

Changes in Children's Height in Japan and South Korea in the Past Half Century: The Roles of Fruit/Vegetables on Top of Animal Protein

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ABSTRACT

Children in Japan and South Korea in North East Asia grew in height unprecedentedly fast, 1 cm per decade in the post war economic prosperity. Food consumption increased in quantity and quality as well, with caloric supply from animal products augmented. Children in Japan began to grow much slower in the 1980s and ceased to grow at all ages in the early 1990s, while animal protein supply was still on the rise. Children in Korea kept growing taller in the 1990s and overtook their Japanese peers by 3.0 cm in mean height in the mid-2000s, even though per capita consumption of animal products was still lower than in Japan. Children in Korea then suddenly ceased to grow taller in mean height, while per capita supply of animal products kept increasing vigorously toward the end of the 2010s. It was discovered that children started to turn away from vegetables in their diets in the beginning of the 1990s and strikingly, ate less than 10% of the volume eaten by the older generation in their 50s-60s in the end of the 2010s. As the author has repeatedly emphasized, children in Japan started to reduce consumption of fruit a decade before they stopped growing taller in the early-1990s. Fruit and/or vegetables seem to have something to do with the human metabolism, which calls for in-depth biological researches.

Keywords: children's height, animal protein, fruit/vegetables, Japan, South Korea

INTRODUCTION

R. Steckel stated, "stature is a net measure that captures the supply of inputs to health (1995, p. 1903). It is widely accepted in human biology that protein, particularly high-quality protein from animal products, is associated with mean height of populations, on top of genetic effects (Baten and Blum, 2014; Grasgruber et.al., 2014; etc.). Children in "temperate Asia" (Grasgruber, 2021), Japanese and South Koreans grew in height unprecedentedly in the past half century, as measured by mean height of male high school seniors (17 years of age): more than 1cm per decade, (*School Health Examination Surveys*, various issues, Ministry of Education, government of Japan; Department of Education, government of Republic of Korea).

Japanese were a few centimeters taller than Koreans in the 1960s and 1970s, they grew more slowly in the 1980s and stopped growing taller in height in the early-1990s. Koreans kept growing steadily and overtook their Japanese peers by 3 cm in the mid-2000s, and then ceased to grow any taller. Food consumption in the two countries increased appreciably, with the supply of animal products augmented, in particular. When Korean heights exceeded those in Japan in the mid-2000s, Japan's per capita daily caloric supply from animal products was still

15% greater than Korea's. Per capita supply of animal products kept increasing vigorously in South Korea after Korean children stopped growing in height in the mid-2000s (Fig. 1).

There is no question that animal products played an important role in "the supply of inputs to health" (Steckel) in the two countries but other elements must have been involved in the game: genetics or ethnic traits (Kopczynski, 2016) and other "essential nutrients" (Blum, 2017; Mori, 2018).

The author has no background in anthropology. So, genetics cannot be discussed in this note. The author has been engaged in food demand analyses as his main subjects and tackling with changes in food consumption from age/cohort aspects in the past two decades or so. People stop growing in height after their adolescence. If there exist discernible differences between generations/ birth cohorts; i.e., children in growing ages today eat differently from those in decades ago = current adults (Mori, Inaba, and Dyck, 2016)]. We do need to look at children. Simple adjustments based on "adult-equivalence scales" cannot identify changes in children's consumption from population's total consumption (Prais, 1953).

Steering away from fruit by the young and the end of growth in children's height in Japan

In the 1994 *White Paper on Agriculture*, Japan's Ministry of Agriculture, called for public attention to the tendency of Japan's young to turn away from fruit, wakamono no kudamono-banare, in the prior decade. The *White Paper* referred to declining fruit consumption by households headed by the young people in their 20s and 30s, as shown by *Family Income and Expenditure Surveys (FIES)*, classified by age groups of household head (HH) in the 1980s. Mori and Inaba (1997) designed an econometrically robust model, to derive individual consumption by family members, including children, from *FIES*, classified by HH age groups. Tanaka and Mori (2003) determined age and cohort effects of individual household consumption of fruit using Nakamura's Bayesian cohort model and projected household consumption of fruit in the 2010s by aggregating the estimated age and cohort effects. In 2011, when actual household consumption of fruit by HH age groups in 2010 was published, Mori and Stewart examined how close Tanaka and Mori's projections have turned out.

