Review Article

Dietary intake and anthropometry of Korean elderly people: a literature review

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The health status of elderly people is an important issue in Korea due to the expansion of the elderly population. However, data on their nutritional status are limited. This review aims to give an overview of the dietary intake and anthropometry of Korean elderly people based on studies published, mainly in local journals in Korea. In total 18 studies were reviewed. Mean calcium and vitamin A intakes were inadequate, namely less than 67% of the Korean recommended daily allowances, in all groups of Korean elderly people. The intake of both nutrients was lower in urban elderly with a low income and in rural elderly (200-496 g/day of calcium and 117-281 retinol equivalents/day). In particular, "low income" urban elderly people had a low energy intake (less than 5300 kJ/day) with an inadequate intake of iron, thiamin, riboflavin and niacin in addition to calcium and vitamin A. In urban areas underweight (body mass index < 20 kg/m^2) occurred in 7-31% of "all income" groups, whereas it occurred in 15-42% of "low income" groups. Rural elderly people showed a higher proportion of underweight (37% for men and 38% for women) as well as the lowest body mass index (21.0 kg/m^2 for men and 21.3 kg/m^2 for women). In conclusion, an inadequate intake of several micronutrients in old age, mostly calcium and vitamin A, is a matter of concern in Korea. This was observed most frequently in elderly people with a low income. In this group an inadequate intake of micronutrients is likely to be caused by a low energy intake.

Key Words: elderly, Korean, review, nutritional status, dietary intake, anthropometry

Introduction

Since the mid-twentieth century, nutritional status in South Korea has much improved due to the rapid economic growth.[1,2] Along with the economic development and industrialization, epidemiological and demographic changes also took place. Acute and transmittable diseases used to be the main causes of death. Now chronic diseases are the main causes of death.[3] The Korean population has almost doubled.[4] The relative proportion of elderly people has remarkably increased. Korean elderly people are the largest group among extensive medical care consumers in the country[5] and their health status is a major health concern.[6]

It has been reported that dietary intake decreases with aging.[7,8] Inadequate dietary intake in elderly people may result in considerable dysfunction and disability, and is related to increased morbidity and mortality.[9,10] So far data on the nutritional status of Korean elderly people are limited. Though there are few nutritional surveys conducted in this population, most of these studies were performed in specific groups and sample size was often small.[2] The aim of this review is to give an overview of studies published on the dietary intake and anthropometry of Korean elderly people. This review starts with the demography and the trend in the general dietary pattern of the Korean population in order to put the data of the elderly people in their context before describing the nutritional status of Korean elderly people.

Methods

To describe the demography and the general trend in the dietary pattern of Korean people, a recent report of Korean national statistics[4] and national nutrition survey reports[11,12] were used. Since 1969 the national nutrition survey was carried out annually till 1995. After 1995, it was con-ducted every three years. In this survey, a multistage stratified sampling procedure has been applied to select a representative sample of the South Korean households. The number of selected households increased from 543 in 1971 to 2000 in 1988. Afterwards, it was kept at 2000 households until 1995 and was expanded to 3799 households in the 1998 survey. Food consumption at home was assessed at the household level by a weighing record method until 1995. In 1998, a 24-hour recall method was used, including individuals rather than households. Food intake was converted into nutrients by using the Korean food composition table.[13]

To describe the nutritional status of Korean elderly people, papers were searched in Medline. The following keywords were used for searching through the literature;

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Korea, elderly, nutritional or health status, dietary or nutritional intake and anthropometry. Because there are only very few studies about the nutritional status of Korean elderly people in Medline, additional papers published in local journals in Korean were also used. Studies were taken into account if they included at least 20 subjects.

All articles used in this review report on cross-sectional surveys. For the dietary intake of Korean elderly, data of 13 studies[14-26] were used, including 2557 subjects in total. For the anthropometric data, 8 studies[15,16,21,27-31] including 1386 subjects were used. Though the resident areas of the populations in the studies reviewed were spread all over Korea, these studies could be categorized into urban and rural. For the studies conducted in the urban areas, elderly people with a "low income", including those who receive welfare support from the government or who are admitted to a free lunch program, could be addressed separately from the studies including elderly people with the whole range of incomes, the "all income" elderly. In the "low income" elderly, all subjects reported a household income of less than $800 per month. In other studies, it varied widely within study from $170-3300 per month. Most Korean elderly men had no education or were educated till elementary school. Korean elderly women mostly had no education. No education was more prevalent in rural areas and among those with a lower income. All sample populations used in this study included apparently healthy and free-living elderly people.

