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REGULAR ARTICLE

Food intake survey of kindergarten children in Korea: Part 1 food, energy, and nutrient intake

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Abstract
Objectives Nutrient intakes of children were surveyed at the time when a nation-wide shift took place in the Republic of Korea from agriculture-based to industrialized society. Taking advantage of the survey locations (see below), possible delay in nutritional improvement in rural areas (as compared with that in an urban area) was also examined.
Methods In total, 108 4- to 6-year-old children (boys and girls in combination) in 4 kindergartens (KGs; 1 in Seoul and 3 in Jeju Island) participated in the survey in 2003–2004. 24-h food duplicate samples were prepared by the mother of each child. Food items in each duplicate sample were separated and coded with reference to the Dietary Reference Intake for Koreans (the 2005 version). Nutrient intake of the day was estimated from the code and weight followed by summation for daily intake.
Results The children in the KG in Seoul studied were younger, and therefore were smaller in body size than those in other KGs. Thus, it was considered necessary to evaluate nutrient intake not only on a daily basis, but after adjustment for body weight. The AM daily intake of energy (protein in parenthesis) for the 108 children was 1479 kcal (55 g)/day or 69.8 kcal (2.6 g)/kg body weight/day. Evaluation by individual nutrient suggested that the intake was sufficient for almost all nutrients except for sodium and potassium. Sodium and potassium intake (2285 and 1840 mg/day, respectively) was in excess and insufficient, respectively, with potential risk of inducing hypertension later in life.
Conclusions Inter-KG difference was not remarkable and therefore urban–rural difference was not apparent. Nutrient intakes as a whole appeared to be sufficient urban and rural areas. Nevertheless, excess Na intake coupled with insufficient K intake was a common problem.

Keywords Children · Food intake · Kindergarten · Korea · Nutrient intake

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Introduction

It is well known that the Korean National Health and Nutrition Examination Survey (KNHANES) covering the whole country was initiated in 1998, and that the survey has been repeated in every 3–5 years [1, 2]. It is also known that Recommended Dietary Allowances for Koreans has been published from the Korean Nutrition Society [3, 4].

Survey on nutrient intake among children is particularly important. As many studies in pediatric medicine had shown, children are not just small adults. From nutritional point of view, they are physically much more active and dynamic than adult people, and they need more nutrients not only for daily life, but also for growth. Nevertheless, reports on nutrition of children are still limited.

There has been a remarkable shift in the Republic of Korea from the agriculture-based community to an industrialized one in 1970s [5, 6]. The shift may have induced improvement not only in economy, but also in nutrition of the people, especially children. Such favorable change is quite conceivable but not yet proved. The present study on nutrition was conducted early in 2000s with a special focus on 4- to 6-year-old preschool children in kindergartens, one in Seoul, a megalopolis as the capital, and one in a smaller city and two in rural areas in Jeju Island in southern part of Republic of Korea.

For the survey, the food duplicate collection method [7] was employed so that the collected samples could be employed not only for nutrient intake examination, but also for instrumental determination of selected metals in food. The 2005 version of Dietary Reference Intake for Koreans [3] was employed for nutritional evaluation as the publication date was close to the date of survey (2003–2004).

The survey report consists of three parts, i.e., Part 1 on nutrient intake (i.e., this article), Part 2 on tin intake via foods [8], and Part 3 on the burden of two pollutant metals of cadmium and lead [9].

Materials and methods

Survey sites, survey subjects and ethical issues

Surveys were conducted in one kindergarten (KG 1 with 33 children) in Seoul in September, 2004, and in three KGs in Jeju Island in October, 2003 (KG 2 in the city of Jeju with 37 attending children, KG 3 with 18 children and KG 4 with 20 children in rural areas in the island). Guardians of the children (mostly mothers) provided informed consents, demographic parameters of children and food duplicate samples. The study protocol was approved by the Institutional Review Board of Dankook University (DKU2015-03-007), Yongin-si, Gyeonggi-do 448-701, Korea.

