Original Article

South Korea's entry to the global food economy: shifts in consumption of food between1998 and 2009

Haeng-Shin Lee PhD[1], Kiyah J Duffey PhD[2], Barry M Popkin PhD[2]

[1]*Korea Health Industry Development Institute, South Korea*
[2]*Department of Nutrition, University of North Carolina at Chapel Hill, USA*

Korea has undergone a major opening of its food markets and economy in the past decade. Little is understood about the impact of these shifts on the diet of Koreans. This analysis studies the shifts in consumption of foods between 1998 and 2009 to provide a thorough understanding of the transition and insights into directions in the next decades in Korea. Data are from the Korea National Health and Nutrition Examination Survey (KNHANES). The sample used was a nationally representative sample of individuals age ≥2 in 1998 and 2009 (n=10,267 and 9,264, respectively). The data was corrected for seasonality, and the original raw food data was regrouped into 53 food groups. SAS was used to adjust for design effects and weight. Despite a decade of efforts to increase whole grains intake, and fruit and vegetable intake, the mean intake of whole grains increased only a small amount (16 kcal/person/day); however, the proportion consuming any whole grains doubled from 24% to 46.3%. Rice declined significantly, and several important less healthful food trends emerged: total alcohol intake increased from 39 kcal/person/day to 82 kcal/person/day. Also, energy from sugar-sweetened beverages increased among teens and energy from tea and coffee increased among adults. Remarkably, compared to other Asian countries and a general worldwide trend, vegetable intake remained relative high in South Korea during this last decade while fat energy increased modestly from relative low levels. Dynamic causes of these trends and the government's response are discussed.

Key Words: nutrition transition, South Korea, diet, National Health and Nutrition Examination Survey, energy intake

INTRODUCTION

South Korea has undergone many stages of dietary transition since the 1960s, but it has been one of the few countries to retain its traditional high vegetable, low fat diet as it underwent a remarkable economic transition in the period between 1960 and 1990.[1-5] More recently, an array of global forces, including membership in the World Trade Organization (WTO), a rapidly modernizing food distribution systems, the rapid emergence of the fast food and restaurant sector, and increasing access to modern processed foods have all led to major dietary changes.[6-8] Furthermore, over the past decade the removal of barriers to food importation, and the development of the Korean Food Trade Association (FTA) has been linked with increased food availability, reduced prices and significant increases in food importation.[9]

During this same period, the prevalence of obesity, hypertension, and other cardio-metabolic outcomes have increased: the prevalence of overweight and obesity among adults was 13.9% (11.7% in men, 18.0% in women) in 1995 but it increased by 2001 to 30.6% (32.4% in men, 29.4% in women).[10] These changes led the Korean government to not only revise the dietary guidelines and Dietary Reference Intakes (DRIs) for Koreans[11] but also to initiate several diet-related programs to attempt to offset some of these changes. In particular the government has attempted to increase fruit and vegetable and whole grain intake. However, rapid shifts in the food environment have occurred, concurrent with major lifestyle changes in Korea.

To date, shifts in the quality of the Korean diet over this period have not been carefully studied. This article examines shifts in diet during this recent transition period when the Korean food system became open to global influences and trade, using the series of nationally representative individual dietary data surveys that were initiated in 1998 and have continued through 2009.

METHODS

Sample

The Korea National Health and Nutrition Examination Survey (KNHANES) is a cross-sectional health and nutrition examination survey using nationally representative samples of non-institutionalized Korean civilians aged 1 and older. KNHANES is based on a multistage, stratified area probability sample of non-institutionalized Korean households in different geographic areas and in different age and sex groups. Weights indicating the probability of

Corresponding Author: Dr Barry M Popkin, Department of Nutrition and Carolina Population Center, University of North Carolina at Chapel Hill, 123 W Franklin St, Chapel Hill, NC 27599, USA.
Tel: 919-966-1731; Fax: 919-966-9159
Email: popkin@unc.edu
Manuscript received 6 March 2012. Initial review completed 15 June 2012. Revision accepted 29 July 2012.

being sampled were assigned to each respondent, enabling the results to represent the entire Korean population. We use data from individuals ages 2 years and older from 1998 (n=10,267) and 2009 (n= 9,264).

The 1998 and 2001 KNHANES were conducted by the Korean Institute for Health and Social Affairs (KIHASA) and the Korea Health Industry Development Institute (KHIDI); the 2005 KNHANES was conducted by KIHASA, KHIDI, and the Korean Centers for Disease Control and Prevention (KCDC). But from 2007, the KNHANES was conducted by KCDC.[9,11-15]

Dietary data

Beginning in 2007, dietary data were collected over a 12-month seasonally weighted sample. Prior to that, however, the surveys were collected in winter (November-December, 1998 and 2001), and spring (April-May, 2005) with additional replicate samples collected from subsamples of the population in other seasons. This study is the first to use these seasonal replicates (which adjust all data at all-time points) to create seasonally adjusted data.

Trained dietitians followed multi-pass procedures to collect a single, in-person detailed 24-hour recall of dietary intake data. To enhance recall, particularly for away-from-home food consumption, food models and two-dimensional model of actual size traditional bowels/pots and food shapes were used to help the respondent report the volume and dimensions of the food items consumed. Detailed methodologies are published elsewhere.[16]

Based on the recipes collected from each household, the weight of each ingredient was estimated from the volume of food ingested. Then nutrient intake was calculated using Korean Food Composition Tables[17-19] and the Recipe Database for Korea health and nutrition examination.[20]

Historical dietary data

Prior to 1998, all dietary data in South Korea came from household food consumption surveys, which were conducted annually by the Ministry of Health and Welfare since 1969.[21] Sample sizes of approximately 2000 households were collected in each round. These data are discussed in greater detail in earlier publications.[9] Data come from government reports as raw data are unavailable and do not allow age adjustment. These household data are presented in per capita terms for vegetable trends and as a proportion of energy from fat for fat trends.

Food grouping

Food grouping was based on the University of North Carolina-Chapel Hill food grouping system.[22] Briefly, USDA food groups were broken into more detailed, nutrient-based food groups using a systematic method which has been described in detail elsewhere.[23-25] Additions and modification were made to account for foods commonly consumed in South Korea. For example, white rice, kimchi (traditional fermented cabbage), salted vegetables, and soju (Korean distilled spirits) were pulled from their parent food groups because of their importance to and prominance in the Korean diet. Ultimately 53 food groups were examined.

Statistical analysis

All statistical analyses were conducted using SAS (release 9.2; Cary, NC, USA). We used data from the two surveys for these analyses. The chi-square test was used to compare the percentage of demographic variable groups by year. Student t-test was also used to assess trends in mean consumption (per capita and per consumer) across food group.

