

Prevalence of Dietary Supplement Use in Korean Children and Adolescents: Insights from Korea National Health and Nutrition Examination Survey 2007-2009

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The purpose of this study was to estimate the prevalence of dietary supplement (DS) use in Korean children and adolescents and to examine the related factors associated with DS use from the 4th Korea National Health and Nutrition Examination Survey. Total 6,131 participants aged between 2 and 18 yr were included in the analysis. We estimated the prevalence of DS use mainly from the DS questionnaire data of the Nutrition Survey. Reported supplements were classified according to the Health Functional Food Code. We also assessed the relationship between DS use and anthropometry, socioeconomic factors, health behaviors, and chronic diseases. Approximately 34% of Korean children and adolescent was taking DS. Younger age ($P = 0.003$), higher household income ($P < 0.001$), presence of chronic diseases ($P = 0.05$), regular meal consumption ($P = 0.002$), frequent snack consumption ($P = 0.001$), and normal body mass index rather than overweight ($P = 0.10$) or obesity ($P = 0.03$) were associated with the DS use after adjustment for related factors. Vitamin/mineral supplements (343.5/10³ persons) were the most commonly taken DS in Korean children and adolescents, followed by Omega-3 (28.8), ginseng (18.3), colostrums (14.1) and chlorella/spirulina (10.0). In conclusion, DS use is common as much as in 34% of Korean children and adolescents and is associated with age, household income level, chronic diseases, meal regularity, and obesity status.

Key Words: Dietary Supplements; Child; Adolescent; Korean

INTRODUCTION

With improvement of economic state, there are increasing interests on “well-being” and how diet might influence the personal health. There are several reports that taking dietary supplements (DS) compensates the nutritional deficit derived from unbalanced diets (1), improves physical health and personal performance in occupation, and as well as prevents diseases (2). Furthermore, many people believe that the more DS they take, the healthier they will be, so that up to one third of study participants took two or more types of DS simultaneously (3). However, it is unknown whether DS intake improves health of otherwise healthy persons who have balanced diet or improve study ability. In addition, there could be drug-DS interactions or DS-DS interactions which might lead to adverse drug reactions or alter the clinical response of prescribed medication (4).

Although the academic society does not recommend supplemental vitamins to the healthy children having proper diet (5), a considerable proportion of Korean children and adolescents take DS. The prevalence of Korean children and adolescents taking DS is reported to be 19%-63% depending on the study

population (1, 6-8). Most studies were performed in selected regions or schools and therefore did not represent the entire Korean children. The only one nationwide survey described the DS use in Korean children very briefly and did not assess the relationships between factors of DS use or the DS types thoroughly (8).

The aim of this study was to estimate the prevalence of DS use in Korean children and adolescents from the 2007-2009 National Health and Nutrition Examination Survey (KNHANES) and to identify the factors associated with DS use.

MATERIALS AND METHODS

Study subject

The KNHANES has been implemented annually to assess the health related behavior, the health condition, and the nutritional state of the Koreans. It consists of the Health Interview Survey (HIS), the Nutrition Survey (NS), and the Health Examination Survey (HES). The study subject of this study included children and adolescents aged between 2 and 18 yr who participated in all three surveys of the 4th KNHANES from 2007 to 2009. Detailed

descriptions of the plan and operation of the survey have been described on the KNHANES website (<http://knhanes.cdc.go.kr/>).

Measurement and classification of variables

The participants were categorized by age into preschooler (2-6 yr), 1st-3rd grader (7-9 yr), 4-6th grader (10-12 yr), 7-9th grader (13-15 yr), and 10-12th grader (16-18 yr). The household income level was classified into quartiles and residing region was divided into urban and rural areas. Past medical history of anemia, atopic dermatitis, asthma, diabetes, and congenital heart disease diagnosed by physicians was questioned. The self-reported health status was classified as 'good', 'moderate', and 'bad'. 'Regular exercise' was defined as doing moderate or strenuous exercise more than once a week.

