

## Review



## OPEN ACCESS

**Received:** Oct 26, 2021

**Revised:** Feb 9, 2022

**Accepted:** Mar 28, 2022

**Published online:** Apr 27, 2022

### **Corresponding Authors:**

#### **Oran Kwon**

Department of Nutritional Science and Food Management, Graduate Program in System Health Science and Engineering, Ewha Womans University, 52, Ewhayeodae-gil, Seodaemun-gu, Seoul 03760, Korea.  
Tel. +82-2-3277-6860  
Fax. +82-2-3277-2862  
Email. orank@ewha.ac.kr

#### **Ji-Yun Hwang**

Major in Foodservice Management and Nutrition, Sangmyung University, 20 Hongimun 2-gil, Jongno-gu, Seoul 03016, Korea.  
Tel. +82-2-781-7521  
Fax. +82-2-2287-0104  
Email. jiyunhk@smu.ac.kr


©2022 The Korean Nutrition Society and the Korean Society of Community Nutrition

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### **ORCID iDs**

Hyesook Kim 

<https://orcid.org/0000-0002-4840-3082>

Ji-Yun Hwang 

<https://orcid.org/0000-0003-4003-1293>

<https://e-nrp.org>

# Dietary Reference Intakes for Koreans with special consideration to older adults

Hyesook Kim <sup>1</sup>, Ji-Yun Hwang <sup>2§</sup>, and Oran Kwon <sup>1§</sup>

<sup>1</sup>Department of Nutritional Science and Food Management, Graduate Program in System Health Science and Engineering, Ewha Womans University, Seoul 03760, Korea

<sup>2</sup>Major of Foodservice Management and Nutrition, Sangmyung University, Seoul 03016, Korea

## ABSTRACT

**BACKGROUND/OBJECTIVES:** The Dietary Reference Intakes for Koreans (KDRIs) were revised in 2020. Due to the rapidly aging Korean population, special consideration was given to reclassify the KDRI age group categories of older adults. This article examines the evidence for modifying the current KDRI age group ranges of older adults (65–74 and  $\geq 75$  yrs).

**SUBJECTS/METHODS:** We first reviewed the domestic and international data on the elderly, following which we received expert opinions on age classification from the KDRI Advisory Committee. Finally, the 6th and 7th (2013–2017) Korea National Health and Nutrition Examination Survey (KNHANES) data were used to analyze the nutritional intake statuses by considering the age of older adults.

**RESULTS:** According to the review results of domestic and international data and the inputs received from the expert advisory committee, the minimum age considered for the elderly was maintained at 65 yrs. However, the KNHANES data was analyzed to review whether there was a need to subdivide the later periods. Examining the differences in nutrient intakes by age group through the interaction effect term of the piecewise linear regression model revealed the interaction effect was maximum in the groups divided by 65 yrs (50–64 and 65–80), as compared to the groups divided by 70 yrs (50–69 and 70–80) and 75 yrs (50–74 and 75–80). The mean adequacy ratio was calculated per 1 yr of age, and a 3-yr (age) moving average analysis was performed to examine the change in the trends of overall nutrient intake. However, it was challenging to secure a scientific basis for subdivision into age groups in older adults from the results obtained.

**CONCLUSIONS:** This study could not find any scientific evidence for modifying the KDRI age groups for older adults.

**Keywords:** Dietary Reference Intake; elderly; age groups; nutritional intake

## INTRODUCTION

The Dietary Reference Intakes for Koreans (KDRIs) are population estimates for daily nutrient requirements and dietary recommendations set by the Korean Ministry of Health and Welfare (MOHW) to maintain the health of the general population by eliminating nutritional deficiencies and reducing the risk of chronic diseases. First established by

Oran Kwon   
<https://orcid.org/0000-0002-2031-7238>

**Funding**

This research was supported by the Policy Research Program for Project No. 20180415A13-00, 25193068200, 25203084501 from the Ministry of Health and Welfare in 2018–2020.

**Conflict of Interest**

The authors declare no potential conflicts of interest.

**Author Contributions**

Conceptualization: Hwang JY, Kwon O; Formal analysis: Kim H; Funding acquisition: Kwon O; Methodology: Hwang JY; Supervision: Hwang JY, Kwon O; Writing - original draft: Kim H; Writing - review & editing: Hwang JY, Kwon O.

the Korean Nutrition Society (KNS) in 2005, the KDRIs consist of Estimated Average Requirement (EAR), Recommended Nutrient Intake (RNI), Adequate Intake (AI), Tolerable Upper Intake Level for nutrients, Estimated Energy Requirement for energy, and Acceptable Macronutrient Distribution Range of macronutrients [1,2]. The first revision of the KDRIs was in 2010. Since creating the National Nutrition Management Act in 2010, the task to establish and revise the KDRIs has been assigned to the MOHW. The task of revising the KDRIs was thus assigned to the KNS, and in 2015, the KDRIs were first published at the national level [3]. The 2015 KDRIs comprised life-stage subgroups to be considered when assessing the growth and stages of human development. The KDRi framework has 13 age groups which include the following categories: infants (0–5 and 6–11 mon), toddlers (1–2 and 3–5 yrs), children (6–8 and 9–11 yrs), adolescents (12–14 and 15–18 yrs), adults (19–29, 30–49, and 50–64 yrs), and older adults (65–74 and ≥75 yrs). Moreover, due to physiological characteristics, the age groups ≥ 6 yrs are further classified by gender (male and female) and additional recommendations are given for pregnant and lactating women. The latest version of the KDRIs was released in 2020, following which the necessity to discuss the age subgroups for older adults was broached.

The population of older adults is rapidly increasing around the world. According to the 2015 World Health Organization (WHO) data, Japan was the only country where the proportion of people aged ≥ 60 exceeded 30%. However, by 2050, the proportion of people aged ≥ 60 is expected to exceed 30% in Asia, Europe, and North and South America [4]. In particular, Korea is one of the countries with the highest growth rate of the elderly population. Statistics published by the Korea National Statistical Office show steady growth in the proportion of older adults aged ≥ 65 yrs in Korea, which is expected to increase to 24.3% by 2030 to become a ‘super-aged society’ [5]. With the rapidly growing population of the elderly in Korea, it is necessary to reconsider the classification of the older adult age group by scrutinizing domestic and international data and examining the nutritional intake status according to the age of older adults. This article aims to perform a reality check and decipher the reason for the KDRi modifications in the age range for adults ≥ 65 yrs (65–74 and ≥ 75 yrs).