RESULTS

Background

The distribution of demographic factors among respondents in 1998 and 2009 are presented in Table 1. Level of education and region of residence have changed significantly between 1998 and 2009; specifically those with less than a high school diploma ($p<0.001$), and rural and urban residence decreased, while higher levels of education and residence in a small city increased ($p<0.05$).

Overall trends

Food groups, for which caloric intake per person changed significantly within the past 10 years, are presented in Table 2. The vast majority of Koreans consumed white rice on a daily basis, as evidenced by the data. However, daily consumption of white rice declined by the largest amount compared to any other food group during this time period decreasing from 743 kcal in 1998 to 664 kcal in 2009 ($p<0.001$). Consumption of energy from whole grains, however, increased an average of 16 kcal ($p<0.001$). Other changes were seen for fruit (12 kcal, $p<0.05$), alcohol (particularly Soju (Korean distilled spirits) 29 kcal, $p<0.001$; and beer 12 kcal, $p<0.001$), and coffee and tea (19 kcal, $p<0.001$). Shifts in the gram consumption of all 53 food groups can be found in Table 3.

Table 4 shows changes in the proportion of the population who consume food groups between 1998 and 2009. Consumption of whole grains showed the largest change over the 10 year period, with consumption nearly doubling between 1998 and 2009, from 24.0% to 46.3% ($p<0.001$). Nuts and Seeds, and Coffee and Tea had the next largest change in percent consuming, at 21.5% ($p<0.001$) and 16.2% ($p<0.001$), respectively. Percent consuming, grams consumed, and energy intake from Soju also increased significantly ($p<0.001$) over this time period.

Comparison of historical and current trends in vegetables and percent fat

One of the unique features highlighted in earlier research was the high vegetable and low fat levels in the Korean diet.[5,26] Energy intake from fat remained low in South Korea relative to the country's low economic position at that time; however in the past decade this has steadily increased from 152 to 365 kcal/person/day (Figure 1). Figure 2 provides data on vegetable intake trends. Although the historical and current sampling frame and dietary data collection are not comparable, it is clear that vegetable intake has remained high, with Kimchi the largest contributor to vegetable consumption. In particular while other vegetable intake has fluctuated over time, consumption of Kimchi has risen steadily since 1969 increasing from 58 g to 117 g/person/day in 2009 (Figure 2).

Table 1. Distribution of demographic factors in KNHAES[†], 1998 and 2009

Demographic group	1998 KNHANES	2009 KNHANES	*p* value[‡]
Sample size, (n)			
Number of individuals	10,400	9,391	
Number of households	3,475	3,761	
Mean household size	3.2	3.2	
Gender (%)			
Male	48.7	50.1	<0.010
Age groups, y, (%)			
2-6	8.0	5.0	0.068
7-12	9.2	7.3	
13-18	10.2	9.0	
19-39	36.0	32.8	
40-59	24.8	30.8	
≥60	11.8	15.2	
Income as percentage of poverty, (%)[§]			
Low (< 120%)	32.7	23.5	0.194
Middle (120-250%)	45.9	37.0	
High (≥250%)	21.5	39.5	
Adults (≥19 y) education, (%)			
<High school diploma	36.7	35.0	<0.001
≥High school diploma	63.3	65.0	
Region[¶],(%)			
Large city	47.9	46.4	
Small city	32.0	37.2	<0.050
Rural	20.1	16.4	

[†]Weighted to be nationally representative.
[‡]Chi-squared Test comparing the percent of each demographic group between 1998 and 2009.
[§]Calculated values based on Minimum Cost of Living (MCL) of each year. A family is considered poor if its income or expenditure falls below MCL measured by government as poverty.
[¶]Large city: cities with more than a million people each. Small city: cities with more than 50 thousand and less than a million people each. Rural: cities with less than 50 thousand people each.

Table 2. Top 20 Food Groups in terms of changes in kcal per day per person of dietary intake between 1998 and 2009.

Rank	Food Group	Calories per person [‡]			
		1998	2009	10 y change[§]	*p* value[¶]
1	White rice	743	664	-79	<0.001
2	Soju (Korean distilled spirits)	24	54	30	<0.001
3	Coffee and tea	14	33	19	<0.001
4	Whole grain	20	36	16	<0.001
5	Pork	68	84	16	<0.001
6	Cakes, cookies, pies	30	44	14	<0.001
7	Fruit, fresh	62	74	12	<0.050
8	Beer	9	21	12	<0.001
9	Noodle and Pasta	76	65	-11	<0.05
10	Sauces	11	21	10	<0.001
11	Milk and milk/soy drinks	43	52	9	<0.001
12	Fish plain	47	38	-9	<0.001
13	Savory snacks	20	11	-9	<0.001
14	Beef	40	31	-9	<0.001
15	Other grains products and dishes	98	90	-8	0.113
16	Other legumes and legume dishes	15	23	8	<0.001
17	Ramen	61	54	-7	0.113
18	Nuts and seeds	7	13	6	<0.001
19	Fats and oils, Salad dressings and dips	58	63	5	<0.010
20	Tofu	15	19	4	<0.001

[†]Rank ordered according to calculated difference in mean daily per person caloric intake between 1998 and 2009.
[‡]Mean daily per person caloric intake.
[§]Change in per person calories calculated as difference between 1998 and 2009.
[¶]Student t-test comparing mean per person caloric intake between 1998 and 2009.

Healthful dietary trends

Although consumption of cereals and grain products decreased continuously between 1969 and 1995. White rice consumption remained relatively stable[3,4,26] until the last decade when consumption declined from 213 g in 1998 to 178 g per person per day in 2009 (p<0.001). The average intake of whole grains doubled from 6 g/capita/day in 1998 to 11 g/capita/day in 2009 (p<0.001) (Table 3) and

Table 3. Top 20[†] changed food groups in per capita[‡] (grams), per consumer[§] (grams), and percent consuming[¶] between 1998 and 2009.

