Original Article

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Ability of community pharmacists to promote self-care and self-medication by local residents [I]: Improvements in bone mineral density

Yoshiko Wada, Yuko Wada, Satoko Ennyu, Ken-ichi Shimokawa, Fumiyoshi Ishii*

Department of Pharmaceutical Sciences, Meiji Pharmaceutical University, Tokyo, Japan.

Summary **This study was conducted in order to establish a health management method for the elderly in a community through follow-ups of bone mineral density (BMD) measurement results over a 1-year period based on BMD measurements performed by pharmacists and a guidance program. Regarding BMD measurement results, the percent young adult mean (%YAM: mean BMD in healthy persons of the same sex aged between 51 and 82 years old) significantly increased in Period I, during which the intervention by pharmacists was performed (6 months after the start of measurements), but significantly decreased in Period II, during which this intervention was not performed (between 7 and 12 months after the start of measurements). Based on these results, lifestyle improvements were effective in Period I regardless of sex or age; however, it may be important to maintain an improved diet and subject motivation in the future. The results of this study suggest that community pharmacists play an important role in community medicine through positive intervention for local residents' health support.**

Keywords: Bone mineral density, nutrition, exercise, health support pharmacy, health expectancy

1. Introduction

The number of patients with osteoporosis in Japan, which is a rapidly aging society, has increased annually, reaching approximately 13,000,000. Health expenditure for osteoporosis is estimated to be approximately one trillion yen (*1,2*). According to a survey conducted by the Ministry of Health, Labour and Welfare in 2013, fall-related fractures were found to be the third most common reason (14.6%) for a state requiring support/nursing (*3*). Vertebral body/hip fractures were frequent in patients with osteoporosis, raising an important issue for the current medical system to prevent sequelae, such as fracture-related reductions in viability and long-term restrictions in daily living.

According to the World Health Organization (WHO), osteoporosis is a disease that is characterized by a low bone mass and the microarchitectural deterioration of bone tissue, leading to enhanced bone fragility and a consequential increase in the risk of fractures (*4*). Regarding the risk of fractures, assessments using bone mineral density (BMD) measurements are recommended by the "Japanese 2015 Guidelines for Prevention and Treatment of Osteoporosis", which were edited by the Japan Osteoporosis Society, Japanese Society for Bone and Mineral Research, and Japan Osteoporosis Foundation (*1*). In these guidelines, BMD of < 70% young adult mean (%YAM) has been established as a diagnostic criterion for osteoporosis; however, routine health check-ups do not currently involve BMD measurements. Furthermore, special qualifications and measurement-place settings are not necessary; therefore, positive activities, such as the addition of BMD to measurement items and holding measurement sessions for local residents, may be important in the future.

Regarding BMD measurements, informing each subject of their measurement results alone does not lead to healthy bone maintenance. A previous study reported that effective exercise/diet guidance for individuals based on BMD measurement results contributed to the

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**Address correspondence to:*
Dr. Fumiyoshi Ishii, Department of Pharmaceutical Sciences, Meiji Pharmaceutical University, 2-522-1, Noshio, Kiyose, Tokyo 204-8588, Japan.
E-mail: fishii@my-pharm.ac.jp

prevention of osteoporosis (*5*), suggesting future trends in community medicine.

The Ministry of Health, Labour and Welfare recommended that pharmacists, as a "health support pharmacy", provide advice regarding nutrition and lifestyle to individuals in order to prolong national health expectancy (*6*). However, few studies have reported outcomes of BMD education for the elderly by pharmacists. In the present study, we examined changes in BMD with the presence or absence of diet-improving guidance by pharmacists involving local residents.

2. Materials and Methods

2.1. *Study design and subjects*

This study was conducted on the campus of Meiji Pharmaceutical University (Kiyose City, Tokyo, Japan) between December 2013 and December 2014. Subjects were 50 middle-aged or elderly residents in the neighborhood of the university (9 males, 41 females), with a mean age of 69 years (range: 51 to 82 years) (Table 1). Subjects were recruited for BMD measurements through advertising or posters. We excluded individuals who had cardiac attacks or stroke within 6 months, those with heart diseases (angina pectoris, heart failure, and severe arrhythmia), those with serious complications related to diabetes, those with markedly high blood pressure, those with chronic obstructive pulmonary disease, those with acute arthralgia, arthritis, low back pain, or neuralgia, those with acute inflammation such as pneumonia and hepatitis, those who had been instructed to restrict exercise by physicians, and those who had undergone surgery for cataracts or glaucoma within 6 months. The protocol of this study was approved by the Ethics Review Board of Meiji Pharmaceutical University. Written informed consent was obtained from all subjects.

