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Boys' Height in South Korea in the Past Three Decades : Why They Ceased to Grow Taller? —Steering away from Kimchi

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Abstract

Japan's economy made rapid and steady progress in the post-war half century and children grew by 2 cm per decade. Economic development in South Korea was some two decades behind Japan, due to the Korean War (1950-53). Teens in Korea were 2-3 cm shorter in height than their Japanese peers in the 1960-70s, caught-up with the latter in the early 1990s and then outgrew Japanese teens by 3 cm in the mid-2000s. They ceased, however, to grow any taller afterwards, whereas the national economy remained prosperous and per capita supply of animal-sourced foods, including milk increased appreciably.

School boys in Korea were 1.5 cm greater than their Japanese peers in growth velocity from 1st graders in primary school to high school seniors in the early 2000s but began to fall persistently in velocity to be 2 cm below Japanese in the end of the 2010s.

Analyzing *Household Expenditure Surveys*, 1990 to 2019, the authors were stunned to discover that Korean children started to turn away from vegetables in household consumption in the mid-1990s and ate as little as 10% of vegetables as the control group (people in their 50s) in the mid-2010s. Children in Japan started to steer away from fruit and vegetables in the end of the 1970s, when supply of per capita meat and milk was expanding. It is suspected that vegetables and fruit may be among essential nutrients for child height development.

JEL classification : B41, O53, P46
Key words : height ; growth velocity ; South Korea ; Japan ; animal protein ; vegetables and fruit

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Introduction

After the end of WWII, economies in North East Asia achieved remarkable, lasting progress, with Japan as the front runner, followed by South Korea with some two decades' lag, due to the Korean-war (1950-53). Accordingly, children grew unprecedentedly taller in height within a half century. Children in South Korea were 2-3 cm shorter than their Japanese peers in the 1960-70s, caught-up with Japanese in the 1990s who ceased to grow any taller since then, and Korean teens outgrew Japanese by 3 cm in the mid-2000s and ceased to grow taller afterwards [1] (Mori and Kim, 2020). One could conceive that the two nations have attained their respective genetic potential, with Koreans showing a 3 cm advantage over Japanese in height, possibly as ethnic traits.

With command of large-sample size data on mean height of children by age, 6 to 17 years of age, derived from the *School Health Examination Surveys* conducted by each country's Ministry/ Department of Education, [2;3], this technical note examines variation in mean height of children in the two countries in the past three decades, focusing particularly on variation in growth velocity.

Before moving into the data analyses, the authors would like to mention the key aspect of human growth, i.e., one ages one year, as a calendar year passes one year. Consider 17 years-old in 2017, born in 2000: one year old in 2001, 6 years old, primary school 1st graders in 2006, 12 years old, middle school 1st graders in 2012, and seniors in high school in 2017. To measure the growth patterns/velocity of high school seniors in 2017, for example, it is biologically natural to trace primary school 1st graders in 2006, middle school 1st graders in 2012, instead of comparing primary school 1st graders, middle school 1st graders, so forth observed in the same year, 2017.

In economically mature countries from Northern Europe or North America, it may not make much difference whether one compares ascending ages in the same year or one compares ascending ages along their biological growth over time [4;5] (Cole, 2012; Gao and Schneider, 2020). Countries in North East Asia in the past half century, however, have experienced radical economic and social changes [6;7] (Mori and Stewart, 2011; Mori, Inaba and Dyck, 2016). Researchers must be careful to rely on historically reasonable data-sets for their analyses[1].

1) Gao and Schneider stress the importance of using **"**individual-level datasets, that is, birth cohorts**"**, in identifying growth patterns of children over a number of decades (**Abstract**).

Data

The Governments of Japan, since 1900, and Republic of Korea, since 1961 [2;3], have conducted nationwide school health examination surveys every year in the first month of the respective school year, in which mean height of children, by sex, from 1st grade in primary school, 6 years in age, to seniors in high school, 17 years of age are published. 1st graders in primary school may contain up to one twelfth who are already 7 years of age.