## AGE GROUP FOR OLDER ADULTS IN THE NATIONAL STATISTICAL DATA OF KOREA

Based on the data obtained from the Ministry of the Interior and Safety of South Korea (MOIS) and Statistics Korea (KOSTAT), including the 2015 KDRIs which used age classification data, we investigated the current status of age classification in domestic statistical data (**Table 1**). The age group of older adults in the 2015 KDRIs is subdivided into the age groups 65–74 and ≥ 75 yrs [3]. Korea’s official population statistics of resident registration categorized males and females separately (by gender) and by 10-yr age intervals (0–9, 10–19, ... 70–79, 80–89, 90–99, and ≥ 100 yrs) [6]. The Korean Statistical Information Service (KOSIS) of KOSTAT divided males and females separately and by age: below 65 yrs were grouped by 5-yr intervals, and ≥ 65 yrs were divided into 3 groups (≥ 65, ≥ 85, and ≥ 100 yrs) [8]. The KOSTAT ‘Statistics of Aged People’ divided males and females separately and classified the ages into 65–69, 70–79, and ≥ 80 yrs [9]. The KOSTAT ‘Projected Population by Major Age Group’ classification included the working-age population (15–24, 25–49, and 50–64 yrs) and the aged population (65–74, 75–84, and ≥ 85 yrs), with 3 subgroups each [10]. The Korean Ministry of Education divided the school-age population into preschool (3–5 yrs), elementary school (6–11 yrs), middle school (12–14 yrs), high school (15–17 yrs), and

**Table 1.** Comparison of age segments in the national statistics of Korea

Variables	Ministry of Health and Welfare	Ministry of the Interior and Safety	Statistics Korea				Ministry of Education
	2015 KDRIs	Population statistic <sup>1)</sup>	Population and housing census <sup>2)</sup>	Population structure by age <sup>3)</sup>	Statistics of aged people <sup>4)</sup>	Projected population by major age group <sup>5)</sup>	School-age population <sup>6)</sup>
Classification of M/F from childhood		M/F	M/F	No gender classification	M/F		No gender classification
Infancy	0–5 mon 6–11 mon	0–9 yrs	0–4 yrs	0–14 yrs			
Toddler	1–2 yrs 3–5 yrs						Preschool 3–5 yrs
Childhood	6–8 yrs 9–11 yrs		5–9 yrs				Elementary school 6–11 yrs
Adolescence	12–14 yrs 15–18 yrs	10–19 yrs	10–14 yrs 15–19 yrs	15–64 yrs		Working-age population 15–24 yrs	Middle school 12–14 yrs High school 15–17 yrs
Adulthood	19–29 yrs	20–29 yrs				Working-age population 25–49 yrs	Higher education 18–21 yrs
						Working-age population 50–64 yrs	
Middle age/Older adults	65–74 yrs ≥ 75 yrs		≥ 65 yrs	≥ 65 yrs	65–69 yrs 70–79 yrs ≥ 80 yrs	≥ 65 yrs ≥ 70 yrs ≥ 80 yrs	
		80–89 yrs 90–99 yrs ≥ 100 yrs	≥ 85 yrs ≥ 100 yrs				

KDRI, Dietary Reference Intake for Koreans.

<sup>1)</sup>‘Population statistics of resident registration’ by the Ministry of the Interior and Safety (2017) [6].

<sup>2)</sup>‘Population by age and gender’ of ‘Population and Housing Census’ from the Korean Statistical Information Service by Statistics Korea (2015) [7].

<sup>3)</sup>‘Population structure in age’ in e-national indicators by Statistics Korea (2016) [8].

<sup>4)</sup>‘Statistics of aged people’ by Statistics Korea (2016) [9].

<sup>5)</sup>‘Projected population by major age group’ in Korean Statistical Information Service by Statistics Korea (2017) [10].

<sup>6)</sup>‘School-age population’ in the Ministry of Education’s ‘Brief Statistics on Korean Education’ (2016) [11].

higher education (18–21 yrs), but did not distinguish between genders [11]. In addition, the ‘Korean National Survey on Elderly’ conducted by the Korea Institute for Health and Social Affairs classified age ≥ 65 yrs into 5-yr intervals (65–69, 70–74, 75–79, 80–84, and ≥ 85 yrs) [12]. In the field of geriatric medicine, such as the Korean Academy of Clinical Geriatrics and the Korean Gerontological Nursing Society, age is divided into 5- or 10-yr intervals and includes the subgroups 80, 85, and ≥ 100 yrs. The Korea Centers for Disease Control and Prevention (KCDC) divides the seniors into 60–69 and ≥ 70 yrs by 10-yr intervals in the ‘Korea Community Health Survey’ [13], whereas the Korea National Health and Nutrition Examination Survey (KNHANES) divides the older adults into 60–69 and > 70 or > 65 yrs [14].

## AGE GROUP FOR OLDER ADULTS IN OTHER COUNTRIES

When comparing the age range for Dietary Reference Intakes (DRIs) with other countries, the older adult age group of the United Kingdoms (UK), China, and South Korea was the most subdivided (Table 2). The 2015 DRIs in Japan [15], the 2011 DRIs in the United States and Canada [16], and the 2017 Nutrient Reference Values in Australia and New Zealand [17] do not classify age ranges over 70 yrs, while the 2011 Dietary Reference Values in the UK [18] and the 2015 DRIs in South Korea [3] are presented for ages up to > 75 yrs. The 2013 DRI of China [19] divides older adults into the groups 65–79 and ≥ 80 yrs. In addition, the United Nations classifies the age ranges of older adults as ≥ 60 or ≥ 65 yrs. WHO’s ‘World Report on Ageing and Health’ presents age ranges up to 85 or 100 yrs by dividing the age into

**Table 2.** Comparison of age groups for DRIs of Korea with other countries

Korea (2015 KDRI) [3]	United States and Canada (2011 DRI) [15]	Australia and New Zealand (2017 NRV) [16]	United Kingdom (2011 DRV) [17]	China (2013 DRI) [18]	Japan (2015 DRI) [14]
			Male/Female <sup>1)</sup>	Male/Female	Male/Female
0-5 mon	0-6 mon	0-6 mon	0-3 mon	0 yrs	0-5 mon
6-11 mon	7-12 mon	7-12 mon	4-6 mon	0.5 yrs	6-11 mon
			7-9 mon		
			10-12 mon		
1-2 yrs	1-3 yrs	1-3 yrs	1-3 yrs	1 yrs	1-2 yrs
3-5 yrs	4-8 yrs	4-8 yrs	4-6 yrs	4 yrs	3-5 yrs
Male/Female	Male/Female	Male/Female	7-10 yrs	7 yrs	6-7 yrs
6-8 yrs	9-13 yrs	9-13 yrs	Male/Female <sup>2)</sup>		8-9 yrs
9-11 yrs	14-18 yrs	14-18 yrs	11-14 yrs	11 yrs	10-11 yrs
12-14 yrs	19-30 yrs	19-30 yrs	15-18 yrs	14 yrs	12-14 yrs
15-18 yrs	31-50 yrs	31-50 yrs	19-24 yrs		15-17 yrs
19-29 yrs	51-70 yrs	51-70 yrs	25-34 yrs	18 yrs	18-29 yrs
30-49 yrs	> 70 yrs	> 70 yrs	35-44 yrs		30-49 yrs
50-64 yrs			45-54 yrs	50 yrs	50-69 yrs
65-74 yrs			55-64 yrs	65 yrs	≥ 70 yrs
≥ 75 yrs			65-74 yrs	80 yrs	
			≥ 75 yrs		

KDRI, Dietary Reference Intake for Koreans; DRI, Dietary Reference Intake; NRV, Nutrient Reference Value; DRV, Dietary Reference Value.