BMD measurements were performed before the intervention by pharmacists (1st session) and 1.5, 3, and 6 months after the start of the intervention (2nd, 3rd, and 4th sessions), with the intervention period (6 months) being Period I. BMD was measured again at 12 months (5th session), with the non-intervention period (6 months) being Period II. In 40 subjects, the intervention by pharmacists and BMD measurements (1st to 4th sessions) were completed in Period I. At the completion of Period II, the 5th session of measurements was conducted in 23 subjects.

Table 1. Subject characteristics at baseline

Number of patients	n = 50
Mean age	69 ± 8.6* (51-82)
Men	9
Women	41
Thyroid disease	1
Diabetes	0
Prostatomegaly	1
Asthma	2
Gynopathy	0
High blood pressure	4
Epilepsy	0
Osteoporosis	1
Thrombosis / embolism	0
Digestive disorder	1
Alcohol habit (every day)	3
Smoking habit	0
Previous smoker	3

*mean ± SD

2.2. *BMD measurements*

BMD was measured using the ultrasound bone densitometer Model CM-200 (Furuno Electric Co., Ltd., Hyogo Prefecture, Japan). Using the ultrasonic pulsed penetration method, jelly for ultrasonography was applied to the right calcaneus, with the right knee of each subject being flexed at 90 degrees, and measurements were then conducted. Measurement items consisted of the speed of sound (SOS), T-score, Z-score, %YAM, and %AGE. After height, abdominal circumference, and body weight had been measured using the high-precision organization composition DF-851 (Yamato Scale Co., Ltd., Hyogo Prefecture, Japan), pharmacists performed lifestyle guidance based on the measurement results.

2.3. *Intervention by pharmacists*

In the intervention by pharmacists, each subject was given advice related to diet, sun exposure, and exercise (Table 2). Regarding diet, pharmacists explained that calcium, vitamin D, and vitamin K were essential for bone formation. Foods containing these nutrients and ingestion methods were explained in detail. Each subject was also instructed to adequately expose his/her body to sunlight because exposure to ultraviolet rays

Table 2. Contents of the calendar for recording

Items	Points
Scores regarding diet	
Ingestion of 3 nutrients	4
Ingestion of 2 nutrients	3
Ingestion of 1 nutrient	2
No intention to ingest each nutrient	1
No record (blank column)	0
Scores regarding sun exposure	
Exposure to the sun for 1 hour or more	4
Exposure to the sun for 30 minutes to 1 hour	3
Exposure to the sun for 30 minutes or less	2
No sun exposure	1
No record (blank column)	0
Scores regarding exercise	
Pilates was performed in addition to other types of exercise	4
Pilates was performed	3
Exercise other than Pilates was performed	2
No exercise	1
No record (blank column)	0

from sunlight leads to the synthesis of vitamin D in the skin (*7*). Adequate walking or low-intensity exercise (Pilates) was recommended for exercise. Each subject was instructed to perform exercise involving Pilates in order to improve articular stability and muscular mobility through trainers' guidance 3 times a week for 6 months after the start of the intervention. A calendar was delivered to record diet, sun exposure, and exercise every day in Period I, but not in Period II.

2.4. *Data analysis*

The paired *t*-test was performed in order to analyze the group consisting of subjects who participated in this study in Period I (1^{st} to 4^{th} sessions of measurements: 40 subjects) and the group consisting of subjects who participated during Periods I and II (1^{st} to 5^{th} sessions of measurements: 23 subjects). A p-value < 0.05 was regarded as significant.

3. Results

3.1. *Subject information*

Subject information is presented in Table 1. Fifty subjects initially participated in the 1^{st} session of measurements. Of these, 40 participated in all measurement sessions (1^{st} to 4^{th} sessions) in Period I. BMD was measured in these subjects (54 to 85 years, mean: 69 ± 8.6 years) using %YAM as an index according to the diagnostic criteria prepared by the Japan Osteoporosis Society. Age-plotted results are shown in Figure 1. Mean BMD was 67.1%YAM.