Most of the published studies used 65 years (y) as the cut-off point to define the elderly population. Other studies used 60 y.[18,19,25,28-31] The mean age of the sample population ranged from 70.4y (SD 5.8) to 76.6y (SD 6.9) and from 65.8 y (SD 4.9) and 74.9 y (SD 9.8) for men and women, respectively. There seems to be no difference in age distribution by living areas or income levels. Data on nutrient intakes were used to describe the dietary intakes of Korean elderly people. In most of the studies, dietary intake was assessed by a 24-hour recall method, except for the three studies in which a food frequency questionnaire (FFQ) or a dietary record was used.[20,24,25] In all the studies, nutrient intakes were calculated using the fourth edition of the Korean food composition tables.[32] Nutrient intakes were also expressed as a percentage of the Korean recommended dietary allowances (RDAs) at the time of publication of the study. In this review a nutrient intake below 67% of the Korean RDAs was defined as inadequate. Data on body mass index (BMI) and percentage body fat were used to describe anthropometry and body composition. Bioimpedance analysis (BIA) was used to estimate the percentage of body fat. A BMI value of 20 kg/m^2 was used as the cut-off value for underweight. BMI cut-off values for overweight and obesity differed between studies (i.e. 24 or 25 kg/m^2 for overweight and 27 or 30 kg/m^2 for obesity). In this review, subjects were classified based on the reported cut-off values in the published papers, because individual data were not available.

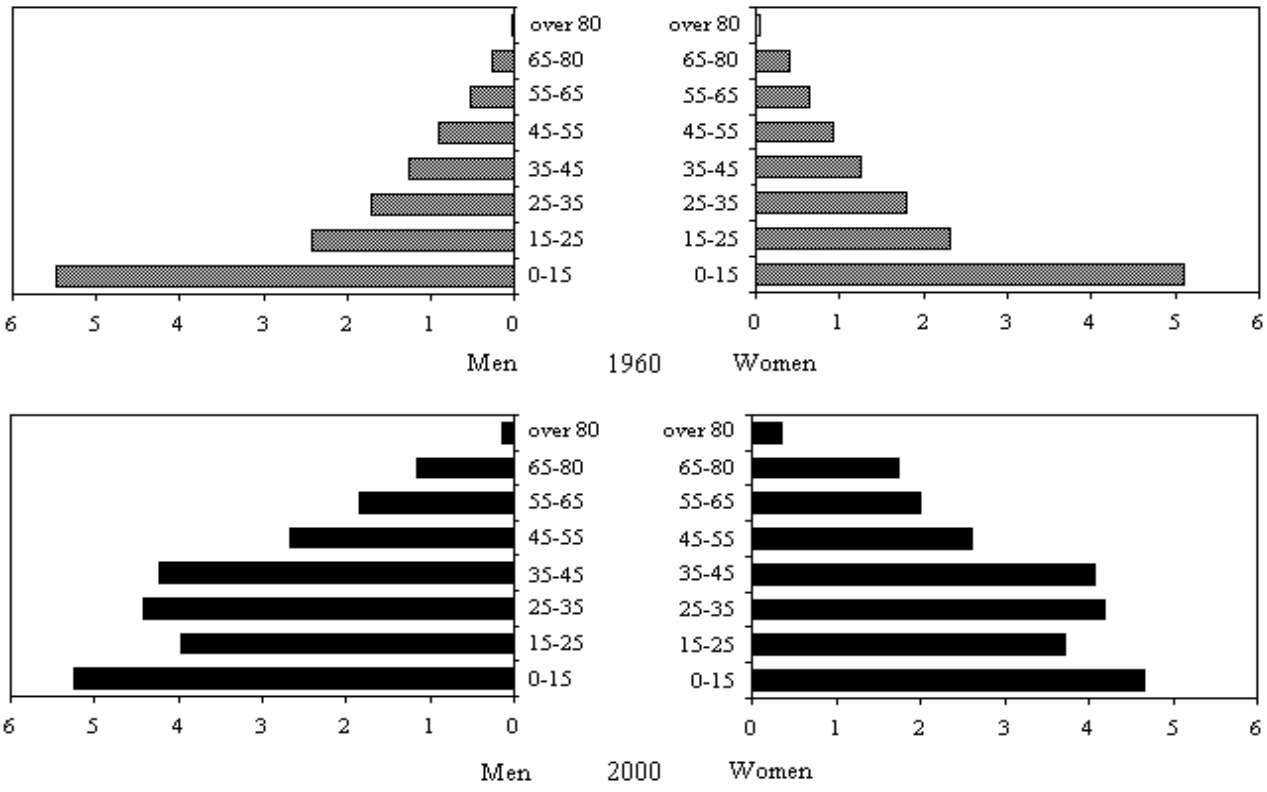

Figure 1. Distribution of the Korean population by sex and age in 1960 and in 2000 (million)[4]

Note: For adult population (between 15y and 65 y), 10 years of age interval is used. For other age populations (under 15 y or over 65 y), 15 years of age interval is used.