<sup>1)</sup>In case of energy, males and females are classified from infancy.

<sup>2)</sup>In case of macronutrients, vitamins, and minerals, males and females are classified from 11 yrs age.

5- or 10-yr intervals [4]. The WHO 2000–2025 standard population is divided by age range into 5-yr periods and 9 subgroups for older adults (60–64, 65–69, 70–74, ..., 90–94, 95–99, and ≥ 100 yrs) [4]. The 2011 DRIs of the United States and Canada [16] do not classify age groups over 70 yrs, but suggest that for adults aged over 70 yrs, the DRIs should reflect the variations in the calculation of EAR and AI because of the large variation in physical activity and individual differences in functional capacity. In addition, the WHO’s ‘World Report on Aging and Health’ [4] reports that with progressing age, there is a decrease in the physical capacity, which is reported to vary greatly from person to person due to the individual environment interaction. Several foreign countries have presented the necessity to examine the classification of the age group of older adults, but since no grounds for changing the age range have been provided, the age range for older adults remains unchanged.

## ADVISORY COMMITTEE

The KDRI Advisory Committee provided the following suggestions on the review of age ranges.

- Given the changing patterns of aging and physiological alterations resulting in longer lifespan up to the age of 70 yrs, the need to change to 70 yrs needs to be considered. This needs to be properly examined due to age-specific aspects of geriatric disease and malnutrition. Hence, it is necessary to review data of age groups 70 and 75 yrs. Moreover, afflicted adults over 80 yrs have a slow recovery when hospitalized, but this is not significant in terms of prevention and early diagnosis.
- Since personnel managing the patient’s diet (dietitian, clinical dietitian, etc.) often refer to KDRI, realistic age classification is necessary. Given the expanding scale of meals for seniors, modifying to age 70 yrs may not be practically appropriate.
- Considering the size of the baby boomer generation, it would be realistic to maintain the current 2020 KDRI age group criterion.
- If altering the KDRI changes the criteria for the modifying the age range of older adults to 70 yrs, it is necessary to consider how this criterion is to be applied to the age group

50 to 69 yrs. In older adults, it is necessary to examine the age ranges that define this population. If changed to 70 yrs, additional information needs to be collected after reviewing any problems associated by increasing the previous range of 50–69 yrs age.

- There has been no analysis focused on age differences in chronic disease and undernutrition in the 70s and 80s age group. The results differ when analyzed as 65–74 and  $\geq 75$  yrs (of age). It is, therefore, necessary to review the analysis by dividing the age groups into 70 yrs and 75 yrs.
- Overall, there is insufficient data to change the older adult criterion (65 yrs) set in the current KDRIs. It is necessary to review the analysis results for age groups 65–74 and 75–79 yrs. Due to the large difference in results expected when the analysis is divided into groups based on 65 yrs of age, it may be difficult to set 50–74 yrs as the age range for older adults.

Based on the above estimations, the starting point should be maintained at 65 yrs of age, i.e., the same as the current age range for older adults. Further scientific evidence is required to determine the points of division that distinguish between malnutrition and chronic disease management. In addition, it is necessary to analyze and reexamine the health status according to the age range by applying various age groups.

## NUTRITIONAL INTAKE STATUS OF OLDER ADULTS

Data from the 6th and 7th KNHANES (2013–2017), a cross-sectional, nationally representative survey carried out by the KCDC, were examined to clarify characteristics of the nutritional intake status of older adults. The KNHANES uses a stratified, multistage sampling method and comprises 3 surveys: a health interview, a health examination, and a nutrition survey. Detailed information of KNHANES is available on the website (<https://knhanes.kdca.go.kr>). The study population encompassed males and females aged  $\geq 50$  yrs who responded to the 2013–2017 KNHANES ( $n = 16,410$ ). The following exclusion criteria were applied: subjects without the 24-h dietary recall data ( $n = 4,347$ ), pregnant or lactating women ( $n = 11$ ), subjects with a self-reported doctor-diagnosed disease such as hypertension, dyslipidemia, stroke, myocardial infarction or angina pectoris, arthritis, and various cancers ( $n = 10,431$ ), subjects who consumed differently than the usual intake ( $n = 1,056$ ), and subjects with daily calorie intake levels less than 500 kcal/day or more than 5,000 kcal/day ( $n = 33$ ). A total of 3,213 participants (1,685 males and 1,528 females) were included in the final analysis. The 2013–2014 KNHANES protocol was approved by the Institutional Review Board of the KCDC (2013-07CON-03-4C and 2013-12EXP-03-5C), whereas the 2015–2017 KNHANES were exempted from research ethics review based on the Bioethics and Safety Act. Written informed consent was obtained from all participants.

The nutrient adequacy ratio (NAR) was calculated for each of the 9 nutrients (protein, vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, phosphorus, and iron) using the following formula:  $NAR = \text{Subject's Daily Intake of a Nutrient} / \text{RNI of that nutrient}$  according to the subject's gender and age. For a given nutrient, the NAR is the ratio of the subject's intake to the RNI but is limited not to exceed 1. The nutrient consumed is less than the RNI when the NAR is  $< 1$ ; the nutrient consumed is greater than or equal to the RNI when the NAR is 1 [20]. To evaluate the overall dietary adequacy, the mean adequacy ratio (MAR), which is the mean value of 9 NARs, was calculated using the following formula:  $MAR = \sum NAR$  (each truncated at 1)/Number of Nutrients. In this study, nutrient intake was assessed based on the 2015 KDRIs [3].

