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Effect of community-based nutrition education intervention on calcium intake and bone mass in postmenopausal Vietnamese women

Vu Thi Thu Hien[1,2], Nguyen Cong Khan[2], Le Bach Mai[2], Nguyen Thi Lam[2], Tuan Mai Phuong[2], Bui Thi Nhung[2,3], Nguyen Van Nhien[2], Masayo Nakamori[1] and Shigeru Yamamoto[1,*]

[1]Department of International Nutrition, Ochanomizu University Graduate School of Humanities and Sciences, 2-1-1 Ohtsuka, Bunkyo-ku, Tokyo 112-8610, Japan: [2]National Institute of Nutrition, Hanoi, Vietnam: [3]Department of International Public Health Nutrition, Tokushima University Graduate School of Health Biosciences, Tokushima, Japan

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Abstract

Objective: To examine the effect of community-based nutrition education intervention on calcium intake and bone mass in Vietnamese postmenopausal women.
Design: A controlled trial was conducted in two groups as intervention and control. The intervention group was given nutrition education during 18 months to improve calcium intake, while the control subjects had the usual diet. Calcium intake and bone mass were evaluated every 6 months. Bone mass was assessed by speed of sound (SOS) at calcaneus, referred to as quantitative ultrasound measurement. Anthropometric indices and serum parathyroid hormone (PTH) were determined at baseline and at the end of intervention.
Setting: Two rural communes of Hai Duong province located in the Red River Delta in Vietnam.
Subjects: A total of 140 women aged 55–65 years, who were more than 5 years postmenopausal and with low calcium intake (<400 mg/d), were recruited. After 18 months of intervention, 108 women completed the study.
Results: Calcium intake in the intervention group had increased significantly ($P<0·01$) while it had no significant changes in controls. SOS values were not changed significantly in the intervention subjects while it decreased significantly by 0·5% in the controls ($P<0·01$). The intervention led to a decrease in serum PTH by 12% ($P<0·01$). In the controls, there was an increase in serum PTH by 32% ($P<0·001$).
Conclusion: Nutrition education intervention was effective in improving calcium intake and retarding bone loss in the studied subjects.

Keywords
Nutrition education intervention
Calcium intake
Bone mass
Vietnamese
Postmenopausal women

Osteoporosis is a disorder linked with ageing. It usually occurs in elderly people, especially postmenopausal females(1). In Asia, osteoporosis is rapidly becoming a major public health problem with increasing life expectancy(2). The pathogenesis of osteoporosis is multi-factorial. Several risk factors have been identified and dietary factors play a major role, particularly in the elderly(3). It is also reported that low calcium intake is one of the risk factors for osteoporosis amongst Asian women(4). Many intervention studies have shown the positive effect of increased calcium intake in reducing the rate of bone loss in postmenopausal women(5–9). However, calcium supplementation is not a sustainable solution in the long term for improving calcium intake, especially in poor countries. A preferred approach to achieve increased calcium intake is to use dietary strategies to enhance the consumption of local calcium-rich foods. It is also proved that nutrition education can improve calcium intake and retard bone loss in women(10).

Quantitative ultrasound (QUS) is able to distinguish normal persons from persons with low bone density or with fractures due to osteoporosis(11,12). QUS parameters had been decreased over time in subjects of longitudinal studies(11,13–15). Previous studies that assessed the effect of intervention on QUS indicated that QUS parameters were positively influenced in postmenopausal women in the intervention group, whereas it showed a significant decrease in the control group(16–18).

We have previously reported a relatively high prevalence of osteoporosis in Vietnamese women compared to the neighbouring countries(19). Although local calcium-rich foods are very cheap and available, the mean calcium

*Corresponding author: Email yamamoto.shigeru@ocha.ac.jp

intake in Vietnamese adult women was still much lower than the recommended dietary allowance (RDA) for calcium[20]. Therefore, in the present study we aimed to examine whether a nutrition education intervention during 18 months would have an impact on improving the calcium intake of postmenopausal women, and to explore whether the increase in calcium intake would lead to subsequent effect on retarding bone loss in the women.