The survey samples are huge, but even so mean height by age is not very stable from year to

year. We use 3-year moving averages, $Y_{it} = (Y_{it-1} + Y_{it} + Y_{it+1})/3$, in the analyses ($i$ denotes age ; t survey year) (Table 1).

Steckel (1995) [8] states, "stature is a net measure that captures the supply of inputs to health". From a standpoint of food economics, the authors have treated food consumption as a major element of "inputs to health". In this technical note, the authors rely on food balance sheets and household expenditure surveys as major sources of supply of inputs to health (*Food Balance Sheets*, FAOSTAT [9] and Ministry/ Department of Agriculture, respective country [10 ; 11] and *Family Income and Expenditure Survey*, Bureau of Statistics, Japan ; *Household Income and Expenditure Survey*, Statistics Korea [12 ; 13]).

Measuring Height Growth Velocity in School Boys over the Past Three Decades

As mentioned in the preceding section, high school seniors, 17 years of age in 2000, for example, were born in 1983, 1st graders in primary school in 1989, 1st graders in middle school in 1995, and so on. High school seniors in South Korea were 172.9 cm tall (mean height, omitted from here on) in 2000, and the same children were 117.6 cm at age 6 in 1989. They grew by 172.9 − 117.6 = 55.3 cm from age 6 to age 17 between 1989 and 2000. The growth velocity of 55.3 cm relates to the environmental influences which the 1983 birth cohort underwent through the school years from 1st grade in primary school in 1989 to 3rd grade in high school in 2000.

In 2000, 1st graders in primary school were 120.2 cm and high school seniors were 172.9 cm respectively, with a difference of 52.7 cm. Mean height, 120.2 cm for the first manifests the composites of environmental influences this 1994 birth cohort underwent from 1994 to 2000, from zero to 6 years in age and 172.9 cm for the latter represents the composites of environmental effects the 1983 birth cohort acquired from 1983 to 2000 at various ages. The magnitude of difference in mean height between 6 and 17 years in age observed in the same year, 2000, for example, is not easy to interpret, i.e., it is by no means growth velocity, because 17 years old in 2000 has not grown from 6 years old in the same year, 2000.

Table 1 Changes in mean height of school boys by age, South Korea and Japan, 1970 to 2017

(cm)

Korea	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2017
6 yrs	112.9	112.9	115.4	116.2	117.7	119.0	120.2	121.0	121.8	120.5	120.6
12 yrs	143.7	143.2	145.2	147.6	149.7	152.0	154.8	156.9	158.0	156.7	157.2
17 yrs	166.1	166.0	167.3	168.9	169.7	171.0	172.9	173.7	173.7	173.4	173.5
Japan											
6 yrs	114.5	115.2	115.7	116.4	116.8	116.8	116.7	116.7	116.7	116.5	116.5
12 yrs	147.0	148.6	149.5	150.1	151.5	152.0	152.8	152.6	152.4	152.6	152.7
17 yrs	167.9	168.8	169.6	170.2	170.5	170.9	170.9	170.8	170.7	170.7	170.6

Sources : *School Health Surveys*, Dept. Education, respective country.
Note : 3-year moving average, as 2000 = average (1999 : 2001).

Discussions

Growth Patterns

Fig. 1 provides changes in height growth velocity from 1st grade in primary school to senior year in high school, for boys in South Korea and Japan, from 2000 to 2017. For reference, differences between 6 and 17 years of age observed in the same year, respectively from 2000 through 2017, are appended, although they are less easy to interpret.

Korean boys grew 55.3 cm from primary 1st graders in 1989 to high school seniors in 2000, 1.3 cm more than their Japanese peers. They grew a little faster in the early-2000s by 55.5 cm, and then slowed, almost linearly to 52.3 cm toward the end of the 2010s, 2017 (3 year moving average of 2016 to 2018), whereas their Japanese peers kept growing almost constantly at 54.0 cm over the same period. In the early 2000s, Korean boys grew 1.6 cm faster from primary 1st grade to high school senior than their Japanese peers, but the situation reversed toward the end of the 2010s, i.e., Japanese school boys grew nearly 2.0 cm faster than their Korean peers.

