《**Original Article**》

The relationship between lifestyle and the actual condition of bone mineral density in middle-aged and elderly Japanese women

Hisashi Susaki[*], **Shizuno Ishida**[*], **Kiwako Okada**[*], **Aya Sumiya**[*],
Hideyoshi Tanaka[**] **and Katsumi Yamanaka**[*]

Summary

We measured the bone mineral density (BMD) of middle aged and elderly women living in this region; and carried out a questionnaire survey of their dietary habits and lifestyle.

The subjects were 150 females over 60 years old living in this region. (average age ± standard deviation : 71.3±6.4 years old). We used supersonic wave bone mineral density measuring devices on the heel of the right foot. A questionnaire survey was also used to investigate meal intake frequency and lifestyle.

If the BMD was higher than average for the same generation, we categorized those people in the group known as the high BMD group. When it was lower, people were put in the low BMD group. There were three items we examined; these were the intake of types of food group and the intake of nutrients group and lifestyle. The results for lifestyle in the high BMD group, for those with exercise habit were high significantly ($p < 0.05$). Concerning the nutrients for the high BMD group, intake levels of zinc were low significantly ($p < 0.05$). For the food groups in the high BMD group, the intake levels of fats were low significantly ($p < 0.05$). The results are as follows; we acknowledge a strong correlation between regular physical exercise and bone mineral density, and it is suggested that even a once a week physical form of exercise would hugely contribute to the maintenance of bone mineral density.

Key words: bone mineral density, lifestyle, middle-aged and elderly women, regular physical exercise

Introduction

As we approach a super aging society, The Law of Nursing Care Insurance has been devised and it has been decided to develop a new regional support project. From now on, the vital issues are how we can prevent an increase in the number of care receivers both those requiring support and those who require nursing, through this project. The principle preventative measures (that is to prevent the need of nursing)

for the elderly are locomotory function improvement, nutritional modification or improvement, oral function improvement, prevention of social withdrawal (i.e. staying at home), prevention and support of dementia, prevention and support of depression[1]. It is therefore crucial that we understand the health condition of elderly people in various regions and link this to improve quality of life (QOL) from the perspective of these preventative measures. This time we have decided to investigate the measure-

　＊ Nagoya University of Arts and Sciences, School of Nutritional Sciences
＊＊ Ichinomiya Women's Junior College

ment of BMD at the centre of our investigation as a connection with bone fractures. In addition we will look at dietary habits and lifestyle.

In order to maintain BMD, diet and exercise have a huge influence[2]. In addition, concerning the relation between elderly people's BMD and exercise, there are reports that show exercise and training have effects[3] yet they are not able to confirm a specific effect[5][6]. We are not necessarily in complete agreement with this.

Therefore, this time, we investigated the actual conditions of BMD, dietary habits, as well as lifestyle for a group of elderly people in this region and our aim was to gain basic information of how we can maintain BMD by revealing the dietary habits and lifestyle characteristics which are connected to healthy maintenance of BMD.

1　Survey term and subjects.

From August to September 2006. The subjects were female regional residents over 60 years old (average age ± standard deviation : 71.3±6.4 years old).We explained in advance the purpose and methodology of this study to the subjects and gained their agreement, also we received the compliance of Nagoya University of Arts and Sciences Ethical Committee.

2　Method of investigation

(1) Questionnaire survey

The articles for the questionnaire survey are as follows; concerning dietary habits「No meal habit」「Eat breakfast daily」「Three regular meals」「Intake of essential nutrients」「Enjoyment of meals」「Bite ability」「Staple food・Main Dish・Side dish」「Frequency of cooking meals」「Frequency of eating out」「Food choice when eating out」「Frequency of buying lunchboxes from convenience stores」「Frequency of eating pre-prepared food」「Consumption frequency of convenience food etc.」「Mindful awareness of intake of calcium, dairy and soy bean products」etc. Concerning lifestyle;-「Health condition」「regular physical exercise」,「understanding

and maintaining ideal weight」,「smoking habit」,「drinking habit」,「frequency of stumbling, staggering」,「falling」etc. The survey was carried out as a self assessment, a method where a form was given to the respondents and collected after a certain period of time. In the case of missed questions, we checked with the respondents personally at the time of their BMD measurement.

(2) QOL investigation.

