CASE STUDY: IMPROVE BONE QUALITY AND SKELETAL MUSCLE MASS WITH A PROPER DIET AND EXERCISE FOR A PERSON AGED >60 YEARS OLD

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ABSTRACT

Objective: To evaluate the effects of proper dietary and exercise practice on bone mineral quality, skelet muscle and fatty mass in a person aged > 60y. ***Subject*** & ***Methods:*** A 60 ys- old male subject, risk of osteoporosis received the daily diet 2000Kcal, Ca 1300mg, protein 1.7mg/kg.bw, vitamin D 665IU. Endurance exercise 3 times/week x 60 minutes/ session with moderate & high intensity levels; 45 minutes daily morning with moderate and light intensity, and 8 hours working at office. Heel- bone mineral density (BMD) measured by Quantitative Ultra-Sonic (QUS) instrument, skelets muscle and fat mass by Inbody 370S intrument every 6 months. The study period lasted 60 months (T60). ***Results:*** The T-score of heel bone increase from -2.4 (high risk osteoporosis) at the beginning (T0) to level of pick bone mass at T36, then maintained until T60 of intervention. The BUA (Broadband Ultrasound Attenuation), reflects the quality of the bone s' trabecular, were also improved from 39.5dB/MHz to 108.1dB/MHz (+173.7%) from T0 to T60 respectively. The body weight, skelet-muscle & fat mass were maintained quite stable during 60 months of the study. ***Conclusion:*** A proper diet and exercise restored bone quality to pick bone mass levels, maintain skeletal muscle and body fat mass in the elderly.

Key words: *Older person, diet, exercise, osteoporosis, BMD, skeletal muscle, fat mass*

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I. INTRODUCTION

Survey data in 2021 show that the average life expectancy of Vietnamese people is 73ys old, but healthy age is only 64ys, elderly people > 65 will reach 7.4 million, will increase to 17.28 million by 2029 (16.5% of the population) [1]. Elderly people often accompany, or combine with chronic diseases such as cardiovascular, bone and joint diseases... in which 40-50% of women have osteoporosis-related fractures [2,3].

After 30 year old, especially after menopause in women, bone density tends to decrease gradually by 1-2% and muscle mass also decreases by 2-3% per year, while the fat mass increase and replace lost muscle mass, leading to weakening muscle strength, easy to lose balance and fall, and chronic diseases arise [4,5]. To prevent osteoporosis, muscle atrophy, the proper nutrition and exercise are the two important measures. Scientific evidence shows that for 1 SD of BMD decrease, the risk of fracture increases by 30% in the elderly [6,7].

This study presents the results of improving bone quality, of stabilizing muscle mass and fat mass, of a subject man (60 years old), by application a dailly proper diet and exercise during 60 months (5 years), has greatly improved bone quality, maintained muscle mass, fat mass. The results have scientific significance, have new points, and the lessons learned are practical for the

Vietnamese elderly community to be able to apply.

II. STUDY METHOD

Anthropometric index of the subject at the beginning of the study: Male 60 years old, no chronic diseases, high 1m67, weighed 72kg, BMI 25.8, fat mass 15.9kg (22% rate), skeletal muscle mass 48kg (in normal range). However, heel bone density measured (BMD) by SONOST 2000 ultrasound machine gave a T-score of -2.4 (risk of osteoporosis), only 64.5% of bone peak, and 83.2% of age 60.

Intervention dietary: The dailly dietary intake were designed according to the recommendations (RDA) for Vietnamese people [8], according to the subjects' nutritional status. In order to maintain muscle mass, increase bone density, and reduce fat mass by about 5 kg to achieve the <20% standard.