All statistical analyses were performed using the SAS software (version 9.4; SAS Institute, Inc., Cary, NC, USA). Due to the complex sampling design of the KNHANES study, our analysis considered the relevant primary sampling units, stratification, and sample weights. Nutrient intake status (MAR) in older adults is expressed as weighted means and SEMs using the procedures of SURVEYMEANS. A 3-yr moving average was applied to smooth the mean ages against the nutrient intake trends using the PROC EXPAND procedure. A piecewise linear regression model (using the PROC GLIMMIX procedure) [21,22] was used to observe significant changes in the linear regression slope of nutrient intakes across 2 age groups (under or over a specific age). All dietary nutrient intake variables (carbohydrate, protein, fat, vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, phosphorus, iron, sodium, and potassium) were energy-adjusted using the residuals method, before applying a piecewise linear regression model.

We first examined the association between energy-adjusted nutrient intake and age group across each gender using the piecewise linear regression model. In this model, the scatter plot is divided into 2 parts (at each point of age 65, 70, and 75 yrs), and 2 separate and connected lines fitted, one for each piece function connected at the knot point. The piecewise linear regression model where 2 pieces are connected at  $\chi = 65$ ,  $\chi = 70$ ,  $\chi = 75$  can be formulated as follows:

$$y = \beta_0 + \beta_1 \chi_1 + \beta_2(\chi_1 - 65) \chi_2 + \varepsilon$$

This formula is for the age 65 years as the knot point and can be simplified as follows:

$$y = \beta_0 + \beta_1 \chi_1 + \beta_2 \chi_2^* + \varepsilon$$

where  $\chi_1$  is age, and  $\beta_1$  is the slope of age. The interaction effect term ( $\beta_2$ ) shows the difference in intake by age group, while  $\chi_2$  is a dummy variable (0 if  $\chi_1 < 65$ , and 1 if  $\chi_1 \geq 65$ ).  $\chi_2^*$  denotes  $\beta_2 (\chi_1 - 65) \chi_2$ , the interaction effect term.

Results of the piecewise linear regression for each of the 13 nutrients (carbohydrate, protein, fat, vitamin A, thiamine, riboflavin, niacin, vitamin C, calcium, phosphorus, iron, sodium, and potassium) revealed maximum interaction effect in the groups aged under and over 65 yrs (50–64 and 65–80; 10 and 12 nutrients were significant in males and females, respectively), as compared to the groups aged under and over 70 yrs (50–69 and 70–80; 7 and 10 nutrients were significant in males and females, respectively), and under and over 75 yrs (50–74 and 75–80; 7 nutrients were significant in both males and females).

None of the nutrients showed an interaction effect on the groups aged under and over 65 yrs (50–64 and 65–80), whereas groups aged under and over 70 yrs (50–69 and 70–80), or under and over 75 yrs (50–74 and 75–80) showed an interaction effect on nutrient intake (**Table 3**).

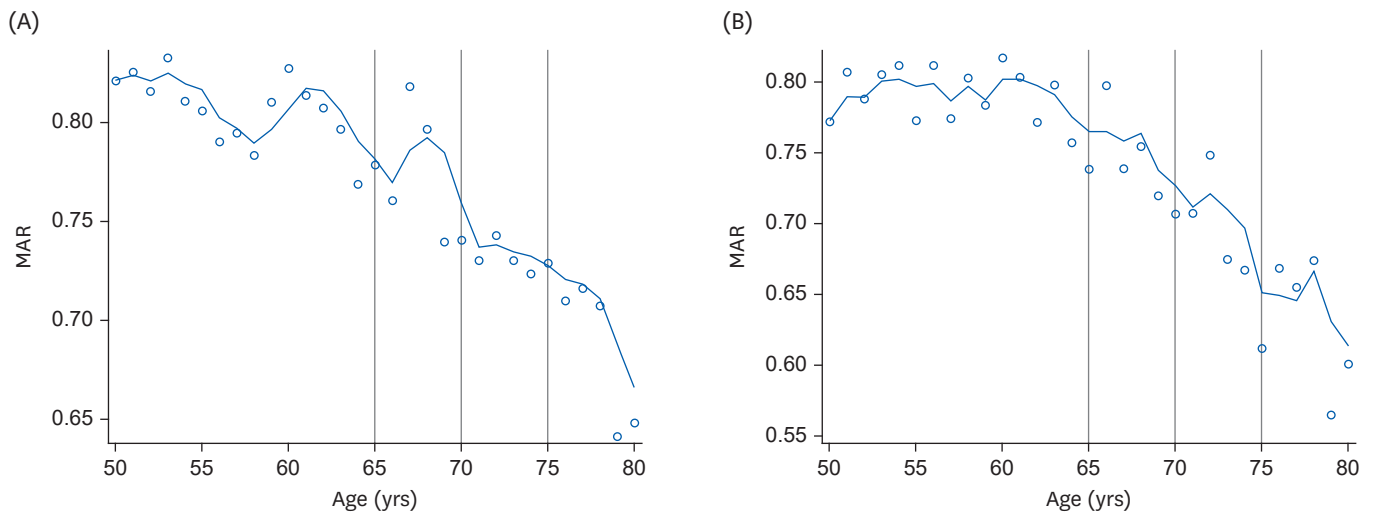
Next, we calculated the MAR and observed the change (reduction) in overall nutrient intake (measured by MAR) trends (whether smooth or not) in older age groups across each gender, using the 3-yr (age) moving average method. Our results revealed an overall decrease in MAR in males, regardless of the age junction (at the age 65, 70, and 75 yrs); in females, the MAR tended to remain constant until 65 yrs of age after which there was a tendency to decrease (**Fig. 1**). In addition, in the comparison of MAR by 1-yr interval of age, the age at which MAR started to fall below 0.75 (the standard value indicating nutrient intake adequacy [23]) was determined to be 69 yrs for males and 65 yrs for females (**Table 4**).

## Age group categories for KDRIs of older adults

**Table 3.** The association between energy-adjusted nutrient intake and age group across each gender using piecewise linear regression model; age group (under and over a specific age)