In order to detect QOL, we investigated using the revised version of the PGC (Philadelphia Geriatric Center) Moral Scale[7]

This scale is;

1　Do you think life gets worse as you get older?
　①Yes I do　②No I do not.

2　Are you as healthy as last year?
　①Yes　②No

3　How lonely do you feel?
　①Not at all　②Not much
　③A little　　④A lot

4　Do small things bother you more this year?
　①Yes　②No

5　Do you often meet your friends or relatives?
　①Yes　②No

6　As you get older, do you have feelings of uselessness?
　①Yes I do　②No I do not

7　Have you ever not been able to sleep due to worry?
　①Yes I have　②No I have not.

8　Do you think getting older is better than you expected when you were younger?
　①Better　②Same　③Worse

9　Have you ever thought that life is not worth living?
　①Yes I have　②Not really
　③No I have not

10　Do you think you are as happy now as when you were younger?
　①Yes　②No

11　Do you have a lot to be sad about?

①Yes　②No

12　Do you worry about a lot of things?

①Yes　②No

13　Do you get angry more than you used to?

①Yes　②No

14　Is life hard for you?

①Yes　②No

15　Are you satisfied with your life now?

①Yes　②No

16　Do you tend to consider things seriously?

①Yes　②No

17　Do you tend to be upset by trivial things?

①Yes　②No

We assigned one point for each underlined response given for the 17 items above.

The survey was carried out as a self assessment, a method where a form was given to the respondents and collected after a certain period of time. In the case of missed questions, we checked with the respondents personally at the time of their BMD measurement.

(3) Meal Survey

For the meal survey we used a food frequency questionnaire based on food groups. We undertook a survey of meal intake frequency. We handed out survey sheets beforehand and in the case of missed questions, we checked with the respondents personally at the time of their BMD measurement.

(4) Bone Mineral Density (BMD) Measurement

BMD was measured on the heel of the right foot using supersonic wave bone mineral density measuring devices AOS-100 (ALOKA). We measured supersonic waves at the speed of sound (SOS) and transmission indication (TI) through the heel, then calculated the Osteo Sono Index (OSI). The calculation formula is given as $OSI = TI \times SOS^2$.

We treated the average OSI as the standard value used by Mitsui et al.[6] who measured a target group of Japanese people in 5 year increments of age. Subjects who had a higher than average amount were deemed as those to be placed in the high BMD group, and those with lower than average were placed in the low BMD group. Then we studied the relationship between lifestyle, food group intake and nutrients intake conditions.

3　Analysis method

Bivariate analysis was carried out by chi-square test to determine the statistical difference between the two groups. Analysis was performed using the SPSS (Statistical Package for the Social Sciences)15.0 for Windows.

Results

Table 1 shows the number of people in 5 years increments in age, BMI and the average amount of BMD. All BMI scores show the average amount ± standard deviation of 22.9±3.0. This group had mostly standard figures. The OSI scores decreased accordingly with an increase in age.

Next, as shown in Table 2, the number of people with no meal habit were 4/150 and for those not eating breakfast the number was 1/150. The number of people not eating three meals regularly was 5/150. Concerning eating habits, this group has basically good habits. We showed the relation between BMD and lifestyle. Concerning the relation with lifestyle, for the question: '*do you exercise?*' for those in the high BMD group results showed people who answered they do was inevitably high (p < 0.05). In addition, even though we do not accept any significant difference, for the question '*do you move your body*'*?* or '*Do you fall*'*?* we acknowledge a tendency that many people answer in the affirmative that they try to move their body and in the negative to falling in the high BMD group.

For the questions regarding '*Mindful awareness in intake of calcium*', '*of dairy products*', and '*of soy bean products*' we could not show any significant difference.

Next, regarding QOL, table 3 shows the score distribution of moral scores and table 4 shows the tally of each item. The moral scores are shown to be

Table 1 Breakdown of No. of people in each age group, BMI, Average BMD, High BMD group, Low BMD group

Age	No. of people	BMI*	OSI*	Low BMD group**	High BMD group**	OSI standard***
60-64yrs	25	23.5±2.3	2.395±0.299	17 (68.0)	8 (32.0)	2.343
65-69yrs	35	23.7±3.1	2.366±0.203	8 (22.9)	27 (77.1)	2.269
70-74yrs	43	22.4±3.4	2.245±0.184	22 (51.2)	21 (48.8)	2.249
75-79yrs	30	23.2±2.4	2.225±0.172	8 (26.7)	22 (73.3)	2.135
80-84yrs	13	21.4±2.9	2.115±0.260	8 (61.5)	5 (38.5)	2.095
85-89yrs	4	21.5±2.6	2.075±0.086	2 (50.0)	2 (50.0)	2.095
Total	150	22.9±3.0	2.279±0.231	65 (43.3)	85 (56.7)	

