Nutrition Research and Practice (*Nutr Res Pract*) 2011;5(5):443-449
http://dx.doi.org/10.4162/nrp.2011.5.5.443

A comparison of food and nutrient intake between instant noodle consumers and non-instant noodle consumers in Korean adults

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Abstract

Instant noodles are widely consumed in Asian countries. The Korean population consumed the largest quantity of instant noodles in the world in 2008. However, few studies have investigated the relationship between instant noodles and nutritional status in Koreans. The objective of this study was to examine the association between instant noodle consumption and food and nutrient intake in Korean adults. We used dietary data of 6,440 subjects aged 20 years and older who participated in the Korean National Health and Nutrition Examination Survey III. The average age of the instant noodle consumers (INC) was 36.2 and that of the non-instant noodle consumers (non-INC) was 44.9; men consumed more instant noodles than women ($P < 0.001$). With the exception of cereals and grain products, legumes, seaweeds, eggs, and milk and dairy products, INC consumed significantly fewer potatoes and starches, sugars, seeds and nuts, vegetables, mushrooms, fruits, seasonings, beverages, meats, fishes, and oils and fats compared with those in the non-INC group. The INC group showed significantly higher nutrient intake of energy, fat, sodium, thiamine, and riboflavin; however, the INC group showed a significantly lower intake of protein, calcium, phosphorus, iron, potassium, vitamin A, niacin, and vitamin C compared with those in the non-INC group. This study revealed that consuming instant noodles may lead to excessive intake of energy, fats, and sodium but may also cause increased intake of thiamine and riboflavin. Therefore, nutritional education helping adults to choose a balanced meal while consuming instant noodles should be implemented. Additionally, instant noodle manufacturers should consider nutritional aspects when developing new products.

Key Words: Instant noodle, ramyon, food intake, nutrient intake, Korean

Introduction

Instant noodles, a steamed and deep-oil fried noodle that is also known as ramen in Japan and ramyon in Korea, originated in Japan in the 1950s and are currently produced in over 80 countries [1]. As of 2008, approximately 93.6 billion servings of instant noodles have been consumed worldwide [2]. Chinese consumed 45.2 billion packages of instant noodles in 2008, representing 51% of the global consumption of instant noodles, whereas Indonesians consumed 13.7 billion packages, Japanese consumed 5.1 billion packages, Americans consumed 4.3 billion packages, and South Koreans consumed 3.3 billion packages [2]. South Koreans eat the highest per capita quantity of instant noodles at 69 servings per year, which is 4.8 times higher than the consumption of Americans, and 1.7 times higher than the per capita consumption in Japan. Based on the Korean National Health and Nutrition Examination Survey (KNHANES) III report [3], instant noodles were consumed at a level of 18.1 g per day per capita nationwide, which made this the second largest food type after steamed rice that contributes to the overall energy intake of individuals.

Instant noodles are often criticized as unhealthy or as a type of junk food. A single serving of instant noodles is usually high in carbohydrates but is low in fiber, vitamins, and minerals. Instant noodle manufacturers have made efforts to lower the sodium and fat content in response to public health concerns [4]. Instant noodles are now promoted as a nutrient vehicle in developing countries by fortifying either the flours used to make the noodles or the seasoning powders consumed with the noodles [5,6].

The popularity of instant noodles has been expanding very rapidly during recent decades due to their convenience and reasonable price [2]. However, few data are available with respect to the nutritional status of instant noodle consumers in both Asian and western countries [2]. As Koreans consume the largest quantity of instant noodles, it is necessary to identify the relationship between instant noodle consumption and nutritional status and food consumption patterns of Koreans. Therefore, we

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Received: April 15, 2011, Revised: July 25, 2011, Accepted: July 25, 2011

compared food and nutrient intake in Korean adults that consume instant noodles with those who do not consume instant noodles using data from KNHANES III to examine the nutritional status of instant noodle consumers (INC). We also evaluated whether the nutrient intake of Koreans consuming instant noodles is appropriate in comparison to the Korean dietary reference intakes (KDRI) [7]. We hope that this study will help to construct guidelines for nutritional education regarding instant noodle consumption.

Subjects and Methods

Study population

The data analyzed in the present study were obtained from KNHANES III, a study conducted by the Ministry for Health, Welfare, and Family Affairs in Korea in 2005. KNHANES consisted of health behavior, health examination, and nutritional surveys. The surveys were given to stratified multistage samples of the Korean population from multiple geographic areas, ages, and genders. In total, 33,848 people responded to the KNHANES III survey; 6,440 adults aged 20 years and older participated in both the health examination and the nutrition surveys and were selected for the present study. Energy and food intake was obtained from the nutritional survey, whereas data on height, weight, and body mass index (BMI) were obtained from the health examination survey.

As part of the standard KNHANES data collection protocol, 24-hour dietary recalls were elicited and were used here to estimate food and nutrient intake. General characteristics, food and nutrient intake, and anthropometric data were compared across the INC and non-instant noodle consumers (non-INC). Income groups were categorized according to the average monthly income in 2005 in relation to the minimum cost of living. Low income was defined as an average monthly income that was, at most, 1.2 times the minimum cost of living, a middle income was defined as an average monthly income that was 1.2-2.5 times the minimum cost of living, and a high income was defined as an average monthly income that was > 2.5 times the minimum cost of living. Subjects were categorized based on their educational level, defined as follows: middle school or lower (9 years and below), high school (10-12 years), and college or higher (13 years or more).