There is very little question that changes in "inputs to health" for children in their growing ages, rather than the changes for total population, should be put into consideration in discussing the changes in the mean height of those in their early 20s, especially in rapidly changing economies. Children in Japan ceased to grow any taller in the early-1990s, when per capita supply of animal protein was still on the rise (Fig. 1). Is this basically because Japanese depleted their gene potential (Kopczynski, p.52; p.57). As the 1994 *White Paper on Agriculture* pointed out, Japan's young=children had turned away from fruit in the 1980s. If Japan's young had turned away from milk in the 1980s and ceased to grow taller in the 1990s, no one would argue that there could have been connections. But concerning the case of fruit, everyone might question that there could have been meaningful connections, particularly in Japan where fruit has long been called mizukashi, jelly dessert. Fruit is regarded as something consumed for taste rather than nourishment.

M. Sugiura and his colleagues at the Japan Fruit Tree Research Institute, in collaboration with M. Nakamura, Hamamatsu School of Medicine have been engaged in the Mikkabi-prospective cohort studies since the mid-2000s, to ascertain if large intakes of mandarins lower the risks of

osteoporosis in post-menopausal women. Their studies conclude that consumption of mandarins helps bone-mineral accrual in human body, referring to similar empirical investigations, which cover growing children conducted overseas (McGartland, 2004; Whiting et al., 2004; Vatanparast et al., 2005; Prynne et al., 2006; Li, JJ, et.al.,2013; etc.).

Table 1 demonstrates that children in Japan started to turn away from fruit in the mid-1970s, to eat in the early 1990s less than one third of what they ate in the beginning of the 1970s and they ate one tenth of fruit consumed by adults in their 50s and 60s in the 2000s (refer to Mori and Stewart, 2011 for greater details). The author has been suspecting that very low consumption, nearly zero intakes of fruit by the growing children in Japan has something to do with the cessation of mean height growth since the early 1990s, with little recognition from human biologists either in Japan or overseas, South Korea in particular. People, either professionals or non-professionals are in strong belief that the Japanese depleted their “gene potential” in height in the early 1990s, whereas the Koreans kept growing in height to reach their gene potential in the mid-2000s, in combination with continuous increases of animal protein supply as a favorable environmental factor (B-O Lee, *Korea Times*, 2017; Kopczynski, 2017).

Gene Potential: Personal Observations

Japan's economy recovered to the pre-war level in 1955 and made very fast and steady progress to the early-1990s. Partly due to the Korean War (1950-53), Korea's economy started fast and steady growth only in the beginning of the 1960s. Even in the beginning of the 1990s, Korea's per capita GDP was only \$8,496, as compared to Japan's \$38,074. In 2005, when Korean teens overtook their Japanese peers in height by 3.0 cm, Korea's per capita GDP was \$19,225, less than half of Japan, \$44,394 (in 2010 US\$, World Bank, *national accounts data file*).

Despite substantially lower real GDP/capita, the Korean people, including children, have been eating more foods, in terms of per capita caloric supply of grand total, than Japanese, as shown in Table 2. Koreans consumed 3,025 kcal/day, 8% greater than Japanese in 1980 (1979-81 averages) and 3,094 kcal/day, 195 kcal greater than Japanese in 2000, for example. Further details saved (see Table 2).

Generally, Koreans eat much more cereals (rice), with a lot more vegetables, than Japanese. The author is fully aware of the importance of animal protein for the human body growth. However, people in Japan grew a few cm in height in the pre-war years, with the supply of animal protein was nearly zero (Mori and S. Kim, 2020).

Teens in Japan ceased to grow taller in the early-1990s, with male high school seniors at 171 cm in mean height, while teens in Korea kept growing taller vigorously but suddenly stopped growing taller in the mid-2000s, at mean height of 174 cm. Have Japanese and Koreans depleted their respective gene potentials? The author would not agree, from his own personal observations. He was 166 cm when young. He was hungry, wanted to eat more rice, all the years from his middle school to the second year of the university, when he could buy a cup of noodle, without ration tickets. Average per capita caloric supply was less than 1,700 kcal/day, when he was in middle and high school and 1,955 kcal/day, when he graduated from university (Ministry of Agriculture, *Food Balance Sheets*, Ministry Library).