Material and methods

Design, settings and subjects

The present study was a controlled evaluation of the impact of an intervention designed to increase calcium intake and retard bone loss. It was approved by the Research and Ethical Committee of the Vietnamese National Institute of Nutrition, and was conducted in Thanh Mien rural district of Hai Duong province located in the Red River Delta. The district is situated about 70 km south-east of Hanoi with a population of nearly 138 000. Both curative and preventive health activities are the responsibility of district and commune health centres. Of the community organisations, which always supported health activities in the district, the Women's Union is very strong, with a well-organised network from district to communes and villages. Members of the Union are known for their active participation in many primary health-care programmes.

Two communes in the district were selected for the study based on similar socio-economic and calcium-rich food source characteristics (primarily access to small crab, shrimp and fish). Each commune was far from the other, and was assigned randomly to be the intervention place or the control place. In each commune, all women who were aged 55–65 years, with low calcium intake (<400 mg/d) and more than 5 years postmenopausal, were screened for the study. Calcium intake was assessed by the Semi-Quantitative FFQ (SQFFQ). This questionnaire assesses the mean quantity of calcium in gram consumed per day in the previous 6 months. The questionnaire was developed and validated for use in a previous study[21]. Subjects were excluded if they had the following factors: (i) current cancer or hyperparathyroidism; (ii) a kidney stone in the past 5 years, renal disease or bilateral hip surgery; (iii) therapy with a bisphosphonate, calcitonin, oestrogen, tamoxifen or testosterone in the past 6 months or fluoride in the past 2 years; and (iv) laboratory evidence of kidney or liver disease. After screening, seventy women eligible for participation were recruited for the study in the intervention commune. Then, in the control commune, seventy women who met the criteria and matched with those in the intervention group for age, years of postmenopause, educational level, life-long occupation, current weight-bearing exercise and calcium intake were selected for the study.

The intervention group was given nutrition education to improve calcium intake during 18 months. The control group continued with their usual diet. The control subjects were provided with the education at the end of data collection period. All subjects had given a written informed consent before conducting the study.

Participant retention

Given the all-volunteer nature of the subjects, several efforts were made to minimise the rate of attrition. In addition to indicating that bone mass would be provided for free, we also informed the participants that they would be examined for health status free of charge and given advice if they suffered from any disease.

Method of intervention

Based on calcium RDA for the elderly[22–25], the overall goal of intervention was to increase the calcium intake of the intervention group up to 800 mg/d.

Exploring resource of calcium-rich foods in the locality

Available calcium-rich foods in the locality were investigated and ranked in order of calcium content. Those food items were also grouped into seasonal food lists. From the food items, a series of seasonal menus were designed for 7 days in a week to meet the calcium intake expected as 800 mg/d.

Approaches to promote participation of subjects

Organising training courses. Subjects were provided with training focused on promoting to eat local available calcium-rich foods with designed menus. Subjects were taught about the importance of osteoporosis, the role of calcium intake in controlling the disease, how to identify calcium-rich foods in the locality and how to prepare meals with local foods based on guided menus. In the training course, subjects were provided with visual education materials such as posters, leaflets, booklet and video tape, which illustrated all essential information with exciting pictures. Practising was also emphasised in the training. All available calcium-rich foods in the locality were bought from the local market, brought to the training site and used as an example for preparing, processing and cooking the meals, with the participation of all subjects and guidance from nutritionists. After the lesson, subjects could understand thoroughly and apply for organising the meals rich in calcium in their household.

Disseminating education message through a loudspeaker. Education messages including 'Take calcium rich foods every day to enhance your bone health' and 'Take guided menu into your meals to reach enough calcium intake' were given daily to the subjects by a loudspeaker system of the intervention commune. Furthermore, short and clear summary of the lesson given to the subjects in the training course was also repeated every day through a loudspeaker.

Approaches for monitoring, refreshing and maintaining practice of subjects

Monitoring subject's intake at home. Subjects were provided with recording sheets. Throughout the 18 month period of intervention, subjects recorded all calcium-rich foods that they consumed daily on the sheet. Reliability of those recording sheets was checked and edited by collaborators recruited from the Women's Union in the locality, who could see and communicate with the subject easily and frequently. They were noted for their creative activities to contribute to the success of previous community mobilisation programmes to control anaemia among reproductive-age women[26].