Statistical analysis

All analyses were conducted using survey weighting to account for the complex survey design, which consisted of multistage, stratified, and clustered sampling. Probability sampling weights were used with strata and primary sampling units in the data analysis. Subject characteristics were compared between the INC and non-INC groups using a chi-square test. Weight, height, and BMI were adjusted for age. Mean values and standard errors of food and nutrient intake were calculated, and *t*-tests were used to verify the significance of each in the INC and non-INC groups. Energy intake was adjusted for age, whereas other nutrient and food intake data were adjusted for age and energy intake. Total food and nutrient intake was compared between the two groups to determine their relationship , and nutritional status was then evaluated using the matched KDRI references. Energy intake was compared with the estimated energy requirement, sodium and potassium were compared with the intake level considered to be adequate, and the remaining nutrients were compared with the recommended intakes. All statistical analyses were performed using the SURVEY procedure of SAS software (version 9.12, Cary, NC, USA) and the REGRESS procedure of SUDAAN software (release 9.0, Research Triangle Institute, Research Triangle Park, NC, USA) using a significance level of $P > 0.05$.

Results

General characteristics of the participants in the two groups with respect to instant noodle intake are shown in Table 1.

Table 1. General characteristics of study subjects with respect to the consumption of instant noodles in Korean adults

	Non-INC[a] (n = 5,666)	INC[b] (n = 774)	*P*-value
Age (yrs)[c]	44.9 ± 0.3	36.2 ± 0.5	< 0.001
Age group (yrs)[d]			
20～49	3,347 (65.0, 1.0)	637 (86.8, 1.3)	< 0.001
50～64	1,360 (21.4, 0.7)	92 (9.4, 1.1)	
≥ 65	959 (13.6, 0.6)	45 (3.8, 0.6)	
Sex[2)]			
Male	2,425 (47.2, 0.7)	452 (63.5, 1.9)	< 0.001
Female	3,241 (52.8, 0.7)	322 (36.5, 1.9)	
Income[d,e]			
Low	1,388 (22.3, 1.1)	144 (17.3, 1.8)	0.009
Middle	2,067 (36.8, 1.0)	320 (41.9, 2.2)	
High	2,211 (40.9, 1.4)	310 (40.8, 2.2)	
Education[d]			
Middle school or lower	2,074 (31.3, 1.0)	150 (15.5, 1.7)	< 0.001
High school	1,917 (34.9, 0.9)	311 (41.1, 2.2)	
College or higher	1,675 (33.8, 1.2)	313 (43.4, 2.4)	
Region[d]			
Large city	2,577 (47.2, 1.0)	392 (50.5, 2.4)	0.053
Small city	1,837 (33.6, 1.1)	258 (34.5, 2.5)	
Rural area	1,252 (19.2, 0.9)	124 (15.0, 1.8)	
Weight (kg)[c,f]	62.4 ± 0.2	63.7 ± 0.6	0.032
Height (cm)[c,f]	162.3 ± 0.1	163.8 ± 0.4	0.001
BMI (kg/m^2)[c,f]	23.6 ± 0.1	23.7 ± 0.1	0.724

[a] Non-INC, non-instant noodle consumer group
[b] INC, instant noodle consumer group
[c] Mean ± SE
[d] N (%, SE)
[e] Low income: monthly income < minimum cost of living × 1.2
Middle income: minimum cost of living × 1.2 ≤ monthly income < minimum cost of living × 2.5
High income: monthly income ≥ minimum cost of living × 2.5
[f] Adjusted for age.

Table 2. Comparison of food intake in study subjects with respect to instant noodle consumption in Korean adults (g/day)

