Public Health Res Perspect 2011 2(3), 192–197
doi:10.1016/j.phrp.2011.11.044
pISSN 2210-9099 eISSN 2233-6052

ELSEVIER

ORIGINAL ARTICLE

Food and Nutrient Intakes According to Income in Korean Men and Women

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Received: July 22, 2011
Revised: September 26, 2011
Accepted: October 27, 2011

KEYWORDS:
income,
food,
nutrient,
KNHANES,
adults

Abstract
Objectives: The present study investigated associations between income and intake of nutrients and food in adults (n = 11,063) from the fourth Korea National Health and Nutrition Examination Survey 2007–2009.
Methods: To examine relationships between individual dietary intake and anthropometric measures and family income, multiple linear regression models were constructed for each outcome variable. All models were adjusted for age, education, energy intake, smoking, body mass index, and physical activity.
Results: For men, intakes of protein, calcium, phosphorus, potassium, and vitamin C were lower in low-income compared to high-income groups. For women, intakes of protein and niacin were lower in low-income groups. Lowest income group ate less dairy products in men and less fruits and fishes or shellfishes in women.
Conclusion: Low-income groups had severe food insecurity and low diet quality compared to high-income groups. The study results will provide direction for public health efforts regarding dietary intakes according to economic status among Korean men and women.

1. Introduction

Socioeconomic inequalities in food and nutrient intakes have been widely reported [1,2]. In such studies, individuals with higher socioeconomic status (SES) have higher intakes of healthy foods such as whole grains, low-fat dairy products, fruits, and vegetables, and lower intakes of unhealthy foods with added sugar or high fat content. In addition, individuals of higher SES are more likely meet dietary recommendations compared to those of lower SES.

Income may influence dietary quality associated with food accessibility and availability [3]. Previous studies have shown that low-income families are exposed to greater food insecurity [4,5]. As food insecurity increases, the intake of fruit and vegetables decreases [6]. Food costs may contribute to differences in household diet quality in purchasing behavior for food. Diets

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of higher quality with low-energy, nutrient-dense foods tends to cost more than energy-dense diets [7,8].

The Korean economic status has been changed dramatically since the 1960s, with a transition to Westernized eating patterns and health behavior [9]. Therefore, associations between income and eating behavior and dietary intake are likely to have significantly changed. Identification of groups at high nutritional risk according to economic status is necessary to develop appropriate intervention programs for adult dietary behavior and to control future health costs. Thus, the purpose of this study was to investigate associations between income and intake of nutrients and food using cross-sectional data from the fourth Korean National Health and Nutrition Examination Survey 2007−2009.

2. Materials and Methods

2.1. Subjects

KNHANES 2007−2009 data were derived from a cross-sectional survey of a nationally representative, stratified, multistage probability sample of the non-institutionalized Korean population. Each survey participant was interviewed at home to evaluate dietary intake and underwent a physical examination conducted by trained personnel at a mobile examination center.

In this study, 2007, 2008 and 2009 data sets were combined to form one 2007−2009 data set. The combined data set included data from 11,547 adults aged 19−64 years for whom demographic, anthropometric, dietary intake, and physical activity data were available.

2.2. Income

Income was measured as the average total monthly income of all family members, defined as those who live together and share living-related expenditure. The equivalent income was calculated as income divided by the square root of family number.

2.3. Dietary intake

Subjects were interviewed by trained staff with a complete 24-hour recall. Nutrient intake was calculated by multiplying nutrient concentration data for a specific food code by the corresponding weight for each food item reported. All reported items were coded using the Korea Food Composition Table [10], which provides nutritional content based on standardized recipes. The ratio of nutrient intake to dietary reference intake [11] was calculated to evaluate dietary quality.

2.4. Anthropometric measures

Height and weight were measured as part of the physical examination process according to the Anthropometry Procedures Manual for KNHANES data collection. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared.

2.5. Statistical analyses

Appropriate sampling weights were used to account for differential selection probabilities and the complex sampling design.

To examine relationships between dietary intake and anthropometric measures and income, multiple linear regression models were constructed for each outcome variable. Dietary intake was modeled as the dependent variable. Income quartile from the lowest to the highest (entered as 1, 2, 3, 4) by age (in 5-year intervals) and gender was modeled as the independent variable. All models were adjusted for age, education, energy intake, smoking, BMI, and physical activity. Dietary intake data (food, nutrients, and energy intake) and anthropometric data are presented as adjusted least squares mean ± standard error of the mean according to income quartiles (Q1, Q2, Q3, and Q4). Data were examined using SAS version 9.2 software (SAS Institute Inc., Cary, NC, USA). The statistical significance was set to $p < 0.05$.