Height was measured to the nearest 0.1 cm on a stadiometer (SECA 225, Hamburg, Germany). Body weight was measured to the nearest 0.1 kg on a balance scale (GL-6000-20, Cas, Yangju, Korea) with the subject wearing a lightweight gown or underwear. Body mass index (BMI) and height percentile were estimated based on the age and sex specific 2007 growth chart for Korean children (9). Body mass index percentile (BMIP) was classified into -5% (underweight), 6%-84% (normal), 85%-94% (overweight), and 95%- (obese) (9). Height percentile was further categorized into quartiles.

Total energy intake was estimated based on the NS using the one-day 24-hr recall, and energy intake adequacy was assessed with the age-specific energy intake reference from the Recommended Dietary Allowances for Korean (10). Participants who skipped any meals during the previous two days were classified as 'meal skipper'. The frequency of daily snack intake was classified as 'less than once', 'once', and 'more than twice' a day.

Definition and classification of dietary supplements

Following the definition by the KNHANES, 'DS' of our study included vitamin-mineral supplements (VMS) and functional foods. The health functional foods were defined as foods manufactured (including processed foods) with functional raw materials or ingredients that are beneficial for the human body (11).

The Dietary Supplement Questionnaire from the NS composed of two main parts. First part included questions about the consumption experience of DS for longer than 2 weeks during the previous one year, and the second part identified the types of DS taken currently. Trained interviewers recorded the brand name and the manufacturer of each supplement. Each reported DS was mainly coded based on the ingredients according to the Health Functional Food Code (No. 2010-7) (12). To simplify classification, single vitamin, multiple vitamin, single mineral, multiple mineral, vitamin/mineral combination were all categorized into vitamin/mineral supplements. Ginseng and red ginseng were combined into 'ginseng', and chlollela and spirulina as 'chlollela/spirulina'. Ingredients unlisted in the Health Func-

tional Food Code such as colostrums and shark cartilage were categorized into new categories. We estimated the prevalence of DS use and assessed the factors related to DS use from the first part questionnaire and listed the top 5 popular DS from the second part.

Statistical analysis

We incorporate sampling weight (wt_tot) to consider the multi-stage stratified sampling design and the response rate. Data were presented as proportion (\pm standard error) for categorical variables, and mean (\pm SE) for continuous variables. The prevalence of DS use was estimated based on the first part questions of the Dietary Supplement Questionnaire which included the consumption experience of DS for longer than 2 weeks during the previous one year, and the DS types currently used were on the second part questions. Univariate and multivariate logistic regression analyses were performed to examine the relationship between DS use and the related factors. Odds ratio (OR) and 95% confidence interval (CI) were presented. The top 5 most commonly taken DS types were listed according to the age categories. Two-sided *P* values less than 0.05 were considered statistically significant. Statistical test were carried out using the SPSS 18 statistical package (SPSS, Inc., Chicago, IL, USA).

Ethics statement

The study protocol was reviewed and approved by the institutional review board of the Seoul Paik Hospital (IRB No. IIT-2011-170). The informed consent was waived by the board.

RESULTS

This study included 3,211 boys and 2,920 girls. When sampling weight was applied, the 3,211 boys represented 5,461,502 (standard error, SE, 173,021) of Korean boys and the 2,920 girls represented 4,847,146 (157,523) of Korean girls, totaling 10,308,648 (286,568) Korean children and adolescents. The general characteristics of study population were shown in Table 1.

Overall, 33.4% (SE, 0.9) of study population took DS. Prevalence of DS use was 33.6% (\pm 1.2) for boys and 33.2% (\pm 1.3) for girls (Table 2). The prevalence of DS use in preschooler, 1st-3rd grader, 4-6th grader, 7-9th grader, and 10-12th grader were 46.0% (\pm 1.6), 36.2% (\pm 1.7), 29.5% (\pm 1.6), 28.0% (\pm 1.8), and 25.9% (\pm 1.9), respectively. Fig. 1 shows the prevalence of DS use experience according to the age groups. The prevalence reached its highest peak in children aged 6 yr (48.4%) and decreased with increasing age to 23.8% in 12th graders.

