Journal of Orthopaedic Surgery 2003: 11(1): 6–9

Comparison of bone mineral density among residents of a mountain village and a fishing village in Japan

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ABSTRACT

Objective. To compare the bone mineral density of residents of a mountain village with that of residents of a fishing village in Mie Prefecture, Japan.
Methods. Microdensitometry was used to measure bone mineral density of the second metacarpal bone of 202 participants living in a mountain village and of 852 participants living in a fishing village to identify contributory factors for osteoporosis. The participants were interviewed using a questionnaire on alcohol consumption, fish intake, milk intake, and daily activity.
Results. Analysis of covariance revealed that bone mineral density was significantly higher among the participants living in a fishing village than among those living in a mountain village (2.5–2.9 versus 2.1–2.7 mmAl; $p<0.001$). A higher proportion of women in the fishing village than of those in the mountain village consumed alcohol (17% versus 10%; $p<0.05$).
Conclusion. Nutrition may be a contributory factor to the lower incidence of osteoporosis among residents of the fishing village compared with those of the mountain village.

Key words: *bone density; osteoporosis; risk factors*

INTRODUCTION

Osteoporosis is a major public health problem, not only because of its associated morbidity and mortality, but also because of the health care costs that it generates. Many risk factors are related to the development of osteoporosis: hormonal, dietary, and genetic factors. In Japan, there seem to be many environmental differences between people living in a mountain village and those living in a fishing village. For example, mountain village residents prefer to eat rice, vegetables, and meat rather than fish, while fishing village residents prefer to eat

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fish as a source of calcium. Daily activity level and alcohol consumption also differ. Such factors may affect the risk of osteoporosis to people in these 2 types of villages, especially when relocation from one village to the other is extremely rare in Japan.

Bone densitometry is currently the most useful method of diagnosing osteoporosis and assessing fracture risk. Methods of assessing bone mineral density (BMD) include single-energy X-ray absorptiometry, dual-energy X-ray absorptiometry, and quantitative computed tomography. Computer-controlled radiographic absorptiometry is precise and accurate; it is also fast, inexpensive, and easy to use in a wide variety of clinical settings.[1,2] In this study, BMD was assessed with radiographic absorptiometry in inhabitants from a mountain village and a fishing village to evaluate factors that may be associated with osteoporosis.

MATERIALS AND METHODS

Participants

The study comprised 2 groups. Group A included 202 participants (48 men and 154 women) among 548 inhabitants aged 40 years or older living in a typical mountain village Kiwa, in Mie Prefecture in 1991. Group B was composed of 852 participants (308 men and 544 women) among 3541 inhabitants aged 40 years or older living in a typical fishing village Nansei, in Mie Prefecture in 1992. These volunteers were recruited using announcements in hospital publications concerning health examinations.

Measurements

Height and weight were measured without shoes, with participants in either a hospital gown or light clothes; height was measured with a wall-mounted ruler and weight on a digital scale.

BMD was measured at the second metacarpal bone of the non-dominant hand by micro-densitometry. X-ray of the hands, placed palm-side down, was taken from the back, and then again with an aluminium step-wedge placed between the hands. The optical density was measured at the middle position of the second metacarpal bone on the X-ray film using a microdensitometer (2405; Array Corporation, Tokyo, Japan). The densitometric pattern was recorded at 10x magnification, and the optical density of each step of the aluminum wedge was measured simultaneously. The width of the bone (D) was determined by identifying the edge of each line and measuring the distance between the first and last edges. The ΣGS value was obtained by computerised integration of the pattern area. The coefficient of variation—i.e. the precision of the method on repeated analyses—was 5% for the metacarpal bone.