3. Results

The study included 11,063 adults aged 19−64 years for whom complete and reliable dietary intake data were available. Those in the high-income group had higher education status compared to the low-income group for both men and women (Table 1). For women, those in the high-income group were less obese compared to the low-income group. In addition, those in the high-income group ate out more often and skipped meals less frequently than the low-income group did. Only approximately one-third of the low-income group were fully food-secure, and the rest were either marginally food-secure or food-insecure. However, food-insecure individuals were not limited to the low-income group; a very small percentage of those with Q2, Q3 and even Q4 incomes were also food-insecure.

Unadjusted mean intakes of vitamin A, iron, and niacin increased from the low- to the high-income group for men. In addition, the high-income group had higher intakes of energy, protein, calcium, phosphorus, potassium, riboflavin, and vitamin C compared to the low-income group. For women, unadjusted mean intakes of protein, fat, calcium, phosphorus, potassium, iron, thiamin, riboflavin, niacin, vitamin C, and fiber increased from the low- to the high-income group (data not shown). After adjusting for age, education, BMI, energy intake, physical activity, and smoking, intakes of calcium, phosphorus, potassium, and vitamin C were higher in the high-income compared to the low-income group for men (Table 2). However, significant differences remained only for protein and niacin intakes by women after adjusting for confounding factors.

The lowest-income group consumed less fruit than the high-income group for men and women (Table 3).

Table 1. Characteristics of adults aged 19−64 years by income group in the KNHANES 2007−2009 survey

Variable	Male					Female				
	Q1 n = 1105	Q2 n = 1107	Q3 n = 1101	Q4 n = 1109	*p*	Q1 n = 1629	Q2 n = 1650	Q3 n = 1691	Q4 n = 1671	*p*
Education										
Elementary school or less	217 (19.6)	160 (14.5)	98 (8.9)	58 (5.2)	<0.001	444 (27.3)	396 (24.0)	274 (16.2)	155 (9.3)	<0.001
Middle school	177 (16.0)	147 (13.3)	112 (10.2)	87 (7.8)		241 (14.8)	216 (13.1)	185 (10.9)	165 (9.9)	
High school	502 (45.4)	491 (44.4)	465 (42.2)	394 (35.5)		684 (42.0)	704 (42.7)	715 (42.3)	638 (38.2)	
University or more	209 (18.9)	309 (27.9)	426 (38.7)	570 (51.4)		260 (16.0)	334 (20.2)	517 (30.6)	713 (42.7)	