*Number refers to average amount ± standard deviation
**Number refers to No. of people (%)
***Value according to measurements made by Mitsui et. al[6]

Table 2 The relationship between Bone Mineral Density and Dietary habits or lifestyle

		High BMD group （n=85）		Low BMD group(n=65)		χ^2	p value
		No.of people	Percentage (%)	No.of people	Percentage (%)		
Health food products	Consume	43	50.6	38	58.5	0.919	0.409
	Not consume	42	49.4	27	41.5		
No meal	yes	1	1.2	3	4.6	1.678	0.317
	No	84	98.8	62	95.4		
Breakfast	Eat	84	98.8	65	100.0	0.770	1.000
	Do not eat	1	1.2	0	0.0		
Three meals	Eat	82	97.6	62	95.4	0.564	0.653
	Do not eat	2	2.4	3	4.6		
Nutrients	Consume	77	92.8	61	95.3	0.406	0.732
	Not consume	6	7.2	3	4.7		
Enjoyment of meals	Yes	65	77.4	51	78.5	0.025	1.000
	No	19	22.6	14	21.5		
Bite ability	Can	66	78.6	55	85.9	1.321	0.288
	Can not	18	21.4	9	14.1		
Staple food・Main dish・Side dish	Included	85	100.0	62	98.4	1.358	0.426
	Not included	0	0.0	1	1.6		
Cook meals	Cook	84	98.8	61	93.8	2.832	0.167
	Do not cook	1	1.2	4	6.2		
Eating out	Yes	17	20.2	16	24.6	0.407	0.555
	No	67	79.8	49	75.4		
Convenience store	Use	5	6.0	4	6.3	0.006	1.000
	Do not use	79	94.0	60	93.8		
Pre-Prepared food	Consume	26	31.0	20	31.7	0.011	1.000
	Not consume	58	69.0	43	68.3		
Convenience food	Consume	13	15.5	7	10.8	0.699	0.473
	Not consume	71	84.5	58	89.2		
Calcium intake	Aware	81	97.6	61	93.8	1.314	0.405
	Not aware	2	2.4	4	6.2		
Dairy products intake	Aware	81	96.4	62	96.9	0.022	1.000
	Not aware	3	3.6	2	3.1		

Soybean products intake	Aware	83	98.8	65	100.0	0.779	1.000
	Not aware	1	1.2	0	0.0		
Subjective feeling of health	Good	77	90.6	55	84.6	1.244	0.315
	Bad	8	9.4	10	15.4		
Movement of body	Aware	83	97.6	59	90.8	3.451	0.077
	Not aware	2	2.4	6	9.2		
Do you do exercise?	Yes	74	87.1	39	60.0	14.513	0.000*
	No	11	12.9	26	40.0		
Ideal weight understanding	Yes	73	86.9	51	78.5	1.871	0.190
	No	11	13.1	14	21.5		
Maintainance of ideal weight	Yes	52	61.2	45	69.2	1.046	0.389
	No	33	38.8	20	30.8		
Do you smoke?	Yes	5	5.9	6	9.2	0.608	0.533
	No	80	94.1	59	90.8		
Alcohol consumption over appropriate amount	Yes	8	9.5	6	9.4	0.001	1.000
	No	76	90.5	58	90.6		
Do you attend hospital regularly?	Yes	61	71.8	42	67.7	0.277	0.716
	No	24	28.2	20	32.3		
Do you often stumble?	Yes	44	51.8	34	52.3	0.004	1.000
	No	41	48.2	31	47.7		
Feeling dizzy in standing position	Yes	25	30.9	14	23.0	1.094	0.345
	No	56	69.1	47	77.0		
Do you fall?	Yes	14	16.7	18	27.7	2.642	0.113
	No	70	83.3	47	72.3		
Moral Scale Score	12 points (above)	52	61.2	36	55.4	0.510	0.507
	11 points (less)	33	38.8	29	44.6		