	Total		Male		Female	
	Non-INC[a] (n = 5,666)	INC[b] (n = 774)	Non-INC (n = 2,425)	INC (n = 452)	Non-INC (n = 3,241)	INC (n = 322)
Plant food intake	1,117.9 ± 8.7 [c]*	964.9 ± 18.1	1,277.6 ± 13.3*	1,109.5 ± 25.1	961.8 ± 8.7*	832.8 ± 19.9
Cereals and grain products	322.8 ± 2.2*	364.8 ± 4.3	351.8 ± 3.4*	402.0 ± 6.2	293.9 ± 2.1*	325.6 ± 5.8
Potatoes and starches	21.4 ± 1.0*	9.7 ± 1.8	22.1 ± 1.4*	9.2 ± 2.0	20.7 ± 1.1*	12.2 ± 3.3
Sugars and sweets	8.2 ± 0.2*	6.5 ± 0.5	9.6 ± 0.3*	8.0 ± 0.6	6.8 ± 0.2*	5.0 ± 0.6
Legumes and their products	41.9 ± 1.2	35.8 ± 3.9	46.5 ± 1.7	42.1 ± 5.7	37.6 ± 1.4*	27.5 ± 3.6
Seeds and nuts	4.9 ± 0.3*	3.4 ± 0.5	5.6 ± 0.4	4.5 ± 0.8	4.3 ± 0.3*	2.1 ± 0.5
Vegetables	377.9 ± 3.8*	302.2 ± 8.3	425.9 ± 6.1*	338.8 ± 10.8	331.6 ± 3.4*	267.6 ± 11.6
Mushrooms	4.8 ± 0.3*	2.8 ± 0.6	4.9 ± 0.4	3.2 ± 0.8	4.7 ± 0.3*	2.5 ± 0.7
Fruits	92.7 ± 4.4*	58.4 ± 7.8	82.9 ± 5.1*	49.4 ± 8.0	100.8 ± 5.3	80.2 ± 13.4
Seaweeds	9.8 ± 0.5	8.2 ± 1.3	9.4 ± 0.7	6.8 ± 1.2	10.1 ± 0.6	11.1 ± 2.3
Beverages	170.0 ± 7.9*	131.7 ± 14.6	247.9 ± 14.0	199.7 ± 21.8	95.4 ± 6.5*	58.8 ± 13.5
Seasonings	43.0 ± 0.6*	26.5 ± 1.2	49.2 ± 0.9*	30.5 ± 1.8	36.9 ± 0.6*	24.1 ± 1.6
Oils and fats	10.4 ± 0.2*	6.7 ± 0.4	12.3 ± 0.3*	8.4 ± 0.6	8.7 ± 0.2*	5.0 ± 0.4
Others	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Animal food intake	262.1 ± 3.6*	196.9 ± 8.3	296.3 ± 4.6*	222.3 ± 10.8	228.5 ± 4.5*	181.3 ± 13.1
Meat, poultry and their products	98.9 ± 3.0*	66.1 ± 4.5	119.1 ± 3.7*	82.0 ± 5.9	79.2 ± 3.8*	52.9 ± 7.2
Eggs	24.4 ± 0.8	23.8 ± 1.5	27.9 ± 1.2	28.9 ± 2.0	21.0 ± 0.8	18.1 ± 1.8
Fishes and shell fishes	78.7 ± 1.9*	52.6 ± 4.8	94.0 ± 3.0*	64.5 ± 6.2	63.9 ± 1.9*	41.5 ± 5.0
Milks and dairy products	59.9 ± 2.1	53.4 ± 6.1	54.9 ± 3.0	45.3 ± 6.6	64.3 ± 2.5	68.7 ± 11.1
Oils and fats	0.1 ± 0.0*	0.0 ± 0.0	0.1 ± 0.0	0.0 ± 0.0	0.1 ± 0.0*	0.0 ± 0.0
Others	0.2 ± 0.1	0.9 ± 0.8	0.3 ± 0.1	1.6 ± 1.2	0.1 ± 0.0*	0.0 ± 0.0
Total food intake	1,380.0 ± 9.9*	1,161.7 ± 18.1	1,573.9 ± 13.9*	1,331.8 ± 24.8	1,190.3 ± 9.4*	1,014.1 ± 23.0

Adjusted for age and energy intake
[a] Non-INC: non-instant noodle consumer group
[b] INC: instant noodle consumer group
[c] Mean ± SE
* Significantly different between non-INC and INC groups at $P = 0.05$, as indicated by the *t*-test.

Subjects consuming instant noodles accounted for 12.0% of the 6,440 participants. The mean age of the participants in the INC group was lower than that in the non-INC group (36.2 vs. 44.9 yrs, respectively). Age and gender differences were observed for instant noodle consumption. Participants aged 20-49 years accounted for 86.8% of the INC group; this proportion was significantly higher than that of the non-INC group ($P < 0.001$). Participants aged 50-64 years or 65 years and older accounted for only 9.4% and 3.8% of the INC group, respectively. Men (63.5%) consumed more instant noodles than women (36.5%). Additionally, participants in the middle and high income group accounted for 41.9% and 40.8% of INC, respectively, whereas the lower income group accounted for 17.3% of the INC group. In total, 84.5% of the participants in the INC group had a high school education or a higher level of education, whereas 31.3% of participants in the non-INC group had a middle school or lower level of education, which was twice the proportion in the INC group (15.5%). No regional differences were observed between the two groups. No significant difference in BMI was observed between the INC and the non-INC groups, although the weights and heights of the INC group were relatively higher than those of the non-INC group.

As shown in Table 2, the intake of total plant-originating foods, animal-originating foods, and total food in the non-INC group was significantly higher than that of the INC group after adjusting for age and energy intake. When we looked separately at each individual food group, intake of cereals and grain products in the INC group was significantly higher than those in the non-INC group ($P = 0.05$). In contrast, the intake of potatoes and starches, sugars and sweets, seeds and nuts, vegetables, mushrooms, fruits, beverages, seasonings, meats, fishes, and oils and fats in the non-INC group was significantly higher than those in the INC group. This food intake pattern was similar for both men and women. However, seeds and nuts, mushrooms, and beverages in the INC group did not differ from those of the non-INC group in men, whereas women in the INC group had a significantly lower intake of legumes and their products compared with women in the non-INC group.