3.2. *Presence or absence of the intervention by pharmacists*

Serial changes (●) in %YAM (n = 40) in the presence of the intervention by pharmacists in Period I and those (○) in %YAM (n = 23) in its absence during Periods I and II are shown in Figure 2. Mean %YAM values in the presence of the intervention 3 and 6 months after the start of measurements were 70.8 and 74.5%YAM, respectively, and were significantly higher than that at the start of measurements (67%YAM) ($p < 0.05^*$ and $p < 0.01^{**}$, respectively). However, the intervention by pharmacists increased %YAM by 7.5% in Period I, whereas a 4.3% decrease was observed after the completion of Period II (74.5 → 70.2%YAM) ($p < 0.01^{**}$).

3.3. *Effects of the dietary intervention*

Serial changes in %YAM (n = 40) in the presence of the dietary intervention by pharmacists in Period I are shown in Figure 3. Group A (●) showed a score of ≥ 3

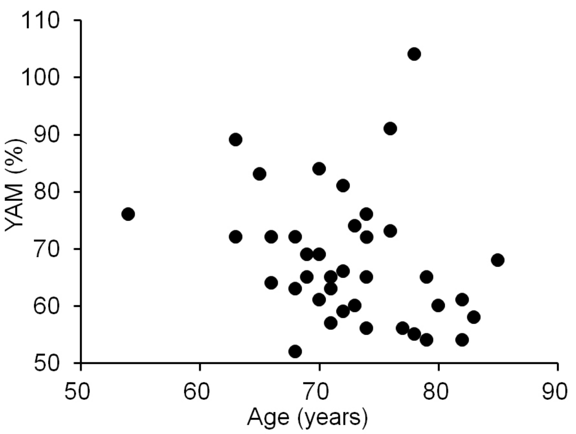

Figure 1. Relationship between YAM (%) and age before the intervention. (n = 40)

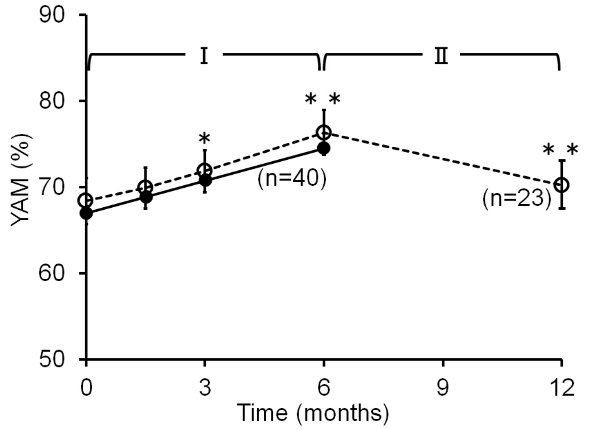

Figure 2. Effects of the pharmacist intervention on YAM (%). Solid line (●): 6 months (n = 40), Dotted line (○): 12 months (n = 23), paired t-test: $p < 0.05^*$, $p < 0.01^{**}$, With (I) and without (II) the pharmacist intervention.

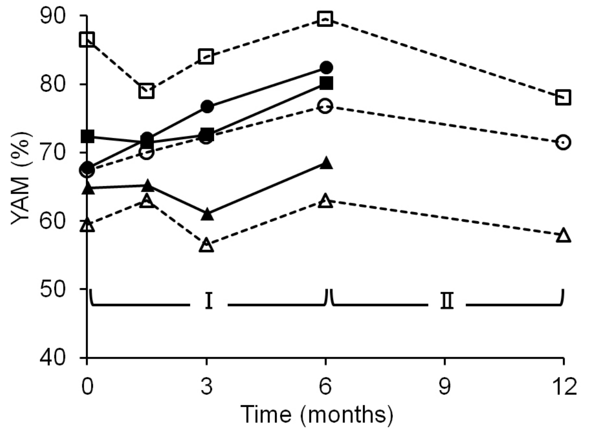

Figure 3. Effects of various food habit points on YAM (%). Solid line: 6 months (n = 40); Group A (●): Food habit points are more than 3. (n = 30), Group B (■): Food habit points are less than 3 and more than 2. (n = 6), Group C (▲): Food habit points are less than 2 and more than 0. (n = 4). Dotted line: 12 months (n = 23); Group A (○): Food habit points are more than 3. (n = 19), Group B (□): Food habit points are less than 3 and more than 2. (n = 2), Group C (Δ): Food habit points are less than 2 and more than 1. (n = 2). With (I) and without (II) pharmacist intervention.