Rank	Food Group	1998			2009			*p*-value 10 y change		
		Per Capita	Percent Consuming	Per Consumer	Per Capita	Percent Consuming	Per Consumer	Per Capita[††]	Percent Consuming[‡‡]	Per Consumer[§§]
1	White Rice	213.3	94.8%	224.9	178.4	97.0%	183.9	<0.001	<0.001	<0.001
2	Beer	23.3	3.2%	729.9	55	6.5%	840.3	<0.001	<0.001	0.053
3	Coffee and Tea	11.4	31.5%	36.2	38.1	47.7%	79.9	<0.001	<0.001	<0.001
4	Soju (Korean distilled spirits)	16.8	6.9%	245.1	37.6	10.3%	363.9	<0.001	<0.001	<0.001
5	Kimchi	101.9	89.8%	113.5	117.3	90.8%	129.1	<0.001	0.141	<0.001
6	Milk & milk/soy drinks	70.1	28.2%	248.4	84.2	28.4%	296.9	<0.001	0.883	<0.001
7	Vegetable, fresh, frozen or processed and vegetable dishes	144.6	97.4%	148.5	158.2	97.4%	162.5	<0.001	0.857	<0.001
8	Other Grains products and dishes	45.5	51.7%	88	32.3	63.4%	50.9	<0.001	<0.001	<0.001
9	Fruit, fresh	154.7	48.0%	322.1	167.8	50.9%	329.8	0.184	0.107	0.541
10	Other meats and meat dishes	3.4	6.4%	53.4	13.8	8.5%	163.4	<0.001	<0.001	<0.001
11	Pork	24.8	34.3%	72.4	32.1	40.5%	79.3	<0.001	<0.001	<0.05
12	Poultry plain and Poultry dishes	13.5	8.8%	152.9	19.9	15.4%	129.1	<0.001	<0.001	<0.05
13	Tofu	17.6	35.6%	49.4	23.2	40.6%	57.1	<0.001	<0.001	<0.001
14	Fruit juices	11.2	4.7%	238.4	16.3	10.2%	160.3	<0.001	<0.001	<0.001
15	Whole grain	5.6	24.0%	23.3	10.7	46.3%	23.1	<0.001	<0.001	0.894
16	Beef	21	39.0%	53.9	16	33.7%	47.6	<0.001	<0.001	<0.01
17	Sugar sweetened beverages, sports drinks	36.1	14.1%	255.9	41	14.3%	287.7	0.078	0.857	<0.001
18	Cakes, cookies, pies	9.5	11.0%	86.5	14.4	15.7%	91.3	<0.001	<0.001	0.408
19	Seasonings	23.8	98.0%	24.3	27.8	97.7%	28.4	<0.001	0.277	<0.001
20	Fish plain	29.5	65.4%	45	25.6	63.0%	40.7	<0.05	<0.05	<0.05

[†]Rank ordered according to difference of the mean per capita daily consumption (grams) between 1998 and 2009.
[‡]Mean daily per capita intake (grams).
[§]Percent of the sample who reported consuming the food.
[¶]Mean per consumer intake (grams), calculated only among those who reported consuming the food.
[††]Student t-test comparing per capita mean intake (grams) between 1998 and 2009.
[‡‡]Chi-squared test comparing percent consuming between 1998 and 2009.
[§§]Student t-test comparing per consumer mean intake (grams) between 1998 and 2009.

Table 4. Top 20 Food groups in terms of changes in the percent consuming[†] the food group between 1998 and 2009

Rank	Food group	Percent Consuming[†]			
		1998	2009	10 y change	*p* value[§]
1	Whole grain	24.0%	46.3%	22.3%	<0.001
2	Nuts & seeds	46.8%	68.3%	21.5%	<0.001
3	Coffee & Tea	31.5%	47.7%	16.2%	<0.001
4	Other Grains products & dishes	51.7%	63.4%	11.7%	<0.001
5	Other legumes & legume dishes	28.8%	40.3%	11.6%	<0.001
6	Seaweeds	44.0%	53.1%	9.1%	<0.001
7	Mushrooms	14.5%	22.4%	7.9%	<0.001
8	Sauces	20.1%	26.9%	6.7%	<0.001
9	Poultry plain & Poultry dishes	8.8%	15.4%	6.6%	<0.001
10	Pork	34.3%	40.5%	6.2%	<0.001
11	Fruit juices	4.7%	10.2%	5.5%	<0.001
12	Beef	39.0%	33.7%	-5.3%	<0.001
13	Eggs plain	48.2%	53.5%	5.3%	<0.001
14	Tofu	35.6%	40.6%	5.0%	<0.001
15	Cakes, cookies, pies	11.0%	15.7%	4.7%	<0.001
16	Fruit, frozen, canned or dried	5.4%	9.6%	4.1%	<0.001
17	Other alcohol	5.9%	10.0%	4.1%	<0.001
18	Plain processed meat including Ham, Sausage, Bacon	9.1%	13.1%	4.1%	<0.001
19	Processed fish, processed Crustaceans and processed shellfish	35.1%	39.0%	3.9%	<0.001
20	Soju (Korean distilled spirits)	6.9%	10.3%	3.5%	<0.001

[†]Percentage of the sample who reported consuming the food
[§]Chi-squared test comparing percent consuming between 1998 and 2009.

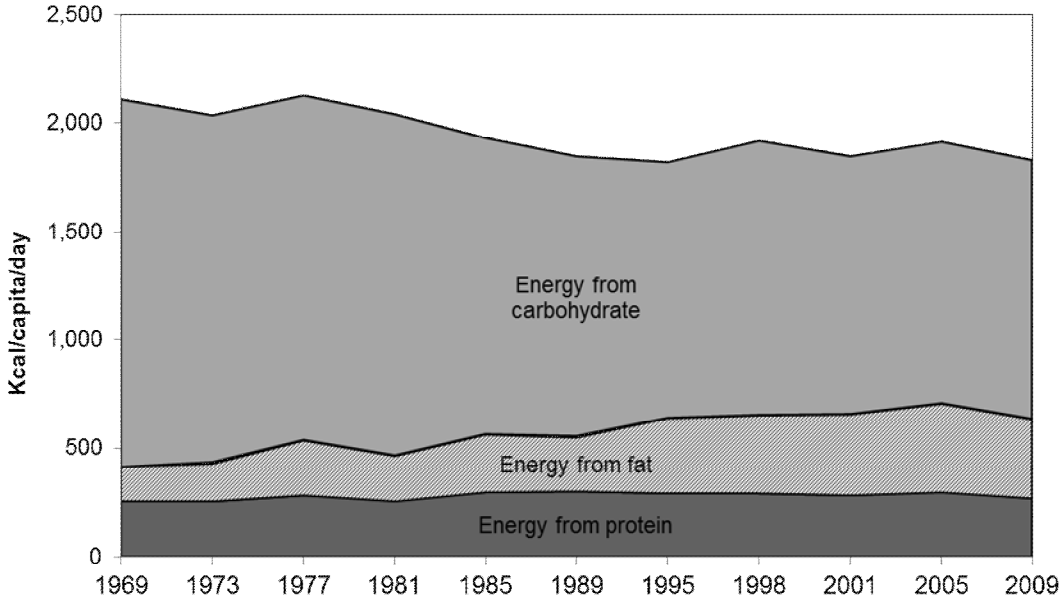

Figure 1. Trends[†] in total energy intake and sources of energy in South Korea. [†] Values are presented as a 3-year or 4-year moving average between 1969 and 2009. Historical data from[47]

and from 20 kcal/capita/day in 1998 to 36 kcal/capita/day in 2009 (p<0.001), respectively, (Table 2).

Legume intake increased until the mid-1980s and decreased in the 1990s.[3,4,26] These shifts then reversed again as consumption of Nuts and Seeds, other legumes, and legume dishes increased between 1998 and 2009 (Table 2). For example, between 1998 and 2009, the percent consuming nuts and seeds and other legumes increased from 46.8% to 68.3% (p<0.001) and 28.8% to 40.3% (p<0.001) respectively (Table 2).