Alcohol consumption, fish intake, milk intake, and daily activity were assessed using a questionnaire. Alcohol consumption was categorised as one drink or above per day (habit of drinking) or less than one drink per day (abstain from alcohol); one drink contained a mean of 18 g of alcohol. The frequency of fish consumption was categorised as follows: nearly every day (frequent), one to 4 times per week (sometimes), or less than once per week (seldom). The frequency of milk consumption was categorised as follows: more than once a week (frequent) or less than once a week (seldom). Daily activity, which was estimated as the mean amount of time spent in habitual physical exercise or sports (e.g. walking or gate ball), was categorised as none (sedentary) or more than once a month (active).

Statistical methods

Results for continuous variables were presented as means and standard deviations. Univariate analysis of continuous variables with a normal distribution was carried out using Student's *t* test. Relationships between categorical variables were assessed using the chi-square or Mann-Whitney *U* test. Variables that were significant in the univariate analysis were included in an analysis of covariance. All statistical tests were two-tailed, with statistical significance defined as $p<0.05$.

RESULTS

Because BMD was significantly different between men and women, analysis was performed for each sex separately. Univariate analysis indicated that age, height, weight, and BMD were significantly different between the 2 groups (Table). Analysis of covariance revealed that for both sexes, the only factor that remained significantly different between groups A and B was BMD. The BMD was significantly higher among the participants living in the fishing village than among those living in the mountain village.

We compared the risk factors between the 2 groups of participants. Among women, the proportion of individuals who took alcohol was significantly higher in group B than in group A (Table).

Table

Means (standard deviations) of demographic variables, bone mineral density, and alcohol consumption among Group A (mountain village) and Group B (fishing village) populations

Characteristic	Group A	Group B	p value
Women			
Age (years)	66.7 (10.3)	57.7 (8.8)	<0.001
Height (cm)	147.1 (6.2)	150.9 (5.8)	<0.001
Weight (kg)	47.8 (8.4)	51.8 (7.6)	<0.001
BMD* (mmA1)	2.13 (0.3)	2.48 (0.3)	<0.001
Alcohol consumption (proportion who drank)	10.4%	17.1%	0.043
Men			
Age (years)	69.9 (10.9)	57.4 (9.2)	<0.001
Height (cm)	158.2 (7.9)	162.7 (6.3)	<0.001
Weight (kg)	54.5 (10.4)	60.5 (8.5)	<0.001
BMD (mmA1)	2.71 (0.3)	2.88 (0.3)	<0.001

* Bone mineral density

DISCUSSION

Kiwa is a typical mountain village in the south of Mie Prefecture, the closing of coal mines has caused progressive depopulation. The area lacks adequate transportation, and it takes at least an hour to reach a more centrally located city by car, thus making it difficult to obtain fresh fish or shellfish. In contrast, Nansei is a typical fishing village near the Gokasyo Bay at the Shima Peninsula in the centre of Mie Prefecture. In this area, the percentage of the population engaged to fishing and fish-raising industry, compared with the population engaged to all industry, was about 40% in the 1970s and 20% in the 1990s.[3] According to a national nutritional study, both caloric and seafood intake were above the national average in this area.[4] In this study, we used identical methods to compare the BMD of the inhabitants of these 2 areas.

Various methods of bone densitometry have recently been developed. Photon absorptiometry and quantitative computed tomography allow accurate measurement of bone mass with minimal error, but these methods are expensive. However, radiographic absorptiometry of the phalanges[1,2] seems to be useful as a screening technique. In the microdensitometry method developed by Inoue et al.,[5] bone density is measured from an X-ray image of the hand at the middle site of the second metacarpal bone using a densitometer. The ΣGS / D value as an index of BMD has been reported to exhibit significant correlations with other established indices of bone mineral assessment.[6–8] Hence, microdensitometry provides an index that can be used as a criterion in screening for osteoporosis.

Using analysis of covariance, we found that BMD was significantly higher in the participants living in a fishing village than those in a mountain village. This result may be caused by differences in environment between the 2 villages, especially nutritional environment.