points. In Group B (■), scores ranged between 2 and 2.9 points. In Group C (▲), scores ranged between 0 and 1.9 points. The "diet" score was calculated based on the calendar recorded by each subject every day through the 1st to 4th sessions of measurements in Period I. As shown in Figure 3 (solid lines), %YAM increased linearly until the 4th session of measurements (6 months after the start of measurements) in Group A (●) (n = 30). In Groups B (■) (n = 6) and C (▲) (n = 4), %YAM slightly increased from the 3rd session of measurements (3 months after the start of measurements). %YAM (n = 23) in Periods I and II are shown as dotted lines in Figure 3. In Group A (○) (n = 19), %YAM increased linearly until the 4th session of measurements in Period I. In Groups B (□) (n = 2) and C (Δ) (n = 2), a decrease was observed in the 2nd or 3rd session of measurements, whereas an increase was noted in the 4th session of measurements. However, all groups showed a decrease in the 5th session of measurements in Period II. The values obtained in Groups B (□) and C (Δ) returned to those at the start of measurements.

3.4. *Effects of the sun exposure intervention*

Serial changes in %YAM (n = 40) in the presence of the sun exposure intervention in Period I are shown in Figure 4. As indicated by the solid lines, %YAM increased linearly until the 4th session of measurements in Groups A (●) (n = 11), B (■) (n = 27), and C (▲) (n = 2). %YAM (n = 23) in Periods I and II are shown as dotted lines in Figure 4. In Groups A (○) (n = 9), B (□) (n = 13), and C (Δ) (n = 1), %YAM increased linearly until the 4th session of measurements, whereas a decrease was observed in the 5th session of measurements. The value in Group B (□) returned to that at the start of measurements.

3.5. *Effects of the exercise intervention*

Serial changes in %YAM (n = 40) in the presence of the exercise intervention in Period I are shown in Figure 5. As indicated by the solid lines, %YAM increased linearly until the 4th session of measurements in Group A (●) (n = 30). In Groups B (■) (n = 6) and C (▲) (n = 4), an increase was observed in the 4th session. %YAM (n = 23) in Periods I and II are shown as dotted lines in Figure 5. In Groups A (○) (n = 4), B (□) (n = 17), and C (Δ) (n = 2), a slight decrease was noted in the 2nd or 3rd session of measurements, whereas an increase occurred in the 4th session. However, %YAM subsequently decreased until the 5th session, similar to that observed for the dietary and sun exposure interventions.

3.6. *Comprehensive effects of the intervention*

Serial changes in %YAM (n = 40) in Period I with respect to the total score of "diet", "sun exposure", and "exercise" are shown in Figure 6. As indicated by the solid lines, %YAM increased linearly until the 4th session of measurements in Groups A (●) (n = 16) and B (■) (n = 23). In Group C (▲) (n = 1), a decrease was observed in the 3rd session (3 months after the start of measurements), whereas a slight increase was noted in the 4th session. %YAM (n = 23) in Periods I and II are shown as dotted lines in Figure 6. In Group A (○) (n = 11), a decrease occurred in the 3rd session of

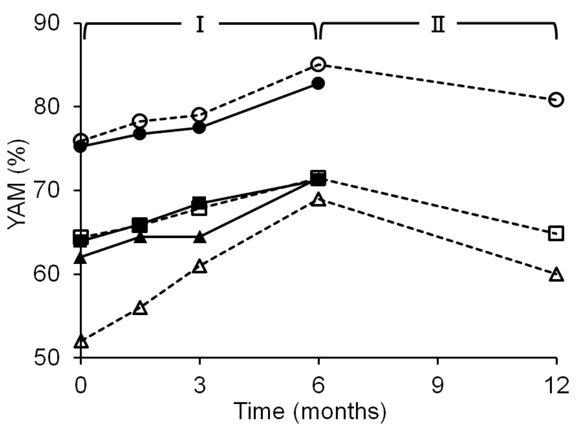

Figure 4. Effects of various sun exposure habit points on YAM (%). Solid line: 6 months (n = 40); Group A (●): Sun exposure habit points are more than 3. (n = 11), Group B (■): Sun exposure habit points are less than 3 and more than 2. (n = 27), Group C (▲): Sun exposure habit points are less than 2 and more than 0. (n = 2). Dotted line: 12 months (n = 23); Group A (○): Sun exposure habit points are more than 3. (n = 9), Group B (□): Sun exposure habit points are less than 3 and more than 2. (n = 13), Group C (Δ) Sun exposure habit points are less than 2 and more than 1. (n = 1). With (I) and without (II) pharmacist intervention.