Collection of food duplicate sample and estimation of nutrient intake

On the day of survey, the guardians were asked to prepare 24-h food duplicate samples (including drinks and water) following the method as previously detailed [6, 10–12]. Food items in each duplicate sample were separated manually, and weights were recorded. Each food item was coded after tables attached to Dietary Reference Intakes for Koreans (the 2005 version [1]). The nutrient intake/day was estimated from the code and amount (by weight) of each food item followed by summation [10–12].

Statistical analysis

Nutrient intakes were assumed to be distributed normally so that arithmetic means (AMs) and arithmetic standard deviations (ASDs) were taken as parameters to represent distributions, although coefficients of variation (CVs) were large for some nutrients (e.g., vitamin D). One-way analyses of variance (ANOVA) followed by post hoc test (Scheffe) were applied to detect possible differences among the four KGs (inter-KG difference); $p < 0.05$ was taken as the point of significance (see Fig. 1).

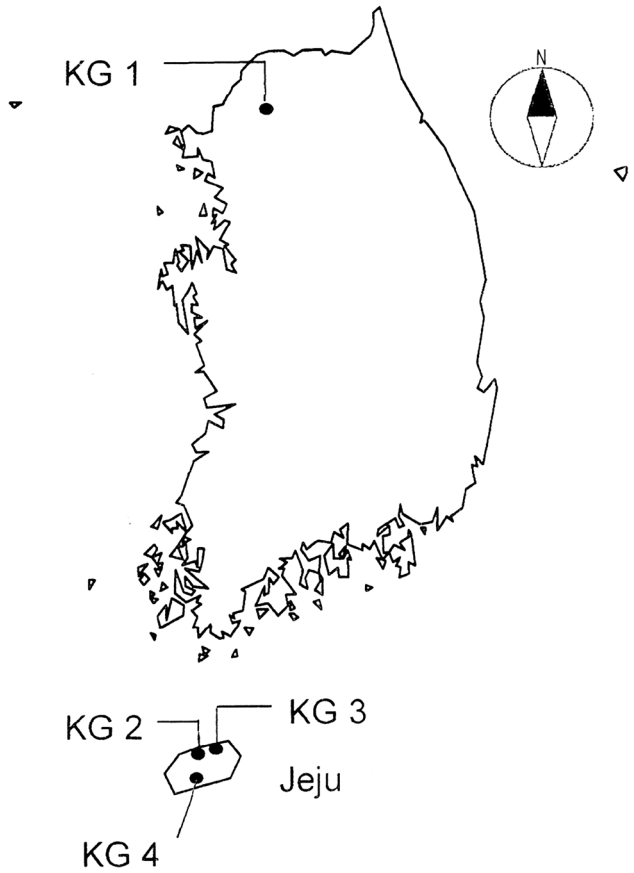

Fig. 1 Locations of 4 kindergartens (KGs) participated in the present survey. A *solid circle* at the *top* shows the location of KG 1 (in Seoul). Two *circles* at the *top* in the Jeju Island (at the *bottom* of the map) are for KG 2 (the *left*; one Jeju City) and KG 3 (the *right* one; a rural area). The *bottom* one in the island shows the location of KG 4 (another rural area)

Results

Demographic characteristics of children

Demographic characteristics of the children as a whole and by KG are summarized in Table 1 in terms of number (by boys and girls), age, height and weight. Most of children were at the ages of 5–6 years, but children in KG 1 were significantly younger ($p < 0.05$) than those in other three KGs with less height and body weight on average (Table 1). The observation suggested that the nutrient intake should be evaluated on a kg body weight basis in addition to that on a daily intake basis.

Daily dietary intake of nutrients

The results of nutrient intake estimation are summarized in Table 2 in terms of both on the daily intake basis and on the daily intake per by body weight basis. Amounts of food intake were also presented in terms of food groups (Table 3).