Results

Demographic trend

Figure 1 shows the distribution of the Korean population by age and sex in 1960 and in 2000. The total population has doubled from 25 million in 1960 to 47 million in 2000. The size of the elderly population (65y and more) has increased from 0.7 million to 3.4 million over the same period. Consequently the proportion of the elderly people in the total population has increased from 2.9% to 7.2%. This increasing rate is higher in women. In rural areas, elderly people accounted for 21.2%, which is much higher than the 7.2% in the total population. This expansion of the size of the elderly population is due to an increase in the average life expectancy. The average life expectancy in 1999 was 71.7y and 79.2y for men and women, respectively; an increase by 13 y compared to 1971. The decrease of the annual birth rate, 31.2% to 13.2% during the same period, further contributed to the increase of the proportion of elderly people.

Dietary intake trend of the Korean population

In Table 1, dietary intake per day by the Korean population is shown for each food group for the period 1969 to 1998. The intake of cereals and starchy roots per capita per day declined from 559g and 76g to 347g and 31g, respectively. However, the intake of fruit increased from 48g to 198g. In line with the increase of animal food supply,[33] the intake of animal foods increased. The proportion of animal food to total food intake increased rapidly from 3% in 1969 to 17% in 1985. Afterwards it remained around 20%, though the intake of fish and shellfish gradually decreased from 1985 onwards. The intake of milk and dairy products per day per capita increased remarkably from 2g in 1969 to 88g in 1998.

The energy intake per day per capita of the Korean population fluctuated within the range of 7.7-8.8 MJ/day (Table 2). Though the increase in total protein intake was only little, the contribution of animal protein to total protein intake markedly increased from 12% in 1969 to 42% in 1985 and it went up to 48% in 1998. The percentage of energy (% E) derived from fat increased from 7% in 1969 to 19% in 1998, whereas % E from carbohydrate decreased from 80% to 66%. In general, the average intake of micronutrients was close to or above the RDAs in 1998. Only the intake of calcium tended to be relatively low, reaching 73% of the Korean RDA (511mg/d) in 1998, after a declining trend since 1980.

Nutritional Status of the elderly in South Korea

Dietary intake

Dietary intake data of elderly Korean men and women are presented in Table 3 and 4, respectively. The studies are grouped by living areas (urban versus rural). Three studies conducted in urban areas focused on the elderly people with a low income ("low income" groups) whereas the other studies in urban areas included elderly people with an income varying from low to high ("all income" groups).

According to the studies in which income is not specified, no clear difference emerged in energy intake of elderly people living in rural areas versus those living in urban areas ("all income" groups). In the "all income" urban elderly, the mean energy intake ranged from 5.8 MJ/d to 8.1 MJ/d in men and from 4.8 MJ/d to 7.5 MJ/d in women. Lower energy intake was reported for the "low income" urban elderly people. These elderly had an average energy intake below 5.3 MJ/d, clearly below the mean intake of the "all income" urban elderly and of rural elderly people. Their energy intake adjusted for body weight (88-101 kJ/kg) was comparable to the lower quartiles of the distribution in energy intake of all groups (88-126 kJ/kg).