Occupation										
Manager or professional	106 (9.6)	119 (10.9)	217 (20.0)	313 (28.6)	<0.001	102 (6.3)	117 (7.1)	197 (11.7)	299 (18.0)	<0.001
Officer	53 (4.8)	117 (10.7)	128 (11.8)	162 (14.8)		70 (4.3)	94 (5.7)	114 (6.8)	183 (11.0)	
Employee in service or sales	121 (11.0)	178 (16.2)	172 (15.9)	147 (13.4)		270 (16.6)	299 (18.2)	258 (15.3)	202 (12.1)	
Farmer or fisherman	140 (12.7)	102 (9.3)	84 (7.7)	76 (6.9)		119 (7.3)	114 (6.9)	93 (5.5)	75 (4.5)	
Technician	248 (22.5)	300 (27.4)	262 (24.2)	200 (18.3)		60 (3.7)	60 (3.6)	53 (3.1)	33 (2.0)	
Manual labor	131 (11.9)	105 (9.6)	81 (7.5)	56 (5.1)		223 (13.7)	178 (10.8)	133 (7.9)	85 (5.1)	
Other (including housewife)	301 (27.4)	175 (16.0)	140 (12.9)	141 (12.9)		779 (48.0)	782 (47.6)	836 (49.6)	786 (47.3)	
Obesity index[a]										
Underweight	37 (3.3)	34 (3.1)	37 (3.4)	19 (1.7)	0.104	91 (5.6)	78 (4.7)	97 (5.7)	124 (7.4)	<0.001
Normal	665 (60.2)	625 (56.5)	655 (59.5)	648 (58.4)		1030 (63.2)	1071 (64.9)	1225 (72.4)	1180 (70.6)	
Overweight	357 (32.3)	397 (35.9)	374 (34.0)	399 (36.0)		413 (25.4)	424 (25.7)	326 (19.3)	328 (19.6)	
Obesity	46 (4.2)	51 (4.6)	35 (3.2)	43 (3.9)		95 (5.8)	77 (4.7)	43 (2.5)	39 (2.3)	
Skipping meal										
Breakfast	307 (27.8)	287 (25.9)	290 (26.4)	261 (23.6)	0.142	397 (24.4)	398 (24.1)	418 (24.7)	429 (25.7)	0.737
Lunch	99 (9.0)	76 (6.9)	59 (5.4)	65 (5.9)	0.004	188 (11.5)	160 (9.7)	147 (8.7)	131 (7.8)	0.002
Dinner	75 (6.8)	53 (4.8)	66 (6.0)	51 (4.6)	0.076	163 (10.0)	156 (9.5)	120 (7.1)	136 (8.1)	0.013
Eating out										
More than once per day	91 (8.2)	130 (11.7)	153 (13.9)	177 (16.0)	<0.001	62 (3.8)	49 (3.0)	65 (3.9)	68 (4.1)	<0.001
Once per day	178 (16.1)	242 (21.9)	287 (26.1)	283 (25.5)		137 (8.4)	124 (7.5)	172 (10.2)	170 (10.2)	
One to six times per wk	443 (40.1)	475 (42.9)	462 (42.0)	490 (44.2)		499 (30.7)	634 (38.5)	750 (44.4)	831 (49.8)	
Less than four times per mo	392 (35.5)	260 (23.5)	199 (18.1)	159 (14.3)		929 (57.1)	841 (51.0)	701 (41.5)	601 (36.0)	
Household food security status										
Fully food-secure	353 (32.0)	436 (39.4)	510 (46.3)	619 (55.9)	<0.001	508 (31.3)	617 (37.4)	773 (45.7)	947 (56.7)	<0.001
Marginally food-secure	586 (53.1)	611 (55.2)	555 (50.4)	476 (43.0)		876 (53.9)	920 (55.8)	855 (50.6)	697 (41.8)	
Food-insecure without hunger	133 (12.0)	54 (4.9)	33 (3.0)	11 (1.0)		200 (12.3)	99 (6.0)	59 (3.5)	22 (1.3)	
Food-insecure with hunger	32 (2.9)	6 (0.5)	3 (0.3)	1 (0.1)		41 (2.5)	13 (0.8)	3 (0.2)	3 (0.2)	