The daily per capita intake of fruits has also been increasing over time, with particularly rapid change in the 1990s.[5] In 1995, 146 g of fruits were consumed, and this is almost a 10-fold increase from the 18.9 g consumed in 1970.[3] This trend has continued until 2009 (p<0.001). Particularly, energy intake per capita of fresh fruits was 61 kcal/capita/day in 1998 and 73 kcal/capita/day in 2009 (p<0.05) (Table 2).

Unhealthful dietary trends

Consumption of beverages shifted markedly in the 1998-2009 period. Most notable was consumption of alcohol, with energy nearly doubling between 1998 and 2009. Even though per capita energy intake from coffee and tea was not high, the increase over time is noteworthy. Energy from coffee and tea almost tripled from 14 kcal in 1998 to 33 kcal in 2009 (p<0.001). Also, the percent of persons consuming these beverages increased from 31.5%

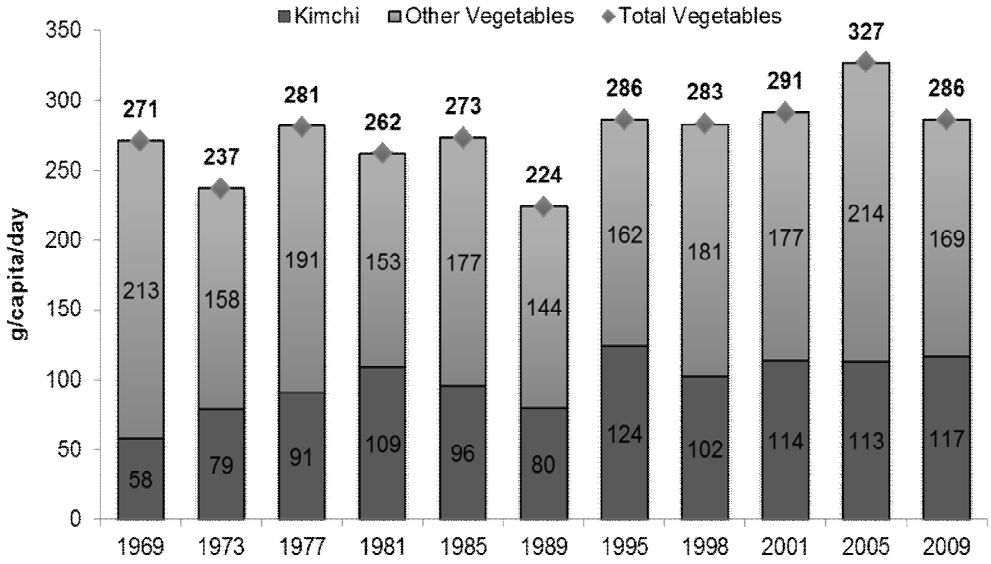

Figure 2. Trends[†] in daily per capita energy intake of vegetables, 1969 to 2009. [†]Values are presented as a 3-year or 4-year moving average between 1969 and 2009. Historical data from reference number 47. [‡]Mean of kimchi intake of age ≥1 from 1969 to 1995, mean of Kimchi intake of age ≥ 2 from 1998 to 2009.

in 1998 to 47.7% in 2009 (p<0.001) (Table 4).

In addition, meat and poultry consumption increased 10-fold between 1969 and 1995. The rate of increase was highest starting in the early 1980s.[3] During the past decade, beef and poultry consumption decreased, and energy intake of pork increased from 68 kcal in 1998 to 84 kcal in 2009 (p<0.001) (Table 2). The percent of persons consuming pork, beef, and processed plain meat (including ham, sausage, and bacon) also increased over this time period (p<0.001) (Table 4).

Healthy versus unhealthy foods changes

The energy intake from total grain products decreased and that from fruits & vegetables increased, with a large shift in fruit consumption (p<0.001) (Figure 3). While total animal food consumption was constant, Pork intake increased (p<0.001). Beverage intake showed the largest shift with a threefold increase of coffee and tea (p<0.001). Mean caloric intake of alcoholic beverages also increased substantially, from 39 kcal/capita/day in 1998 to 82 kcal/capita/day in 2009 (p<0.001). The major sources of alcohol intake are soju and beer.

Beverage consumption patterns by age

Sugar-sweetened beverage intakes increased in the adolescent group (13–18yr) from 22 kcal/capita/day in 1998 to 35kcal/capita/day in 2009 (p<0.05). Consumption of coffee and tea went from 15 kcal to 46 kcal/capita/day (p<0.05) in the middle age group (40–59yr) (Figure 4).

Intake of alcoholic beverages has increased in all adult age groups. These changes occurred in particular among middle-aged group (40–59 yr), especially in males, increased intake of soju from 70 kcal/capita/day in 1998 to 153 kcal/capita/day in 2009 (p<0.001). And young females (19-39yr) also increased intake of soju (6 kcal/capita/day to18 kcal/capita/day in 1998 and 2009, p<0.001, respectively). Beer intake also increased 7 kcal/capita/day to 25 kcal/capita/day in 1998 and 2009, p<0.001, respectively (Figure 5).

DISCUSSION

During the last decade, major shifts occurred in both more and less healthful components of the diet. Whole grain consumption showed small increases and fruit intake increased considerably. At the same time the major staple, rice, declined in both absolute and relative terms. Increases were seen in sugar sweetened beverages (mainly among adolescents), tea and coffee, and alcohol. Interestingly, most of the alcohol intake increases were from traditional Korean alcohol (Soju).

Economic changes represent an important influence on diet. However while economic changes in South Korea occurred earlier than in most Asian countries,[27, 28] they retained their very high level of vegetable intake,[5] and lower level of total fat.[3] This high vegetable and low fat intake pattern was unique to South Koreans compared to other Asians and were elements that allowed them to retain a lower overweight and obesity level despite their very high income and reduced overall physical activity patterns.[29] In contrast, much later, and with much lower levels of economic improvement, diets in the two largest Asian countries, China and India, shifted toward higher fat and lower carbohydrate content while South Korea continued a low fat high vegetable diet.[30] Similarly, rapid economic change in Thailand was linked with a marked replacement of staples and side dishes by a higher proportion of fats and animal meat, and a shift to away-from-home consumption and to increased ready-to-eat food, in both rural and urban settings.[31] And similar changes occurred in Indonesia, again with much smaller levels of economic improvement than in South Korea.[32]

South Korea's per capita gross domestic product (GDP) increased dramatically from the early 1960s; the rate of has more than doubled between 1998 and 2009 (from $501 million in 1998 to $1,065 million in 2009).[33] Furthermore, with entry into WTO the Korean Food Trade Association (FTA) has worked with several countries resulting in a collapse of the food boundaries between countries. These changes have led to an increase in na-