Protein intake was on average lower in the "low income" urban elderly, as well as their fat intake which was among the lowest in the 10-19% E range reported for the various groups of elderly people.[21,22] When evaluating minerals, it appeared that calcium intake was clearly below the 67% of the RDA cut-off value, independent of

Table 1. Dietary intake (g) per capita per day by food group in the Korean population during 1969 –1998[11,12]

Food group	1969	1975	1980	1985	1990	1995	1998[a]
Cereals	559	474	495	384	344	309	347
Starchy roots	76	55	36	40	43	21	31
Legumes	25	31	47	74	58	35	31
Vegetables	271	246	301	273	281	286	284
Fruit	48	22	41	64	69	146	198
Meat and poultry	7	14	14	39	47	67	69
Eggs	4	5	8	21	20	22	23
Milk and dairy products	2	5	10	43	52	66	88
Fish and shellfish	18	48	66	81	79	75	66
Total	1055	922	1061	1050	1048	1101	1290
Proportion of plant food(%)	97	92	91	83	81	79	81
Proportion of animal food(%)	3	8	9	17	19	21	19

[a]The dietary intake was measured by a weighing method at the household level until 1995. In 1998, it was measured by a 24-hour recall method at the individual level.

resident areas and income levels of elderly people. Only in a few studies of the "all income" urban elderly, an adequate intake of calcium was observed. In particular, the "low income" urban elderly had a low calcium intake. This was as low as 29-45% and 31-39% of the RDA in men and in women, respectively. Iron intake was also below 67% of the RDA in the "low income" urban elderly.

Low intake of vitamin A was found in most of the studies. The intake was as low as 117 retinol equivalents (RE)/d to 596 RE/d in men and 122 RE/d to 578 RE/d in women. Reported intake of vitamin A most seriously failed to meet 67% of the RDA, this was observed most frequently in the rural areas and in the "low income" elderly in urban areas. In addition, an inadequate intake of thiamin, riboflavin, and niacin was observed in the "low income" urban elderly. An inadequate intake of ribo-flavin was also reported for the elderly in rural areas. Vitamin C intake was reported to be adequate in all the groups of Korean elderly people ranging from 37 mg/d to 122 mg/d.

Anthropometry and body composition

Table 5 shows anthropometric data of Korean elderly people. According to the WHO standards (BMI between 20 and 25 kg/m^2)[34] the mean BMI of Korean elderly people in all the studies was within the normal range. Rural elderly people had the lowest mean BMI with a 21.0 kg/m^2 for men and 21.3 kg/m^2 for women. Urban elderly people in general ("all income" and "low income" groups) had mean BMI values ranging from 21.7 kg/m^2 to 22.9 kg/m^2 in men and 22.9 kg/m^2 to 24.9 kg/m^2 in women. The prevalence of underweight (BMI<20 kg/m^2) was high in rural elderly people, namely on average in 37% of men and 38% of women. In urban areas, the proportion of elderly people with underweight varied from 7% to 31% in the "all income" elderly, whereas it tended to be higher in the "low income" elderly ranging from 15% to 42%. Data on body fat percentage estimated by BIA were only available for elderly people in urban areas. In elderly men, the percentage of body fat ranged from 19.5% to 25.0%. In elderly women it was clearly higher and generally above 30%, which was used as a cut off value for overweight.[34] Both in men and women, the proportion of overweight and obesity estimated by body fat percentage tended to be higher than the proportion based on BMI cut off values.

Discussion

According to the present review, inadequate intakes of vitamin A and calcium are highly prevalent in all groups of Korean elderly people. Moreover, in urban areas elderly people with a low income had a low intake of energy and micronutrients, whereas the lowest average of the BMI and the higher prevalence of underweight emerged for elderly people living in rural areas.

The results reported in this review cannot be considered representative for the Korean population, because none of the studies included representative samples for a certain area, income category, or age category. In addition, the definition of elderly people differed in the reviewed studies. This might hamper the comparability of parameters.[35] In this review, energy intake tended to be higher in the studies including younger age groups (>60y), whereas dietary intake of other nutrients and BMI means were not clearly different between the elderly people over 60y versus over 65y.

Differences in methodologies in the reviewed studies

Table 2. Nutrient intake per capita per day in the Korean population during 1969 – 1998[11,12]

Nutrient	1969	1975	1980	1985	1990	1995	1998[a]	% of RDA[b]
Energy (MJ)	8.8	8.3	8.6	8.1	7.8	7.7	8.3	95
Protein (g)	66	64	67	75	79	73	74	118
Percentage of animal protein to total protein	12	21	29	42	40	47	48	
% E derived from Protein	13	13	13	15	17	16	15	
% E derived from Fat	7	9	10	14	14	19	19	
% E derived from Carbohydrate	80	80	77	71	69	65	66	
Micronutrient								
Calcium (mg)	444	407	598	569	517	531	511	73
Iron (mg)	24.8	12.4	13.5	15.6	22.7	21.9	12.5	92
Vitamin A (RE)[b,c]	1,400	1,362	1,688	1,846	1,662	443	625	96
Thiamin (mg)	1.76	1.21	1.13	1.34	1.15	1.16	1.35	126
Riboflavin (mg)	1.28	0.77	1.08	1.21	1.27	1.20	1.09	86
Niacin (mg)	27.8	15.3	19.1	25.7	21.6	16.7	15.7	111
Vitamin C (mg)	89.9	78.9	87.9	64.7	81.2	98.3	123.1	234