When we investigated contributory factors, we found that women living in the fishing village consumed more alcohol than those from the mountain village. In this study, individuals drinking even a small quantity of alcohol were included in the group of alcohol consumers. We hypothesise that alcohol intake increases appetite and thereby indirectly induces an increase in bone density. Alcohol misuse is well recognised as a cause of osteopenia[9–11]; however, little is known concerning the relationship between small quantities of alcohol and bone density. Several recently published studies have shown that a moderate intake may be associated with increased bone density,[12–14] perhaps by stimulating the secretion of calcitonin.[15]

ACKNOWLEDGEMENTS

We thank the staff of Nansei Town Hospital and Kinan Hospital for their help. We also thank Mr Hiroshi Oomizu for his help in statistical analysis and discussion.

REFERENCES

1. Cosman F, Herrington B, Himmelstein S, Lindsay R. Radiographic absorptiometry: a simple method for determination of bone mass. Osteoporosis Int 1991;2:34–8.
2. Yang SO, Hagiwara S, Engelke K, Dhillon MS, Guglielmi G, Bendavid EJ, et al. Radiographic absorptiometry for bone mineral measurement of the phalanges: precision and accuracy study. Radiology 1994;192:857–9.
3. Prompt Tabulation Series No.1, Preliminary Counts of the Population on the Basis of Summary Sheets. Japan: Statistics Burear & Statistics Center; 2000.
4. Matsuba H. Preventive policy of a regional public health center to patients with senile dementia based on the investigative analysis of daily living and diseases in old people living in a Nansei town [in Japanese]. Project report on promotion of a community health 1991 from the Ministry of Welfare. Ise: Ise Public Health Center; 1992:11–8.
5. Inoue T, Kusida K, Miyamoto S, Sumi Y, Orimo H, Yamashita G. Quantitative assessment of bone density on X-ray picture. Nippon Seikeigeka Gakkai Zasshi 1983;57:1923–36.
6. Hayashi Y. Microdensitometric method of the second metacarpal bone [in Japanese]. Rinsho Hoshasen 1990;35:15–22.
7. Ohta H, Nemoto K, Nozawa S, Iizuka R. Changes in bone mineral content and bone metabolism related to menopause [in Japanese]. Nippon Sanka Fujinka Gakkai Zasshi 1989;41:1447–54.
8. Yamada H. Long-term effect of 1 alpha-hydroxyvitamin D, calcium and thiazide administration on glucocorticoid-induced osteoporosis [in Japanese]. Nippon Naibunpi Gakkai Zasshi 1989;65:603–14.
9. Diamond T, Stiel D, Lunzer M, Wilkinson M, Posen S. Ethanol reduces bone formation and may cause osteoporosis. Am J Med 1989;86:282–8.
10. Felson DT, Kiel DP, Anderson JJ, Kannel WB. Alcohol consumption and hip fractures: the Framingham Study. Am J Epidemiol 1988;128:1102–10.
11. Holbrook TL, Barrett-Connor E. A prospective study of alcohol consumption and bone mineral density. BMJ 1993;306: 1506–9.
12. Felson DT, Zhang Y, Hannan MT, Kannel WB, Kiel DP. Alcohol intake and bone mineral density in elderly men and women. The Framingham Study. Am J Epidemiol 1995;142:485–92.
13. Ganry O, Baudoin C, Fardellone P. Effect of alcohol intake on bone mineral density in elderly women: the EPIDOS Study. Epidemiologie de l'Osteoporose. Am J Epidemiol 2000;151:773–80.
14. Johnell O, Kristenson H, Redlund-Johnell I. Lower limb fractures and registration for alcoholism. Scand J Soc Med 1985;13: 95–7.
15. Dymling JF, Ljungberg O, Hillyard CJ, Greenberg PB, Evans IM, MacIntyre I. Whiskey: a new provocative test for calcitonin secretion. Acta Endocrinol (Copenh) 1976;82:500–9.