Effect of Soybean Intake on Nutritional Status of the Healthy Elderly

Yaung-Ja Park and Seung-Gyo Rhie*[†]

Dept. of Food and Nutrition, Seoul National University, Seoul 151-742, Korea
*Dept. of Food and Nutrition, The University of Suwon, Suwon 445-743, Korea

Abstract

The purpose of this study was to develop the dietary enhancement program for rural elderly. The subjects consisted of 71 normal healthy elderly aged over 60 living in rural and senior citizen center. Daily supplementation of 20g soybean powder for 3 months revealed no statistically significant elevation in serum parameters of the elderly, but resulted in the increment in the number of the subject with normal range of serum parameters and the improvement in perceptions of health status by CMI score, even though the nutrients intake had constantly lowered. The nutrients intake of rural elderly was very low: energy intake was 59~68% of RDA, that of protein 47~59%, and calcium 21~60% only. Supplementation of 20g soybean powder per day for 3 months, did not enhance nutrients intake of rural elderly. We can recommend that constant nutrients supplementation program as well as dietary enhancement program are needed to improve the quality of life of rural elderly.

Key words: soybean intake, nutritional status, biochemical indices, rural elderly

INTRODUCTION

The aging process leads to deterioration in most body organs, although there are substantial differences in the rate of loss among organs and individuals. Interindividual differences are widen with age, but it is less clear how far the increased variation is attributable to true variations in the rate of aging, and how far it reflects the varying impact of disease and poor life style. In the context of nutrition for the elderly, particular interest attaches to the deterioration of work performance, impairment of organ function, and diminished ability to adopt to environmental challanges.

The nutritional status of the rural Korean elderly population has been described in several studies(1-4). Most dietary intake surveys of this age group reported lower intake of nutrients. Maintenance of nutritional status is dependent on adequate food supply regardless of social status. The situation of rural elderly living alone or couple will be widespread in the industrialized area. The impairment of function and diminished ability of the elderly make them more difficult to prepare foods. It will be suggested that the rural elderly become undernutrition, which will become one of the serious public health problems.

When the major source of protein is a cereal protein, it would be required to supplement of essential amino acids quantitatively and qualitatively. Supplementation of amino acids by minimum level of animal proteins can adequately be balanced amino acids in predominantly cereal-vegetable diet. The use of locally grown legumes (pulses) in daily food preparations in villages is notably economical and nutritionally practical. Legume is generally used as side dishes in Korea. It is cheaper source of nutrients compared to meat and fish. The Institute of Nutrition for Central America and Panama Group using combinations of maize and rice with stringbeans and cowpea had already reported that legumes with rice combination had a higher protein value than rice itself.

Determining the effect of soybean intake is useful for Koreans because of Korean food habit and frequent intake of soy products such as soy sauce and soy paste. And some investigators(5-10) reported that genstein which is isoflavonoids derived from soybean products, has been shown to inhibit thrombin formation and platelet activation *in vitro* and *in vivo*. Thus, it is important to eat soy products for keeping hematological status and better health of elderly.

Maintenance of health of the elderly requires good

[†] Corresponding author

nutrients intake. Also dietary proteins have various functions in the gastrointestinal tract. For example, the protein and its hydrolysate affect membrane and digestive enzymes, various transports and motility of the gastrointestinal tract(11). The adequate protein intake of the elderly was in the nitrogen balance without changes in lean tissue and with improvements in immune response(12,13).

This study was carried out by interviewing the elderly to investigate nutrients intake and dietary environments of rural and asylum elderly in Kyunggi area. And to determine the effects of soybean supplementation for nutritional improvement of the elderly, biochemical indicators, such as, total serum cholesterol, triglyceride content, hematocrit and hemoglobin levels, were used as criteria to test their nutritional status before and after the study period.

SUBJECTS AND METHODS

Selection of elderly subjects

The subjects consisted of 71(rural 38 and senior citizen center 33 persons were selected) normal healthy elderly aged over 60. They agreed to the purpose of study and accepted to eat soybean powder during the study period.

Survey period

Investigation started from June 1995 and continued for 3 months of eating soybean powder. Test was carried before and after the study period.

Preparation of soybean powder product

To drink in summer season, it makes same as beverages, 1 : 1 of soybean powder and glutinous brown rice powder product. And eat 40g of dried powder product with water between meals every day, and can put sugar if they want sweety taste.