Four years ago, when the authors became involved in the comparative analyses of child height development in Japan and South Korea in the post-war years, they presumed that Korean children tended to grow faster during adolescence than their Japanese peers (Mori, 2016; 2017) [14; 15]. Fig. 2 shows changes in height velocity from 1st grade in middle school, 12 years of age to senior grade in high school, 17 years of age for boys in South Korea and Japan from 1995 to 2017. Korean high school seniors in 1995 had grown by 21.5 cm from middle school 1st graders in 1990, 2.0 cm faster than their Japanese peers. This remained constant at 21.5 cm till 1998 and then began to fall to 15.3 cm in 2012 and levelled off. Korean boys grew faster than their Japanese peers before 2007 but nearly 3.0 cm slower in the mid-2010s.

Figs. 3 and 4 show changes in the growth patterns of boys from age to age in the two countries

Table 2 Changes in per capita caloric intakes : grand total and animal products,1961 to 2015 : Japan and South Korea

(kcal/capita)

	Grand total			Animal products	
Year	Jp	Kr		Jp	Kr
1961	2549	2160	1961	261	55
1970	2721	2812	1970	426	108
1980	2785	3046	1980	539	230
1990	2950	2990	1990	618	317
2000	2895	3090	2000	600	449
2010	2691	3279	2010	549	545
2015	2703	3336	2015	542	600

Note : 3-year moving average.
Sources: FAOSTAT, *Food Blance Sheet*, various issues, on the internet.

Fig. 1 Comparison of growth velocity, same year data vs birth cohorts, from 6 to 17 years, school boys in Korea and Japan, 2000 to 2017

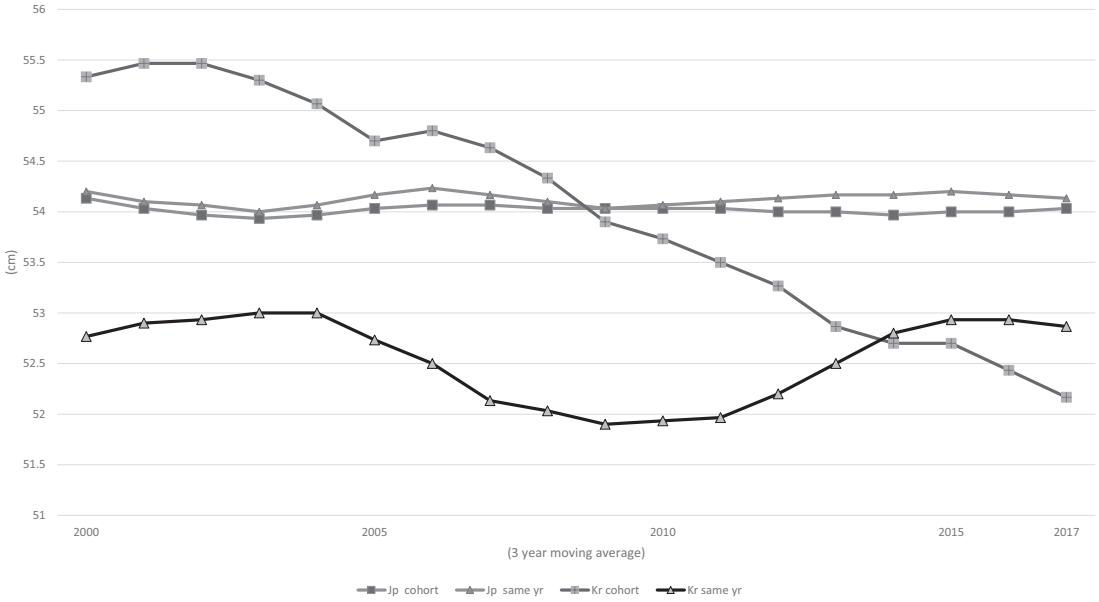


Fig. 2 Comparison of growth velocity, same year data vs birth cohorts, 12 to 17 years, schol boys in Korea and Japan, 1995 to 2017