Table 2 displays the association between socioeconomic factor, anthropometry, health behavior, and chronic disease and DS use. The DS use was associated with a higher household income ($P < 0.001$), presence of chronic disease ($P = 0.05$), not-skipping meals ($P = 0.002$), frequent snack consumption ($P = 0.001$), and

Table 1. Demographic and lifestyle characteristic of study participants

Characteristics	Proportion or mean	SEP or SEM
Sex		
Male	53.0%	0.8
Female	47.0%	0.8
Age (yr)	9.8	0.06
2-6	22.9%	0.7
7-9	17.4%	0.6
10-12	20.4%	0.6
13-15	20.0%	0.7
16-18	19.3%	0.8
Household income level		
Low	10.9%	0.8
Mid-low	25.0%	1.1
Mid-high	33.7%	1.1
High	30.3%	1.4
Region		
Urban	84.3%	1.9
Rural	15.7%	1.9
Self reported health status		
Bad	5.4%	0.4
So so	26.6%	0.8
Well	68.0%	0.9
Exercise for week		
Less than once	55.6%	1.5
More than once	44.4%	1.5
Height, cm	138.3	0.3
Height percentile* (%)		
<25	14.7%	0.6
25-50	20.6%	0.6
50-75	26.9%	0.8
75-	37.8%	0.9
Body mass index (kg/m ²)	18.52	0.05
Obesity degree* (body mass index percentile, %)		
Obesity (> 95)	6.5%	0.4
Overweight (85-95)	11.8%	0.5
Normal (5-85)	75.5%	0.8
Low weight (< 5)	6.3%	0.5
Chronic disease [†]		
No	80.8%	0.6
Yes	19.2%	0.6
Anemia	1.6%	0.2
Atopic dermatitis	14.0%	0.6
Asthma	5.0%	0.3
Diabetes	0.09%	0.04
Energy intake [‡]		
More than reference	33.7%	0.9
Less than reference	66.3%	0.9
Skipping meals during last 2 days		
Never skipping	67.6%	1.1
More than once	32.4%	1.1
Snack frequency		
More than twice a day	56.5%	1.0
Once a day	34.4%	0.9
Less than once a day	9.1%	0.6

*from the Growth Chart for Korean Children 2007. Korean Center for Disease Control and Prevention & The Korean Pediatric Society (9). [†]Anemia, atopic dermatitis, asthma, diabetes, congenital heart disease at any one of were diagnosed by doctors as having chronic diseases. There was no participant with a past medical history of congenital heart disease. Multiple answers were allowed. [‡]from the Dietary Reference Intakes For Koreans 2010. The Korean Nutrition Society (10). SEP, standard error of proportion; SEM, standard error of mean.

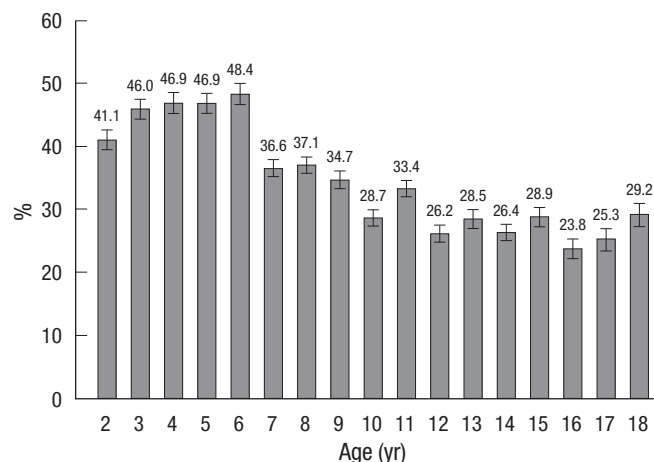


Fig. 1. Prevalence of dietary supplement use by age. The prevalence was estimated based on the Dietary Supplement Questionnaire from the Nutrition Survey, which questioned whether dietary supplement(s) was (were) consumed for longer than 2 weeks during the previous one year.

normal BMI rather than lean ($P = 0.43$) or overweight ($P = 0.10$), obesity ($P = 0.03$) after adjustment for related factors.

Table 3 shows the five most commonly taken DS types along with the prevalence of their use according to the age groups. VMS (343.5 per 1,000 persons) was the most frequently consumed DS in all age groups, followed by omega 3 (28.8 per 1,000 persons) and ginseng (18.3 per 1,000 persons).

