 women are presumably in the bedridden state. The number increases with advances in age and especially among women. From among these 400,000 patients confined to bed, 300,000 are above the age of 70. Thus, 10–15%, or almost 50,000, may have such advanced immobilization osteoporosis that a mere change of position readily causes fracture.

If we add these cases of potential hip fracture to the actual cases, we may double the incidence of hip fracture. Though some cases of bedridden state no doubt also exist in the United States, the number is presumably smaller. Even if 25,000 is added to the U.S.

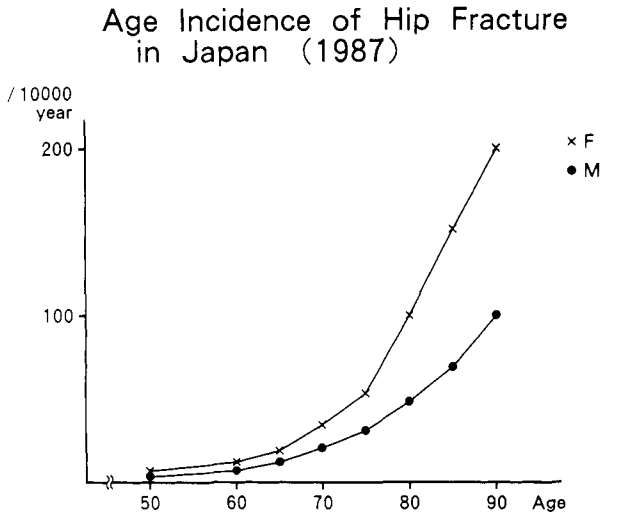

Figure 2. Age and fracture incidence in Japan in 1987 according to the whole Japan survey sponsored by the Ministry of Health and Welfare. The age in years is on the horizontal axis and fracture incidence per 10,000 population in 1987 is on the vertical axis. Rise of fracture incidence is much more pronounced in women than in men.

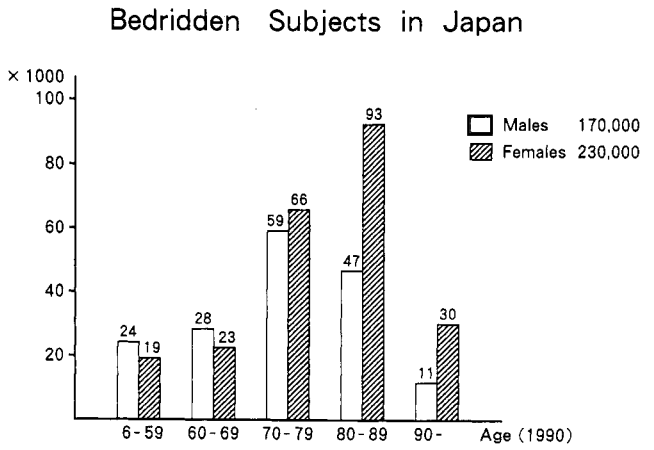

Figure 3. Estimated number of bedridden subjects in Japan. Age in years is on the horizontal axis and the number × 1000 is on the vertical axis. Open bars stand for men and shaded bars for women. A definite female preponderance is seen in later years.

figure of 250,000, no major change occurs in the incidence, so that the incidence of hip fracture between the two countries may actually be similar (Table II). This conclusion, however, is based on so many assumptions that it is hardly acceptable at this stage. It does, however, point out the need for further effort to assess the prevalence of bedridden patients in both countries.

If there is still a real difference in hip fracture incidence between the two countries, how can it be explained? Racial differences in osteoporosis are well known; blacks, for example, sustain less hip fracture than whites. In view of the lower bone mineral density in Japanese women than in American whites, in contrast to the higher bone mass in blacks, the lower incidence of hip fracture in Japanese women appears rather paradoxical, unless some concept of bone quality is introduced (5). Postmenopausal bone loss apparently occurs in both Japanese and American whites, though a possibility remains that the more hyperestrogenic American women lose more bone calcium after menopause than do childlike-appearing Japanese women.

Japanese women ingest less calcium, in part because of the traditional low calcium diet and in part due to the high prevalence of lactose intolerance. This makes it even harder to explain the low incidence of hip fracture. Eating fish with polyunsaturated fatty acids may be strengthening bone, but no direct evidence is available on this point. A positive correlation was obtained between bone mass and protein and vegetable intake in Japanese women according to the collaborative study with Drs. J. J. B. Anderson and J. Lacey of the University of North Carolina (6).

A good possibility to be entertained is the influence of the traditional Japanese life-style. Direct sitting on a tatami mattress with the knees completely flexed may be nothing but torture for American women. Frequent sitting and standing from this position would strengthen the pelvic muscles and may also provide skill and agility to prevent falls (7). The Japanese style of squatting in the toilet also strains the pelvic muscles more than the comfortable Western sitting style. The American way of life, with automobile driving, use of elevators and escalators, and automated household devices, may be depriving the muscles of the opportunity to develop and strengthen the bones. In Hong Kong, for example, modernization of the way of living is reported to be associated with a rise in the incidence of hip fracture (8). In addition to jogging, tennis, and other sports, American women might try the tea ceremony on tatami mats to strengthen their hip muscles.

Conclusion

Although osteoporosis remains a serious complication of aging, especially for women, all over the world, there seem to be some differences in the background factors, clinical picture, and complications of this disease between Japan and the United States. Bone mass and calcium intake are lower in Japanese women than in their U.S. white counterparts, but the incidence of hip fracture seems to be less in Japan than in the United States and other Western countries. A large number of bedridden patients in Japan may make the difference appear greater than it actually is. Differences in lifestyle, which may influence both hip muscle develop-

Table II. Is Hip Fracture More Frequent in Japan Than in United States?[a]

	United States	vs	Japan
Manifest Hip Fracture	$\frac{250{,}000}{250{,}000{,}000} \fallingdotseq 0.1\%$	>	$\frac{50{,}000}{125{,}000{,}000} \fallingdotseq 0.04\%$
Latent Hip Fracture (bedridden patients)	$\frac{25{,}000}{250{,}000{,}000} \fallingdotseq 0.01\%$	<	$\frac{50{,}000}{125{,}000{,}000} \fallingdotseq 0.04\%$
Total	$\frac{275{,}000}{250{,}000{,}000} \fallingdotseq 0.11\%$	$\fallingdotseq$	$\frac{100{,}000}{125{,}000{,}000} \fallingdotseq 0.08\%$

ment and motor control, and thereby prevent falls, may represent an important factor.

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