The daily nutrient intake of the INC and non-INC groups is shown along with the contribution of instant noodles in Table 3. The INC group had a significantly higher total energy intake than that in the non-INC group (2,024.6 kcal/day vs. 2,252.3 kcal/day) after adjusting for age. Additionally, the INC group consumed more fat, sodium, thiamine, and riboflavin than those in the non-INC group after adjusting for age and energy intake. In contrast, lower intake of protein, calcium, phosphorus, iron, potassium, vitamin A, niacin, and vitamin C was observed in the INC group. The percentages of energy from carbohydrates

Table 3. Comparison of daily nutrient intake in study subjects according to instant noodle consumption in Korean adults

	Total				Male				Female			
	Non-INC [a] (n = 5,666)	INC[b] (n = 774)			Non-INC (n = 2,425)	INC (n = 452)			Non-INC (n = 3,241)	INC (n = 322)		
		Total intake	Intake by instant noodle	Ratio (%)[a]		Total intake	Intake by instant noodle	Ratio (%)		Total intake	Intake by instant noodle	Ratio (%)
Energy (kcal)	2,024.6 ± 16.9[c]*	2,252.3 ± 42.1	532.6 ± 17.9	24.8 ± 0.8	2,322.1 ± 25.4*	2,456.3 ± 55.2	568.7 ± 24.7	24.3 ± 0.9	1,757.1 ± 15.6*	1,909.9 ± 43.0	469.6 ± 16.2	25.8 ± 1.0
Protein (g)	79.6 ± 0.4*	68.6 ± 1.0	10.8 ± 0.3	17.0 ± 0.7	91.2 ± 0.6*	79.5 ± 1.4	11.5 ± 0.5	16.7 ± 0.8	68.2 ± 0.5*	58.4 ± 1.0	9.5 ± 0.3	17.4 ± 0.9
Fat (g)	42.7 ± 0.4*	51.9 ± 0.8	20.3 ± 0.7	38.4 ± 1.1	49.2 ± 0.6*	60.0 ± 1.2	21.8 ± 0.9	37.4 ± 1.3	36.2 ± 0.5*	43.8 ± 1.2	17.8 ± 0.6	39.9 ± 1.4
Carbohydrates (g)	315.0 ± 1.4	314.4 ± 2.5	75.3 ± 2.4	24.3 ± 0.8	344.9 ± 2.3	349.3 ± 3.6	80.7 ± 3.3	24.2 ± 0.9	285.6 ± 1.3	278.7 ± 3.6	66.5 ± 2.4	24.4 ± 1.0
Ca (mg)	574.9 ± 6.6*	479.6 ± 11.6	38.9 ± 1.6	10.2 ± 0.6	627.5 ± 8.7*	529.8 ± 13.7	41.2 ± 2.1	10.3 ± 0.7	522.6 ± 7.2*	439.6 ± 17.2	35.2 ± 1.8	10.0 ± 0.7
P (mg)	1,306.3 ± 6.9*	1,108.9 ± 12.2	127.9 ± 4.1	12.6 ± 0.5	1,470.5 ± 10.3*	1,267.3 ± 15.9	135.9 ± 5.7	12.4 ± 0.7	1,145.5 ± 6.1*	959.9 ± 14.9	114.9 ± 4.1	12.9 ± 0.7
Fe (mg)	14.9 ± 0.2*	11.9 ± 0.3	0.79 ± 0.03	8.7 ± 0.5	16.7 ± 0.2*	13.5 ± 0.5	0.82 ± 0.04	8.6 ± 0.6	13.2 ± 0.2*	10.5 ± 0.4	0.75 ± 0.04	8.8 ± 0.6
Na (mg)	5,588.5 ± 48.1*	6,456.9 ± 126.0	2,032.2 ± 78.1	31.0 ± 0.9	6,284.1 ± 67.8*	7,297.0 ± 157.5	2,174.7 ± 105.3	30.5 ± 1.1	4,906.8 ± 50.8*	5,534.9 ± 170.8	1,803.1 ± 78.7	31.8 ± 1.1
K (mg)	3,018.6 ± 18.9*	2,571.5 ± 38.9	337.1 ± 12.3	14.1 ± 0.5	3,360.6 ± 27.3*	2,864.3 ± 48.7	364.1 ± 17.0	14.5 ± 0.7	2,682.8 ± 18.8*	2,334.4 ± 52.7	293.0 ± 11.6	13.5 ± 0.7
Vitamin A (ug RE)	860.1 ± 13.3*	689.5 ± 24.9	73.4 ± 2.7	14.3 ± 0.7	952.0 ± 21.1*	762.8 ± 33.9	80.4 ± 3.5	14.8 ± 0.8	769.7 ± 12.5*	636.4 ± 28.7.	61.9 ± 2.7	13.3 ± 0.8
Thiamine (mg)	1.26 ± 0.01*	1.66 ± 0.03	0.74 ± 0.03	41.7 ± 1.0	1.43 ± 0.02*	1.84 ± 0.03	0.80 ± 0.03	42.0 ± 1.3	1.08 ± 0.01*	1.49 ± 0.04	0.63 ± 0.02	40.9 ± 1.3
Riboflavin (mg)	1.17 ± 0.01*	1.40 ± 0.02	0.51 ± 0.02	34.6 ± 0.9	1.31 ± 0.01*	1.57 ± 0.03	0.56 ± 0.02	34.8 ± 1.2	1.03 ± 0.01*	1.23 ± 0.03	0.43 ± 0.02	34.2 ± 1.3
Niacin (mgNE)	18.5 ± 0.1*	14.4 ± 0.3	1.26 ± 0.05	10.5 ± 0.5	21.2 ± 0.2*	16.9 ± 0.4	1.37 ± 0.07	10.4 ± 0.6	15.8 ± 0.1*	12.2 ± 0.3	1.10 ± 0.04	10.6 ± 0.6
Vitamin C (mg)	108.2 ± 1.8*	78.2 ± 3.2	0.0 ± 0.0	0.0 ± 0.0	116.3 ± 2.5*	79.2 ± 3.4	0.0 ± 0.0	0.0 ± 0.0	100.1 ± 1.7*	84.4 ± 5.3	0.0 ± 0.0	0.0 ± 0.0
% energy from carbohydrate	66.9 ± 0.2*	64.9 ± 0.4			66.5 ± 0.2*	64.2 ± 0.5			67.4 ± 0.3*	65.5 ± 0.5		
% energy from protein	15.4 ± 0.1*	13.2 ± 0.2			15.5 ± 0.1*	13.3 ± 0.2			15.3 ± 0.1*	13.1 ± 0.2		
% energy from fat	17.7 ± 0.2*	21.9 ± 0.3			18.0 ± 0.2*	22.5 ± 0.4			17.3 ± 0.2*	21.4 ± 0.5		