Environmental factors

Education, degree of labor, meal frequency, meal quantity, appetite, teeth status, meal regularity, alcohol drink, smoke, sleep, and feeling health were surveyed by interview using questionnaire.

Nutritional status

Food habit score and food intake were determined by indirect method(14). Food habit test was composed of 3 different degrees respond of alcohol drink, salt and fat intake and others. Food intake survey was questionned about frequency and quantity of different food groups.

Anthrophometric measurement

Height, weight, and blood pressure were measured.

The self-consciousness health status by CMI

31 questions were selected from CMI(Cornell Medical Index: it composed over 200 questions about physical and mental complains) and adopted for elderly situation.

Biochemical assessment

Blood samples were collected from each subject before and after experiment with the help of regional health care center of Hwasung Gun. The levels of serum cholesterol, triglyceride, hematocrit, and hemoglobin were determined with non-fasting serums.

The statistical analysis

All the surveyed data were calculated about frequency and x^2-value for significance. To compare before and after soybean intake and other factors, unbalanced ANOVA of general linear model(GLM) procedure was used by SAS method.

RESULTS AND DISCUSSION

General environmental characteristics of rural and asylum elderly

The details of general environmental characteristics of elderly were as followes.

The age distribution of subjects was in Table 1. The age over 75 year olds were 68% of this subjects, especially asylum women of this age group were 30% of all.

The physical status of elderly was shown in Table 2. Asylum elderly was smaller in height and weight, but blood pressure was lower than that of rural elderly.

Subjects were not varied widely in height and weight status. The values in our study were slightly lower than Korean standards, 166~167cm 60~64kg for male and 152~154cm 51~54kg for female elderly(15). By the meaning that height and weight status would reflect the previous nutritional status, they were lower status of

Table 1. Age distribution of the elderly   (unit : persons(%))

Gender	Rural						Asylum					
	Men			Women			Men			Women		
Age	Under 64	65~74	Over 75	Under 64	65~74	Over 75	Under 64	65~74	Over 75	Under 64	65~74	Over 75
Persons	3(4)	12(17)	10(14)	4(6)	6(8)	13(18)	1(1)	5(7)	4(6)	0(0)	2(3)	21(30)

Table 2. Height, weight and blood pressure of the elderly   (Mean±SD)

Devision	No.(n)	Height(cm)	Weight(kg)	Blood pressure(mmHg)	
				Systolic	Diastolic
Rural	38	156±2	56±1	148±4	90±2
Asylum	33	148±2	52±2	141±4	81±2
Total	71	154±1	55±1	147±2	88±1

Table 3. General characteristics of the elderly   (unit : frequency(%))

General characteristics	Level	Rural	Asylum	Total	
Education	Illiteracy	9(13.0)	8(11.6)	17(26.6)	
	Literacy	14(20.3)	12(17.4)	26(37.7)	x^2=0.199 ns
	Over educated	15(21.7)	10(15.9)	26(37.7)	
Labor	Not work	10(15.1)	8(12.3)	18(27.9)	
	A little work	15(23.1)	14(21.5)	29(44.6)	
	Moderate work	10(15.4)	0(0.0)	10(15.4)	x^2=9.157 p<0.05
	Hard work	3(4.6)	5(7.7)	8(12.3)	
Alcohol use	No drink	24(33.8)	33(46.5)	57(80.3)	
	Drink	14(19.7)	0(0.0)	14(19.7)	x^2=15.14 p<0.01
Smoking	No smoke	20(28.2)	33(46.5)	53(74.7)	
	Smoke	18(25.3)	0(0.0)	18(25.3)	x^2=20.94 p<0.01
Sleeping	Well	6(8.5)	7(9.9)	13(18.3)	
	Normal	10(14.1)	9(12.7)	19(26.8)	
	1~2times awake	5(7.0)	6(8.5)	11(15.5)	x^2 =3.723 ns
	Awake several times	7(9.9)	8(11.3)	15(21.1)	
	Can't sleep well	10(14.1)	3(4.2)	13(18.3)	
Feeling health	Healthy	7(9.9)	11(15.5)	18(25.4)	
	Well	5(7.0)	7(9.9)	12(16.9)	
	Weak	19(26.8)	9(12.7)	28(39.4)	x^2 =4.555 ns
	A little bad	6(8.5)	5(7.0)	11(15.5)	
	So bad	1(1.4)	1(1.4)	2(2.8)	

nutrition and health status. But this result was similar to those who lived in Seoul 10 years ago(16) and to those of Japanese elderly(17). The blood pressure of elderly of 147/88mmHg was not high(18), since aged person's blood pressure was a little higher than the young's.