DISCUSSION

In this study, we investigated the prevalence of DS use in Korean children and adolescents. We listed the top 5 most commonly taken DS types and assessed the factors related to DS use using the 4th KNHANES.

About 34% of Korean children and adolescents were taking DS without significant gender difference. There are several studies which investigated the DS intake in different countries. Since the definition of DS use and the period investigated by the survey differed from study to study, a direct comparison and interpretation should be performed with caution. However, the prevalence of DS use in Korean children was very similar to that of the US (32%) (13), but lower than Canadians (42.5%) (14). If we restrict analysis only to VMS, the Korean prevalence would be 25.6% (data not shown) which is similar to Germans (25.8%) (15). The prevalence of DS use of Korean children and adolescents was very similar to Korean adults' (33.8%) (16). In contrary, the US adults showed higher prevalence (52%) than children and adolescents (32%) (13).

The prevalence of DS use was higher in young children, families with higher household income, and in people with chronic disease, regular meal intake, snacks consumption, and normal body weight. These factors suggest that DS intake is associated with a higher socioeconomic status and good personal health

Table 2. Demographic and lifestyle characteristics of study participants with dietary supplement use

Characteristics	User % (SE)	Unadjusted		Adjusted*	
		OR (95% CI)	P value	OR (95% CI)	P value
Overall	33.4 (0.9)				
Sex					
Male	33.6 (1.2)	1		1	
Female	33.2 (1.3)	0.98 (0.85, 1.13)	0.79	0.89 (0.73, 1.11)	0.28
Age (yr)			< 0.001		0.003
2-6	46.0 (1.6)	1		1	
7-9	36.2 (1.7)	0.67 (0.56, 0.79)	< 0.001	0.73 (0.54, 0.98)	0.04
10-12	29.5 (1.6)	0.49 (0.40, 0.60)	< 0.001	0.54 (0.39, 0.75)	< 0.001
13-15	28.0 (1.8)	0.46 (0.37, 0.56)	< 0.001	0.60 (0.42, 0.84)	0.003
16-18	25.9 (1.9)	0.41 (0.33, 0.52)	< 0.001	0.54 (0.37, 0.78)	0.001
Household income level			< 0.001		< 0.001
Low	16.6 (2.2)	1		1	
Mid-low	30.8 (1.8)	2.23 (1.56, 3.19)	< 0.001	2.22 (1.39, 3.55)	< 0.001
Mid-high	35.9 (1.6)	2.82 (2.02, 3.92)	< 0.001	2.53 (1.62, 3.93)	< 0.001
High	38.8 (1.7)	3.19 (2.24, 4.52)	< 0.001	2.90 (1.83, 4.59)	0.001
Region					
Urban	34.4 (1.0)	1		1	
Rural	28.5 (2.5)	0.76 (0.59, 0.99)	0.04	0.76 (0.56, 1.03)	0.07
Self reported health status			0.36		0.28
Bad	29.2 (3.3)	1		1	
So so	33.3 (1.6)	1.21 (0.87, 1.69)	0.26	1.32 (0.82, 2.13)	0.25
Well	33.6 (1.1)	1.23 (0.89, 1.70)	0.22	1.37 (0.86, 2.20)	0.19
Exercise for week (more than moderate exercise)					
Less than once	35.5 (1.5)	1		1	
More than once	26.7 (1.7)	0.67 (0.54, 0.82)	< 0.001	0.96 (0.74, 1.24)	0.73
Height [†] (percentile, %)			0.98		0.36
25	34.4 (2.0)	1		1	
25-50	33.4 (1.7)	0.96 (0.77, 1.20)	0.70	0.90 (0.66, 1.22)	0.48
50-75	34.2 (1.6)	0.99 (0.80, 1.24)	0.94	1.06 (0.78, 1.45)	0.71
75-	32.6 (1.4)	0.92 (0.75, 1.14)	0.46	0.84 (0.61, 1.15)	0.27
Obesity degree [†] (percentile, %)			0.004		
Obesity (> 95)	24.1 (2.5)	0.54 (0.50, 0.59)	< 0.001	0.63 (0.42, 0.96)	0.03
Overweight (85-95)	29.8 (2.2)	0.78 (0.63, 0.97)	0.03	0.77 (0.56, 1.05)	0.10
Normal (5-85)	35.2 (1.0)	1		1	
Low weight (< 5)	29.5 (3.2)	0.77 (0.57, 1.04)	0.09	0.84 (0.54, 1.31)	0.43
Chronic disease [‡]					
No	32.0 (1.0)	1		1	
Yes	38.7 (1.8)	1.34 (1.14, 1.57)	< 0.001	1.25 (0.99, 1.54)	0.05
Energy intake [§]					
More than reference	36.6 (1.5)	1		1	
Less than reference	31.9 (1.1)	0.81 (0.70, 0.94)	< 0.001	0.89 (0.72, 1.11)	0.32
Skipping meals during last 2 days					
Never skipping	37.3 (1.1)	1		1	
More than once	25.3 (1.4)	0.57 (0.49, 0.67)	< 0.001	0.71 (0.57, 0.88)	0.002
Snack frequency			< 0.001		0.001
More than twice a day	37.6 (1.2)	1		1	
Once a day	30.2 (1.5)	0.72 (0.61, 0.84)	< 0.001	0.78 (0.62, 0.99)	0.04
Less than once a day	19.8 (2.6)	0.41 (0.30, 0.57)	< 0.001	0.56 (0.38, 0.82)	0.003