Variables	65 yrs				70 yrs				75 yrs			
	Male		Female		Male		Female		Male		Female	
	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F	F Value	Pr > F
Carbohydrate*age group	3.03	0.0484	22.01	< 0.0001	15.68	< 0.0001	31.98	< 0.0001	21.15	< 0.0001	29.63	< 0.0001
Protein*age group	5.62	0.0037	5.88	0.0028	1.66	0.1910	8.02	0.0003	4.02	0.0181	12.68	< 0.0001
Fat*age group	7.33	0.0007	7.32	0.0007	13.19	< 0.0001	26.51	< 0.0001	20.70	< 0.0001	48.29	< 0.0001
Vitamin A*age group	1.59	0.2045	1.35	0.2603	0.10	0.9017	1.13	0.3228	0.23	0.7964	1.42	0.2421
Thiamine*age group	3.95	0.0195	11.19	< 0.0001	2.14	0.1176	5.14	0.0060	0.25	0.7750	2.31	0.0998
Riboflavin*age group	3.57	0.0284	4.46	0.0117	3.71	0.0247	8.45	0.0002	6.46	0.0016	19.09	< 0.0001
Niacin*age group	5.80	0.0031	13.07	< 0.0001	2.00	0.1354	11.98	< 0.0001	5.21	0.0056	17.56	< 0.0001
Vitamin C*age group	6.01	0.0025	7.28	0.0007	3.27	0.0382	1.67	0.1881	1.31	0.2711	2.67	0.0697
Calcium*age group	2.86	0.0573	7.57	0.0005	0.59	0.5538	4.73	0.0090	2.92	0.0540	14.96	< 0.0001
Phosphorus*age group	10.90	< 0.0001	13.50	< 0.0001	3.71	0.0246	6.78	0.0012	3.23	0.0398	14.46	< 0.0001
Iron*age group	8.72	0.0002	4.32	0.0135	9.62	< 0.0001	3.79	0.0227	7.49	0.0006	0.26	0.7705
Sodium*age group	2.18	0.1132	3.80	0.0225	0.71	0.4915	0.79	0.4530	0.80	0.4497	0.69	0.4996
Potassium*age group	19.52	< 0.0001	25.86	< 0.0001	9.64	< 0.0001	7.46	0.0006	1.85	0.1574	2.37	0.0941

\*Denotes the interaction effect term between nutrient and age group.



**Fig. 1.** Trends of MAR in older adults in South Korea. The smoothed curves were obtained by the 3-yr moving average. X-axis, age (yrs); Y-axis, MAR. (A) Males; (B) Females. MAR, mean adequacy ratio.

Summarizing the above results, we could not find any scientific evidence for changing the age group of older adults because the number of subjects aged over 70 yrs was too small (424 males and 390 females) and showed inconsistent patterns. Even if the age group is subdivided, it is considerably difficult to secure the necessary scientific evidence when setting the KDRIs for the segmented age group. The limitations of this analysis are as follows. First, the number of subjects is too small. Second, it is currently difficult to comprehensively evaluate age-related changes in the physical and morphological functions of older adults, and to understand the scientific basis for estimating nutritional requirements in older adults. Third, there is insufficient evidence to determine truly healthy older people. In the future, it is necessary to reorganize the concept of how “health,” as defined by the KDRIs, is applied to older adults. In particular, although the KDRIs are standards for a healthy population, further research is required to interpret the meaning of “health” in older adults as the absence of disease, which is not realistic due to the characteristics of this population. Nevertheless, this study is meaningful in that it attempts to reconsider the classification of older adults by