The general situation of rural and asylum elderly was surveyed as shown in Table 3. Educational level of rural and asylum elderly was only literacy. And rural elderly worked more than the aged asylum. Information on the consumption of alcoholic beverages and smoking was collected. Normally Korean elderly are much abused of alcohol especially during busy season of farming in rural area, but this result showed the better states of alcohol drink. Asylum elderly did not smo-

ke either alcohol drink. In the institution rule, the person living there could neither smoke nor drink alcohol because of the character of senior citizen center funded by protestant religion. And sleeping state was normal and feeling health state was a little weak.

The results of dietary condition were presented in Table 4. Meal frequency was almost 3 times(2.96times per day) and meal quantity was slightly small. The teeth status was not good, but appetite was not problem.

Biochemical indices of nutritional status of rural and asylum elderly before and after treatment of soybean

The results of biochemical indices of serum as the

Table 4. The dietary condition of the elderly

Factor	Mean	Caculated score level(number means the point)
Meal frequency	2.96	① 1/day ② 2/day ③ 3/day ④ 3/day over
Meal quantity	2.24	① over eat ② normal ③ small eat ④ sometimes no eat
Appetite	1.81	① very good ② normal ③ bad
Teeth status	2.56	① very good ② normal ③ bad
Meal regularity	1.11	① yes ② no

Table 5. Changes of serum cholesterol and TG status before and after treatment of soybean-intake

Devision	Sex	No. (n)	Serum cholesterol(mg/dl)		Serum triglyceride(mg/dl)	
			Before	After	Before	After
Rural	Men	25	168±34	168±39	161±142	195±202
	Women	13	188±35	192±37	147± 91	172± 96
	Sub total	38	175±35	178±40	156±125	185±164
Asylum	Men	10	183±32	206±25	143± 38	129± 56
	Women	23	219±49	214±34	178± 74	175±159
	Sub total	33	209±47	212±32	167± 66	161±137
Total	Men	35	173±33	181±39	156±121	171±167
	Women	36	208±46	206±36	167± 81	174±138
	Total	71	191±44	195±39	161±101	173±150
Age	Under 64	8	171±23	176±17	159± 88	245±292
	65~74	25	176±29	182±34	166±142	165± 84
	Over 75	38	204±51	209±42	159± 71	160±138

Cholesterol; area*sex*before and after treatment: F=5.80 p<0.05 sex: F=3.04 p<0.1

Table 6. Changes of blood hematocrit and hemoglobin before and after treatment of soybean intake

	Sex	No.	Hematocrit(%)		Hemoglobin(g/dl)	
			Before	After	Before	After
Rural	Men	25	41.1±3.2	39.0± 9.9	14.1±1.1	14.2±1.8
	Women	13	36.3±3.1	36.8± 3.1	12.4±11	12.6±1.3
	Sub-total	38	39.4±3.9	38.1± 7.8	13.5±1.4	13.5±1.8
Asylum	Men	10	39.1±6.5	43.1± 4.9	13.5±2.6	14.9±1.7
	Women	23	36.0±2.8	36.3± 3.4	12.2±1.1	12.3±1.2
	Sub-total	33	37.0±4.5	38.3± 5.0	12.6±1.8	13.1±1.8
Total	Men	35	40.5±4.5	40.5± 8.5	14.0±1.7	14.5±1.8
	Women	36	36.1±2.9	36.5± 3.2	12.2±1.1	12.4±1.2
	Sub-total	71	38.3±4.3	38.2± 6.4	13.1±1.6	13.3±1.8
Age	Uder 4	8	38.2±4.3	34.2±13.0	13.2±1.7	13.6±2.1
	65~	25	39.6±4.7	40.5± 4.2	13.6±1.8	13.9±1.5
	Over 75	38	37.5±4.0	37.6± 4.7	12.7±1.5	12.8±1.8

Ht; area*sex*before and after treatment: F=4.41 p<0.05 sex: F=8.52 p<0.01 age: F=3.80 p<0.05
Hb; area*sex*before and after treatment: F=5.71 p<0.05 sex: F=12.57 p<0.01 age: F=2.77 p<0.1

role of nutritional states were listed in Tables 5 and 6.