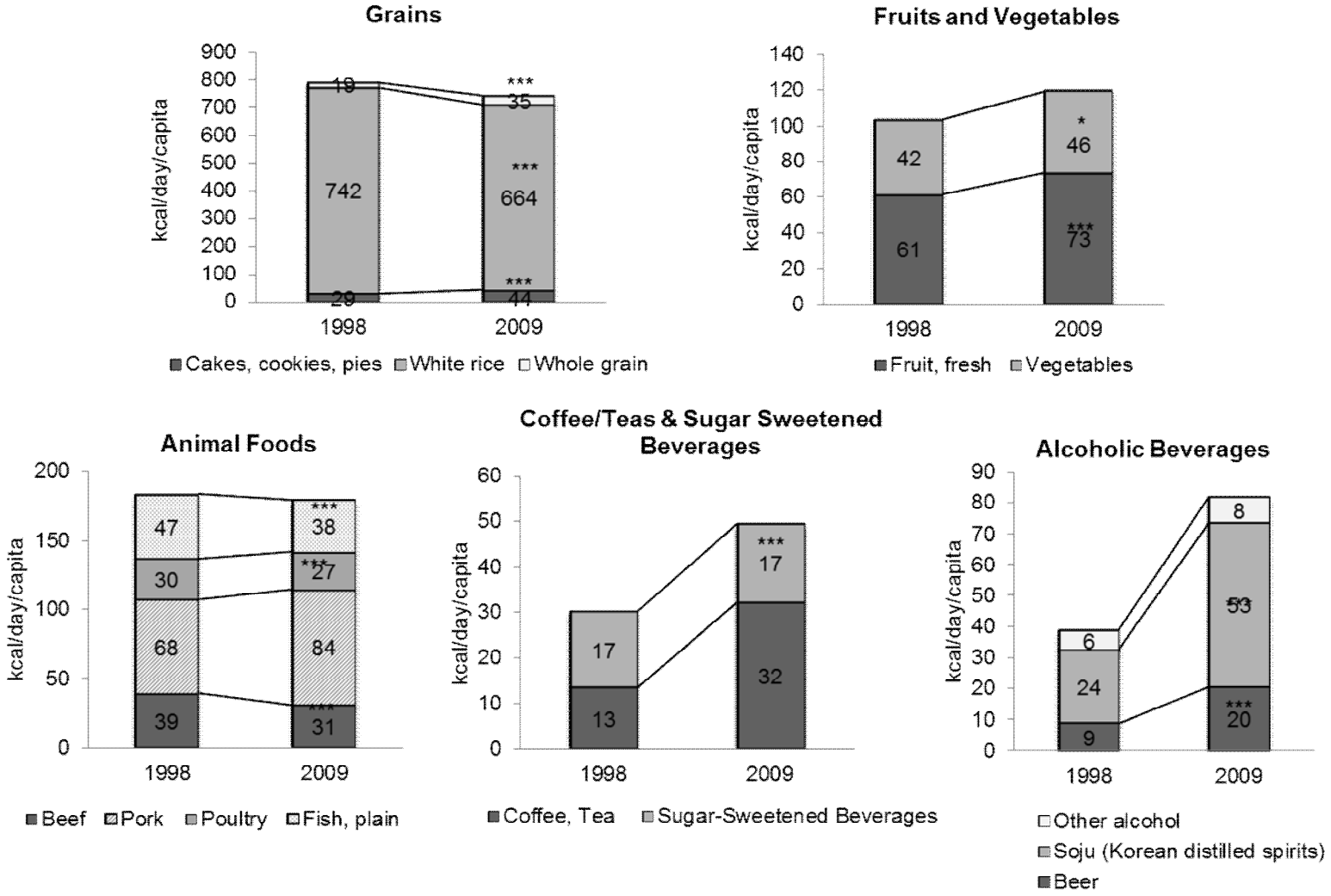

Figure 3. Mean difference in per capita caloric intake of healthy† versus unhealthy‡ foods between 1998 and 2009. † Whole grains, fruits, and vegetables, white rice, poultry, fish, and coffee & tea. ‡ cakes, cookies & pies, beef, pork, sugar-sweetened beverages, and alcoholic beverages. * Means are statistically significantly different using Student t-test, $p<0.05$. ** Means are statistically significantly different using Student t-test, $p<0.01$. *** Means are statistically significantly different using Student t-test, $p<0.001$