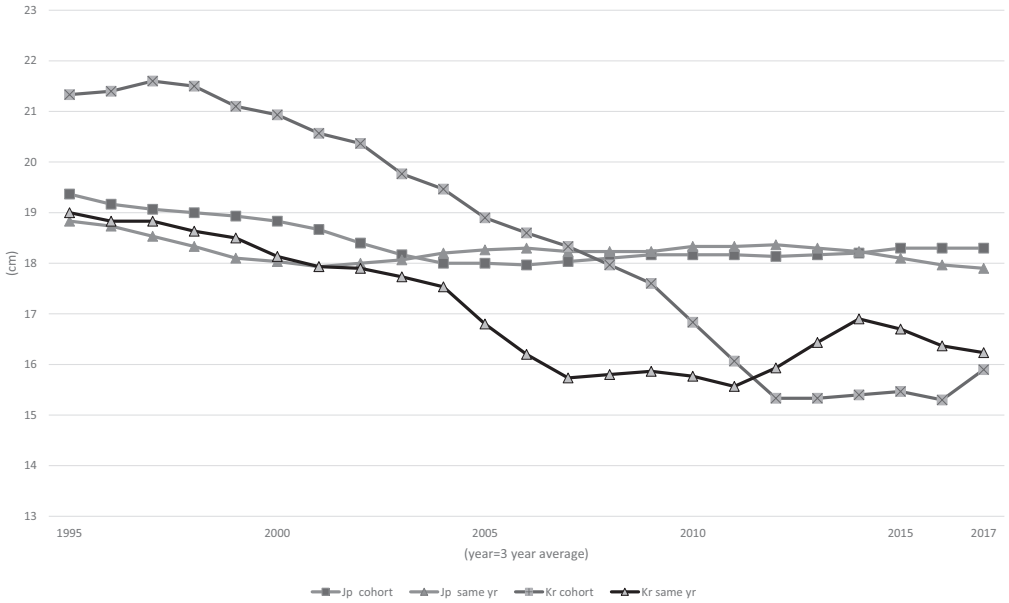


Fig. 3　Changes in growth from age 6 to 7, 7 to 8, ---,and 16 to 17, 1978, 1989 and 2000, Japanese school boys : birth cohorts