% E, percentage energy. RE, retinol equivalents. [a]The dietary intake was measured by a weighing method at household level until 1995. In 1998, it was measured by a 24-hour recall method at individual level. [b]Nutrient intake in 1998 expressed as percentage of the Korean RDAs. [c]Vitamin A is expressed as international unit (IU) until 1990. Note: The decreased iron intake at 1998 is mostly due to a correction of iron content of rice from 3.7 mg/100 g to 0.5 mg/100 g in the fifth edition of the food composition table.

must be considered in the interpretation of the results. As the 24-hour recall method underestimates dietary intake of elderly people (due to their impairment in short-term memory[36]), energy intake was higher in the three studies in which the FFQ or the dietary history was used. In addition, the FFQ measurement might have contributed to the relatively high intake of micronutrients observed in these studies. In the studies in which the 24-hour recall was used, the energy intake of the elderly people with a low income turned out to be the lowest. Though deficiencies may have been overestimated by the 24-hour recall, the difference between income groups indicates that elderly people with a low income have an increased risk of malnutrition due to an inadequate dietary intake.

Differences in methodologies also existed for anthropometry: cut-off values of BMI for overweight and obesity differed between the studies. Several cut-off values are suggested for elderly people.[34,37,38] Mostly they were developed in Caucasian subjects. So far none of them have been validated in the Korean elderly population. The observed low intake of calcium prevalent in Korean elderly people could be explained mainly by the low consumption of milk and dairy products. Though the consumption of milk and dairy products increased rapidly in the Korean population, the proportion of calcium intake provided by these products is still very low (13% in 1995).[11] In elderly people who do not have milk and dairy products in their traditional dietary pattern,[39] the unfamiliar taste of these products might make the consumption even lower.[40] This low intake is comparable to that of elderly people in other Asian countries where the consumption of milk and dairy products is also low.[41,42] In these studies calcium intake was lower in rural elderly people. This is consistent with the results of the present review. The inconsistency between the trend of calcium intake and the consumption of milk and dairy products in the Korean population might be due to revisions in the food composition table in which calcium content of foods such as anchovy, soybean curds, and dried pollack was 'updated' towards lower values. In addition, the increased consumption of milk and dairy products might partly have been counter-balanced by the declining fish consumption.

In all the groups of Korean elderly people, vitamin A was the most deficient nutrient compared to the Korean RDAs. This inadequate intake might be due to a low intake of animal foods. As the bioavailability of carotenoids from plant food is much lower than that of retinol from animal food, vitamin A intake is easily limited in a plant based diet.[43] Monotonous dietary patterns developed with aging[44] might have aggravated this low intake of vitamin A. In Korea, the number of food sources of vitamin A is more limited than that of other nutrients.[45] Therefore, the supply of vitamin A intake is likely to be

Table 3. Nutrient intake of Korean elderly men expressed as mean ± standard deviation and percentage of the Korean RDAs