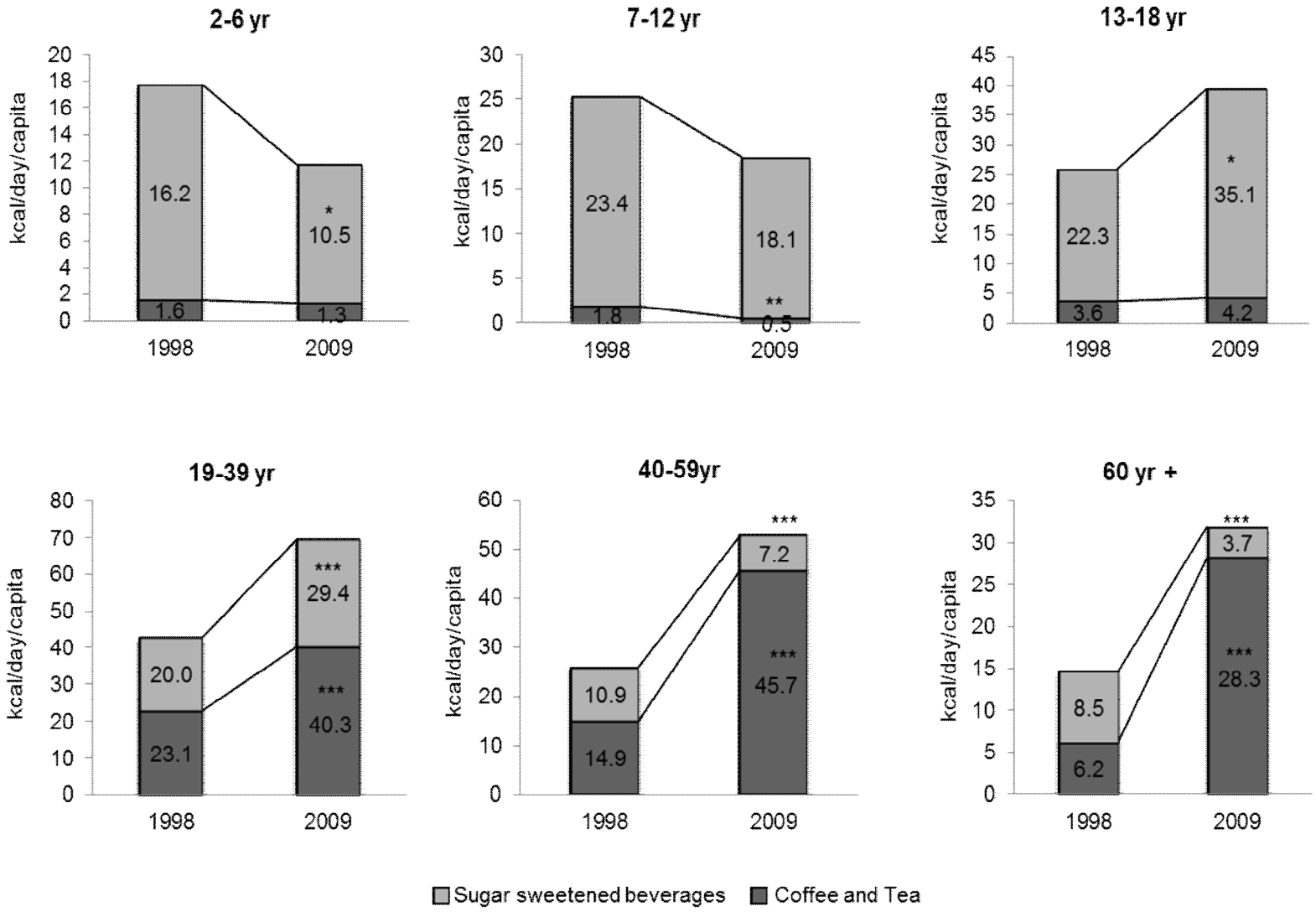

Figure 4. Mean difference in per capita caloric intake of non-alcoholic beverage by age between 1998 and 2009. * Means are statistically significantly different using Student t-test, $p<0.05$. ** Means are statistically significantly different using Student t-test, $p<0.01$. *** Means are statistically significantly different using Student t-test, $p<0.001$

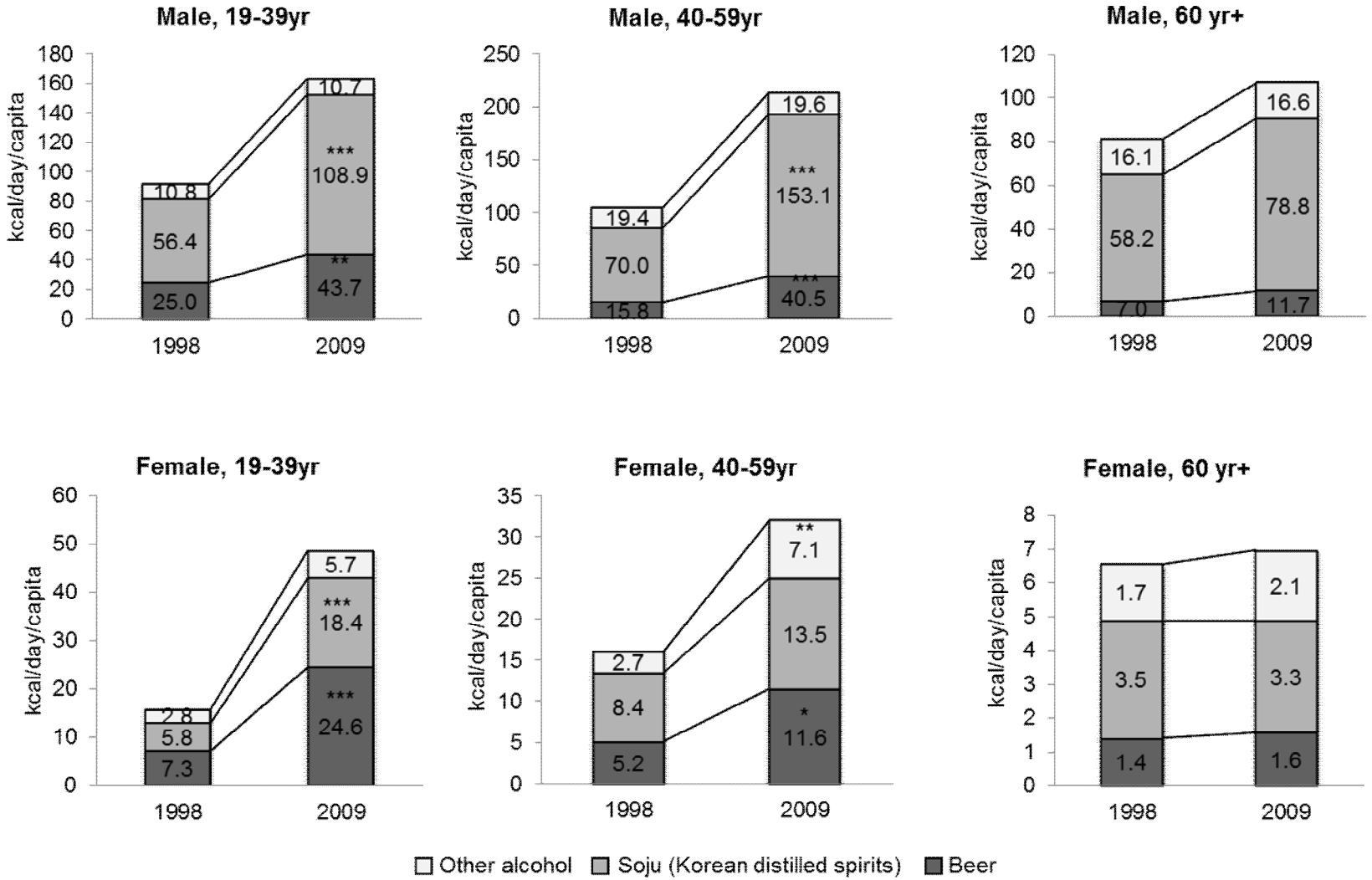

Figure 5. Mean difference in per capita caloric intake of alcoholic beverage by sex and age between 1998 and 2009. * Means are statistically significantly different using Student t-test, $p<0.05$. ** Means are statistically significantly different using Student t-test, $p<0.01$. *** Means are statistically significantly different using Student t-test, $p<0.001$.

tional food availability, enhanced individuals' purchasing power, and accelerated the nutrition transition.