It is clear from Table 2 that the children took about 1480 kcal/day (or 70 kcal/kg body weight/day) and 55 g protein/day (2.6 g protein/kg body weight/day). When coefficients of variation (CVs) were calculated, CVs for macronutrients were less than 30 % (with exception of dietary fibers). CVs tended to be greater for minerals, and

Table 1 Number of children surveyed and their ages and body sizes by kindergarten

Kindergarten (KG)	No. of children			Age (years)		Hight (cm)		Body weight (kg)	
	Total	Boys	Girls	AM	ASD	AM	ASD	AM	ASD
Total	108	54	54	5.5	0.6	115.2	5.3	21.6	3.8
A. KG 1	33	15	18	5.1	1.1	112.4	4.7	19.2	2.9
B. KG 2	37	19	18	5.7	1.0	117.3	4.0	23.2	3.2
C. KG 3	18	8	10	5.8	1.4	116.1	5.2	22.4	4.4
D. KG 4	20	12	8	5.8	1.3	115.0	6.4	21.7	3.9
Comparison among KGs[a]				B ≒ C ≒ D > A		B ≒ C ≒ D > A		B ≒ C > A ≒ D	

[a] $P > Q$ means that P was significantly ($p < 0.05$) greater than Q, and $P \fallingdotseq Q$ means that the difference between P and Q was statistically insignificant ($p > 0.05$)

Table 2 Daily take by nutrients and by food groups

Nutrient or food group (unit)	Parameter	Item					
Macronutrients		Energy (kcal)	Protein (g)	Lipid (g)	Carbohydrate (g)	Dietary fiber (g)	Ash (g)
Intake/day	AM	1478.7	54.9	42.7	216.5	5.2	13.0
	CV (%)	20.1	24.7	27.7	22.7	46.4	27.8
Intake/kg BW/day[a]	AM	69.8	2.58	2.02	10.2	0.25	0.61

Minerals		Ca (mg)	P (mg)	Fe (mg)	Na (mg)	NaCl (g)	K (mg)	Zn (mg)
Intake/day	AM	616	915	7.83	2285	5.80	1840	6.36
	CV (%)	35.7	23.2	34.74	36.7	36.68	26.4	23.84
Intake/kg BW/day[a]	AM	29	43	0.37	107	0.27	87	0.30

Micronutrients		Vitamin C (mg)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin B_6 (mg)	Niacin (mg)	Vitamin B_{12} (μg)
Intake/day	AM	64.5	0.80	1.14	1.45	9.8	1.45
	CV (%)	67.8	32.0	28.5	41.1	35.5	51.4
Intake/kg BW/day[a]	AM	3.044	0.038	0.054	0.069	0.464	0.07

Micronutrients		Folic acid (μg)	Vitamin A (μg RE)	Vitamin D (mg)	Vitamin E (mg)	Retinol (μg)	β-Carotene (μg)
Intake/day	AM	150.3	460	0.16	10.0	155	1578
	CV (%)	39.5	58.2	355.0	32.7	54.1	78.1
Intake/kg BW/day[a]	AM	7.0	21	0.007	0.465	7	73

[a] Intake by body weight/day

Table 3 Daily take by food groups

Nutrient or food group (unit)	Parameter	Item								
Food group (1–9) (g)		1 Cereals	2 Potatoes and starches	3 Sugars and sweets	4 Pulses	5 Nuts and seeds	6 Vegetables	7 Mushrooms	8 Fruits	9 Meats and poultries
Intake/day	AM	332.8	22.0	11.1	23.7	4.4	93.1	1.7	138.7	42.1
	CV (%)	26.3	147.5	241.7	204.3	353.7	55.4	265.6	83.3	92.4
Intake/kg BW/day[a]	AM	15.7	1.09	0.51	1.11	0.22	4.38	0.08	6.60	2.02
Food group (10–17) (g)		10 Eggs	11 Fishes and shellfishes	12 Algae	13 Milks	14 Fats and oils	15 Beverages	16 Seasonings	17 Prepared foods	
Intake/day	AM	18.3	32.5	6.7	311.1	6.0	25.7	17.8	94.7	
	CV (%)	128.9	79.6	200.1	43.8	47.7	329.3	57.2	114.6	
Intake/kg BW/day[a]	AM	0.84	1.47	0.33	14.7	0.28	1.16	0.83	4.58	

[a] Intake by body weight/day

further greater in the cases of micronutrients; CV was as large as >300 % in case of vitamin D. The second largest was 78 % for β-carotene.