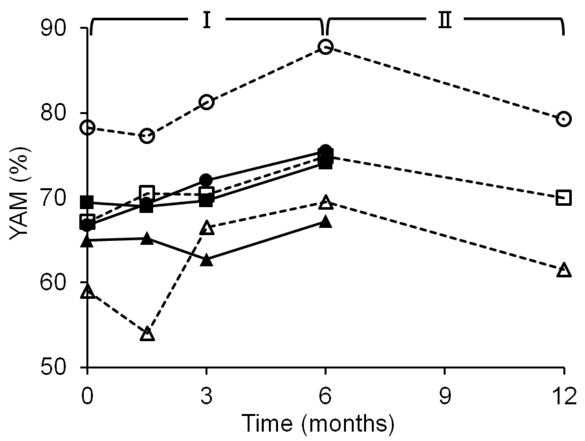

Figure 5. Effects of various fitness habit points on YAM (%). Solid line: 6 months (n = 40); Group A (●): Fitness habit points are more than 3. (n = 30), Group B (■): Fitness habit points are less than 3 and more than 2. (n = 6), Group C (▲): Fitness habit points are less than 2 and more than 0. (n = 4). Dotted line: 12 months (n = 23); Group A (○): Fitness habit points are more than 3. (n = 4), Group B (□): Fitness habit points are less than 3 and more than 2. (n = 17), Group C (Δ): Fitness habit points are less than 2 and more than 1. (n = 2). With (I) and without (II) pharmacist intervention.

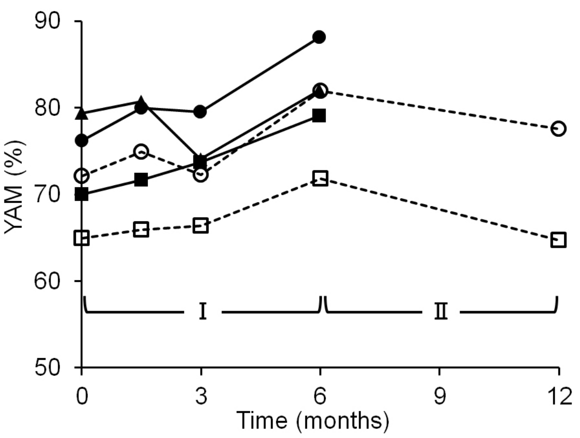

Figure 6. Effects of overall habit points on YAM (%). Solid line: 6 months (n = 40); Group A (●): Overall habit points are more than 3. (n = 16), Group B (■): Overall habit points are less than 3 and more than 2. (n = 23), Group C (▲): Overall habit points are less than 2 and more than 0. (n = 1). Dotted line: 12 months (n = 23); Group A (○): Overall habit points are more than 3. (n = 11), Group B (□): Overall habit points are less than 3 and more than 2. (n = 12). With (I) and without (II) pharmacist intervention.

measurements, whereas an increase was noted in the 4th session. In Group B (□) (n = 12), %YAM serially increased until the 4th session of measurements. No subject was assigned to Group C (Δ). In all groups, a decrease was observed in the 5th session (12 months after the start of measurements). The value in Group B (□) (n = 13) returned to that at the start of measurements.

4. Discussion

Regarding the effects of diet, the balanced ingestion of calcium (*8,9*)/vitamin D (*10*)/vitamin K (*11*) is recommended by the "Japanese 2015 Guidelines for Prevention and Treatment of Osteoporosis" (*1*), and several studies have reported that it increases BMD, thereby preventing fractures (*12-14*). In the intervention performed in the present study, a leaflet was delivered to visually promote understanding, and guidance through detailed explanations was conducted. Subjects were instructed to ingest milk products, soybean products, small fish, and seaweed as foods containing high levels of calcium, fish (particularly bluefish), salmon, dried mushrooms, and wood ear mushrooms as foods containing high levels of vitamin D, and fermented soybeans, vegetables (green vegetables), liver, and cheese as foods containing high levels of vitamin K. They were also instructed to avoid excessive consumption of foods containing high levels of phosphorus (processed foods and some soft drinks), salt, foods containing high levels of caffeine (coffee and tea), and alcohol (*15*).