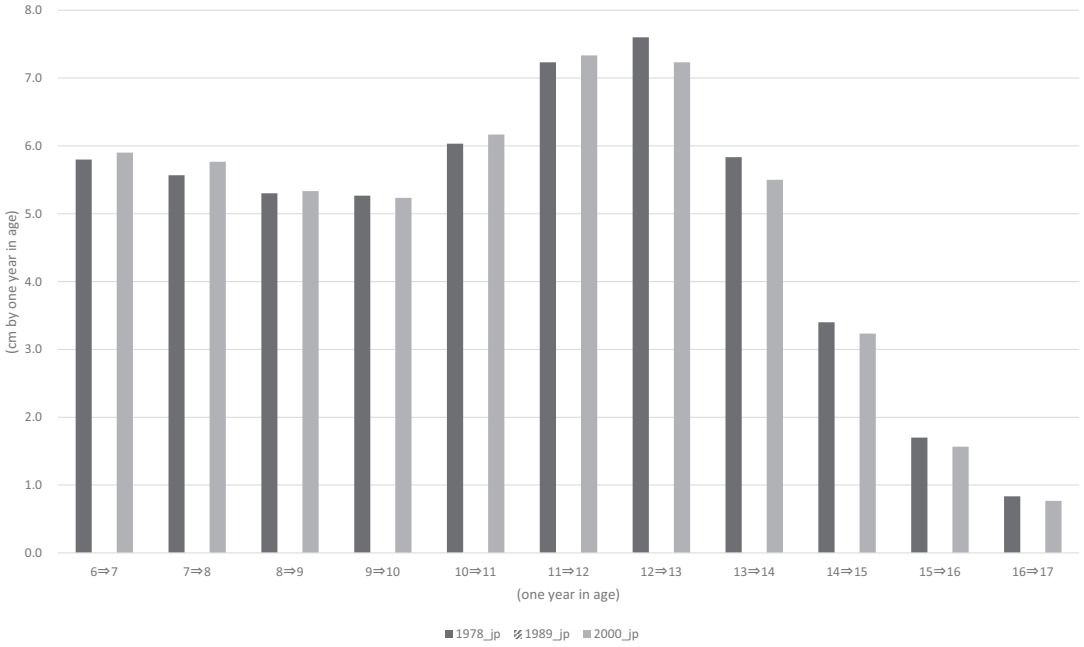
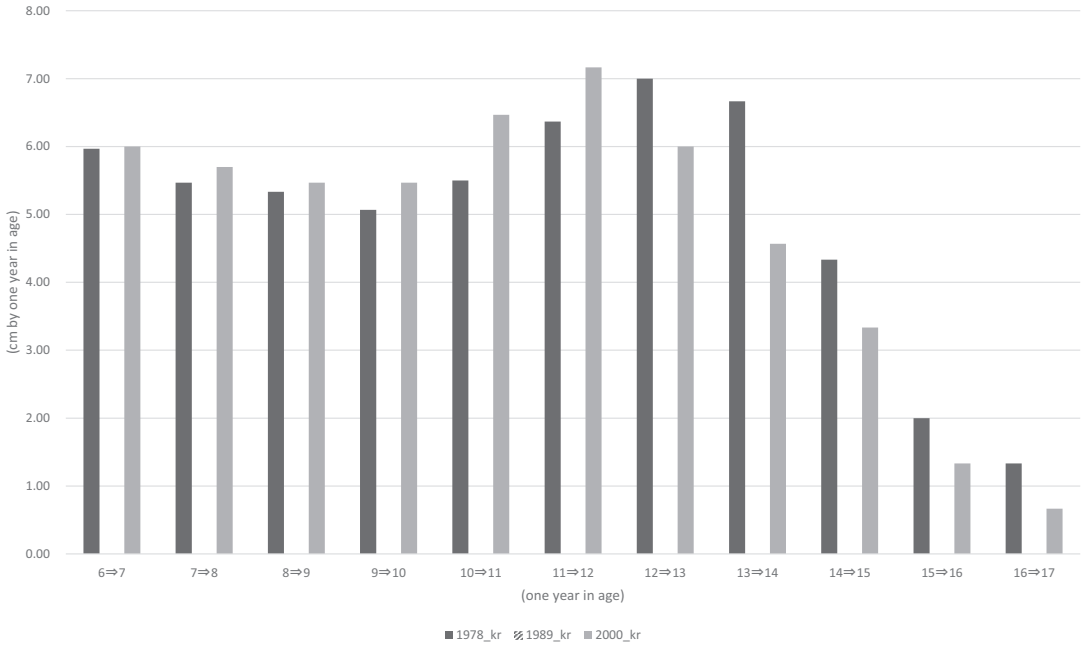


Fig. 4　Changes in growth from age 6 to 7, 7 to 8, ---and 16 to 17, 1978, 1989 and 2000, Korean school boys : birth cohorts



in recent years, by birth cohorts 1978, 1989, and 2000. Boys grew fastest from age 11 to 12 and 12 to 13, in common in the two countries in recent years. From age 13 to 14, Korean boys grew as much as 6.6 cm for the 1978 birth cohort, but only 4.5 cm for the 2000 birth cohort, 1.0 cm less than their Japanese peers.