[a]*The obesity index was defined using WHO obesity criteria: underweight, <18.5 kg/m²; normal, 18.5−24.9 kg/m²; overweight, 25−29.9 kg/m²; obese, > 30 kg/m².*

Data are presented as *n* (%). Q1, Q2, Q3 and Q4 are mean income quartiles from the lowest to the highest income.

Table 2. Mean nutrient intake for adults aged 19−64 years by income group in the KNHANES 2007−2009 survey

	Male					Female				
Variable	Q1 n = 1105	Q2 n = 1107	Q3 n = 1101	Q4 n = 1109	*p*	Q1 n = 1629	Q2 n = 1650	Q3 n = 1691	Q4 n = 1671	*p*
Energy (kcal)	2233.1 ± 39.5	2353.2 ± 33.5	2296.9 ± 38.3	2286.0 ± 39.5	0.073	1669.8 ± 37.5	1711.6 ± 44.5	1697.2 ± 41.8	1707.4 ± 41.4	0.499
Carbohydrate (g)	347.5 ± 4.3	349.2 ± 3.6	343.8 ± 3.4	343.7 ± 4.1	0.509	270.5 ± 4.5	263.6 ± 5.1	265.4 ± 4.7	266.6 ± 4.9	0.098
Protein (g)	82.6 ± 1.4	82.7 ± 1.1	81.6 ± 1.2	85.4 ± 1.3	0.115	58.6 ± 1.2	60.6 ± 1.4	61.3±1.4	60.9 ± 1.3	0.007
Fat (g)	46.5 ± 1.0	45.9 ± 0.9	46.2 ± 1.1	46.7 ± 1.2	0.941	35.6 ± 2.0	37.5 ± 2.8	37.2 ± 2.2	37.2 ± 2.1	0.147
Calcium (mg)	552.7 ± 12.8	572.1 ± 17.3	551.0 ± 12.4	591.8 ± 12.9	0.032	413.6 ± 13.4	432.1 ± 12.5	431.8 ± 13.2	419.5 ± 14.0	0.285
Phosphorus (mg)	1334.7 ± 17.6	1342.7 ± 17.3	1322.3 ± 16.5	1374.4 ± 16.7	0.042	998.0 ± 18.1	1006.1 ± 17.5	1019.9 ± 19.5	1008.3 ± 18.6	0.398
Sodium (mg)	6193.6 ± 128.9	6120.9 ± 113.2	6140.5 ± 124.6	6088.3 ± 104.5	0.901	4439.0 ± 190.4	4464.7 ± 214.8	4590.7 ± 206.6	4573.2 ± 204.3	0.302
Potassium (mg)	3341.7 ± 48.0	3378.5 ± 48.0	3334.8 ± 53.3	3554.4 ± 56.3	0.002	2607.2 ± 58.6	2604.4 ± 59.1	2700.4 ± 60.1	2685.8 ± 66.5	0.120
Iron (mg)	16.6 ± 0.5	16.3 ± 0.4	16.5 ± 0.5	17.5 ± 0.5	0.186	12.2 ± 0.4	12.3 ± 0.4	12.5 ± 0.4	12.7 ± 0.4	0.585
Vitamin A (μg RE)	877.2 ± 33.7	844.5 ± 30.1	886.1 ± 35.4	964.8 ± 43.0	0.101	683.6 ± 34.7	664.5 ± 31.6	734.9 ± 34.9	711.9 ± 37.6	0.112
Thiamin (mg)	1.5± 0.0	1.5 ± 0.0	1.5 ± 0.0	1.5 ± 0.0	0.916	1.1 ± 0.0	1.1 ± 0.0	1.1 ± 0.0	1.1 ± 0.0	0.185
Riboflavin (mg)	1.3 ± 0.0	1.3 ± 0.0	1.3 ± 0.0	1.4 ± 0.0	0.164	1.0 ± 0.0	1.1 ± 0.0	1.0 ± 0.0	1.0 ± 0.0	0.127
Niacin (mg)	18.6 ± 0.3	19.0 ± 0.3	19.2 ± 0.3	19.7 ± 0.3	0.079	14.1 ± 0.4	14.4 ± 0.4	14.7 ± 0.4	15.0 ± 0.4	0.001
Vitamin C (mg)	105.0 ± 3.1	116.9 ± 3.9	108.3 ± 3.4	118.9 ± 4.4	0.002	88.1 ± 4.8	91.2 ± 5.4	94.6 ± 5.0	94.2 ± 5.6	0.405
Fiber	8.3 ± 0.2	8.2 ± 0.2	8.1 ± 0.2	8.4 ± 0.2	0.687	6.6 ± 0.2	6.5 ± 0.2	6.8 ± 0.2	6.6 ± 0.3	0.215
Energy from carbohydrate (%)	66.7 ± 0.5	66.2 ± 0.4	66.1 ± 0.4	65.1 ± 0.5	0.075	67.6 ± 0.7	66.2 ± 0.8	66.3 ± 0.7	66.3 ± 0.7	0.005
Energy from protein (%)	15.2 ± 0.2	15.3 ± 0.2	15.3 ± 0.2	16.0 ± 0.2	0.007	14.3 ± 0.2	14.8 ± 0.3	14.9 ± 0.2	14.8 ± 0.3	0.001
Energy from fat (%)	18.2 ± 0.4	18.5 ± 0.3	18.6 ± 0.4	18.9 ± 0.4	0.419	18.1 ± 0.6	19.0 ± 0.7	18.8 ± 0.6	18.8 ± 0.6	0.083

Data are presented as mean ± SE and means are adjusted for age, education, BMI, energy intake, physical activity and smoking. Q1, Q2, Q3 and Q4 are mean income quartiles from lowest to highest income.

Table 3. Mean food group intake for adults aged 19−64 years by income group in the NHANES 2007−2009 survey