Author Published year	Method	N	Energy (kJ)	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)
Urban											
All income											
Kim *et al.*, 1997[14]	Recall	91	6485 ± 197	49 ± 2	294 ± 21 (42)[a]	7.7 ± 0.4 (64)	171 ± 23 (25)	0.8 ± 0.04 (75)	0.7 ± 0.04 (59)	10 ± 0.5 (76)	41 ± 3 (74)
Han *et al.*, 1998[15]	Recall	47	5991 ± 1109	49 ± 14	424 ± 193 (61)	11.1 ± 7.0 (92)	273 ± 260 (39)	1.0± 0.6 (98)	0.8 ± 0.4 (68)	12 ± 6.3 (94)	77 ± 52 (141)
Lee *et al.*, 1998[16]	Recall	42	5745 ± 1996	49 ± 31	288 ± 144 (41)	8.4 ± 7.4 (70)	463 ± 509 (66)	0.8 ± 0.7 (80)	0.8 ± 0.8 (64)	10 ± 7.6 (73)	68 ± 55 (124)
Kye *et al.*, 2000[§17]	Recall	241	7661 ± 2113	76 ± 53	499 ± 268	14.4 ± 6.6	354 ± 419	1.0± 0.5	1.1 ± 0.5	19 ± 10.0	87 ± 64
Hong & Oh,1998[18]	Recall	37[†]	8125 ± 1339	84 ± 21	659 ± 171 (94)	16.8 ± 5.6 (140)	416 ± 356 (59)	1.2 ± 0.3 (114)	1.2 ± 0.3 (96)	19 ± 5.2 (141)	91 ± 21 (166)
Jeong & Kim,1998[19]	Recall	97[†]	7025 ± 1423	50 ± 13	297 ± 167 (42)	8.0 ± 2.7 (66)	196 ± 150 (28)	0.9 ± 0.3 (89)	0.8 ± 0.3 (69)	12 ± 4.2 (91)	46 ± 27 (84)
Hong SM, 1996[20]	FFQ	114	7146 ± 1615	68 ± 21	714 ± 200 (102)	16.1 ± 4.7 (134)	596 ± 185 (85)	1.3± 0.2 (107)	1.2 ± 0.3 (97)	18 ± 3.8 (136)	51 ± 18 (92)
Low income											
Son *et al.*, 1996[21]	Recall	53	4837 ± 226	40 ± 3	309 ± 39 (45)	8.1 ± 0.8 (68)	212 ± 84 (27)	0.6 ± 0.04 (61)	0.5 ± 0.04 (45)	9 ± 0.9 (62)	37 ± 5 (75)
Son *et al.*, 1997[22]	Recall	28	5255 ± 1406	41 ± 18	282 ± 91 (40)	5.8 ± 2.3 (51)	144 ± 88 (21)	0.6 ± 0.4 (67)	0.6 ± 0.3 (52)	9 ± 5.1 (68)	37 ± 23 (69)
Lee *et al.*, 1998[16]	Recall	50	5268 ± 1753	42 ± 23	200 ± 221 (29)	6.1 ± 4.8 (51)	208 ± 369 (30)	0.6 ± 0.3 (60)	0.5 ± 0.4 (42)	8 ± 5.7 (62)	44 ± 34 (80)
Rural											
Han *et al.*, 1998[15]	Recall	83	6125 ± 1598	46 ± 17	364 ± 188 (48)	9.8 ± 6.4 (80)	117 ± 104 (16)	0.8 ± 0.4 (78)	0.7 ± 0.4 (60)	12 ± 4.4 (87)	78 ± 44 (136)
Kwon *et al.*, 1998[23]	Recall	68	7318 ± 2925	54 ± 29	286 ± 150 (41)	9.5 ± 4.0 (79)	266 ± 315 (38)	0.9 ± 0.7 (85)	0.7 ± 0.4 (57)	17 ± 9.1 (127)	68 ± 77 (123)
Korean RDAs					700	12	700	1	1.2	13	55

RDAs, recommended dietary allowances. FFQ, food frequency questionnaire. RE, retinol equivalents. [a]Numbers in parentheses are the percentage of the Korean RDAs. †, the definition of elderly people is 60 years or more. §, data of percentage of the Korean RDAs are not available.

most restricted due to little variety in food intake of elderly people. Meanwhile, Russell[46] suggested that the current recommendation of vitamin A for elderly people is too high considering that the clearance of serum vitamin A in blood is slower than in adult people.[47] Further study is needed on serum vitamin A status to underpin this hypothesis in Korean elderly people.

In this review, urban elderly people with a low income had an energy intake even below 5300 kJ/day. Underweight was highly prevalent as compared to the "all income" group in urban areas. In Korean elderly people, more than 20% belong to a low income household.[48] Low nutrient intakes are common in poor elderly people because of limited food affordability.[49] When energy intake is below 6.3 MJ, it is hard to obtain an adequate supply of essential micronutrients.[50] This explains, amongst others, why an inadequate intake of micronutrients is observed in elderly people with a low income. Underweight was not only present in the "low income" urban elderly people, but also in rural elderly people, although this group had a higher energy intake close to the intake of the "all income" urban elderly people. This is also observed in other Asian countries.[51,52] This might be explained by higher energy expenditure of rural people due to a higher physical activity level and by a relatively low fat intake.[41] Though no data on energy expenditure were available, this review observed a lower tendency of fat intake in rural elderly people. (Data are not shown)

On the other hand, overweight elderly people can be found mainly in urban areas. As mentioned above, less activity and a higher fat diet are reported to make urban elderly people at higher risk for obesity.[41] However, uncertainties in the assessment of anthropometry and body composition must be noted. BIA equations which are generally determined in younger populations are not valid in elderly people probably due to hydration variability with aging.[53] Moreover, BMI cut off values for Caucasians are not applicable to Asians because of ethnic differences in body composition.[54,55] These misapplications might explain the discrepancy in the proportion of overweight and obesity based on BMI and body fat percentage.