Table 3 shows that children took 333 g of cereals on average (assumedly boiled rice as staple foods). The CV was as small as 26 %; the small CVs were taken to suggest that every child had rice at least once a day. CVs were greater for other food groups, but such was quite conceivable because each family may take different meals.

Difference in nutrient intake among 4 KGs

Analyses for possible difference in nutrient intake (including energy intake) showed that the inter-KG difference was quite limited. Only the nutrient items with significant inter-KG difference ($p < 0.05$) are listed in Table 4.

Thus, no significant difference could be detected in protein and carbohydrate intakes. Energy intake was lower in KG 2 in agreement with lower lipid intake. The observation did not support the assumption of possible urban–rural difference. For example, the values for energy intake in KG 3 and KG 4, the two KGs in rural areas in Jeju Island, were indeed greater than the value for KG 1 in Seoul (although the difference was statistically insignificant with $p > 0.05$). It was quite conceivable that vitamin C intake was higher in KG 3 and KG 4 in the rural areas. There was no significant inter-KG difference ($p > 0.05$) in intakes of minerals or vitamins other than vitamin C (Tables 2, 3).

Difference in intake by food groups among 4 KGs

Similar analyses on food intakes by 17 food groups (including prepared foods) (Table 5) disclosed that inter-KG differences were detectable in 5 groups only. It was interesting to note that children in KG 4 took less potatoes (and starches) and more vegetables (in agreement with higher intake of vitamin C). It was conceivable that fishes and shell fishes intakes were higher in the 3 KGs in Jeju Island than in KG 1 in the inland city of Seoul.

Discussion

In Korea, there had been substantial changes in food intake and therefore that of nutrients in 1970s (e.g., [4, 5]). The society had been predominantly agricultural previously, but during this period, a shift took place in the location of working forces so that less than 5 % was in the agricultural sector after the shift [4]. Correspondingly, there was a remarkable shift in nutrient intake from cereal-based foods rich in carbohydrate to animal-based foods with substantial intake of lipid [4]. Thus, intake of plant foods dropped

Table 4 Intake of nutrients with significant inter-KG difference

Kindergarden	No.	Macronutrients			Micronutrient
		Energy (kcal)	Lipid (g)	Dietary fiber (g)	Vit. C (mg)
Total	108	69.8	2.02	0.25	3.04
A. KG 1	33	71.8	2.09	0.27	2.56
B. KG 2	37	63.8	1.81	0.22	2.60
C. KG 3	18	71.1	1.94	0.19	4.27
D. KG 4	20	76.2	2.34	0.32	3.56
Comparison among KGs[a]		A ≒ C ≒ D > B	A ≒ C ≒ D > B	D > A ≒ B ≒ C	C ≒ D > A ≒ B

Intakes were shown in terms of unit (as shown in the table)/kg body weight/day: AM values are shown

[a] Notes are as under Table 1

Table 5 Food intakes with significant inter-KG differences

Kindergarten (KG)	No.	2 Potatoes and starches	6 Vegetables	9 Meats and poultries	11 Fishes and shellfishes	14 Fats and oils
Total	108	1.09	4.38	2.02	1.47	0.28
A. KG 1	33	1.48	4.36	2.08	0.98	0.24
B. KG 2	37	0.51	4.19	1.18	2.03	0.28
C. KG 3	18	2.43	3.10	1.68	1.39	0.27
D. KG 4	20	0.29	5.89	3.77	1.29	0.35
Comparison among KGs[a]		A ≒ B ≒ C > D	D > A ≒ B ≒ C	D > A ≒ B ≒ C	B ≒ C ≒ D > A	D > A ≒ B ≒ C