Alongside these economic and administrative changes, there has been an increase in food imports from $7.0 billion in 1998 to $21.2 billion in 2009.[34] In particular fruits imports increased 5.2 times between 1998 and 2009 (from $94 million in 1998 to $491 million in 2009).[35] Finally, the consumer price index of citrus (top source of fruit in Korea) was dropped by a third between 1998 and 2009.[36] These shifts likely influenced the purchasing power of individuals and may partially explain the shifts in Fruit intake observed in the present study.[16]

Alcohol consumption in 2009 was double the level found in 1998. In particular beer and soju consumption in the age 19-39 female groups have tripled. From 1993 to 2006 in the United States, median alcohol consumption (from survey accounting) has slightly increased, from 0.51 gallon in 1993 to 0.64 gallon in 2006.[37] In the Western Pacific regions, WHO has shown stable alcohol intake but South Korea represents an exception.[38]

Sugar-sweetened beverage consumption among adolescents (13-18 years) has increased, and coffee and tea consumption of all adult groups has doubled. In particular for the middle-aged group (40-59 years), coffee and tea consumption has tripled. This trend matches that of many countries across the globe.[39,40]

As stated, beverage intake was the most noticeable change in South Korea between 1998 and 2009. During the past decade, the beverage industry experienced substantial growth.[41] Total annual production of alcoholic beverage has increased from 2,729 MT/year in 2001 to 3,065 MT/year in 2009. The market size for nonalcoholic beverage is larger than alcoholic beverage. The total annual production of nonalcoholic beverage also has increased from 4,556,143 MT/year in 2001 to 5,086,584 MT/year in 2009. In particular, production of water, coffee beverage, mixed beverage and soy milk have increased.

A shift in composition of animal source foods occurred as the proportion from beef and poultry decreased while that of pork increased following cheaper pork prices. Sensitivity to price changes in animal food consumption is common.[42-44]

Since 2002, the South Korean government has been promoting increased consumption of whole grains, fruits and vegetables and reduced consumption of fat. In April 2002, based on the Health Plan 2010, the Korea Ministry of Health and Welfare instituted the Comprehensive Health Promotion Policy, with health goals including improvement of the nutritional status of South Koreans. The plan includes various important programs and interventions for nutrition, such as the revision and dissemination of dietary guidelines, the enforcement of mandatory nutrition labeling on processed and packaged foods, the provision of nutrition services to groups at risk, and nutrition information made available to the public.[45] We report modest increases in whole grain and fruit intake resulting from this effort. In contrast, intake of vegetables did not increase as much as fruits. In fact, there was decreased at-home vegetable consumption among persons aged 16-64 years, although the proportion of vegetables consumed away from home did increase over the time period examined.

This paper has several limitations. First, the food composition table and 24-hour recall data do not allow us to understand fully whether the foods consumed were processed foods. Further, although we have detailed nutritional information and descriptions on each food, we do not have brand names which would allow us to precisely identify these foods as imported or as a newer addition to the marketplace. Second, there is the classic limitation in using a single 24-hour recall; data may not be representative of usual intake. However, by focusing on broad patterns and adjusting for seasonality we attempt to provide meaningful patterns at the population level.

In summary, the key changes between 1998 and 2009 are a significant decline in rice, small increases in whole grains, a larger shift in fruit consumption and large increases in alcohol, sugar-sweetened beverages, and tea and coffee. Up to the 1990s, South Korea provided a unique example of the good things a country can do to preserve the healthful elements of its traditional cuisine. A combination of large-scale training of housewives in preparation of the traditional low-fat, high-vegetable cuisine coupled with strong social marketing have led to low fat and high vegetable intake levels.[46] With the opening of South Korea to global food markets, another transition appears to be occurring. To date, government efforts to improve whole grain consumption have met with small successes. The shifts in beverage consumption patterns represents a new challenge as does that for food policies to focus on a strategy to enhance whole grain intake and retain the healthier high vegetable intake.

ACKNOWLEDGEMENTS

We thank Ms. Frances Dancy, BS, UNC Carolina Population Center for her helpful administrative assistance, Donna R. Miles PhD. for programming and technical support, and Tom Swasey for graphic support.

AUTHOS DISCLOSURES

Funding: Korea Health Industry Development Institute and UNC-CH. Conflict of Interest: None of the authors report any conflict of interest. Online supporting material is associated with this manuscript.

REFERENCES

1. Tchai BS, Ju JS. The trend of the nutritional status of the Korean, 1969-1984. World Rev Nutr Dietet. 1987;51:45-73.
2. Ju JS. Nutrition in the Republic of Korea. Br J Nutr. 2000; 84:S195-S8.
3. Kim S, Moon S, Popkin BM. The nutrition transition in South Korea. Am J Clin Nutr. 2000;71:44-53.
4. Kim S, Moon S, Popkin BM. Nutrition transition in the Republic of Korea. Asia Pacific J Clin Nutr. 2001;10:S48-S56.
5. Lee MJ, Popkin BM, Kim S. The unique aspects of the nutrition transition in South Korea: the retention of healthful elements in their traditional diet. Public Health Nutr. 2002; 5:197-203.
6. Reardona T, Timmer P, Minten B. Supermarket revolution in Asia and emerging development strategies to include small farmers. Proc Natl Acad Sci U S A. 2010;108:1-6.