Serum triglyceride(TG) and cholesterol contents were shown in Table 5. By this result, serum TG was not significantly different between age, sex, and before and after treatment of soybean intake. But serum cholesterol was different by sex, and men had higher cholesterol level than women. The elderly in the senior citizen center had higher cholesterol level than that of rural but

it was not statistically significant. Serum TG level was higher than other national reports(19), but that of other Korean elderly over 60 was similar(20). It was also reported by Lee and Kim (21), that Korean serum lipid levels are lower than that of Americans. By this result, Korean elderly showed lower degree of serum lipids than American of total-cholesterol 241.5mg/dl, TG 165.7mg/dl after exercise(22), so the problem by serum lipids was

Table 7. Changes in proportion of elderly before and after treatment of soybean intake under or over the cut-off point value of blood parameters (unit · frequency)

Aea	Blood parameters	Cholesterol		Tiglyceride		Hematocrit		Hemoglobin	
		Before	After	Before	After	Before	After	Before	After
Rural	Under	6	13	2	7	7	15	6	14
	Normal	30	24	26	21	29	21	30	22
	Over	2	1	10	10	2	2	2	2
Asylum	Under	0	0	0	1	14	8	14	8
	Normal	30	31	19	22	18	22	18	22
	Over	3	2	14	10	1	3	1	3
Total	Under	6	13	2	8	21	23	20	22
	Nomal	60	55	45	43	47	43	48	44
	Over	5	3	24	20	3	5	3	5

The normal range of blood components: albumin 3.3~5.3g/dl, cholesterol 140~250mg/dl, TG 50~170mg/dl, Ca 85~11mg/dl, hematocrit 36~46%, hemoglobin 12~16g/dl

not getting serious in the status of health.

In the aspects of soybean intake, there was no significantly different increased status of serum fat. The garlic intake has been shown to change blood lipoproteins and may be of value in either the prevention or treatment of atherosclerotic disease(23). And also, nutritional therapy by providing oral supplementation of 500kcal/day for 8 weeks resulted in a marked improvement in clinical and biochemical indices of nutrition(24). But the other study(25) concluded that the age, gender and diet did not significantly alter the ability of rats to regulate body composition or fat cell proliferation. It would be more of soybean quantity or longer period to obtain better results of nutritional status for the elderly.

To determine iron status, hemoglobin and hematocrit value is most frequently evaluated, but the normal values for healthy population over 65 are unknown and the values used are those for young adults. The values defined for Ten State Nutrition Survey were 2 categories of unacceptable and high risk(male: <44% <37% of Hct, <14.0g/dl 12.0g/dl of Hb, female: <37% 31% of Hct, 12.0g/dl 10.0g/dl of Hb) populations(26). According to Ten State survey guidelines, iron status for this subjects was in unacceptable categories. It would be possible to have anemia, especially female subjects exhibited inferior iron status. The Korean urban elderly(1) had higher hemoglobin and hematocrit values than this result and also to Japanese elderly Hb and Hct values were higher than these results(17).

The effects of eating soybean-powder on hemoglobin and hematocrit values were not increased significantly among elderly group. Legumes contain more

iron than cereals, but its bioavailability in human is quite limited(27). And the ground soybeans consisted of high fiber and phytate, but it is not the factors that reduces iron bioavailability(28). But zinc absorption is inhibited by soy phytate and soy fiber(29). For this reason, soybean intake was not a good source of iron but protein that would give a good condition to produce erythrocytes.

In Table 7, the blood parameters are summarized by normal and abnormal values. Comparing the initial states of hemoglobin contents(Hb), the elderly average Hb levels was lower, that was marginal anemia state. After feeding soybean-powder supplementation, the number of improved blood parameters was become better but there was a little significant differences(p<0.1) in normal or abnormal blood concentration among elderly.

Hemoglobin levels can not be increased by iron treatment alone but should be accompanied by increasing protein intake. In feeding high protein diet, the best improvement of hematocrit level was observed in malnourished children fed soybean(30), and in malnourished elderly(26).