He was not properly fed, to reach gene potential (his parents were only a little taller than average of their generation). He has two sons who spent their school years in the 1970s, when per capita caloric supply from animal products was 400~500 kcal/day, substantially lower than in the 1990s. So, they did not reach the gene potential and yet both of them are 175 cm. One of them has a son, in university, who is 181 cm in height. He is not an abnormally "huge person" at all, only properly fed: good amounts of animal products, with fruit and vegetables. I suspect that his children, boys in the 2040s, would be as tall as their father.

Korean children started to turn away from vegetables in the early 1990s and suddenly ceased to grow taller in the mid-2000s

The author was born in Seoul, Korea. He does not speak Korean but his two granddaughters took Korean as second foreign language in college and speak it. The author would often visit Korea and stop over at Seoul, whenever he goes overseas. One thing he and his family love about Korea is that Kimchi is free at the restaurants or it is included in the prices of grilled meat, for example. At the university staff cafeteria, you can pick as much Kimchi from Kimchi-stand free. Anyhow, Korean people eat lots of rice with Kimchi.

Only very recently, the author was provided with Statistics Korea, *Household Income and Expenditure Surveys* on major food groups, 1990 to 2019, classified by age groups of household head. Table 3 enumerates the changes in household expenditures on vegetables by household members by age groups, derived from the *Surveys* by the author. The Korea's surveys provide only expenditures in current Wons, not prices paid nor quantities. Numbers in the table denote expenditures in 2010 Wons. Just like the household consumption of fresh fruit in Japan, the young in Korea no longer eat a lot of vegetables in recent years. Children in low teens, 10~14, spend(consume) W 2,154 on vegetables, less than 10% of expenditures by those in their 50s~60s in 2018-19, for example. Per capita expenditures on vegetables have been gradually declining across all age groups in the past three decades and expenditures by the younger age groups have declined radically. Those in 15~19 in 1990-01, aged to 25-29 in 1999-2000, 35-39 in 2009-2010 and 45-49 in 2019-2020, along the diagonal of Table 3. When reading the table vertically, along pure ages, per capita consumption tends to increase distinctly. If you follow the same birth-cohort along the diagonal, per capita consumption neither increase nor decrease appreciably.

Table 4 provides the statistical outcomes of changes in per capita consumption by age groups from 1990 to 2019, decomposed into age/period/cohort effects by *Bayesian* standard cohort model (T. Nakamura, 1982 and 1986, programmed workable in Microsoft Visual Basic by Y. Saegusa, 2010). When age effects (increasingly positive for older people) and cohort effects (increasingly negative for the newer cohorts) are accounted for, pure period effects for vegetables become drastically negative from the mid-1990s to the mid-2000s in Korea, against the author's intuitive judgments. How or why this sudden change in "pure" period effects took place should be investigated by the students of the Korean industry.

The young in the newer cohorts, born after the mid-1970s, started to turn away from vegetables drastically in South Korea. This may have something to do with seemingly sudden suspension of growth in children's height in the mid-2000s, which may deserve in-depth research by human biologists.

CONCLUSIONS

When one eats more, that person or population will get bigger in stature. When one is in the growing ages, one will get taller in height, only if properly fed. Children in Japan and South Korea in Temperate Asia grew in height unprecedentedly in the postwar prosperity. Children in Japan ceased to grow taller at the beginning of the 1990s, despite continued increases in animal protein. Korean children caught-up with them. Korean children kept growing rapidly to overtake their Japanese peers by 3 cm in the mid-2000s but then stopped growing any taller toward the end of the 2010s, despite the steady increases in supply of animal protein.

Children in both countries ceased to grow taller, even though the countries' per capita supply of animal products was still on the rise. The author discovered only recently one thing in common in the two countries in respect of children's food consumption, i.e., children in Japan started to leave away from fruit a decade and a half ago, before ceasing to grow taller and that children in Korea started to reduce consumption of vegetables in their diets a decade and a half before they suddenly ceased to grow any taller.