Table 1. ***Nutrients value of the dailly dietary intake***

Nutrients	Quantity	RDA 50-69 ys old*
Energy (Kcal), BMR	2007 (1450)	1.3 x CHCB
Protid(g); (Pr. Anim)$^{+}$	127.7 (89.8)	1.77g/kg
Lipid (g); (Li. Veget)$^{+}$	59.8 (35.87)	52-65
Glucid (g)	239.5	320-350
Vit. A (mcg)	1135	850
Vit. D (IU)	215	800
Vit. K (mcg)	252.4	150
Calci (mg)	1073	800-1300
Fe (mg)	16.8	11.9
Zn (mg)	12.1	10-20
Fiber (g)	15.6	30
% Total Energy P:L:G = 26.6%: 28%: 49.9%		

**RDA for Vietnamese 61,8kg; BMR: Base Metabolic Rate*

$^{+,}$ Pr. Anim: from animalt; Li.Vegt: from vegetal food

Tab. 1 shows the dietary intake/day of subject: about 2000Kcal, some nutrients are lower than RDA such as Glucid (239.5g), vitamin D (115IU) and fiber (15.6g). Other nutrients exceed the RDA such as Protein (1.77g/kg bw). One tablet of multi-micronutrients was dailly supplemented with contents Ca: 250mg, D3: 450IU, Zn: 30mg, Mg: 45mg). The diet is divided into 5 meals a day (3 main meals, 2 snacks- one after exercise).

Exercises and Physical activities interventions:

Table 2. ***Estimated of the dailly energy expenditure for the exercise and activities***

Type of activities	Characteriristic	Kcal expenditure
BMR	Using Inboby (Korea)	1.400
GYM exercise 3session/week x 60min /session	Moderate & high level, 1000Kcal / session	420
Morning Taichi quan 30’	light level	80
Working at the office	Moderate level	300
Total energy expenditure		***2.200***

Tab. 2 shows the daily activities with an estimated calorie expenditure of 2200Kcal, including 30-45 minutes of light exercise in the morning, working in the office for 8 hours; GYM exercises 3 sessions per week with the ImPulse RE500 (China) instrument, using fat burning mode (Cardio-endurance exercise), 60 minutes per session, intensity increased from 60watt to 290watt, heart rate maintained at 120-155 pulse /min, average and high intensity levels (#50-90% V2Omax) according to WHO 2020 recommendations [6].

Monitoring the changes of Anthropometric and BMD

Weight, fat, muscle, bone, water, were measured on Inbody 370S (Korea) once a month, using Asian standards. Heel bone quality indices were mesuared with SONOST 2000 ultrasound instrument (Osteosys, Korea), every 3 months. However to simplify, the data are presented for every 6 & 12 months.

The SOS indice (speed of sound, m/s) - reflect the thickness of cortical bone, and BUA (dB/MHz) – reflects the quality of the trabecular of bone; the software calculates the T-score, (vs. pick bone mass) and Z-score (vs. actual age), using the reference for Asians, according to WHO classification [9,10,11]. Measurement techniques are standardized for technicians, calibrated dailly with Phantom heel. The fluctuation of the machine was also checked at the beginning of the study on 20 subjects x 3 measurements, giving CV= 2.7% with BUA and 0.5% with SOS.

III. RESULTS

Table 3. ***Changes of the Bone Minerals Density during 60 months of the study***

Time (Mo/Y)	SOS (m/s)	BUA (dB/MHz)	T-Score	Z-Score
T0 (6/2018)	1497.6	39.5	-2.4	-1.2
T6 (12/2018)	1499.2	62.4	-1.2	0.1
T12 (6/2019)	1506.7	72.2	-0.8	0.9
T24 (6/2020)	1512.4	86.0	-0.2	1.7
T36 (6/2021)	1516.6	89.8	0	2.0
T48 (6/2022)	1524.9	108.1	0.8	3.3
T60 (6/2023)	1514.1	86.0	-0.2	1.9

T0, T6, T12, T24, T36, T48, T60: at the beginning, 6mo to 60mo of the study.

Both SOS and BUA index increased gradually during study (***Tab.3***); however BUA increased more rapidly, from 39.5 to 108.1 dB/MHz (at T48), then slitly reduiced, reflecting the rehanbilitation of trabecular-structural of bone, while SOS increased more slowly (+17(m/s)- reflecting of the thickness of cortical bone is also improved.

Simillarlly, T-scores from at high risk of osteoporosis (-2.4) was increased to -0.8 after 12 months, then obtained the normal value at 36mo. Similarlly Z-score was become to normal value after 6mo, then gradulally continue improved to 3.3, 1,9 at T48 and T60 of intervention.