Table 4. Nutrient intake of Korean elderly women expressed as mean ± standard deviation & percentage of the Korean RDAs

Author Published year	Method	N	Energy (kJ)	Protein (g)	Calcium (mg)	Iron (mg)	Vitamin A (RE)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)
Urban											
All income											
Kim *et al.*, 1997[14]	Recall	78	5029 ± 192	37 ± 2	244 ± 18 (35) [a]	6.2 ± 0.4 (51)	122 ± 19 (18)	0.7 ± 0.1 (68)	0.6 ± 0.04 (51)	8 ± 0.5 (60)	41 ± 4 (75)
Han *et al.*, 1998[15]	Recall	116	4828 ± 1255	38 ± 16	304 ± 175 (43)	7.9 ± 4.0 (66)	222 ± 217 (32)	0.7 ± 0.4 (65)	0.7 ± 0.4 (63)	9 ± 4.7 (61)	60 ± 40 (109)
Lee *et al.*, 1998[16]	Recall	45	5866 ± 2289	54 ± 547	383 ± 331 (55)	10.4 ± 7.6 (87)	480± 1947 (69)	1.5 ± 1.7 (123)	0.9 ± 1.5 (73)	10 ± 8.1 (80)	82 ± 111 (148)
Kye *et al.*, 2000[§17]	Recall	309	6335 ± 2029	59 ± 30	462 ± 234	11.7 ± 6.2	351 ± 473	0.9 ± 0.3	0.9 ± 0.4	14 ± 8.1	80 ± 57
Hong & Oh, 1998[18]	Recall	46†	6895 ± 1548	74 ± 27	586 ± 235 (84)	14.5 ± 6.6 (121)	265 ± 139 (38)	0.9 ± 0.3 (94)	1.0 ± 0.4 (86)	17 ± 6.8 (133)	78 ± 24 (141)
Jeong&Kim, 1998[19]	Recall	110†	6389 ± 1364	45 ± 15	304 ± 178 (43)	7.7 ± 3.2 (65)	191 ± 165 (27)	0.8 ± 0.2 (81)	0.8 ± 0.4 (50)	10 ± 3.5 (76)	44 ± 27 (80)
Kim *et al.*, 1997[24]	Recall, Dietary record	51	7473 ± 1812	73 ± 26	513 ± 196 (73)	15.6 ± 7.4 (130)	578 ± 634 (83)	1.0 ± 0.4 (104)	1.4 ± 0.6 (101)	17 ± 6.6 (129)	122 ± 50 (222)
Hong SM, 1996[20]	FFQ	243	6548 ± 1297	59 ± 17	677 ± 180 (97)	14.5 ± 3.8 (121)	566 ± 170 (81)	1.0 ± 0.2 (100)	1.1 ± 0.3 (93)	16 ± 3.1 (125)	49 ± 16 (89)
Lee& Chang 1999[25]	FFQ	66†	6502 ± 908	58 ± 11	566 ± 133 (81)	13.3 ± 2.5 (111)	-	0.9 ± 0.2 (89)	1.7 ± 0.3 (112)	14 ± 2.7 (106)	121 ± 39 (224)
Low income											
Son *et al.*, 1996[21]	Recall	129	4360 ± 201	34 ± 3	254 ± 16 (36)	6.5 ± 0.6 (55)	198 ± 32 (25)	0.6± 0.04 (55)	0.5 ± 0.04 (42)	8 ± 0.9 (62)	37 ± 3 (70)
Son *et al.*, 1997[22]	Recall	71	4565 ± 1414	34 ± 16	275 ± 111 (39)	5.8 ± 3.8 (49)	201 ± 129 (28)	0.5 ± 0.4 (46)	0.6 ± 0.3 (47)	8 ± 4.9 (59)	38 ± 23 (66)
Lee *et al.*, 1998[16]	Recall	43	4841 ± 2586	42 ± 43	216 ± 230 (31)	6.1 ± 4.8 (51)	281 ± 330 (40)	0.6 ± 0.6 (60)	0.5 ± 0.5 (39)	8 ± 10.8 (62)	40 ± 29 (73)
Rural											
Han *et al.*, 1998[15]	Recall	104	5427 ± 1167	39 ± 13	404 ± 168 (58)	9.4 ± 8.6 (80)	192 ± 188 (27)	0.7 ± 0.3 (67)	0.7 ± 0.3 (57)	11 ± 6.9 (85)	68 ± 44 (123)
Kim *et al.*, 1998[26]	Recall	113	6477 ± 2448	57 ± 28	496 ± 271 (71)	11.6 ± 6.8 (97)	-	1.0 ± 0.7 (103)	1.1 ± 0.7 (87)	11 ± 6.9 (85)	87 ± 68 (158)
Kwon *et al.*, 1998[23]	Recall	82	5556 ± 1833	41 ± 19	260 ± 170 (37)	8.2 ± 4.6 (68)	245 ± 352 (35)	0.6 ± 0.3 (62)	0.5 ± 0.3 (44)	13 ± 7.6 (101)	52 ± 47 (95)