Energy was adjusted for age, and other nutrients were adjusted for age and energy intake.
[a] Non-INC: non-instant noodle consumer group
[b] INC: instant noodle consumer group
[c] Mean ± SE
* Significantly different between the non-INC and INC groups at $P = 0.05$, as indicated by the t-test.

Table 4. Comparison of the percentage of Korean dietary reference intakes (KDRI) [a] according to instant noodle consumption in Korean adults (%)

	Total			Male			Female		
	Non-INC[a] (n = 5,666)	INC[b] (n = 774)		Non-INC (n = 2,425)	INC (n = 452)		Non-INC (n = 3,241)	INC (n = 322)	
		Intake	Intake by instant noodle		Intake	Intake by instant noodle		Intake	Intake by instant noodle
Energy	95.8 ± 0.8[c]*	103.1 ± 1.7	23.8 ± 0.8	98.2 ± 1.1*	103.8 ± 2.3	23.5 ± 1.0	93.7 ± 0.8*	101.9 ± 2.2	24.4 ± 0.8
Protein	161.2 ± 0.9*	136.0 ± 1.9	21.2 ± 0.7	170.0 ± 1.1*	148.4 ± 2.5	21.2 ± 0.9	151.5 ± 1.0*	129.7 ± 2.2	21.2 ± 0.8
Ca	81.6 ± 0.9*	67.9 ± 1.7	5.6 ± 0.2	89.6 ± 1.2*	75.7 ± 2.0	5.9 ± 0.3	73.5 ± 1.0*	61.5 ± 2.5	5.0 ± 0.3
P	186.6 ± 1.0*	158.4 ± 1.7	18.3 ± 0.6	210.1 ± 1.5*	181.0 ± 2.3	19.4 ± 0.8	163.6 ± 0.9*	137.1 ± 2.1	16.4 ± 0.6
Fe	137.6 ± 1.5*	112.6 ± 3.4	7.3 ± 0.3	166.8 ± 2.1*	134.7 ± 4.6	8.2 ± 0.4	110.2 ± 1.6*	87.1 ± 3.3	5.7 ± 0.3
Na	393.4 ± 3.4*	452.8 ± 8.7	139.1 ± 5.4	440.1 ± 4.7*	510.1 ± 10.8	148.9 ± 7.3	347.6 ± 3.6*	390.4 ± 12.2	123.3 ± 5.4
K	64.2 ± 0.4*	54.7 ± 0.8	7.2 ± 0.3	71.5 ± 0.6*	60.9 ± 1.0	7.7 ± 0.4	57.1 ± 0.4*	49.7 ± 1.1	6.2 ± 0.2
Vitamin A	125.7 ± 1.9*	99.4 ± 3.6	10.4 ± 0.4	129.3 ± 2.9*	103.6 ± 4.6	10.8 ± 0.5	121.6 ± 2.0*	100.4 ± 4.5	9.6 ± 0.4
Thiamine	108.9 ± 0.9*	142.9 ± 2.2	63.3 ± 2.1	119.3 ± 1.3*	153.6 ± 2.7	66.8 ± 2.9	98.5 ± 1.0*	135.5 ± 3.3	57.7 ± 2.1
Riboflavin	87.0 ± 0.7*	101.3 ± 1.6	36.8 ± 1.3	87.4 ± 0.8*	105.0 ± 1.8	37.3 ± 1.6	85.8 ± 0.7*	102.2 ± 2.5	36.1 ± 1.4
Niacin	122.7 ± 0.8*	94.6 ± 2.0	8.3 ± 0.3	132.4 ± 1.2*	105.7 ± 2.5	8.5 ± 0.5	112.8 ± 0.9*	87.2 ± 2.2	7.8 ± 0.3
Vitamin C	108.2 ± 1.8*	78.2 ± 3.2	0.0 ± 0.0	116.3 ± 2.5*	79.2 ± 3.4	0.0 ± 0.0	100.1 ± 1.7*	84.4 ± 5.3	0.0 ± 0.0

Energy was adjusted for age, and other nutrients were adjusted for age and energy intake.
[a] Non-INC, non-instant noodle consumer group
[b] INC: instant noodle consumer group
[c] Mean ± SE
* Significantly different between the non-INC and INC groups at $P = 0.05$, as indicated by the t-test.

and proteins in the non-INC group were higher than those of the INC group, whereas the percentage of energy from fat in the INC group was 4.2% higher than that of the non-INC group (17.7% vs. 21.9%, respectively). Instant noodle consumption contributed 24.8% to total energy intake, 38.4% of fat intake, 31.0% of sodium intake, 41.7% of thiamine intake, and 34.6% of the riboflavin intake in the INC group.