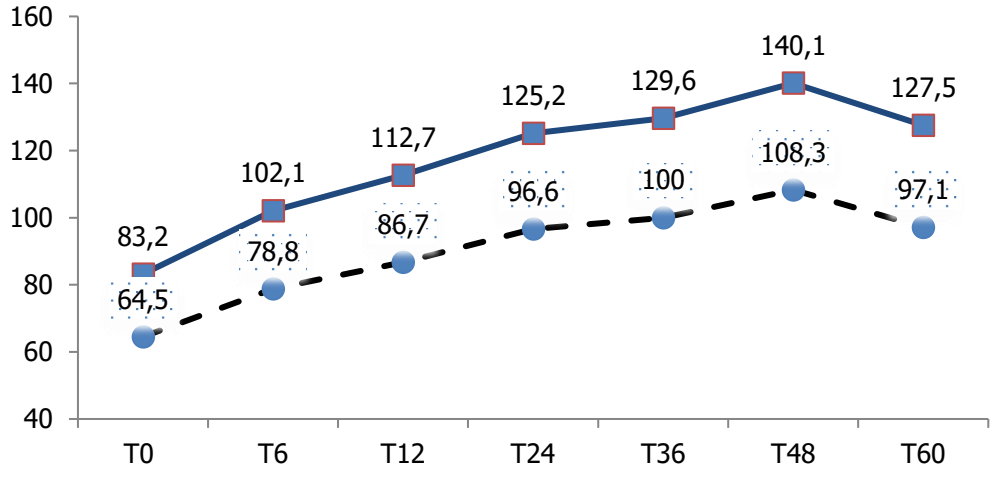

Figure 1: ***Changes (%) of Z-score (solid line) and T- score (dash line) compared to the beginning of intervention***

Fig. 1 indice the gaine in T-score & Z-score compared to the start of the study: Z-score improved and reached normal level (100%) at 6 months, while T-score reached at 100% at 36 months of intervention. By T48 months of the study, T-score and Z-score reached the highest value then remained at 97,1% and 127% respectively at T60.

Tabe 4. ***Changes of weight, skeletal musle and body fat mass during study***

Study time	Weight kg	Skeletal muscle mass		Body Fat mass	
		kg	%	kg	%
T0	73.5	32.3	43.9	16.7	22.7
T6	73.0	32.0	43.8	16.6	22.8
T12	71.5	31.5	44.1	15.9	22.2
T24	72.8	31.3	43.0	17.1	23.5
T36	72.7	31.1	42.8	17.3	23.7
T48	72.3	31.2	43.2	17.2	23.8
T60	72.8	31.4	43.1	17.7	24.3

T0 to T60: moments of the study intervention.

Tab. 4 shows that the body composition was quite stable during the study: 72-73kg with weight; 32.3-31.4kg with skeletal muscle mass, 16.7-17.7 kg with fat mass; and relatively stable in % of body weight.

IV. DISCUSSIONS

Our study showed that with proper diet and exercise, the older person > 60 y -old at hight risk of osteoporosis can be recovered to normal of Z-score at 6months and T-score at 36 months, then maintain at good level to 60 months of intervention, especially bone trabecular quality also restored to normal range. The intervention also has a good effect on stabilizing muscle mass and fat mass in the elderly.

The study diet is formulated for the purpose of increasing bone and muscle BMD, reducing body fat: adequate amounts of calcium, phosphorus, dietary protein and some other micronutrients (see Tab.1).

Moderate and heavy intensity exercise is set up 3 times a week, light exercise daily as recommended by WHO [6].

Scientifically, the DEXA (Dual Energy X-ray Absorptiometry) is considered as the gold standard method to assess the BMD and osteoporosis, the muscle and fat mass of the body. However, DEXA has some limitations in its application: big instrument, the high cost for instuments anf measurement; so it is difficult to apply for wide surveys and screening in populatin, particularlly difficult for longitudinal study with multiple moves and measures osteoporosis status. Meanwhile the QUS instrumentwith compact is machine, low cost, easierly moved in the field for the population surveys, the accuracy acceptable. Some studies have also tested the accuracy and specificity against DEXA, indicating the close correlation (r=0.8888, sensitivity 73.21%, specificity). 93.21% between two), the evidence is very consistent with the results of DEXA [11,12]. Wen-Hui Fang et al 2020 indicate also that the correlation coefficient between the DXA and Inbody instrument for muscle mass and fat mass were 0.977 and 0.978, respectively [13].