To participate in the study, collaborators also received a training course with similar contents as the training given to study participants but more detailed and deeply expanded. Otherwise, they were trained on skills of communicating and disseminating knowledge to the subjects. Each collaborator was assigned to guide five to seven subjects. During the intervention period, collaborators visited each participant every day at the household. From the recording sheet, collaborators calculated the calcium intake of the subjects on the previous day and gave advice for adjusting the dietary intake on the next days. Collaborators were also provided with a check list form developed as a material to monitor and note the food consumption of each subject.

Practices of study subjects were also monitored by nutritional experts who visited the households every week to communicate with subjects and collaborators, gather recording sheets and check lists, and give them advice on improving practices at the households.

Group discussion. Group discussions involving study participants, collaborators and nutritional experts were organised every week. In those discussions, the study participants refreshed their knowledge and corrected practices by the efforts of nutritional experts. The experience of organising calcium-rich meals was exchanged between the study participants. They brought calcium-rich foods from their house to the meeting, calculated the quantity of foods needed for meals per day, and prepared standing dish from the foods in the presence of, and revised by, nutritional experts. From the lively discussions, nutritional experts could understand and assess changes in the knowledge and practices of subjects in order to adjust them properly.

Measurements

At screening and baseline survey, subjects were interviewed about their characteristics including age, postmenopausal years, educational level, life-long occupation, number of births and current weight-bearing exercise using a structured questionnaire. At baseline and 6 months thereafter, subjects underwent measurement of weight, height, bone mass and calcium intake. They provided fasting blood for analysing the serum parathyroid hormone (PTH) level at the beginning and at the end of intervention.

Life-long occupation was defined as the occupation that the participant was engaged in most frequently in her life. It was classified as heavy work (farmers, manual workers), office work (office clerks and other sedentary jobs) or domestic work (housewife).

Education level was defined by the number of years of schooling. Weight-bearing exercise was assessed by enquiring about the regular weight-bearing exercise during at least the past 12 months. The subjects reported the number of ≥30 min sessions of weight-bearing exercise per week. Active behaviour was defined as more than two sessions per week.

Height and weight were measured while standing, wearing light clothing and no shoes. BMI was calculated as the ratio of weight (kg) to height squared (m^2).

Bone mass was assessed by speed of sound (SOS (m/s)) using a QUS device (CM-100; ELK Corporation, Tokyo, Japan) as described in our previous publication[19]. CV for the device were measured short-term *in vivo* and *in vitro*. The precision error (per cent CV) using a phantom was 0·15 % and *in vivo* was 0·27 %[27]. All subjects had SOS measured at the right calcaneus. The measurement was taken in a temperature-controlled environment, and performed only by a trained medical technician. Standardisation and calibration with standards were performed before the first measurement of each survey day.

Calcium intake was determined by the SQFFQ[21] and was based on Vietnamese Food Composition Table[28].

Intact PTH was measured by immunoradiometric assay (IRMA) using the DiaSorin N-tact PTH SP IRMA kit (DiaSorin Inc., Minnesota, MN, USA).

Statistical analysis

Differences in baseline characteristics between intervention and control groups were compared by the *t*-test and χ^2 test. Differences between the groups at each time of follow-up were compared by repeated measures analysis of covariance with baseline values as a covariate and time as the repeated measure. Within-group differences were compared by repeated measures ANOVA with time as the repeated measure. All *P* values are two tailed.

All statistical analyses were performed with the SPSS software for Windows version 10.0 (SPSS, Chicago, IL, USA).

Results

Reasons of dropouts

Thirty-two of 140 subjects dropped out from the study; thus 108 women (fifty-seven in interventions and fifty-one in controls) completed the follow-up, yielding a total dropout rate of 22·8 %. In the control group, nine women withdrew because they lost interest in the study, four subjects moved out of the study site, two subjects had serious illnesses and four others cited personal reasons for dropping out. In the intervention group, only two subjects were unhappy to continue follow-up. Other reasons were moving away from the study site (five subjects), serious illnesses (two subjects) and personal reasons (four subjects).