As shown in Figure 3, BMD increased linearly in Group A (●) in which 3 nutrients (calcium, vitamin D, and vitamin K) were consciously ingested after pharmacists recommended foods that promote an increase in BMD. However, no increase was observed in BMD until the 3rd session of measurements (3 months after the start of measurements) in Group B (■) or C (▲) without this intervention. This result suggests the importance of intentional nutrient ingestion. In addition, in Groups A (○) and B (□), a decrease was observed in BMD after the completion of Period II (in the 5th session of measurements). However, in Group B (□), the value was lower than at the start of measurements, whereas there was a gradual rebound in Group A (○). This result reflects subjects in Group A (○) complying with pharmacists' instructions, indicating that it is important for pharmacists to maintain subject motivation at a high level.

Regarding the effects of sun exposure, vitamin D is ingested from meals or synthesized in the skin through exposure to ultraviolet rays. Therefore, adequate sun exposure is recommended in addition to a balanced diet (*7,10*).

As shown in Figure 4, %YAM increased linearly in Groups A (sun exposure for 30 minutes or more/day), B (sun exposure for 15 to 30 minutes/day), and C (sun exposure for 0 to 15 minutes/day) following pharmacists' recommendations. On the other hand, a decrease was observed in %YAM in each group after the completion of Period II (in the 5th session of measurements). In Group A (○), there was a gradual rebound, similar to that observed with the dietary intervention. The necessity of adequate exposure to sunlight for approximately 15 minutes/day is emphasized by the guidelines (*1*). The results obtained in the present study suggest the importance of consciously going outdoors, even for a short time, during the daytime.

Regarding the effects of exercise, a larger number of clinical studies have compared the influence of exercise interventions on BMD in healthy adults than in patients with osteoporosis. A previous study reported that aerobic exercise or walking increased lumbar vertebral and proximal femoral BMD (*16*). Another study investigating the prevention of decreases in BMD indicated that high-intensity loading on bones, such as weight training, prevented a decrease in %YAM (*17*). However, it may not be realistic to recommend weight training for subjects (particularly the elderly) in community medicine. In the present study, the mean age of subjects was 69 years, and mean BMD at the start of measurements was 67.1%; therefore, aerobic exercise was not conducted, and low-intensity Pilates involving stretching was performed 3 times a week for 6 months in Period I.

As shown in Figure 5, %YAM increased linearly in Group A (other types of exercise were conducted in addition to Pilates at a high frequency) after the exercise intervention by pharmacists. However, it slowly increased in Groups B (other types of exercise were conducted in addition to Pilates at a low frequency) and C (absence of exercise). Since BMD is measured at the calcaneus, calcaneal loading related to the continuation of exercise based on a fixed program may have been reflected by an increase in BMD in Group A (●). On the other hand, the value in Group A (○) after the completion of Period II (in the 5th session of measurements) was similar to that at the start of measurements, as demonstrated for diet and sun exposure, suggesting that a rebound phenomenon occurs in a relatively short period, in contrast to the results obtained for diet and sun exposure.

Regarding comprehensive effects, subjects were classified into Groups A to C based on the total score of "diet", "sun exposure", and "exercise" as comprehensive parameters (Figure 6). As shown in Figure 6 (solid lines), an increase was observed in BMD in Groups A (●) and B (■), whereas a similar value to that before the start of the intervention was noted in Group C (▲); in subjects complying with the guidance of pharmacists, the effects achieved were reflected by numerical data, and a marked difference was observed between these subjects and those who did not comply with the guidance provided. As indicated by the dotted lines in Figure 6, the rebound phenomenon slowly decreased, even after completion of the intervention period in Group A (○), and final BMD was higher than that before the intervention. However, in Group B (□), it was similar to that at the start of the intervention. A comparison of subject backgrounds between Groups A (n = 11) and B (n = 12) revealed that mean ages, 71.5 and 73 years, respectively, were similar. Therefore, the intervention was more effective in the group in which the "guidance program for increasing BMD" was consciously conducted. However, the results obtained also showed that BMD decreased when consciousness for lifestyle improvements was reduced.

In the future, it may be important for a home pharmacy or pharmacist to positively and continuously perform health consultations/management for local residents in order for each pharmacy to function as a "health support pharmacy". If the importance of self-medication is recognized by individual residents under pharmacists' guidance, it may lead to activation of the entire area; therefore, pharmacists need to accomplish this goal.

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