In our study, the increase in BMD was up to 10-15% every 6 months, so with a fluctuation <3% does not distort the trend change, on the other hand the measurement technique is also standardized to minimize possible errors. Therefore, the increase in BMD and bone quality can be claimed to be reliable and scientifically significant. The remarquable increase of BUA proves trabecular structure of bone is restored and improved. In fact, in the elderly, the microstructure shows that the trabecular bones are thinner and even broken, leading to BMD deficiency and osteoporosis. Langton et al. 1996 [14] also demonstrated that BUA increases or decreases proportional to the thickness of the trabeculae, BUA changes most markedly with the ends of bones, for example, the calcaneal bone, the femoral head, and the effectiveness of interventional therapy.

Several factors may explain the large increase in BUA in our study: 1) Heel bone content many trabeculae, blood vessels, minerals and collagen account for the majority, metabolic rate faster than the cortical part [12]; 2) The dailly dietary intake was etablished suitable for individual subject, included calcium 1000-1200mg/day, vitamin D 800IU, protein even reaching 1.7g/kg of body weight, which is optimal for the subject; 3) The physical activity intensity of the subject was in high levels according to WHO recommandation, and higher effect of walking or practicing tai chi in the elderly that was only increased by 2-3% after 6 months or 12 interventions [15,16];. When combined with diet and moderate and heavy resistance training, it has stimulated bone anabolism, increased the absorption of minerals and protein into the bone trabeculae, helping bones recover and regenerate faster; help increase muscle mass regenerate, inhibit the mutation factor in the elderly.

Another factors that can be explained is that when the intervention with a large number of samples, there are more influencing factors, some subjects are less effective, there are subjects with more improvement, leading to improved results. as large as our one case track. On the other hand, the vast majority of community-based studies in middle-aged and elderly groups with light and moderate intensity of physical activity, such as walking or yoga, have

resulted in restoration of bone mass, bone density and muscle mass is smaller than during vigorous physical activity with high resistance. [17,18]. The results of ours study such as helping to prevent muscle mass loss, fat mass not increasing in the elderly in 5 years of implementation, is also a remarkable success and proof, which can be disseminated to the community.

The study has some limitations such as tracking only 1 subject, the assessment is based on the QUS instrument, with 1 location being the heel bone, which may not be representative of the general population. However, the study with 1 subject has the advantage of controlling for confounding factors and errors, so the results are scientifically valid and reliable. Also closely monitoring a subject, so there are strengths that large-scale studies do not have: diet and exercise are tailored to the subject, rigorously implemented, and tightly controlled, standardized QUS technique, limited errors, long follow-up time of 48 months with regular and periodic follow-up assessments by an Inbody and SONOST machine, the subject can automatically Correction and supplementation of some unexpected changes in diet and exercise that may occur.

Our study also shows that assessing heel bone density by QUS is a convenient, low-cost measure that can be applied on a large scale in Vietnam to screen for osteoporosis risk, as well as to monitor the changes in bone density, bone trabecular restoration during the 6-month intervention period. The research results have some new and meaningful points for the community: with appropriate interventions on dietary anf physical activity can restored the bone loss in the elderly, while kept and stabilized the muscle and fat mass, improving nutritional status and health status in general[19,20].

Our study also suggests further research, as well as application to the elderly population at risk of osteoporosis and sarcopenia: 1) Other studies may be more extensive on representative subjects, genders, disease stages, with a diet with sufficient protein and calcium, the intervention duration should be 12-36 months, QUS and Inbody instrument can be used in screening, monitoring and intervention every 6 months, can combine small samples with DEXA -3 positions if conditions permit. 2) For the elderly subjects at risk of osteoporosis and sarcopenia: should visit a nutritionist clinic to assess the status of the diet as well as the body's condition to prevent sacopenia and other chronics deaseases [21].

V. CONCLUSSION

Elderly people with hight risk of osteoporis, with propper dietary intake and regulally exercise, can restore bone mineral density to normal pick bone mass, maintain skeletal muscle mass and fat mass, contribute to improving health and nutritional status.

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