A similar pattern was observed when the groups were divided into men and women. Both men and women in the INC group had a higher intake of total energy, fat, sodium, thiamine, and riboflavin but a lower intake of protein, calcium, phosphorus, iron, potassium, vitamin A, niacin, and vitamin C when compared with those in the non-INC group. The percentages of energy from carbohydrate and protein in both men and women of the non-INC group were higher than those in the INC group, whereas the percentage of energy from fat in the INC group was approximately 4% higher than that in the non-INC group.

Table 4 shows a comparison of the nutrient intake of the INC and non-INC groups in Korea to that of the KDRI. The percentage comparisons to the KDRI for total energy, sodium, thiamine, and riboflavin in the INC group were higher than those of the non-INC group. In contrast, the percentage comparisons to the KDRI for protein, calcium, phosphorus, iron, potassium, vitamin A, niacin, and vitamin C in the INC group were lower than those of the non-INC group. Among them, the intake of calcium, potassium, and vitamin C were lower than the KDRI reference values. Sodium intake in the INC group was 4.52 times higher than that of the KDRI, whereas that of the non-INC group was 3.93 times higher. Instant noodles provided 139.1% of the sodium KDRI in the INC group. Thiamine and riboflavin from instant noodles provided 63.3% and 36.8% of the KDRI, respectively. Similar patterns in men and women with those in the total population were observed for various nutrients; the calcium, potassium, and vitamin C values in the INC group were lower than the KDRI reference values in men (calcium, 75.7% vs. 89.6%; potassium, 60.9% vs. 71.5%,; vitamin C, 79.2% vs. 116.3%, respectively). In women, the INC group showed lower percentages in comparison with the KDRI for calcium, iron, potassium, niacin, and vitamin C than those in the non-INC group, whereas the percentage comparisons to the KDRI for energy, sodium, thiamine, and riboflavin were higher than those of the non-INC group.

Discussion

This study revealed that INC consumed significantly lower amounts of potatoes and starches, sugars, seeds and nuts, vegetables, fruits, beverages, seasonings, oils and fats, meats and fishes than those in the non-INC group, with the exception of cereals and grain products, legumes, seaweeds, eggs, and milk and dairy products. The INC group showed significantly higher intake of energy, fat, sodium, thiamine, and riboflavin; however, the INC group showed a significantly lower intake of calcium, phosphorus, iron, potassium, vitamin A, niacin, and vitamin C when compared to those in the non-INC group.

It is rare to find peer-reviewed studies that have evaluated the relationship between instant noodle consumption and nutritional status, although public concerns regarding this food source are high. To our knowledge, this is the first nationwide study to examine the relationship between instant noodle consumption and nutritional status in Koreans. However, several interventional studies have reported that noodle consumption by children in Korea affects their nutrient intake [8-11]. But, the association between instant noodle consumption and nutritional status has rarely been examined in the adult population.

People typically prefer instant noodles to other convenience foods or fast foods when eating time is a constraint [12,13]. College students consume the largest amount of bowl-type instant noodles among various convenience foods in Korea [12]. These preferences are more strongly observed in people with time constraints. In addition, the preferred type of fast food for working men is instant noodles [13]. Women instant noodle consumers are younger and have a higher socio-economic status than those of other consumers [14]. Similarly, participants who consume instant noodles in this study tended to be younger (20-49 years), mostly in the middle or high income group, and with a level of education greater than high school. Indeed, participants aged 20-49 years consumed 22.2 g instant noodles per day compared to the consumption of persons aged 50-64 years or 65 years and older (7.6 g or 5.8 g, data not shown). Additionally, men consumed more instant noodles than women. Men consumed 23.7 g instant noodles per day, whereas women consumed 11.1 g per day (data not shown). Gender differences in instant noodle consumption have also been observed in previous studies; boys prefer instant noodles to other fast foods, and middle-school male students consume more noodles than girls [15].

Thirty percent of the total sales of instant noodles in Korea are bowl-type instant noodles consumed as a snack [1]. The fat content of instant noodles is in the range of 12-15.8% for the bag-type, and 17.8-26.0% for the bowl-type, with few exceptions [5]. A study reported that energy intake from fat accounts for 30.8% and 34.1% of the energy available from the bag-type and bowl-type noodles, respectively [16]. Increased consumption of the bowl-type of instant noodles is expected due to convenience, and, thus, a higher consumption of energy and fat intake is expected for the same amount of instant noodle consumption. In this study, instant noodle consumption included the consumption of both the bag-type and the bowl-type and was calculated separately with individual nutritional composition tables. Individuals who consume the bowl-type of instant noodles need to be cautious regarding the fat and calorie intake of this food. Thus, nutritional education would be helpful to reduce the fat and total calorie intake and to select the appropriate meal combination of other dishes required to achieve balanced nutritional status.

Dietary patterns together with instant noodle consumption have seldom been reported. One study in Korea reported that INC (middle school students, n = 385) added eggs and onions and often consumed noodles along with kimchi, steamed rice, radish pickles, or dried laver [17]. This limited consumption of side dishes with instant noodles was related to the lower consumption of potatoes and starches, seeds and nuts, vegetables, fruits, and seasonings. Interestingly, individuals who consume instant noodles consume more cereals and grain products, which was coincident with a previous result [17].