Units for intakes were in g/kg body weight/day; AM values are shown

[a] Notes are as under Table 1

down from 1024 g/person/day in 1969 to 871 g/person/day in 1995, whereas animal foods increased from 32 g/person/day to 330 g/person/day during the same period [5]. It is quite conceivable that such shift may take place first in urban areas. The present observation of general absence of urban–rural difference (Table 3) suggests that the shift was already completed in both urban and rural areas at the time of survey (i.e., early in 2000s). Lee and Kim [1] analyzed the KNHANES data and reported that vegetable intake increased significantly in all ages and across two genders, especially at lunch and dinner. Unfortunately, possible urban–rural differences in responses were not mentioned.

For evaluation of dietary intake, the 2005 version of Dietary Reference Intake for Koreans [3] was employed, because of closeness of the publication date with the dates of the present surveys (2003–2004). The version gives the reference value for energy intake of A. 1400 kcal, B. 1600 kcal and C. 1500 kcal for 3- to 5-year-old children, 6- to 8-year-old boys and 6- to 8-year-old girls, respectively. A grand average was calculated by the equation of $\{A + [(B + C)/2]/2\}$ for evaluation of the present results in which 4- to 6-year-old children (boys and girls in combination) participated. The equation gave 1475 kcal. The present result of 1479 kcal (Table 2) was almost equal to the estimated reference value; the agreement may suggest that the food duplicate collection was conducted adequately and the samples were fit for further evaluation. The results of calculation for other nutrition parameters by use of the above-cited equation (the bottom line in Table 6) showed that the intakes were adequate for almost all of the nutrient items. There may be two exceptions, namely excess intake of sodium and insufficient intake of potassium.

Possible inter-KG difference was examined for energy, protein, vitamin B_1, vitamin C, and four minerals of calcium (Ca), sodium (Na), potassium (K) and iron (Fe), by use of ANOVA; the 4 KGs were taken as independent variables and one of the nutrients (including energy) as a dependent variable. For selection of the dependent variables, risks (although quite remote) were considered for malnutrition (energy and protein [13]), vitamin deficiency (vitamin B_1 and vitamin C [14, 15]), iron deficiency anemia (Fe [16]), retarded bone growth (Ca [17]) and hypertension (Na and K [18]).

Nutrient items with statistical significance ($p < 0.05$ by ANOVA) are summarized in Table 7. Intakes of energy and protein (and possibly Fe as well) were lower for children in KG 1, but this may not be a matter of concern, because the children in KG 1 were younger and therefore smaller in body size than those in other KGs (Table 1). Higher intake of vitamin C for children in KG 3 and KG 4

Table 6 Selected dietary reference intake values and the values employed for sufficient intake

Item (Unit/day)	Energy and nutrients															
	Energy (kccal)	Protein (g)	Vitamin A (μg RE)	Vitamin D (μg)	Vitamin E (mg α-TE)	Vitamin C (mg)	Vitamin B_1 (mg)	Vitamin B_2 (mg)	Vitamin B_6 (mg)	Vitamin B_{12} (μg)	Ca (mg)	P (mg)	Na (mg)	K (mg)	Fe (mg)	Zn (mg)
DRI[a] for																
A. 3- to 5-year-old children	1400	20	300	10	6	40	0.5	0.5	0.7	1.1	600	500	1000	3000	7	4
B. 6- to 8-year-old boys	1600	25	400	10	7	60	0.7	0.7	0.9	1.3	700	700	1200	3800	9	5
C. 6- to 8-year-old girls	1500	25	400	10	7	60	0.6	0.6	0.8	1.3	700	600	1200	3800	9	5
Specification[b]	EER	RI	RI	AI	AI	RI	RI	RI	RI	RI	RI	RI	AI	AI	RI	RI
The values to calculate sufficient intakes (D)[c]	1475	22.5	350	10	6.5	50	0.575	0.58	0.78	1.2	650	575	1100	3400	8	4.5
Measured value (intake/day: E)	1479	54.9	460	160	10	64.5	0.8	1.14	1.45	1.45	616	915	2285	1840	7.83	6.36
Sufficiency rate[d]	100	244	131	160	154	129	139	198	187	121	94.8	159	208	54.1	98	141