Baseline characteristics

Only results of 108 women who completed the follow-up were analysed. Of the subjects, 105 (97 %) were farmers and the others were office clerks. The subjects had an average age, time since menopause, years of schooling, number of births and BMI, respectively, of 57·6 (SD 3·0) years, 7·9 (SD 3·2) years, 5·4 (SD 2·7) years, 3·4 (SD 1·4) and 20·3 (SD 2·5) kg/m^2. As shown in Table 1, no significant difference between interventions and controls existed in all considered variables. The prevalence of subjects defined as active weight-bearing exercise was 57·9 % and 60·8 % in interventions and controls, respectively.

Anthropometry and PTH level changes

The results showed that changes in weight and height in both interventions and controls were not significant from the beginning of study to 18 months thereafter (Table 2). The intervention led to a decrease in PTH by 12 % ($P < 0·01$). In the controls, there was an increase in PTH by 32 % ($P < 0·001$) after 18 months.

Calcium intake and bone mass changes

Figure 1 shows the changes in the mean calcium intake at baseline and every 6 months thereafter. Calcium intake in the control group did not change significantly over time. In interventions, calcium intake increased significantly with time from 345 (SD 54) mg/d at baseline to 657 (SD 64) mg/d after 18 months ($P < 0·01$). The mean calcium intake of interventions was also significantly higher than that in controls at 18 months ($P < 0·01$).

The percentage changes in bone mass over the study period of 18 months are presented in Figure 2. Bone mass (SOS value) was reduced significantly in controls by 0·5 % at 18 months ($P < 0·01$), while there was no significant difference for SOS value in the interventions between baseline and every assessment. After 18 months, the change in SOS value differed by 0·4 % between the two groups ($P < 0·05$).

Discussion

Osteoporosis is presenting in epidemic proportions in Asia[2]. Because consumption of milk is poor, the traditional Asian diet is considered to be low in calcium content[8]. In Vietnam, there are many local calcium-rich foods which have high calcium content, especially small crab. But people do not know the importance of these food. Thus, the mean calcium intake of Vietnamese adult women was still much lower than the RDA for calcium, while such calcium-rich foods are cheap and available in the locality.

The current study evaluated whether or not nutrition education intervention would affect the calcium intake of postmenopausal women. The results showed that women

Table 1 Baseline characteristics of subjects who had completed the study

	Intervention group (*n* 57)		Controls (*n* 51)		
Characteristics	Mean	SD	Mean	SD	*P* value
Age (years)	57·6	2·8	57·5	3·2	0·94
Years since menopause	7·9	3·4	8·0	3·0	0·92
Years of schooling	5·5	2·2	5·3	3·1	0·68
Number of births	3·4	1·5	3·6	1·5	0·53
Weight (kg)	44·4	6·1	45·6	6·5	0·30
Height (cm)	148·4	4·8	148·9	4·9	0·62
BMI (kg/m^2)	20·1	2·6	20·5	2·6	0·38
SOS (m/s)	1518	26	1521	25	0·56
Calcium intake (mg/d)	345	54	342	58	0·76
Active weight-bearing exercise (%)	57·9		60·8		0·84
Serum PTH (pg/ml)	52·8	16·7	47·3	17·8	0·11

SOS, speed of sound; PTH, parathyroid hormone.
Values are mean and SD or percentage. Intervention group was compared to control group by independent *t*-test or χ^2 test.

Table 2 Mean changes in anthropometric indices and serum parathyroid hormone (PTH) level of subjects after 18 months

	Interventions (*n* 57)		Controls (*n* 51)		
Variables	Mean	SE	Mean	SE	Significance
Anthropometry (absolute change)					
Weight (kg)	0·6	1·1	0·3	1·2	NS
Height (cm)	−0·19	0·89	−0·39	0·97	NS
Serum PTH (percentage change)	−0·12	0·05	0·32	0·07	$P < 0·01$

Values were compared between data of baseline and 18 months thereafter in both intervention and control groups by *t*-test.