**Age group categories for KDRIs of older adults**

**Table 4.** The NAR and MAR in older adults in South Korea

Variables	Number	NAR									MAR
		Protein	Vitamin A	Thiamine	Riboflavin	Niacin	Vitamin C	Calcium	Phosphorus	Iron	
<b>Male (yrs)</b>											
50	59	0.95 ± 0.02	0.50 ± 0.03	0.98 ± 0.01	0.86 ± 0.02	0.84 ± 0.03	0.60 ± 0.04	0.67 ± 0.03	0.99 ± 0.01	0.99 ± 0.00	0.82 ± 0.02
51	70	0.93 ± 0.02	0.54 ± 0.04	0.98 ± 0.01	0.86 ± 0.02	0.88 ± 0.02	0.62 ± 0.04	0.67 ± 0.03	0.99 ± 0.01	0.98 ± 0.01	0.83 ± 0.01
52	78	0.94 ± 0.01	0.48 ± 0.03	0.98 ± 0.01	0.81 ± 0.03	0.87 ± 0.02	0.64 ± 0.05	0.67 ± 0.03	0.98 ± 0.01	0.98 ± 0.01	0.82 ± 0.02
53	68	0.96 ± 0.02	0.47 ± 0.04	0.97 ± 0.01	0.85 ± 0.03	0.88 ± 0.02	0.67 ± 0.04	0.75 ± 0.03	0.99 ± 0.01	0.97 ± 0.01	0.83 ± 0.02
54	83	0.89 ± 0.02	0.48 ± 0.04	0.98 ± 0.01	0.82 ± 0.03	0.86 ± 0.02	0.66 ± 0.04	0.68 ± 0.03	0.97 ± 0.01	0.96 ± 0.01	0.81 ± 0.02
55	93	0.93 ± 0.02	0.46 ± 0.03	0.98 ± 0.01	0.82 ± 0.03	0.85 ± 0.02	0.60 ± 0.04	0.66 ± 0.03	0.99 ± 0.01	0.98 ± 0.01	0.81 ± 0.01
56	65	0.90 ± 0.03	0.47 ± 0.04	0.96 ± 0.02	0.79 ± 0.04	0.83 ± 0.04	0.60 ± 0.05	0.65 ± 0.04	0.95 ± 0.02	0.94 ± 0.02	0.79 ± 0.03
57	88	0.91 ± 0.02	0.44 ± 0.03	0.98 ± 0.01	0.76 ± 0.03	0.83 ± 0.03	0.60 ± 0.04	0.66 ± 0.03	0.98 ± 0.01	0.98 ± 0.01	0.79 ± 0.02
58	78	0.88 ± 0.03	0.42 ± 0.03	0.95 ± 0.02	0.77 ± 0.03	0.81 ± 0.03	0.65 ± 0.04	0.65 ± 0.03	0.96 ± 0.01	0.96 ± 0.01	0.78 ± 0.02
59	68	0.91 ± 0.02	0.53 ± 0.04	0.96 ± 0.02	0.82 ± 0.03	0.86 ± 0.03	0.64 ± 0.04	0.64 ± 0.04	0.96 ± 0.01	0.96 ± 0.01	0.81 ± 0.02
60	50	0.91 ± 0.02	0.51 ± 0.05	0.98 ± 0.01	0.82 ± 0.04	0.84 ± 0.03	0.70 ± 0.05	0.71 ± 0.03	0.99 ± 0.01	0.98 ± 0.01	0.83 ± 0.02
61	58	0.92 ± 0.02	0.54 ± 0.05	0.98 ± 0.01	0.80 ± 0.04	0.85 ± 0.03	0.64 ± 0.05	0.67 ± 0.04	0.96 ± 0.02	0.96 ± 0.02	0.81 ± 0.02
62	57	0.89 ± 0.03	0.50 ± 0.04	0.97 ± 0.01	0.81 ± 0.03	0.82 ± 0.03	0.69 ± 0.05	0.66 ± 0.03	0.97 ± 0.01	0.95 ± 0.02	0.81 ± 0.02
63	34	0.87 ± 0.03	0.50 ± 0.06	0.98 ± 0.01	0.79 ± 0.04	0.81 ± 0.04	0.64 ± 0.06	0.65 ± 0.04	0.97 ± 0.01	0.97 ± 0.01	0.80 ± 0.02
64	47	0.88 ± 0.03	0.39 ± 0.04	0.96 ± 0.02	0.72 ± 0.04	0.77 ± 0.03	0.58 ± 0.05	0.67 ± 0.04	0.97 ± 0.01	0.97 ± 0.02	0.77 ± 0.02
65	54	0.93 ± 0.02	0.43 ± 0.04	0.99 ± 0.01	0.68 ± 0.04	0.81 ± 0.03	0.59 ± 0.04	0.63 ± 0.04	0.97 ± 0.01	0.98 ± 0.01	0.78 ± 0.02
66	56	0.87 ± 0.04	0.42 ± 0.04	0.94 ± 0.03	0.74 ± 0.04	0.78 ± 0.04	0.62 ± 0.05	0.59 ± 0.04	0.93 ± 0.03	0.96 ± 0.03	0.76 ± 0.03
67	64	0.93 ± 0.02	0.47 ± 0.03	0.96 ± 0.02	0.78 ± 0.03	0.86 ± 0.02	0.69 ± 0.05	0.72 ± 0.03	0.98 ± 0.01	0.98 ± 0.01	0.82 ± 0.02
68	54	0.92 ± 0.03	0.49 ± 0.05	0.97 ± 0.02	0.74 ± 0.05	0.82 ± 0.04	0.61 ± 0.05	0.68 ± 0.05	0.96 ± 0.03	0.99 ± 0.00	0.80 ± 0.03
69	37	0.86 ± 0.04	0.40 ± 0.05	0.94 ± 0.02	0.69 ± 0.05	0.75 ± 0.04	0.59 ± 0.07	0.55 ± 0.05	0.92 ± 0.03	0.96 ± 0.02	0.74 ± 0.03
70	43	0.88 ± 0.03	0.34 ± 0.04	0.94 ± 0.03	0.69 ± 0.04	0.70 ± 0.03	0.51 ± 0.05	0.66 ± 0.03	0.97 ± 0.01	0.98 ± 0.01	0.74 ± 0.02
71	27	0.86 ± 0.04	0.44 ± 0.07	0.92 ± 0.03	0.67 ± 0.07	0.73 ± 0.05	0.53 ± 0.07	0.54 ± 0.05	0.93 ± 0.03	0.96 ± 0.02	0.73 ± 0.04
72	43	0.87 ± 0.03	0.38 ± 0.04	0.97 ± 0.02	0.68 ± 0.04	0.76 ± 0.04	0.55 ± 0.06	0.58 ± 0.04	0.94 ± 0.02	0.97 ± 0.01	0.74 ± 0.03
73	32	0.88 ± 0.03	0.45 ± 0.07	0.97 ± 0.01	0.62 ± 0.05	0.74 ± 0.05	0.48 ± 0.07	0.52 ± 0.04	0.93 ± 0.02	0.98 ± 0.01	0.73 ± 0.03
74	24	0.86 ± 0.05	0.42 ± 0.07	0.95 ± 0.03	0.61 ± 0.05	0.74 ± 0.07	0.50 ± 0.08	0.57 ± 0.06	0.93 ± 0.03	0.94 ± 0.03	0.72 ± 0.04
75	36	0.90 ± 0.02	0.30 ± 0.04	0.94 ± 0.03	0.64 ± 0.05	0.72 ± 0.04	0.55 ± 0.06	0.58 ± 0.05	0.95 ± 0.02	0.97 ± 0.01	0.73 ± 0.03
76	19	0.87 ± 0.05	0.36 ± 0.07	0.94 ± 0.03	0.63 ± 0.06	0.69 ± 0.06	0.48 ± 0.08	0.55 ± 0.06	0.93 ± 0.03	0.93 ± 0.03	0.71 ± 0.04
77	39	0.87 ± 0.03	0.36 ± 0.04	0.92 ± 0.02	0.61 ± 0.05	0.70 ± 0.04	0.53 ± 0.07	0.55 ± 0.05	0.92 ± 0.02	0.98 ± 0.01	0.72 ± 0.03
78	19	0.86 ± 0.05	0.27 ± 0.05	0.92 ± 0.04	0.62 ± 0.07	0.76 ± 0.06	0.49 ± 0.06	0.54 ± 0.05	0.93 ± 0.03	0.97 ± 0.03	0.71 ± 0.04
79	20	0.77 ± 0.06	0.31 ± 0.06	0.82 ± 0.06	0.53 ± 0.07	0.67 ± 0.07	0.48 ± 0.11	0.45 ± 0.07	0.86 ± 0.06	0.89 ± 0.05	0.64 ± 0.05
80	122	0.77 ± 0.02	0.33 ± 0.03	0.88 ± 0.02	0.54 ± 0.03	0.63 ± 0.03	0.43 ± 0.03	0.49 ± 0.03	0.87 ± 0.02	0.91 ± 0.02	0.65 ± 0.02
<b>Female (yrs)</b>											
50	87	0.88 ± 0.02	0.48 ± 0.03	0.95 ± 0.01	0.80 ± 0.03	0.79 ± 0.03	0.65 ± 0.04	0.52 ± 0.03	0.92 ± 0.02	0.96 ± 0.02	0.77 ± 0.02
51	89	0.90 ± 0.02	0.50 ± 0.03	0.96 ± 0.01	0.85 ± 0.02	0.85 ± 0.02	0.68 ± 0.04	0.59 ± 0.03	0.95 ± 0.01	0.98 ± 0.01	0.81 ± 0.01
52	79	0.89 ± 0.02	0.49 ± 0.04	0.95 ± 0.01	0.80 ± 0.03	0.79 ± 0.03	0.67 ± 0.05	0.59 ± 0.04	0.94 ± 0.01	0.98 ± 0.01	0.79 ± 0.02
53	96	0.88 ± 0.02	0.58 ± 0.03	0.95 ± 0.01	0.81 ± 0.03	0.79 ± 0.03	0.74 ± 0.04	0.59 ± 0.03	0.95 ± 0.01	0.98 ± 0.01	0.81 ± 0.02
54	66	0.92 ± 0.02	0.53 ± 0.04	0.96 ± 0.01	0.85 ± 0.03	0.84 ± 0.03	0.66 ± 0.05	0.62 ± 0.04	0.95 ± 0.01	0.96 ± 0.02	0.81 ± 0.02
55	80	0.86 ± 0.02	0.52 ± 0.04	0.93 ± 0.02	0.81 ± 0.03	0.76 ± 0.03	0.68 ± 0.04	0.51 ± 0.03	0.93 ± 0.02	0.95 ± 0.01	0.77 ± 0.02
56	74	0.89 ± 0.02	0.59 ± 0.04	0.95 ± 0.02	0.83 ± 0.03	0.83 ± 0.02	0.72 ± 0.04	0.59 ± 0.04	0.94 ± 0.02	0.97 ± 0.01	0.81 ± 0.02
57	76	0.86 ± 0.03	0.51 ± 0.04	0.95 ± 0.01	0.81 ± 0.03	0.80 ± 0.03	0.67 ± 0.04	0.51 ± 0.03	0.91 ± 0.02	0.94 ± 0.02	0.77 ± 0.02
58	65	0.92 ± 0.02	0.47 ± 0.03	0.97 ± 0.01	0.83 ± 0.03	0.81 ± 0.03	0.67 ± 0.05	0.63 ± 0.03	0.96 ± 0.01	0.98 ± 0.01	0.80 ± 0.02
59	49	0.88 ± 0.03	0.44 ± 0.05	0.96 ± 0.01	0.76 ± 0.04	0.78 ± 0.04	0.75 ± 0.05	0.59 ± 0.04	0.93 ± 0.02	0.98 ± 0.01	0.78 ± 0.03
60	43	0.93 ± 0.02	0.49 ± 0.04	0.97 ± 0.01	0.84 ± 0.04	0.86 ± 0.03	0.68 ± 0.05	0.64 ± 0.04	0.97 ± 0.02	0.98 ± 0.01	0.82 ± 0.02
61	39	0.91 ± 0.02	0.50 ± 0.06	0.95 ± 0.02	0.84 ± 0.04	0.81 ± 0.04	0.68 ± 0.06	0.58 ± 0.04	0.96 ± 0.02	0.99 ± 0.01	0.80 ± 0.02
62	55	0.86 ± 0.03	0.46 ± 0.03	0.95 ± 0.01	0.77 ± 0.03	0.76 ± 0.03	0.69 ± 0.05	0.57 ± 0.03	0.93 ± 0.02	0.95 ± 0.02	0.77 ± 0.02
63	45	0.87 ± 0.03	0.51 ± 0.05	0.95 ± 0.02	0.79 ± 0.05	0.81 ± 0.04	0.77 ± 0.05	0.56 ± 0.05	0.94 ± 0.02	0.99 ± 0.01	0.80 ± 0.03
64	41	0.87 ± 0.03	0.47 ± 0.05	0.97 ± 0.01	0.72 ± 0.04	0.76 ± 0.03	0.65 ± 0.06	0.44 ± 0.03	0.94 ± 0.02	0.99 ± 0.01	0.76 ± 0.02
65	26	0.91 ± 0.03	0.46 ± 0.07	0.97 ± 0.02	0.75 ± 0.05	0.77 ± 0.05	0.48 ± 0.07	0.44 ± 0.05	0.92 ± 0.03	0.96 ± 0.02	0.74 ± 0.03
66	41	0.90 ± 0.02	0.59 ± 0.06	0.96 ± 0.02	0.78 ± 0.04	0.79 ± 0.04	0.68 ± 0.06	0.58 ± 0.05	0.92 ± 0.02	0.98 ± 0.01	0.80 ± 0.03
67	33	0.88 ± 0.04	0.44 ± 0.07	0.94 ± 0.03	0.67 ± 0.06	0.73 ± 0.05	0.61 ± 0.06	0.52 ± 0.07	0.91 ± 0.03	0.95 ± 0.02	0.74 ± 0.04
68	28	0.91 ± 0.02	0.36 ± 0.05	0.95 ± 0.02	0.69 ± 0.06	0.78 ± 0.04	0.67 ± 0.07	0.51 ± 0.05	0.93 ± 0.02	0.99 ± 0.01	0.75 ± 0.03
69	26	0.89 ± 0.03	0.43 ± 0.07	0.95 ± 0.02	0.66 ± 0.05	0.72 ± 0.06	0.52 ± 0.07	0.48 ± 0.05	0.88 ± 0.04	0.96 ± 0.02	0.72 ± 0.03
70	28	0.86 ± 0.04	0.37 ± 0.05	0.94 ± 0.03	0.62 ± 0.06	0.69 ± 0.05	0.62 ± 0.08	0.43 ± 0.05	0.88 ± 0.04	0.96 ± 0.03	0.71 ± 0.04
71	24	0.85 ± 0.04	0.42 ± 0.07	0.97 ± 0.01	0.64 ± 0.07	0.72 ± 0.05	0.53 ± 0.08	0.42 ± 0.05	0.86 ± 0.03	0.97 ± 0.03	0.71 ± 0.03
72	23	0.92 ± 0.02	0.48 ± 0.08	0.97 ± 0.02	0.65 ± 0.05	0.73 ± 0.04	0.59 ± 0.08	0.47 ± 0.05	0.94 ± 0.02	0.99 ± 0.01	0.75 ± 0.02
73	21	0.84 ± 0.05	0.38 ± 0.07	0.86 ± 0.05	0.66 ± 0.08	0.66 ± 0.06	0.57 ± 0.10	0.35 ± 0.06	0.85 ± 0.04	0.90 ± 0.04	0.68 ± 0.05
74	23	0.82 ± 0.04	0.30 ± 0.05	0.97 ± 0.01	0.52 ± 0.05	0.65 ± 0.04	0.54 ± 0.08	0.36 ± 0.04	0.84 ± 0.04	0.99 ± 0.00	0.67 ± 0.03