RDAs, recommended dietary allowances. FFQ, food frequency questionnaire. RE, retinol equivalents. [a]Numbers in parentheses are the percentage of the Korean RDAs. †, the definition of elderly people is 60 years or more. §, data of percentage of the Korean RDAs are not available.
Note: RDAs are the same with those of Korean elderly men

Table 5. Body mass index and body fat percentage of Korean elderly people expressed as mean ± standard deviation and distribution

	Urban						Rural		
	All income					*Low income*			
Author Published year	Hyun & Kim, 1997[27]	Han *et al.*, 1998[15]	Han KH, 1996[28]	Lee *et al.*, 1998[16]	Yim *et al.*, 1997[29], 1998[30]	Son & Lee, 1999[31]	Son *et al.*, 1996[21]	Lee *et al.*, 1998[16]	Han *et al.*, 1998[15]
Men N=	57	37	76†	42	76†	130†	53	50	58
BMI (kg/m^2)	22.6 ± 2.8	22.5 ± 2.8	22.7 ± 2.7	21.7 ± 3.0	22.9 ± 2.8§	22.9 ± 3.0	22.1 ± 3.1	22.6 ± 4.1	21.0 ± 3.3
Distribution									
<20	18	19[a]	20	31	20	15[b]	42[b]	16	37[a]
20< <25	61	72	59	54	62	47	43	57	60
25< <30	19		21	15	17	39	15	25	
>30	2	9	0	0	1	0	0	2	2
BF (%)			19.5 ± 7.3	23.7 ± 6.8	22.3 ± 7.1§			25.0 ± 6.1	
Distribution									
<20				28	46[c]			19	
20< <25				33	49			29	
25< <30				39				53	
>30				0	6			0	
Women N=	29	78	153†	45	71†	180†	130	43	78
BMI (kg/m^2)	24.4 ± 3.3	23.8 ± 3.6	23.9 ± 3.2	24.9 ± 3.3	24.9 ± 3.9§	22.9 ± 3.6	23.3 ± 3.3	23.9 ± 4.3	21.3 ± 3.3
Distribution									
<20	7	13[a]	11	7	18	11[b]	32[b]	15	38[a]
20< <25	59	68	52	41	32	35	41	49	55
25< <30	24		35	49	42	48	28	29	
>30	10	19	3	2	7	7	0	7	7
BF (%)			29.6 ± 6.7	34.9 ± 4.8	33.7 ± 5.8§			33.7 ± 6.5	
Distribution									
<20				0	16[c]			0	
20< <25				3	18			6	
25< <30				9				33	
>30				88	67			61	

BMI, body mass index. BF, body fat. †, the definition of elderly people is 60 years or more. §, Mean value of body mass index and body fat percentage is from the study of Yim KS, 1998[30]. [a]Cut-off criteria of <20, 20-27, >27. [b]Cut-off criteria of <20, 20-24.9, 25-29.9, ≥30.
[c]Cut-off criteria of <20, 20-30, >30.

In conclusion, this review shows that inadequate intakes of vitamin A and calcium were widespread among Korean elderly people. Therefore the promotion of the consumption of foods rich in these nutrients, in particular foods of animal origin, needs to be explored. Elderly people with a low income are at high risk of chronic malnutrition due to an insufficient dietary intake. An assumed high energy expenditure, in combination with insufficient availability of foods puts elderly people in rural areas at risk of undernutrition. Thus Korean elderly people with a low income or those living in rural areas require extra attention to secure adequate dietary intake.

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