Food group	Male					Female				
	Q1	Q2	Q3	Q4	p	Q1	Q2	Q3	Q4	p
	n = 1105	n = 1107	n = 1101	n = 1109		n = 1629	n = 1650	n = 1691	n = 1671	
Grains (g)	351.2 ± 7.2	337.2 ± 5.3	341.6 ± 5.5	326.6 ± 5.5	0.020	263.6 ± 6.7	250.1 ± 7.5	254.2 ± 7.7	253.3 ± 7.5	0.022
Fruits (g)	130.8 ± 11.1	152.7 ± 13.2	138.6 ± 11.6	158.6 ± 14.4	0.211	127.4 ± 14.5	148.9 ± 15.2	168.8 ± 14.8	148.6 ± 16.5	0.022
Vegetables (g)	390.4 ± 9.0	392.9 ± 8.4	390.8 ± 9.3	412.4 ± 10.1	0.181	284.7 ± 9.5	277.4 ± 9.7	292.0 ± 9.6	287.7 ± 9.8	0.277
Meat (g)	112.9 ± 10.0	123.6 ± 6.5	106.1 ± 6.9	124.4 ± 7.8	0.098	74.2 ± 8.3	83.0 ± 11.4	84.7 ± 10.1	85.4 ± 8.6	0.077
Dairy products (g)	52.7 ± 5.3	65.1 ± 8.1	50.6 ± 5.5	78.5 ± 7.4	0.005	68.8 ± 8.6	74.0 ± 7.7	73.1 ± 8.9	64.9 ± 8.4	0.464
Eggs (g)	26.3 ± 2.1	23.4 ± 1.7	24.9 ± 1.9	27.6 ± 2.5	0.410	19.0 ± 1.6	21.5 ± 2.1	20.5 ± 1.7	19.9 ± 1.7	0.350
Fish and shellfish (g)	74.4 ± 5.1	69.0 ± 3.9	75.1 ± 4.4	76.4 ± 4.5	0.583	37.2 ± 3.4	43.1 ± 3.7	44.3 ± 3.5	44.0 ± 4.0	0.034
Sweets (g)	9.4 ± 0.6	10.9 ± 0.6	10.6 ± 0.7	9.4 ± 0.7	0.130	8.6 ± 0.9	9.2 ± 1.0	9.4 ± 1.0	9.4 ± 1.0	0.242

Data are presented as mean ± SE and means are adjusted for age, education, BMI, energy intake, physical activity, and smoking. Q1, Q2, Q3 and Q4 are mean income quartiles from lowest to highest income.

Men with Q1 income ate less vegetables and dairy products and women with Q1 income ate less lean meat and poultry, and fish and shellfish compared to the other groups. After adjusting for confounding factors, the Q1-income men ate less dairy products and Q1-income women ate less fruits and fish and shellfish. In addition, the high-income group consumed less grain products compared to lower-income groups for both men and women after adjusting for confounders. For women, the low-income group ate less lean meat and poultry, but the differences were not significant.

4. Discussion

This study was conducted to examine associations between income and dietary intake in adults using nationally representative data. Our results indicate that overall dietary quality was better in high-income than in low-income groups. After adjusting for confounding factors, significant differences in dietary intake according to income still remained.

For both men and women, mean fruit and vegetable intakes by the low-income group were low. Our findings are in line with the most consistent evidence of dietary inequalities in adults, showing lower consumption of fruit and vegetables in groups with low SES [1]. Furthermore, the present study revealed that intakes of dairy products and meat by low-income men were low, and as were intakes of fish or shellfish and vegetables by low-income women. These findings are consistent with results in previous studies indicating that consumption of lean meat, fish and other seafood was associated with higher SES [12,13]. The current study shows that the low-income group had lower calcium, iron, and potassium intakes than the other groups, which is consistent with results noted in several studies [13−15].

In the Q1 and Q2 income quartiles, a lack of food security was noted. In this study, 14.9% of low-income men and 14.8% of low-income women experienced food insecurity with or without hunger. Differences in food security according to income may be explained by differences in adult educational status. Only 18.9% and 16.0% of low-income men and women had education above university level, compared with 51.4% and 42.7% for the respective high-income groups. Low educational status is likely to be associated with low earning potential. Educational status may facilitate the acquisition of positive psychosocial and economic skills and may protect against unhealthy eating behavior [16].

Limited food availability because of insufficient grocery stores that sell nutrient-dense foods in the neighborhood [17], limited food accessibility because of a lack of transportation or poor health [18], and limited food purchasing behavior because of insufficient income for food costs are likely to be some of the reasons for food insecurity among low-income adults [19,20].

Nutrient-dense, healthier diets that include fruit, vegetables and whole-grain products tend to be more expensive, while energy-dense diets are generally lower in cost [7,20]. Higher-cost diets have been found to be lower in energy density and higher in micronutrient and dietary fiber content compared to lower-cost diets [20].

The limitation of this study is the use of cross-sectional data, so only associations could be reported. In addition, the amount of food intake was counted not in servings but in grams. Dietary guidelines for food-group intake recommend amounts as the number of servings, and thus we could not compare differences between intake amounts and dietary guidelines. However, the study included a large number of subjects from nationally representative data collected in the KNHANES survey. In addition, the results provide a rationale for associations between household income and dietary intake in adults.

In conclusion, the low-income group had severe food insecurity and low diet quality compared to the high-income group. This dietary inequality may be related to disadvantageous health outcomes. Thus, nutritional education and intervention programs for low-income adults are needed to increase dietary quality. In addition, public health professionals and policy makers should devote efforts to increase food availability, accessibility and affordability among low-income adults as a high priority.

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