[a] Dietary reference intake values cited from Korean Nutrition Society, the 2005 Version [1]. The values for energy and protein for 2010 (Korean Nutrition Society, the 2010 Version) [4] were the same with the values for the 2005 Version [1]

[b] *EER* estimated energy requirement, *RI* recommended intake, *AI* adequate intake

[c] The value was calculated from DRI as $\{A + [(B + C)/2]\}/2$

[d] (E/D) in %

Table 7 Nutrients with significant inter-KG difference in sufficiency rate

Kindergarten	No.	Arithmetic mean sufficiency rate (%) by nutrients				
		Energy	Protein	Fe	Vit B_1	Vit C
Total	103	100.3	244.0	97.8	138.9	129.1
A. KG 1	33	92.2	217.3	88.4	122.5	96.6
B. KG 2	37	99.1	251.4	99.0	139.7	115.8
C. KG 3	18	105.8	235.3	91.7	142.5	187.6
D. KG 4	20	110.8	282.2	116.7	160.9	154.6
Comparison between KGs[a]		B ≒ C ≒ D > A	B ≒ C ≒ D > A	B ≒ C ≒ D > A	B ≒ C ≒ D > A	C ≒ D > A ≒ B

[a] Notes are as under Table 1

may be the reflection of the locations that they were in rural areas. Intakes of Na and K did not show inter-KG difference. The lack of the difference suggests that the problem of excess Na intake and insufficient K intake (Table 6) were common to children irrespective of locations of KGs and therefore across urban and rural areas. Possible risk of developing hypertension later in life [18] should be a potential health concern. The risk of hypertension as suggested by the present analysis is not specific to the populations in Korea, but common to the people in Japan [19].

There are several limitations in the present survey. Only one kindergarten was studied in the large city of Seoul. It is quite possible that the kindergarten studied may not be representative of many kindergartens in the metropolis. The food habits of children may vary depending on the individual conditions such as social and economic status of the family. Another problem is the fact that food duplicate samples were collected only for 1 day. This limitation may be inherent to this method, because preparation of the collection is nerve-taxing and hand-requesting. An important advantage is the fact that the collected samples can be used for instrumental analyses for components, e.g., some metals. The ages of children in the 4 KGs distributed from 4 to 6 years (Table 1) and body sizes were inevitably different (i.e., smaller in KG 1 than in other KGs). As the dietary reference intakes were given for age groups of 3–5 and 6–8 years (Table 6), the evaluation for adequate food intakes was possible only for combination of two age ranges (i.e., 3–4 and 6–8 years). The reference values thus calculated could be too demanding for children in KG 1 (Table 7). Higher intakes of meats and poultry together with higher intake of fats and oils in KG 4 might suggest unique food habits there. However, details were not known to explain further.

The present results in Table 4 may need care in evaluation. It is also known that family structure (e.g., living with both parents or not) may affect availability of some foods for children such as fruits and dairy products [20]. No data were available in the present study on the family structures of participating children.

In conclusion, nutrient intakes as a whole appeared to be sufficient across the four kindergartens in urban and rural areas. Nevertheless, excess Na intake coupled with insufficient K intake was a common problem. Attention may be necessary for hypertension later in life. No urban–rural difference in the nutrition for children was detected.

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Conflict of interest The authors declare that they have no conflicts of interest.

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