Supply of Inputs to Health

1994 White Paper on Agriculture, Ministry of Agriculture, Japanese government (1995) [16], remarked on the young's turn away from fruits (wakamono no kudamonobanare) in the 1980s. As shown in the authors' estimate (Table 3), by means of the TMI model [17], derived from *Family Income and Expenditure Surveys*, classified by the age groups of household head [12], children in Japan began to turn away from fresh fruit in their at-home consumption in the end of 1970s. Japanese children aged 0~9 and 10~19 ate only 10 kg of fruit in 1990, drastically down from the 40 kg that they ate at-home in the early-1970s.

They further reduced their fruit consumption to 5.0 kg/year in 2000. Although not to the same extent as fruit, Japanese children also steered away from at-home consumption of vegetables. One of the authors has hypothesized that inadequate intake of fruit and vegetables by young Japanese, particularly growing children, may have contributed to their shortfall in height growth since the end of the 1980s (Mori, 2018 ; 2019) [18 ; 19].

The authors obtained *Household Income and Expenditure Surveys*, classified by age groups of household head, 1990 to 2019 (Statistics Korea) [13]. Table 5 provides per capita household expenditures on vegetables, grain (≒rice), and all meats (including processed meats) by age groups of household individual members, from 1990 to 2019 in South Korea. *Expenditure Surveys*, Statistics Korea, provide household expenditures in current Won, not in kilograms as *Family Expenditure*, Japan. The authors converted the Won to percentages relative to the expenditures by household members in their 50s, by commodity and survey year.

According to *Food Balance Sheets*, either international FAOSTAT or agency representing individ-

Table 3 Changes in per capta at-home consumption of fresf fruit by age groups, 1971 to 2000 in Japan

(kg/year)

age groups	1971	1980	1985–86	1990	1995＝96	2000
0～ 9	36.3	26.5	15.2	8.9	4.7	2.3
10～19	45.6	30.5	20.1	14.9	9.4	5.7
20～29	48.3	31.5	23.4	16.8	15.1	11.8
30～39	46.1	43.8	36.6	30.4	23.6	21.8
40～49	51.0	52.6	48.5	44.9	37.2	33.4
50～59	54.4	59.9	56.6	54.0	50.5	48.5
60～	42.9	56.4	60.4	61.2	60.4	63.3
Grnd-ave	45.6	41.6	36.4	33.8	31.5	31.1

Sources : derived Mori from *FIES*, various issues, the TMI model.

Table 4　Changes in per capita supply of vegetable, milk and meat, 1980 to 2017, Japan and S. Korea

(kg/capita)

	milk		meat		vegetables	
Year	Jp	Kr	Jp	Kr	Jp	Kr
1980	65.3	10.8	22.5	13.9	113.0	120.6
1990	83.2	31.8	26.0	23.6	108.4	132.6
2000	94.2	49.3	28.8	37.5	102.4	165.9
2010	86.4	57.0	29.1	44.4	88.3	132.2
2017	93.5	68.6	32.7	56.7	90.9	142.5

Sources: Governments of Japan and Republic Korea, *Food Balance Sheets*.

ual countries [9 ; 10 ; 11], per capita supply (≒consumption) of vegetables in South Korea has been nearly double that in Japan for the past three decades since the early 1980s. Eating a lot of rice, with Kimchi, if not more meat/fish than the Japanese, typifies the Korean diet (Tables 2 and 4) (Lee, Duffey and Popkin, 2012 ; Lee, J-S and J Kim, 2010 ; etc.) [20 ; 21 ; 22 ; 23]. As a frequent visitor of South Korea, one of the authors was astonished to find that children in South Korea started to turn away from vegetables in the early-1990s, and that those aged 0~9 and 10~19 now eat only 10% of vegetables as much as adults in their 50s. Children in South Korea no longer follow the traditional Korean diet of bowls of rice with Kimchi (Table 5). The young tend to choose less expensive meats, i.e., more pork/chicken than beef or meat cuts than seniors. Slightly less expenditure on meat by the young, as shown in Table 5-C, may not imply that they consume less meat than older people.