7. Reardon T, Timmer CP, Barrett CB, Berdegue J. The rise of supermarkets in Africa, Asia, and Latin America. Am J Agr Econ. 2003;85:1140-6.
8. USDA Foreign Agricultural Service. Korea - Republic of Retail Foods: USDA Foreign Agricultural Service; 2009 2/23/2009.
9. Ministry of Health and Welfare, Korea Institute for Health and Social Affairs. National health and nutrition survey 1998: Korea Institute for Health and Social and Affairs; 1999. (in Korean)
10. Kim DM, Ahn CW, Nam SY. Prevalence of obesity in Korea. Obes Rev. 2005;6:117-21.
11. Ministry of Health and Welfare, Korea Health Industry DevelopmentInstitute. Report on 2001 National Health and Nutrition Survey. Korea Health Industry Development Institute; 2002. (in Korean)
12. Ministry of Health and Welfare, Korea Health Industry Development Institute. The Third Korea National Health and Nutrition Examination Survey (KNHANES III), 2005 nutrition survey. Korea Health Industry Development Institute; 2006. (in Korean)
13. Ministry of Health and Welfare. Health Statistics: The Fourth Korea National Health and Nutrition Examination Survey (2007). the Korean Centers for Disease Control and Prevention; 2008. (in Korean)
14. Ministry of Health and Welfare. Health Statistics: The Fourth Korea National Health and Nutrition Examination Survey (2008). the Korean Centers for Disease Control and Prevention; 2009. (in Korean)
15. Ministry of Health and Welfare. Health Statistics: The Fourth Korea National Health and Nutrition Examination Survey (2009). the Korean Centers for Disease Control and Prevention; 2010. (in Korean)
16. Ministry of Health and Welfare, the Korean Centers for Disease Control and Prevention, the Korea Health Industry Development Institute. Guideline for Nutrition Survey of the Korea National Health and Nutrition Examination Survey 1998-2009. the Korean Centers for Disease Control and Prevention;2009. (in Korean)
17. National Rural Living Science Institute. the 5th edition of the Food composition Table in Kroea. National Rural Living Science Institute; 1996.
18. National Rural Living Science Institute. the 6th edition of the Food composition Table in Kroea. National Rural Living Science Institute; 2001.
19. Rural Resource Development Institute. the 7th edition of the Food composition Table in Kroea. Rural Resource Development Institute; 2006.
20. Ministry of Health and Welfare, Korea Health Industry Development Institute. Development of Recipe Database for Korea Health and Nutrition Examination (in Korean). Korea Health Industry Development Institute; 1998.
21. Moon HK. The method of Korean National Nutrition Survey (in Korean). Korean J Nutr. 1994;27:509-24.
22. Slining MM, Mathias K, Popkin BM. Trends in food and beverage sources among US children and adolescents: 1989-2008. Am J Prev Med. In Press.
23. Duffey KJ, Popkin BM. Shifts in patterns and consumption of beverages between 1965 and 2002. Obesity (Silver Spring). 2007;15:2739-47.
24. Piernas C, Popkin BM. Snacking increased among U.S. adults between 1977 and 2006. J Nutr. 2010;140:325-32.
25. Popkin BM, Haines PS, Siega-Riz AM. Dietary patterns and trends in the United States: the UNC-CH approach. Appetite. 1999;32:8-14.
26. Son SM. Food consumption trends and nutrition transition in Korea. Mal J Nutr. 2003;9:7-17.
27. Lee JW. Economic growth and human development in the Republic of Korea, 1945-1992. Occasional Paper, No. 24. New York: United Nations Development Programme; 1997.
28. Lee SK, Sobal J. Socio-economic, dietary, activity, nutrition and body weight transitions in South Korea. Public Health Nutr. 2003;6:665-74.
29. Boffetta P, Couto E, Wichmann J, Ferrari P, Trichopoulos D, Bueno-de-Mesquita HB, et al. Fruit and vegetable intake and overall cancer risk in the European Prospective Investigation into Cancer and Nutrition (EPIC). J Natl Cancer Inst. 2010;102:529-37.
30. Popkin BM, Horton S, Kim S, Mahal A, Jin SG. Trends in diet, nutritional status, and diet-related noncommunicable diseases in China and India: The economic costs of the nutrition transition. Nutr Rev. 2001;59:379-90.
31. Kosulwat V. The nutrition and health transition in Thailand. Public Health Nutr. 2002;5:183-9.
32. Lipoeto NI, Wattanapenpaiboon N, Malik A, Wahlqvist ML. The nutrition transition in West Sumatra, Indonesia. Asia Pacific J Clin Nutr. 2004;13:312-6.
33. Statistics Korea. Trends in GDP, South Korea, 1970-2010. the Statistics Korea. 2011/11/30 [cited 2012/2/17];Available from: http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_IdxMain.jsp?idx_cd=2736&bbs=INDX_001.
34. Statistics Korea. Trends in agriculture, forestry, and fisheries production, South Korea, 1998-2010. the Statistics Korea. 2012/7/5 [cited 2012/7/13]; Available from: http://www.index.go.kr/egams/stts/jsp/potal/stts/PO_STTS_IdxMain.jsp?idx_cd=2743&bbs=INDX_001&clas_div=A.
35. Association KIT. Trend in trade by commodity, 1998-2009. 2011/11/30 [cited 2012/7/13]; Available from: http://stat.kita.net/top/state/n_submain_stat_kita.jsp?menuId=01&subUrl=n_default-test_kita.jsp?lang_gbn=kor^statid=kts&top_menu_id=db11.
36. The Korea Rural Economic Institute. 2012 Agricultural Outlook. The Korea Rural Economic Institute; 2012.
37. Nelson DE, Naimi TS, Brewer RD, Roeber J. US state alcohol sales compared to survey data, 1993-2006. Addiction. 2010;105:1589-96.
38. World Health Organization. Global status report on alcohol and health. World Health Organization; 2011.
39. Slining MM, N SW, Popkin B. An approach for evaluating food companies' calorie-reduction pledge to improve the U.S. diet. Am J Prev Med. In Press.
40. Barquera S, Hernandez-Barrera L, Tolentino ML, Espinosa J, Ng SW, Rivera JA, Popkin BM. Energy intake from beverages is increasing among Mexican Adolescents and Adults. J Nutr. 2008;138:2454-61.
41. Alcoholic Beverages, Annual Production, South Korea, 2001-2009 [database on the Internet]. Ministry for Food, Agriculture, Forestry and Fisheries. 2001-2009.
42. Timmer CP, Falcon WP, Pearson SR. Food policy analysis. Baltimore: The Johns Hopkins University Press for the World Bank; 1984.
43. Delgado C, Rosegrant M, Steinfield H, Ehui S, Courbois C. Livestock to 2020: The Next Food Revolution. Washington, D.C.: International Food Policy Research Institute, 1999 Discussion Paper 28.
44. Delgado CL. Rising consumption of meat and milk in developing countries has created a new food revolution. J Nutr. 2003;133(11 Suppl 2):3907S-10S.
45. Park H-K. Nutrition policy in South Korea. Asia Pacific J Clin Nutr. 2008;17:343-5.
46. Popkin BM, Ng SW. The nutrition transition in high- and low-income countries: what are the policy lessons? Agr Econ. 2007;37:199-211.

Original Article

South Korea's entry to the global food economy: shifts in consumption of food between 1998 and 2009

Haeng-Shin Lee PhD[1], Kiyah J Duffey PhD[2], Barry M Popkin PhD[2]

[1]*Korea Health Industry Development Institute, South Korea*
[2]*Department of Nutrition, University of North Carolina at Chapel Hill, USA*

南韓進入全球食物經濟體：1998 年及 2009 年間食物攝取的轉變

韓國在過去十年經歷食物市場及經濟的大幅開放。然而這些轉變對於韓國人飲食的影響卻鮮少被了解。經由分析 1998 年至 2009 年食物攝取的變遷，本研究可提供對未來十年韓國的趨勢轉變有較深刻的理解。資料是來自韓國國民健康營養調查(KNHNES)。樣本取自具有全國代表性的 1998 及 2009 年年齡≥2 歲的研究對象(分別為 10,267 及 9,264 位)。將資料依季節校正，並將原始的生食資料歸類為 53 個食物類別。以 SAS 校正設計誤差及加權。儘管當局十年的努力，意圖增加全穀類及蔬果攝取，但全穀類的平均攝取量只有少量增加(16 大卡/人/天)；然而，有攝取任一全穀類的人數比例增倍，從 24%到 46.3%。米攝取顯著降低，而顯現幾個較不健康食物攝取升高的趨勢：總酒精攝取從 39 大卡/人/天增加至 82 大卡/人/天。青少年攝取來自含糖飲料的熱量增加，成人則攝取來自茶及咖啡的熱量增加。值得注意的是，雖然過去十年脂肪熱量從相對低點緩步增加，但比起其他亞洲國家及全世界的趨勢，南韓的蔬菜攝取仍然相對較高。造成這些趨勢的原因及政府的因應措施都在文中加以討論。

關鍵字：營養過渡期、南韓、飲食、國民健康營養調查、熱量攝取