*$P < 0.05$

Table 3　Score distribution of QOL

	Number of people	Percentage (%)
0 Points	1	0.7
2 Points	1	0.7
3 Points	3	2.0
4 Points	2	1.3
5 Points	4	2.7
6 Points	5	3.3
7 Points	7	4.7
8 Points	9	6.0
9 Points	7	4.7
10 Points	7	4.7
11 Points	16	10.7
12 Points	21	14.0
13 Points	16	10.7
14 Points	17	11.3
15 Points	13	8.7
16 Points	13	8.7
17 Points	8	5.3
Total	150	100.0

generally high, and the average score distribution is 11.5. The cumulative percentage is 41.3％ for the 0 ～11 points、55.3％ accounts for 0～12 points. Also in the itemized aggregate calculation; - people who answered 'yes' to '*do you often meet your friends or relatives?*' And those who answered 'no' to '*have you ever thought that life is not worth living? Do you have a lot to be sad about? Do you get angry more than you used to?*' and 'yes' to '*Are you satisfied with your life now?*' was above 80%. For the group with over 50%, people answered 'yes' to both '*Do you think life gets worse as you get older?*' And '*As you get older, do you have feelings of uselessness?*'. The relation of BMD with dietary habit and lifestyle is shown in table 2. Two groups were made, one with moral scores of more than 12 points and the other with lower than 11 points accordingly and these two groups were analyzed, but we didn't observe any

Table 4 Moral Scale (Tally of each item)

		Number of people receiving score	Number of people not receiving score
1	I think life gets worse as I get older.	55 (36.9)	94 (63.1)
2	I am as healthy as last year.	101 (67.8)	48 (32.2)
3	How lonely do I feel?	113 (75.3)	37 (24.7)
4	Small things bother me more this year.	97 (66.9)	48 (33.1)
5	I often meet my friends and relatives.	139 (92.7)	11 (7.3)
6	As I get older, I have feelings of uselessness	69 (46.0)	81 (54.0)
7	I have not been able to sleep due to worry	79 (52.7)	71 (47.3)
8	I think getting older is better than I expected when I was younger.	95 (65.1)	51 (34.9)
9	I have thoughts that life is not worth living.	137 (91.3)	13 (8.7)
10	I am as happy now as I was when I was younger.	115 (77.7)	33 (22.3)
11	I have a lot to be sad about.	124 (82.7)	26 (17.3)
12	I worry about a lot of things.	77 (51.3)	73 (48.7)
13	I get angry more than I used to.	120 (80.0)	30 (20.0)
14	Life is hard for me	84 (56.4)	65 (43.6)
15	I am satisfied with my life now.	129 (87.8)	18 (12.2)
16	I tend to consider things seriously.	101 (69.2)	45 (30.8)
17	I tend to be upset by trivial things	102 (68.9)	46 (31.1)

number of people (%)

relationship with BMD.

In table 5 we show the condition of each food group's intake as the median scores and show the relation between BMD and food groups. The median quantity of the food groups intake is as follows: Green and yellow vegetables 100g, other vegetables 156g, seaweed 5.7g, beans 65g, seafood 77g, meat 46g, egg products 29g, dairy products 205g, fruits 150g, confectionary 68g, sugar products 13g, fats 10g. We set the overall median score as the standard, two groups were made as above this score and below it and we carried out an chi-square test. The only relation we discovered was for fats in the high BMD group compared to the low BMD group the score was low significantly ($p < 0.05$), but no other inevitable relation was found with other food groups.

Table 6 shows the situation of nutritional intake quantity given as median scores and show the relationship between BMD and nutrients. The median scores for nutritional intake quantity are as follows; Protein: 68.7g, Calcium: 714.3mg, Magnesium: 263.6mg, Iron: 8.20mg, Zinc: 7.96mg, Copper: 1.10mg, Vitamin D: 10.6μg, Vitamin K: 232.7μg, Vitamin B_1: 0.92mg, Vitamin B_2: 1.18mg, Vitamin B_6: 1.13mg, Vitamin C: 116mg, Dietary Fibers: 14.9g, Salt: 10.2g.

Similar to the food group analysis concerning nutrition we separated two groups according to median scores and analyzed them. We recognize zinc intake was higher significantly ($p < 0.05$) for the low BMD group, but for other nutritional groups, we can not show further relationship.

Discussion

Nutritional items which have an influence on BMD, are not only calcium and Vitamin D, but also good quality protein, Vitamin K. Magnesium, which influences enzymatic activity, iron, zinc, copper, etc particle elements etc, also play a crucial role. As table 6 shows this food intake frequency investigation, the nutrition which doesn't meet the recommended quantity according to the Japanese Food Intake Standard 2005[8] is Magnesium ($50 \sim 69$yrs old 290mg) only.