*Adjusted OR and trend *P* were based on multiple logistic regression analysis, adjusted for all other characteristics included in the table. [†]From the Growth Chart for Korean Children 2007. Korean Center for Disease Control and Prevention & The Korean Pediatric Society (9). [‡]Anemia, atopic dermatitis, asthma, diabetes, congenital heart disease at any one of were diagnosed by doctors as having chronic diseases. [§]Dietary Reference Intakes For Koreans 2010. The Korean Nutrition Society (10).

behaviors. Foreign studies showed similar results: the DS use was more frequent in whites, people with high household income, high parental education level, easy accessibility to medical service, high physical activity level, short screen time, normal BMI (13, 15, 17, 18). Studies for adult showed similar findings (2, 16, 19, 20).

We found out that children with an adequate energy intake were more likely to take the DS. Considering that calcium and

iron are the only two nutrients which do not meet the daily requirement with a normal Korean diet, the DS use might lead to over-nutrition. Kim et al. (6) reported that the DS users consumed more nutrients than non-users and some nutrients exceeded the daily recommended amount by 60%. Although the DS use might compensate some nutrient deficiencies, it could also lead to overdose of others.

In this study, we showed that children with these chronic dis-

Table 3. Prevalence of top 5 dietary supplements use by age categories*^w

Supplement use per 10 ³ persons (/1,000) by age										Total
2-6 yr		7-9 yr		10-12 yr		13-15 yr		16-18 yr		
VMS	578.7	VMS	419.6	VMS	283.9	VMS	250.9	VMS	216.3	VMS 343.5
Ginseng	36.9	Omega 3	27.6	Omega 3	26.2	Omega 3	45.1	Omega 3	29.0	Omega 3 28.8
Colostrums	33.3	Ginseng	20.1	Ginseng	21.0	Ginseng	11.5	Aloe	12.1	Ginseng 18.3
Omega 3	14.6	Colostrums	18.7	Colostrums	16.3	CS	9.4	CS	9.6	Colostrums 14.1
CS	11.9	CS	8.0	CS	10.8	Aloe	5.9	Yeast	7.0	CS 10.0

*Classification mainly by the Health Functional Food Code (No. 2010-7) (12). Multiple answers were possible up to four supplements. VMS, Vitamin/Mineral Supplements; CS, Chlorella/Spirulina.

eases were more likely to take DS. Three fourths of our participants with chronic diseases had atopic dermatitis. When we assessed the relationship between atopic dermatitis and the DS use separately, the OR was 1.26 (0.97-1.62) with marginal significance (data not shown). One study with Korean adults reported that DS users rather than non-users believed that the DS use help to relieve fatigue, booster vitality, help memory, delay aging and that the supplementation of vitamins and minerals reduces stress and prevents disease (2). The belief on positive effect of DS might be the key factor to use DS when the children are diagnosed with chronic diseases. We cautiously suggest that the higher consumption rate in children with chronic diseases might reflect that the DS use in Korean children and adolescents are not used solely for health promotion, but also for the treatment of diseases.