As observed in the preceding sections, children in Japan reduced their fruit consumption gradually but so drastically that they ate less than 10% of the volume eaten by adults in their 50s and 60s in the 2000s and Korean children reduced their vegetable consumption to eat less than 10% of the amount taken by the older generations in their 50s and 60s in the end of the 2010s.

The author has no background in nutrition and human biology. According to a few literatures, plentiful consumption of fruit and/or vegetables contributes to the bone mineral accrual in the human body, which may be associated with children's height development.

When discussing the children's growth in height, it is preferable to identify changes in per capita food consumption by children during their ages of growth rather than the overall per capita consumption of the population. This is especially true in the modernizing society where consumption varies by generations/birth cohorts.

This is what the food economists can contribute to the clarification of the development of children's height from macro-data.

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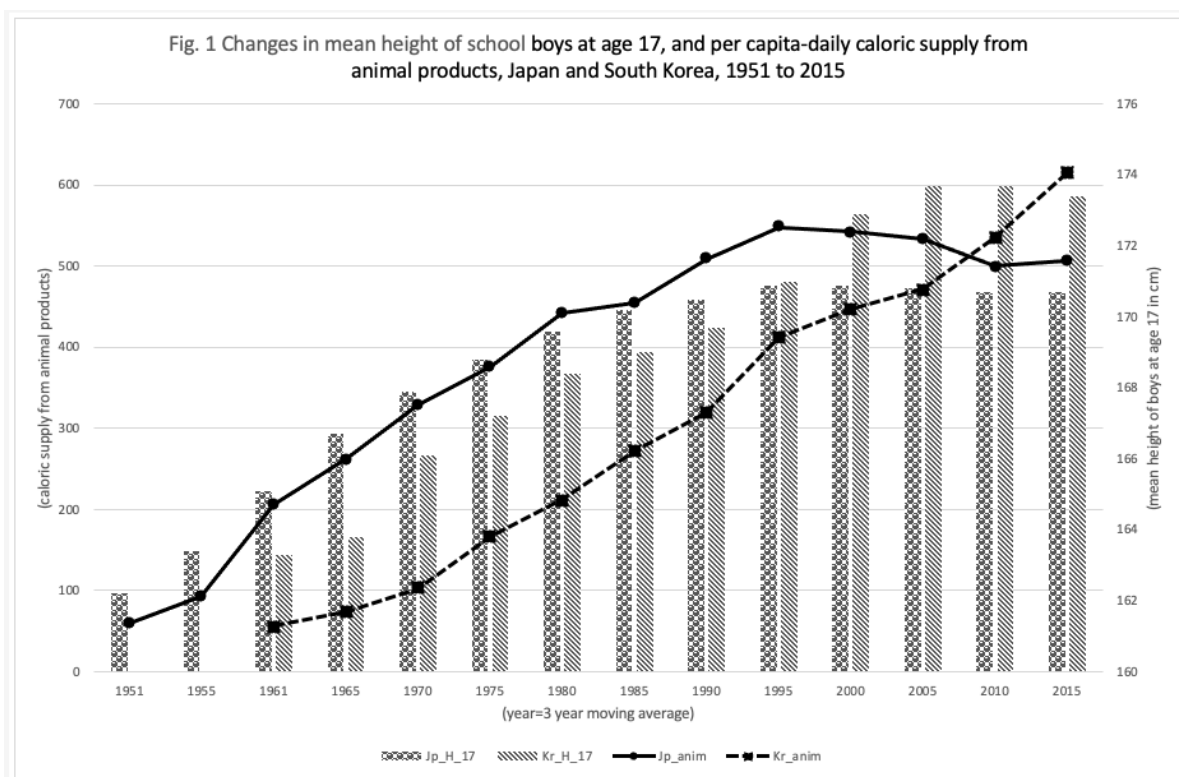


Table 1 Changes in per capita at-home consumption of fresh fruit by age groups,

	1971 to 2010 in Japan						(kg/year)
age/year	1971	1980	1985-86	1990	1995-96	2000	2010
0-9 yo	36.3	26.5	15.2	8.9	4.7	2.3	2.4
10-19	45.6	30.5	20.1	14.9	9.4	5.7	4.4
20-29	48.3	31.5	23.4	16.8	15.1	11.8	9.8
30-39	46.1	43.8	36.6	30.4	23.6	21.8	14.8
40-49	51.0	52.6	48.5	44.9	37.2	33.4	20.5
50-59	54.4	59.9	56.6	54.0	50.5	48.5	32.1
60-69	44.5	58.5	61.1	62.0	58.7	60.7	53.3
70+	41.2	54.2	59.6	60.3	62.1	65.8	58.8
Grand ave.	45.6	41.6	36.4	33.8	31.5	31.1	27.7

Sources: derived from *FIES* by the author, using the TMI model.