The self-consciousness health status by CMI of rural and asylum elderly before and after treatment of soybean

For test of self-consciousness health status, we used CMI selected 31 questions for elderly. The self-consciousness health status by CMI was a good indicator of health status that proved by Han and Kim(31) with osteoporosis. They concluded the risk of osteoporosis can increase as syndrome of bone senility by CMI. The result showed in Table 8. It presented that more aged persons felt sick and complained their abnormal con-

Table 8. Changes of CMI scores[1] of elderly before and after treatment of soybean intake   (Mean±SD)
(CMI [Cornell Medical Index] score : Degree of points of complaining symptom)

	Sex	Age	No.	Before	After
Rural	Men	Under 64	3	8.7±10.8	7.3±4.9
		65~74	12	12.7± 6.4	9.5±4.3
		Over 75	10	11.5± 5.6	11.5±5.4
		Sub-total	25	11.7± 6.5	10.0±4.8
	Women	Under 64	4	12.0± 7.0	8.8±3.6
		65~74	6	11.8± 3.9	9.2±2.8
		Over 75	3	10.3± 2.1	7.3±2.5
		Sub-total	13	11.5± 4.4	8.6±2.8
Asylum	Men	Under 64	1	6.0	8.0
		65~74	5	3.2± 2.5	4.0±1.4
		Over 75	4	3.5± 1.7	3.3±3.3
		Sub-total	10	3.6± 2.1	4.1±2.6
	Women	65~74	2	6.0± 1.4	3.5±4.9
		Over 75	21	9.1± 5.2	7.0±5.0
		Sub-total	23	8.8± 5.0	6 7±5.0
Total	Men	Under 64	4	8.0± 8.9	7.5±4.0
		65~74	17	9.9± 7.0	7.9±4.4
		Over 75	14	9.2± 6.0	9.1±6.1
		Sub-total	35	9.4± 6.7	8.3±5.1
	Women	Under 64	4	12.0± 7.0	8.8±3.6
		65~74	8	10.4± 4.3	7.8±4.0
		Over 75	24	9.3± 4.9	7.0±4.7
		Sub-total	36	9.8± 5.0	7.4±4.4

Age: F-value=3.64 p<0.05
Before and after treatment: F-value=10.51 p<0.01
[1] Total scores of symptoms are 31 points

dition and rural elderly felt more sick than institutional elderly.

But after supplemented soybean powder, they felt significantly better than before. It would be suggested that the self-consciousness health status by CMI reflect the person's situation. Rural person felt more complain than asylum aged. It would be the reason that rural elderly must work more than asylum in the field and in home to prepare own foods. The 2 groups(rural and asylum) were in different situations of eating that means in asylum meal was given at meal time but rural elderly must prepare own food. Then supplements of soybean powder eating made sense the concern of health and made feeling good condition.

Nutritional status by nutrients intake of rural and asylum elderly before and after treatment of soybean

The nutrient intake of the elderly was summerized in Table 9. And the percentage of energy, protein, minerals and vitamins intake by Korean RDA(15) of elderly age

group was concluded in Table 10 and Table 11. The nutrients intake of rural elderly was very low: energy intake was 59~68% of RDA, that of protein 47~59%, and calcium 21~60% only. And there were no significant differences with 2 tests before and after experiment. Results of the present study are in agreement with findings by others(3,4) in that elderly individuals do necessarily consume more foods.

Table 9. Changes of nutrients intake of elderly before and after treatment of soybean intake

(Mean±SD)

Nutrients		Before	After
Energy	kcal/day	1341±535	1690±734
Protein	g/day	46±31	67±41
Fat	g/day	20±26	35±32
Carbohydrate	g/day	245±72	276±107
Calcium	mg/day	542±324	452±265
Iron	mg/day	11±6	11±6
Vitamin A	R.E./day	330±196	186±106
Thiamin	mg/day	0.89±0.29	0.92±0.36
Riboflavin	mg/day	0.88±0.54	0.73±0.43
Niacin	mg/day	15±5	17±7
Vitamin C	mg/day	31±18	19±10

Table 10. The percentage of energy, protein, calcium, and iron intake by Korean RDA(15) of elderly age group before and after treatment of soybean intake

(unit : % (Mean±SD))