Kubota[2] mentioned in his meta- analysis that to

Table 5　The relationship between Bone Mineral Density (BMD) and Food group intake

		High BMD group (n=85)		Low BMD group (n=65)		χ^2	p value
		No. of people	Percentage (%)	No. of people	Percentage (%)		
Green/Yellow vegetables	100g (more than)	42	49.4	36	55.4	0.526	0.512
	100g (below)	43	50.6	29	44.6		
Other vegetables	156g (more than)	40	47.1	35	53.8	0.679	0.510
	156g (below)	45	52.9	30	46.2		
Seaweed	5.7g (more than)	48	56.5	36	55.4	0.018	1.000
	5.7g (below)	37	43.7	29	44.6		
Beans	65g (more than)	47	55.3	29	44.6	1.680	0.249
	65g (below)	38	44.7	36	55.4		
Seafood	77g (more than)	42	49.4	36	55.4	0.526	0.512
	77g (below)	43	50.6	29	44.6		
Meat	46g (more than)	48	56.5	40	61.5	0.390	0.616
	46g (below)	37	43.5	25	38.5		
Egg products	29g (more than)	44	51.8	36	55.4	0.194	0.742
	29g (below)	41	48.2	29	44.6		
Dairy products	205g (more than)	43	50.6	32	49.2	0.027	1.000
	205g (below)	42	49.4	33	50.8		
Fruit	150g (more than)	52	61.2	39	60.0	0.021	1.000
	150g (below)	33	38.8	26	40.0		
Confectionary	68g (more than)	38	44.7	37	56.9	2.199	0.187
	68g (below)	47	55.3	28	43.1		
Sugar products	13g (more than)	42	49.4	34	52.3	0.124	0.744
	13g (below)	43	50.6	31	47.7		
Fats	10g (more than)	36	42.4	39	60.0	4.588	0.048*
	10g (below)	49	57.6	26	40.0		

*P < 0.05

Table 6　The relationship between Bone Mineral Density and Nutritional Intake

		High BMD group (n=85)		Low BMD group (n=65)		χ^2	p value
		No. of people	Percentage (%)	No. of people	Percentage (%)		
Protein	68.7g (more than)	39	45.9	36	55.4	1.330	0.323
	68.7g (below)	46	54.1	29	44.6		
Calcium	714.3mg (more than)	39	45.9	36	55.4	1.330	0.323
	714.3mg (below)	46	54.1	29	44.6		
Magnesium	263.6mg (more than)	39	45.9	36	55.4	1.330	0.323
	263.6mg (below)	46	54.1	29	44.6		
Iron	8.20mg (more than)	40	47.1	35	53.8	0.679	0.510
	8.20mg (below)	45	52.9	30	46.2		
Zinc	7.96mg (more than)	36	42.4	39	60.0	4.588	0.048*
	7.96mg (below)	49	57.6	26	40.0		
Copper	1.10mg (more than)	40	47.1	35	53.8	0.679	0.510
	1.10mg (below)	45	52.9	30	46.2		
VitaminD	10.6μg (more than)	45	52.9	30	46.2	0.679	0.510
	10.6μg (below)	40	47.1	35	53.8		
VitaminK	232.7μg (more than)	43	50.6	32	49.2	0.027	1.000
	232.7μg (below)	42	49.4	33	50.8		

Vitamin B$_1$	0.92mg (more than)	41	48.2	34	52.3	0.244	0.742
	0.92mg (below)	44	51.8	31	47.7		
Vitamin B$_2$	1.18mg (more than)	44	51.8	31	47.7	0.244	0.742
	1.18mg (below)	41	48.2	34	52.3		
Vitamin B$_6$	1.13mg (more than)	43	50.6	32	49.2	0.027	1.000
	1.13mg (below)	42	49.4	33	50.8		
Vitamin C	116mg (more than)	42	49.4	33	50.8	0.027	1.000
	116mg (below)	43	50.6	32	49.2		
Dietary fibers	14.9g (more than)	44	51.8	31	47.7	0.244	0.742
	14.9g (below)	41	48.2	34	52.3		
Salt	10.2g (more than)	44	51.8	31	47.7	0.244	0.742
	10.2g (below)	41	48.2	34	52.3		

*P < 0.05

prevent elderly people breaking bones, calcium intake of more than 600mg per day is effective.