(continued to the next page)



**Table 4.** (Continued) The NAR and MAR in older adults in South Korea

Variables	Number	NAR									MAR
		Protein	Vitamin A	Thiamine	Riboflavin	Niacin	Vitamin C	Calcium	Phosphorus	Iron	
75	29	0.81 ± 0.04	0.26 ± 0.05	0.89 ± 0.03	0.49 ± 0.05	0.63 ± 0.05	0.42 ± 0.07	0.31 ± 0.03	0.80 ± 0.04	0.90 ± 0.04	0.61 ± 0.03
76	19	0.81 ± 0.06	0.37 ± 0.07	0.93 ± 0.03	0.67 ± 0.07	0.64 ± 0.05	0.45 ± 0.06	0.33 ± 0.05	0.84 ± 0.06	0.97 ± 0.02	0.67 ± 0.04
77	20	0.87 ± 0.05	0.30 ± 0.07	0.89 ± 0.04	0.53 ± 0.04	0.63 ± 0.06	0.46 ± 0.08	0.39 ± 0.04	0.86 ± 0.05	0.97 ± 0.02	0.66 ± 0.03
78	20	0.82 ± 0.05	0.38 ± 0.07	0.89 ± 0.04	0.64 ± 0.07	0.59 ± 0.06	0.56 ± 0.10	0.38 ± 0.05	0.84 ± 0.05	0.97 ± 0.02	0.67 ± 0.05
79	20	0.72 ± 0.07	0.21 ± 0.06	0.83 ± 0.05	0.44 ± 0.07	0.55 ± 0.07	0.41 ± 0.09	0.30 ± 0.05	0.73 ± 0.07	0.88 ± 0.05	0.56 ± 0.06
80	163	0.74 ± 0.02	0.32 ± 0.02	0.85 ± 0.02	0.52 ± 0.02	0.54 ± 0.02	0.39 ± 0.03	0.34 ± 0.01	0.77 ± 0.02	0.94 ± 0.01	0.60 ± 0.01

Values are presented as mean ± SE.