Conclusion

Consumption of animal sourced foods is positively correlated to child height growth, both across nations and over time within nations. Our case studies from North East Asia support empirically this contention [1 ; 15 ; 24]. Historically, in both Japan and South Korea, children ceased to grow taller when per capita supply of animal protein was still rising. In Japan, consumption of fruit by growing children had started to fall appreciably before they ceased to grow taller in the late-1980s.

Children in South Korea caught up with their Japanese peers in height in the 1990s, when per capita supply of milk was lower in Korea than in Japan. Children in South Korea, however, ceased to grow taller in the mid-2000s, when the national economy was still in steady progress and per capita consumption of animal sourced food was increasing (Tables 2 and 4). School boys in South Korea began to fall in growth velocity from age 12 to age 17 in the late-1990s, whereas teens still kept growing taller, because preschool children had already grown conspicuously taller earlier. In South Korea, consumption of vegetables by growing children started to decrease conspicuously before they ceased to grow taller. Consumption of vegetables (South Korea) and fruit (Japan) may be implicated in the changing patterns of child height growth.

Table 5 Changes in per capita household expenditures by age groups, 1990 to 2019

A. vegetables (% of the 50's)

age groups	1990–91	1995–96	2000–01	2005–06	2010–11	2014–15	2017–19
0－9	49.8	31.4	30.5	19.4	12.6	13.6	8.5
10～14	51.8	34.5	34.1	22.5	15.3	15.1	10.1
15～19	51.6	35.1	36.5	25.9	18.9	16.8	12.9
20～29	55.2	42.1	43.8	34.5	27.7	25.5	22.4
30～39	73.3	64.7	62.3	54.0	48.2	50.2	45.6
40～49	96.0	87.8	85.5	78.0	72.6	73.3	68.1
50～59	100.0	100.0	100.0	100.0	100.0	100.0	100.0
60～	95.1	98.3	104.0	107.0	116.2	121.1	130.5
per capita supply	131.7	156.4	154.5	149.7	143.4	145.6	(kg/year) 142.5

B : grain≒rice (% of the 50's)

age groups	1990–91	1995–96	2000–01	2005–06	2010–11	2014–15	2017–19
0－9	45.1	30.2	35.4	28.4	9.6	14.5	8.3
10～14	54.2	38.6	42.4	32.8	13.8	18.8	10.6
15～19	58.1	43.9	47.5	36.5	18.7	24.0	13.5
20～29	54.9	44.1	51.8	40.6	25.8	33.0	19.6
30～39	69.5	61.3	61.8	55.0	42.5	48.2	40.6
40～49	97.2	89.0	82.4	77.7	68.7	70.8	68.1
50～59	100.0	100.0	100.0	100.0	100.0	100.0	100.0
60～	101.8	105.7	107.4	125.2	138.2	136.9	155.5
per capita supply	121.4	111.5	101.2	84.9	82.4	74.6	(kg/year) 72.6

C. meat–all (processed meats included) (% of the 50's)

age groups	1990–91	1995–96	2000–01	2005–06	2010–11	2014–15	2017–19
0－9	41.4	39.6	49.5	41.4	45.2	49.8	48.0
10～14	42.6	41.7	52.0	46.2	49.6	52.9	48.4
15～19	38.5	37.0	50.7	47.1	49.2	53.0	46.0
20～29	45.1	43.2	54.8	50.0	50.1	52.6	44.3
30～39	72.3	72.9	73.8	66.6	69.9	70.4	67.8
40～49	95.6	95.6	93.7	91.8	98.2	93.3	91.9
50～59	100.0	100.0	100.0	100.0	100.0	100.0	100.0
60～	92.5	98.1	96.1	98.7	88.1	87.4	92.8
per capita supply	24.2	33.4	37.9	37.5	44.0	52.2	(kg/year) 56.4

Sources: Derived in current won from *Kr Household Expenditure Surveys*, by Mori by means of the TMI model.
KREI, *Food Balance Sheet*, various issues, for per capita supply.

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