Notes: Estimated by 5 year age intervals first, which were simply averaged into 10 year intervals.

Table 2 Changes in per capita supply of major food products
Japan and South Korea, 1970 to 2010

	Japan	S. Korea		Japan	S. Korea
gran total	(kca/cap)	(kca/cap)	Anim Pro	(kca/cap)	(kca/cap)
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
Cereal	(kg/cap)	(kg/cap)	Vegetable	(kg/cap)	(kg/cap)
1970	144.6	219.0	1970	129.4	106.6
1980	133.4	201.8	1980	123.3	206.4
1990	130.5	173.0	1990	117.2	196.1
2000	120.0	160.5	2000	112.7	229.6
2010	110.1	149.1	2010	100.3	212.0

Sources: FAOSTAT, *Food Balance Sheets*, various issues.

Note: 3 year moving averages.

Table 3 Changes in per capita household expenditures on vegetable in Korea, 1990-2019

	(in 2010 Wons)						
	1990-91	1994-95	1999-00	2004-05	2009-10	2014-15	2018-19
0-9	15390	11021	8430	4776	2842	2701	1658
10~14	19357	14628	11055	6289	3920	3422	2154
15~19	18857	14565	11026	7017	4502	3640	2637
20~24	18006	14848	10702	7966	5090	4269	3427
25~29	22707	19571	12339	10148	6709	6473	5425
30~34	24865	23465	13498	12524	9113	9703	8316
35~39	28588	27873	16168	14875	11827	11458	10666
40~44	32685	32067	21491	17538	14538	14246	13045
45~49	35340	35472	24298	20287	17438	16421	15843
50~54	35621	38062	26779	22859	19977	19271	19203
55~59	35645	40027	29460	25112	23163	22726	22733
60~64	37251	39646	31324	26487	25949	25833	27090
65~	30076	32696	28586	23835	25233	24744	27592

Sources: Derived from Household Expenditure Surveys, classified by HH age groups, by the author, using Mori & Inaba model.

Table 4 Changes in individual household expenditures on vegetable decomposed into age, period and (birth) cohort effects, South Korea, by Bayesian Estimator

			Grand Mean Effects=19484(197)			(in 2010 won/month)		
age	age effects	SE	year	period effects	SE	born	cohort effects	SE
10~14	-5137	1666	1990-91	7218	951	~1925	1580	2563
15~19	-5670	1415	1994-95	6986	700	1930~34	3556	2295
20~24	-6019	1148	1999-00	-273	481	1935~39	5416	2018
25~29	-4386	890	2004-05	-2794	379	1940~44	6060	1730
30~34	-2797	663	2009-10	-4287	481	1945~49	6144	1442
35~39	-1025	513	2014-15	-3689	700	1950~54	5287	1161
40~44	1150	513	2018-19	-2981	951	1955~59	4326	894
45~49	2738	663	$\Sigma P_i = 0$			1960~64	2599	683
50~54	4043	890				1965~69	704	546
55~59	5549	1148				1970~74	-903	56
60~64	6910	1415				1975~79	-1806	684
65~69	4646	5689				1980~84	-2434	895
$\Sigma A_i = 0$						1985~89	-2973	1161
						1990~94	-3390	1442
						1995~99	-4546	1730
						2000~04	-5568	2018
						2005~09	-6613	2295
						2010~	-7438	2563
						$\Sigma C_k = 0$		
						Notes: estimates for the older and newer cohorts are not dependable, due to the fewer observations.		

Sources: Table 3, standard cohort table, was decomposed into age/period/cohort effects by the author, using Nakamura's Bayesian cohort model.