NAR, nutrient adequacy ratio; MAR, mean adequacy ratio.

examining domestic and international data on the elderly and by examining the consumption patterns by age through various statistical analyses.

## CONCLUDING REMARKS AND SUGGESTIONS FOR FURTHER RESEARCH

Based on these results, we conclude that there is no scientific basis for changing the age group for older adults in the KDRIs. In the future, there is a need to refine the concept of “healthy” for older adults, as defined by DRIs. Furthermore, it is necessary to know the exact nutrient requirements and intake level of this population for a more accurate analysis of the age group classification of older adults. It is also important to continuously monitor new updates and how it is being updated in other countries with regard to setting the age group for older adults.

## REFERENCES

1. The Korean Nutrition Society. Dietary Reference Intakes for Koreans 2010. Seoul: The Korean Nutrition Society; 2010.
2. The Korean Nutrition Society. Dietary Reference Intakes for Koreans 2005. Seoul: The Korean Nutrition Society; 2005.
3. Ministry of Health and Welfare (KR); The Korean Nutrition Society. Dietary Reference Intakes for Koreans 2015. Seoul: The Korean Nutrition Society; 2015.
4. World Health Organization. World report on ageing and health [Internet]. Geneva: World Health Organization; 2015 [cited 2021 September 20]. Available from: <https://apps.who.int/iris/handle/10665/186463>.
5. Statistics Korea. Population projections for Korea [Internet]. Daejeon: Statistics Korea; 2015 [cited 2021 December 9]. Available from: [http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT\\_1BPA001&vw\\_cd=MT\\_ZTITLE&list\\_id=A41\\_10&seqNo=&lang\\_mode=ko&language=kor&obj\\_var\\_id=&itm\\_id=&conn\\_path=MT\\_ZTITLE](http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1BPA001&vw_cd=MT_ZTITLE&list_id=A41_10&seqNo=&lang_mode=ko&language=kor&obj_var_id=&itm_id=&conn_path=MT_ZTITLE).
6. Ministry of the Interior and Safety (KR). Population Statistics of Resident Registration 2017. Sejong: Ministry of the Interior and Safety; 2017.
7. Statistics Korea. Population and housing census [Internet]. Daejeon: Statistics Korea; 2015 [cited 2021 July 29]. Available from: [http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT\\_1IN1503&vw\\_cd=MT\\_ZTITLE&list\\_id=A11\\_2015\\_1\\_10\\_10&seqNo=&lang\\_mode=ko&language=kor&obj\\_var\\_id=&itm\\_id=&conn\\_path=MT\\_ZTITLE](http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1IN1503&vw_cd=MT_ZTITLE&list_id=A11_2015_1_10_10&seqNo=&lang_mode=ko&language=kor&obj_var_id=&itm_id=&conn_path=MT_ZTITLE).
8. Statistics Korea. e-National indicators: population structure by age [Internet]. Daejeon: Statistics Korea; 2016 [cited 2021 December 9]. Available from: <http://www.index.go.kr>.
9. Statistics Korea. Statistics of Aged People 2016. Sejong: Statistics Korea; 2016.
10. Statistics Korea. Projected population by major age group [Internet]. Daejeon: Statistics Korea; 2017 [cited 2021 December 9]. Available from: [http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT\\_1BPA001](http://kosis.kr/statHtml/statHtml.do?orgId=101&tblId=DT_1BPA001).

11. Ministry of Education (KR). Brief Statistics on Korean Education 2016. Sejong: Ministry of Education; 2016.
12. Korea Institute for Health and Social Affairs. Korean National Survey on Elderly 2017. Sejong: Korea Institute for Health and Social Affairs; 2017.
13. Korea Centers for Disease Control and Prevention. Korea Community Health Survey 2018. Sejong: Korea Centers for Disease Control and Prevention; 2018.
14. Korea Centers for Disease Control and Prevention. Korea National Health and Nutrition Examination Survey 2018. Sejong: Korea Centers for Disease Control and Prevention; 2018.
15. Ministry of Health, Labour and Welfare (JP). Dietary Reference Intakes for Japanese 2015. Tokyo: Ministry of Health, Labour and Welfare; 2015.
16. Food and Nutrition Board (US); Institute of Medicine. Dietary Reference Intakes for Calcium and Vitamin D. Washington, D.C.: National Academy Press, 2011.
17. Department of Health and Ageing, New Zealand Ministry of Health. Nutrient Reference Values for Australia and New Zealand. Canberra: National Health and Medical Research Council; 2017.
18. Committee on Medical Aspects of Food Policy. Dietary Reference Values for Food Energy and Nutrients in the United Kingdom. Report of the Panel on Dietary Reference Values of the Committee on Medical Aspects of the Food Policy. London: HMSO, 2011.
19. Chinese Nutrition Society. Chinese Dietary Reference Intakes Handbook 2013. Beijing: China Standard Press; 2014.
20. Guthrie HA, Scheer JC. Validity of a dietary score for assessing nutrient adequacy. *J Am Diet Assoc* 1981;78:240-5.  
[PUBMED](#) | [CROSSREF](#)
21. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Stat Med* 2000;19:335-51.  
[PUBMED](#) | [CROSSREF](#)
22. Pickle LW, Hao Y, Jemal A, Zou Z, Tiwari RC, Ward E, Hachey M, Howe HL, Feuer EJ. A new method of estimating United States and state-level cancer incidence counts for the current calendar year. *CA Cancer J Clin* 2007;57:30-42.  
[PUBMED](#) | [CROSSREF](#)
23. Hatløy A, Torheim LE, Oshaug A. Food variety--a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *Eur J Clin Nutr* 1998;52:891-8.  
[PUBMED](#) | [CROSSREF](#)