In our results however, we did not show in the tables that 69.3% of the respondents took more than 600mg, hence this group mostly had no nutritional intake problems.

We showed the relation between BMD and food groups in table 5; however, we found that there is little relevance, except for fats. Taking into account that diet during periods of growth has a huge influence for bone formation, henceforth we need to investigate the period of growth when bones are formed as well as diet and regular physical exercise.

In this investigation, we could acknowledge a strong inevitable relation between BMD and lifestyle, especially regular physical exercise. Naka et al.[9] reported in their investigation of middle aged and elderly women, even though it was not necessary to have regular physical exercise in the past, whether people have an exercise habit currently or not contributes to BMD maintenance, this is due to those who carry out regular physical exercise habit also tend to pay attention to their diet.

In the relation between exercise and middle aged and elderly people's BMD is twice a week resistance exercise and endurance exercise as training increasing muscle strength and this links to prevention of falls, however, there is a report[4] that notes there is no change for BMD. In this investigation, most of the regular physical exercise is a once or twice a week recreational type of exercise, but the habit which entails going out to a specific place to exercise is connected with active lifestyle for exercising in daily life. As a result, we are concerned that this might lead to BMD maintenance. We couldn't admit the relationship between QOL and BMD; however, from now on, moreover, we will increase the number of instances also we need to consider a study using questionnaires other than the PCG moral scale.

Acknowledgements

References

1) Social Insurance Institute. Basics of care prevention practice. 2006. Tokyo. Social Insurance Institute, 2006：

2) Kubota M, Optimization of Calcium Intake for the Prevention of Osteoporosis and Osteoporotic Fractures: a Review of the Evidence, Jpn. J. Hyg. 2003, 58, 317-327

3) Nelson, M.K., Fiatarone, M.A. Morganti, C.M., et al, Effects of high-intensity strength training on multiple risk factors for osteoporotic fractures. A randomized

controlled trial. JAMA, 1994, 272(24) 1909-1914

4) Fukuda R, Sakato H, Shinya K, et al, Effect of Exercise Training on Bone and Physical Fitness in Elderly Women. Descente sports science. 2000, 21, 59-67

5) Humphries, B., Newton, R.U., Bronks, R., et al, Effect of exercise intensity on bone density, strength, and calcium turnover in older women. 2000, Med. Sci. Sports Exerc., 32(6), 1043-1050

6) Mitui H.,Harada M., Kumazawa Y., Experience of AOS-100. Osteoporosis. J. 1998. 6(2) 179-182

7) Lawton, M.P. The Philadelphia Geriatric center Morale Scale: A revision. J. Gerontlogy, 1975. 30 85-89

8) Ministry of Health Labour, And Welfare, Japan.Dietary reference intakes for Japanese 2005.Tokyo Dai-ichisyuppann. 2005 XIV-XIX

9) Naka T., Nakajima D., OH T.W,et al. Effects of Lifestyle on Bone Metabolism in Middle-Aged and Aged Japanese Women. J. J. Physio. Anthropology 2004. 9(3) 85-92

中高年女性の骨密度の実態及び生活習慣との関連

須崎　　尚[*]　　　石田　静乃[*]　　　岡田希和子[*]　　　角谷　亜矢[*]
田中　秀吉[**]　　　山中　克己[**]

　地域中高年齢者の骨密度の測定及び食活習慣、生活習慣のアンケート調査を行った。

　調査対象者は地域の60歳以上の女性150名（平均年齢 ± 標準偏差：71.3±6.4歳）で、超音波式骨密度測定装置を用いて、右足の踵骨で行った。またアンケート調査により食事摂取頻度、生活習慣を調査した。

　骨密度が同年代の平均値以上の群を高密度群、平均値に満たない群を低密度群とし、摂取食品群、摂取栄養素、生活習慣と項目ごとのχ^2検定を行った。その結果、生活習慣では高骨密度群で運動習慣のあるものが有意（$p < 0.05$）に高く、栄養素の関連では高骨密度群で亜鉛摂取量が有意（$p < 0.05$）に低く、食品群では、高骨密度群で油脂類の摂取量が有意（$p < 0.05$）に低い結果が得られた。運動習慣と骨密度との間には強い関連が認められ、１週間に１度くらいの運動習慣でも、その習慣そのものが骨密度の維持に大きく寄与していることが示唆された。

＊名古屋学芸大学　管理栄養学部
＊＊一宮女子短期大学