In the present study, the sodium intake in the INC group was > 6.4 g per day, which was 3.2 times higher than the recommended KDRI value. Instant noodle consumption contributed approximately 30% of the total sodium intake (2,032.2 mg per day). The salty taste of the soup base is favored by many consumers. Fortunately, Koreans do not prefer salty and greasy tastes [18]. A study was conducted to reduce sodium levels in instant noodles; that study reported that 20% of the sodium content, approximately 350 mg, from not eating the soup base without changing taste and flavor [19]. Recently, the Ministry of Health and Welfare in Korea announced "Dietary Guidelines for Korean Adults", which suggest ten dietary goals, six dietary guidelines, and 23 actual guidelines, including consuming a balanced energy intake and < 5 g sodium intake in the diet [20]. The Korea Food & Drug Administration has recently established a guide to "the right food selections for Korean kids" to ensure healthy dietary habits in later life. The Toyama Birth Cohort Study in Japan recently reported that junior high school students who frequently consume instant noodles (at least 3 days/week) from the age of 3 show a higher risk for a lower quality of life (odds ratio [OR], 1.49; $P = 0.007$) [21]. Children who have a preference for salty food tend to maintain and reinforce this tendency in their later life, so nutritional education programs promoting proper sodium consumption should be conducted early in life.

Several studies have been conducted to examine the association between gastric cancer, diabetes, and blood lipid profiles and instant noodle consumption [14,22,23]. Instant noodle consumption is associated with a higher risk for gastric cancer compared with that of plain noodles (n = 105; OR,4.76; $P < 0.01$) [22]. However, instant noodle consumption lowers blood glucose in healthy adults compared to consumption of steamed rice (n = 30, $P < 0.05$) [23]. Middle-aged women (40-64-years-of-age; n = 1,308) who consumed instant noodles show relatively healthier lipid profiles in KNHANES II than those who do not consume instant noodles [14]. They also reported that these instant noodle consumers were relatively younger and had a higher socioeconomic status (SES). Similarly, although the INC group consumed significantly higher amounts of fat and calories, no significant difference in BMI was observed between the two groups. The present study also showed similar characteristics with a previous study for age and SES. However, a change in nutritional status may cause an anthropometric change in later life. Thus, fat and calorie consumption should be monitored by INC and management of consumption should be promoted through nutritional education.

Recently, instant noodles in southeast Asia have been fortified with vitamin A, thiamine, riboflavin, niacin, vitamin B_6, folic acid, iron, zinc, and iodine [24]. Many studies have reported the retention rate and stability of fortified nutrients including thiamine, riboflavin, and folate [25-27]. Since the fortification of instant noodle began in developing countries in 1994, southeast Asian countries including Indonesia, Thailand, the Philippines, and Vietnam have voluntarily fortified with micronutrients. The efficacy of fortifying instant noodles has not been fully determined yet, but some results have been reported for these countries. A study in Indonesia found that there is a benefit for vitamin A and iron status of pregnant women and children < 5 years of age who consumed instant noodles fortified with 750 μg (2,500 IU) vitamin A and 9 mg iron/100 g for 3 months, compared with a control product [24]. In Thailand, seasoning powder fortified with zinc (5 mg), iron (5 mg), vitamin A (270 μg), and iodine (50 μg) per serving enhanced levels of hemoglobin, zinc, and iodine in children (n = 569) aged 5.5-13.4 years [6]. In the present study, the iron intake of the INC group was 87.1% of the recommended KDRI intake in women, whereas intake in the non-INC group was 110.2% that of women. Iron intake should be encouraged through nutritional education in individuals consuming instant noodles; the fortification of iron is not suitable for Korean adults due to the result that iron levels were 87.1% of the recommended value. Thus, nutrition education is an appropriate means for improving the intake of iron and vitamin C in Korean adults.

Choosing the appropriate form of a fortificant is important to minimize nutrient-nutrient as well as nutrient-food interactions and any resulting adverse effects. Furthermore, regional nutritional issues should be thoroughly examined and considered, and the fortification strategy should then be arranged by stakeholders, manufacturers, and the local government. In Korea, thiamine and riboflavin are fortified as part of the manufacturing process [5], which contributed to 41.7% and 34.6% of the total consumption, respectively, in this study. Instant noodles contribute a good source of these nutrients in Koreans. Recently, calcium and dietary fiber have become fortified as part of the manufacturing process, whereas sodium content has been reduced by 20-30% [28]. In addition, instant noodles for children fortified with dietary fiber (0-3 g), calcium (250-275 mg), iron (6 mg), and an oil mixture (ω-6: ω-3 = 6:1, 0.6 g) and contain less sodium (550-1,380 mg), fat (0.6-5 g) and calories (305-365 kcal) per package (88-93 g) by means of a non-frying process have been launched by one of the leading manufacturers [28]. We hope that manufacturers continue to pursue these efforts, and that these efforts are extended to other products for adults. Further studies are needed to clarify the effectiveness of fortification or reformulation on the nutritional status of the Korean population using updated food composition tables and new, reformulated instant noodle products.

Some limitations of this study should be considered. The main limitations of this study were its cross-sectional design, and that dietary data were collected for 1 day. As single-day dietary recalls are imprecise at the individual level, the typical dietary intake in individual subjects may not have been assessed precisely.

This study revealed that consuming instant noodles may lead to an excessive intake of calories, fats, and sodium but may also lead to an increased intake of thiamine and riboflavin. Therefore, nutritional education should be implemented to help adults choose a balanced meal while consuming instant noodles. Additionally, instant noodle manufacturers should consider nutritional aspects when developing new products.