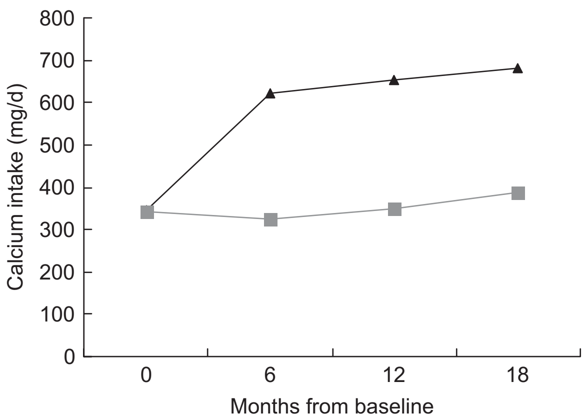

Fig. 1 Mean change in calcium intake from baseline to the end of study (—▲—, intervention group; —■—, control group)

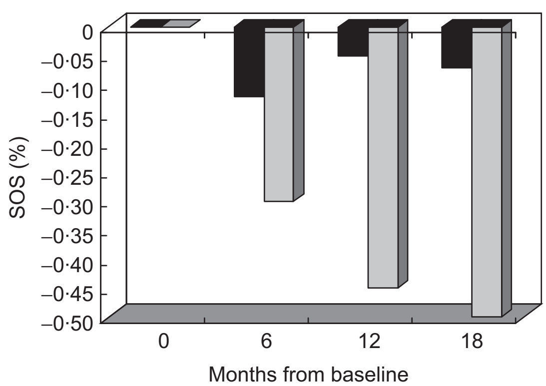

Fig. 2 Percentage change in bone mass, as assessed by speed of sound at the calcaneus on quantitative ultrasound, from baseline to the end of study (■, intervention group; □, control group)

in the intervention group had a greater increase in calcium intake than women in the control group. This finding is similar to a previous nutrition education study in young women with low calcium intake[10]. Consequently, women in the intervention group did not experience significant changes in SOS value, while women in the control group had significantly decreased SOS value by 0·5 % at 18 months. These results of our study generally are consistent with a previously published study, which showed that in postmenopausal women whose calcium intake was lower than 400 mg/d, calcium supplementation of 500 mg/d prevented bone loss[29].

The current study also indicated that the difference between SOS value in interventions and controls after 18 months was 0·43 %. This finding is higher than the results of Krieg *et al.*[16] and Giorgino *et al.*[17], but still worse than the others where the differences were 0·8 % and 0·7 %, respectively[18,30].

In the present study, we found that the mechanism by which increase of calcium intake retarded bone loss was associated with the suppression of PTH levels. We observed a higher level of PTH in controls than in interventions at the end of 18 months. Other calcium supplementation studies have also shown an age-related increase in PTH levels in the controls with time while interventions reduced the serum PTH levels[8,31].

A limitation of the present study was that we could not analyse other bone turnovers to determine the effect of improving calcium intake in bone mechanism. However, substantial effects of the intervention on PTH levels and SOS value make it very likely that there is also an effect on turnover[9].

Perhaps the most remarkable finding was that the nutrition education promoted successfully participation of the community in the studied area, so that the calcium intake of women in the intervention group was improved. Increased consumption of calcium-rich foods may have resulted in improving the intake of other nutrients, which also positively contributed to bone health. Such improvements finally led to retarding bone loss in interventions. Ideally, in view of an overall dietary improvement, our study revealed that there was no significant consequence of weight gain. This is similar to results of milk supplementation trial in postmenopausal Chinese women conducted by Chee *et al.*[9]. It is worth noting that the current intervention targeted women who were consuming low calcium intake while local calcium-rich food sources are abundant. Further, the study was based on the close cooperation between researchers and collaborators as well as on the active participation of subjects. Those efforts strongly contributed to the success of our intervention approach. The effect of this education model should be confirmed in future studies for further expanded application to a larger population.

In conclusion, the results of this study indicated that community-based nutrition education intervention was beneficial in improving the calcium intake of postmenopausal Vietnamese women. Such dietary change had an effect on retarding bone loss in postmenopausal women as measured by QUS.

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Author contribution: V.T.T.H., N.C.K. and L.B.M. contributed to the design protocol and implement activities in the field. In addition, V.T.T.H. interpreted all results of the study. N.T.L. participated in developing the protocol and monitoring activities in the field. T.M.P. and N.V.N. participated in collecting data. B.T.N. and M.N.

helped in analysing data. S.Y. gave advice to design and develop the protocol, monitoring all activities of the study and interpreting results.

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