An interesting finding was that the preschooler group (2-6 yr) had the highest prevalence of DS use with 34.1% among children and adolescents. This is similar to the results from Germany with a prevalence of 50.9% among the 2-4 yr old (15), and those from the US with 30%-43% among 2-8 yr old children (13, 18, 21). Young children develop basic health behaviors and dietary habit in this age group. They start to shape food preference (22). Children might be picky and have unhealthy eating habits (23). The aim of DS use in this age group is to increase appetites, prevent not-serious diseases like common cold, improve cognition, help growth, and compensate irregular eating patterns (17). The DS use decreases with age first, then it increases in high school age group again, when the children are preparing for the college scholastic ability test.

There are different preferences for DS types dependent on age. VMS was the most popular DS in all age groups, followed by omega 3, ginseng, colostrum and chlorella/spirulina. We reported from the 2007-2009 KNHANES that the most popular DS type in Korean adults was VMS followed by omega 3, glucosamine/chondroitin, ginseng, and chlorella/spirulina (16). In contrary, children and adolescents took more colostrum (not-ranked in adults vs 14/1,000 of children) which is claimed to have positive effect on height growth and brain development, but rarely took glucosamine which is advertised to be useful in degenerative osteoarthritis.

VMS was the most popular DS consumed by both Korean adults and children. The expectations of a beneficial health ef-

fect of VMS in combination with the influence from the commercial advertisement are believed to be the driver for their consumption (20, 24). This effect by the parents would extend to children, because they are the buyer of the products, and feed children (1). The second most popular DS was omega-3, which contains docosahexaenoic acid (DHA) and advertised as being good for amelioration of intelligence. DHA has been reported to play an important role for formation and maintenance of cell membrane of the central nerve system, and essential for brain maturation in embryonic periods of human development (25). However its clinical effects on children's school performance are unknown. Ginseng that ranked on the third place, is advertised as a performance enhancer (26). Colostrum is the first milk produced after birth and is particularly rich in immunoglobulins, antimicrobial peptides, and other bioactive molecules, including growth factors (27). Colostrum was ranked high in preschool age group. Chlorella/spirulina contains chlorophyll, protein, essential amino acid, essential fatty acid, vitamins, mineral and fibers. They are advertised to remove reactive oxidants and to substitute micronutrients in body. In contrary to adults, the children and adolescents tend to consume more DS types which are considered to help school performance, growth, and immunity.

The DS market in Korea is expanding substituting the traditional oriental medicine. The sales money of DS increased by 9% from 1,000 billion KRW in 2004 to 1,092 billion KRW in 2008 (28), while the market share of the oriental medicine among total medical expenditure shrunk from 6.1% to 5.3% in the same period (29). With the expanding of DS market in Korea, the popular DS has been changing with time. We do not think that changes in market share of a specific DS are attributed to its efficacy changes. It is more likely that the marketing strategy including advertisement play more important roles in consumers' choice for a specific DS. The 2005 KNHANES showed that in more than two thirds of cases, DS use was encouraged by the family, friends and commercial advertisements, whereas only 7% of them were promoted by their physicians' advice (30).

The main limitation of this study was that we conducted a secondary data analysis. The KNHANES was not designed to evaluate herbal medications and traditionally modified foods. This might lead to underestimation of the true prevalence of supplemental-functional foods intake. Furthermore, self-report of the

DS use was subjected to recall bias. Since the KNHANES data were cross-sectional, the current analyses did not suggest causality but association.

In conclusion, the prevalence of DS use in Korean children and adolescents is high as 34%, especially in the socioeconomically stable groups with good health behaviors. Considering that the DS use in children with adequate dietary intake might cause overdose of some nutrients, assessment of children's nutritional status should precede taking DS. Public education on adequate dietary intake and proper use of DS are required.

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