References

1. Matsuo S, Tanaka M. Development of the world's first "instant noodles as a space food". J Jpn Soc Food Sci Technol 2008;55: 517-9.
2. World Instant Noodles Association (WINA) [Internet]. National Trends in Instant Noodles Demands; c2009 [cited 2009 October 25]. Available from: http://instantnoodles.org/noodles/expanding-market.html.
3. Korean Ministry of Health and Welfare. The Korean National Health and Nutrition Examination Survey - KNHANES III (2005). 2006.
4. NongShim Co., Ltd. [Internet]. Seoul: 2009 [updated 2009; cited 2009 October 25]. Available from: http://www.nongshimi.com/nsi/eve/evet_past_lst.jsp.
5. Kim SK. Overview of Korean noodle industry. Food Sci Biotechnol 1997;6:125-30.
6. Winichagoon P, McKenzie JE, Chavasit V, Pongcharoen T, Gowachirapant S, Boonpraderm A, Manger MS, Bailey KB, Wasantwisut E, Gibson RS. A multimicronutrient-fortified seasoning powder enhances the hemoglobin, zinc, and iodine status of primary school children in North East Thailand: a randomized controlled trial of efficacy. J Nutr 2006;136:1617-23.
7. The Korean Nutrition Society. Dietary reference intakes for Koreans. Seoul: 2005.
8. Cho HS, Ahn MS. A survey on the consumption patterns of ramyon by high school students in a part Chun-nam area. J Living Cult Res 1993;7:43-55.
9. Kang MH, Yoon KS. Elementary school students' amounts of sugar, sodium, and fats exposure through intake of processed food. J Korean Soc Food Sci Nutr 2009;38:52-61.
10. Kim K, Park E. Nutrient density of fast-food consumed by the middle school students in Cheongju city. Korean J Community Nutr 2005;10:271-80.
11. Yu NH, Kim MJ, Han JS. A study on the food intake frequency, dietary habits and nutrition knowledge of middle school students who like sweets in Busan. J Korean Soc Food Sci Nutr 2007;36:735-44.
12. Moon SJ, Yoon HJ, Kim JH, Lee YJ. A factor analysis on the value system of convenience foods by Korean college students. Korean J Soc Food Sci 1999;15:327-37.
13. Park GS, Shin YJ. A study of dining out behaviours of businessmen in urban regions. Korean J Soc Food Sci 1996;12:13-9.
14. Lee SM, Oh AR, Ahn HS. Major dietary patterns and their associations with socio-demographic, psychological and physical factors among generally healthy Korean middle-aged women. Korean J Community Nutr 2008;13:439-52.
15. Sung SH, Yu OK, Sohn HS, Cha YS. A comparison of dietary behaviors according to gender and obesity status of middle school students in Jeonju. J Korean Soc Food Sci Nutr 2007;36:995-1009.
16. Kim MJ, Shin SN, Kim SK. Proximate composition and calorie of Korean instant noodles. Korean J Food Sci Technol 2000;32: 1043-50.
17. Lee JW, Lee YH. Frequency of instant noodle (ramyeon) intake and food value recognition, and their relationship to blood lipid levels of male adolescents in rural area. Korean J Community Nutr 2003;8:485-94.
18. Kim SK, Lee AR. Survey on consumption pattern of ramyon in Seoul area. J Korean Soc Diet Cult 1989;4:395-404.
19. Chang SO. The amount of sodium in the processed foods, the use of sodium information on the nutrition label and the acceptance of sodium reduced ramen in the female college students. Korean J Nutr 2006;39:585-91.
20. Paik HY, Kim CI, Moon HK, Yoon JS, Joung H, Shim JE, Jung HJ. 2008 dietary goals and dietary guidelines for Korean adults. Korean J Nutr 2008;41:887-99.
21. Wang H, Sekine M, Chen X, Yamagami T, Kagamimori S. Lifestyle at 3 years of age and quality of life (QOL) in first-year junior high school students in Japan: results of the Toyama Birth Cohort Study. Qual Life Res 2008;17:257-65.
22. Youm PY, Kim SH. A case - control study on dietary and other factors related to stomach cancer incidence. Korean J Nutr 1998; 31:62-71.
23. Yoon SK, Kim MA. Glycemic responses of Korean domestic meals and diabetes meals in normal subjects. Korean J Food Nutr 1998;11:303-11.
24. Melse-Boonstra A, Pee S, Martini E, Halati S, Sari M, Kosen S, Muhilal, Bloem M. The potential of various foods to serve as a carrier for micronutrient fortification, data from remote areas in Indonesia. Eur J Clin Nutr 2000;54:822-7.
25. Bui LTT, Small DM. The contribution of Asian noodles to dietary thiamine intakes: a study of commercial dried products. J Food Compost Anal 2007;20:575-83.
26. Bui LTT, Small DM. Riboflavin in Asian noodles: the impact of processing, storage and the efficacy of fortification of three product styles. Food Chem 2009;114:1477-83.
27. Hau Fung Cheung R, Hughes JG, Marriott PJ, Small DM. Investigation of folic acid stability in fortified instant Asian noodles by use of capillary electrophoresis. Food Chem 2009;112:507-14.
28. NongShim Co., Ltd. [Internet]. Seoul: c2009 [cited 2009 October 26]. Available from: http://www.nongshim.com/non/pro/prod_deft_viw.jsp.