Area	Sex	Persons	Energy		Protein		Calcium		Iron	
			Before	After	Before	After	Before	After	Before	After
Rural	Men	25	60±21	61±19	59±39	47±19	60±35	34±13	76±48	47±19
	Women	13	67±17	68±21	56±19	54±18	50±28	29±10	64±31	46±18
	Sub-total	38	62±20	64±20	58±34	50±19	56±33	32±12	72±43	47±19
Asylum	Men	10	73±7	138±26	56±8	169±21	88±25	109±7	89±17	159±14
	Women	23	98±46	128±38	100±71	169±35	108±55	99±19	113±57	140±27
	Sub-total	33	91±40	131±35	87±63	169±31	102±48	102±17	105±49	146±25
Total	Men	35	63±19	83±41	58±33	82±59	68±34	56±36	80±41	79±54
	Women	36	87±41	107±44	84±61	128±63	87±54	73±38	95±54	106±51
	Sub-total	71	75±34	95±44	72±51	105±65	78±46	65±38	88±48	93±54
Age	Under 64	8	62±21	60±17	58±18	62±36	66±28	38±28	78±32	58±39
	65~74	25	67±15	87±42	62±33	86±62	69±37	55±38	82±43	79±56
	Over 75	38	83±43	108±44	81±63	127±64	86±54	77±36	94±55	109±51

Table 11. The percentage of vitamin intake by Korean RDA(15) of elderly age group before and after treatment of soybean intake

(unit : %(Mean±SD))

Area	Sex	No.	Thiamin		Riboflavin		Niacin		Vitamin C	
			Before	After	Before	After	Before	After	Before	After
Rural	Men	25	73±25	71±21	55±33	32±13	96±33	98±30	40±25	23±14
	Women	13	83±29	77±23	46±27	26±10	109±34	108±32	41±31	23±24
	Sub-total	38	76±27	73±21	52±31	30±12	101±34	101±31	41±27	23±17
Asylum	Men	10	101±10	138±36	83±25	101±8	122±9	200±53	76±15	47±0
	Women	23	100±32	100±36	104±54	93±18	124±42	146±52	75±34	45±10
	Sub-total	33	101±27	112±40	97±48	96±16	123±35	162±58	75±29	46±8
Total	Men	35	81±25	90±40	63±33	51±34	104±31	127±60	51±28	30±16
	Women	36	94±32	92±34	83±54	69±36	119±40	132±49	62±36	37±19
	Sub-total	71	88±29	91±37	73±45	60±36	111±36	129±54	57±33	34±18
Age	Under 64	8	89±35	72±13	57±26	32±22	113±43	100±20	53±29	24±15
	65~74	25	86±21	95±43	65±36	51±36	111±23	134±64	52±30	32±21
	Over 75	38	88±33	92±35	82±53	72±34	111±42	133±52	61±35	37±16

There were some differences in nutrients intake between 2 groups. From the aspect of dietary intake, in the senior citizen center were better intake than rural. Rural elderly were much lower nutrients intake compared by RDA. But there was a little significantly increased nutritional status by feeding 1 year of urban low-income elderly(32). It means that diet offer programs in the community levels were needed as soon as possible, rural elderly alone could not prepare own meal because of several reasons, for example, fatigue, food deprived, and non-appetite etc. The elderly should take more calories and also choose digestive foods easily.

Several features of dietary intake are related to personality factors and gender specific, both men and women. the food related internal locus of control correlated positively with some fiber and sugar density(33). And iron absorption rate in the elderly decreased than young

person(34). Protein is one of the nutrients needed in a relatively greater amount for sustaining health and immune response of the elderly(13). It would be more investigated with demographic variables and nutrients intake. As observed in this case, we can suggest poor appetite of the elderly resulted in reduced intake of foods, thereby decreasing amount of protein and energy. The effect of plant protein supplements combinations was important in terms of consciousness of health status.

In rural area, elderly people will probably have much exposure to the sun, UV exposure decreases antioxidant enzyme activities, increases peroxidation in the skin, significantly decreases cell-mediated immune responses (35). It is very interested in possible nutritional intervention with beta-carotene, the best known quencher of singlet oxygen. But here the subjects did less eat vitamin A, and C, the factors of anticancer effects. Tho-

se individuals who used vitamin C supplements had significantly decreased risk of cardiovascular mortality (28).

The findings of the present study should be useful to nutritionist and physicians in counseling the elderly for health by helping them to consider all dietary constituents rather than calorie counting alone. Further studies are needed to reveal interrelationships among the key health determining factors including the nutrients intake, physical activity of individuals in free living conditions.

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