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Secular Changes in Boys' Height in South Korea: Comparison with Japan, Particularly with Respect to Growth Velocity

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Abstract

Economies in North East Asia made rapid and steady progress after WWII. Japan was the front runner followed by South Korea with some two decade-lag. As food consumption improved, children grew unprecedentedly in height. Japanese children, however, ceased to grow taller in the early-1990s, whereas their Korean peers kept growing vigorously to overtake their Japanese peers in the mid-2000s and ceased to grow taller afterwards. Children in both countries stopped growing taller, when animal-sourced foods were still increasing. Japanese children started to steer away from fruit at-home consumption conspicuously in the end of the 1970s and Korean children started to steer away from vegetables drastically in the early 1990s.

"A high consumption of animal protein does not result in increasing body height, if overall consumption of calories and other essential nutrients is insufficient" [1] (Blum, 2013). Fruit and vegetables could be considered to supply nutrients essential for body height increases.

Keywords: Child Height; South Korea; Japan; Growth Velocity; Essential Nutrients

Introduction

If a young male in East Asia is tall in height, above 180 cm, one or both his parents is likely to be tall. It's genetics. In Europe, people in the northern regions, Sweden and the Netherlands, are conspicuously taller than those in the southern regions, Italy and Portugal, for example. It is also genetics, or so the author presumed, until recently.

Figure 1 displays changes of mean height of young men at age 20 in the Netherlands, France and Portugal from 1860 to 2000 [2]. Young men in the Netherlands were 183-4 cm, 7-8 and 10 cm, respectively, taller in mean height than in France and Portugal in the end of the 20th century. In the mid-19th century, young men in the Netherlands, were 165 cm, barely 1.0 cm and 2.0 cm taller, respectively than in Portugal and France. Men in France overtook men in Portugal in the turn of the century and were 2.5 cm taller in the end of the last century, as mentioned above. Genetics alone is powerless in explaining the secular changes in men's height in the past one and a half centuries in Western Europe.

Economies in North East Asia achieved very rapid progress after the end of WW II. Young men, accordingly, increased in height at unprecedently high speed. Children in Japan ceased to grow any taller in the mid-1990s, whereas Korean children kept growing in height afterwards to exceed their Japanese peers in mean height by 3-4 cm in the mid-2000s and they ceased to grow any taller (Table 1). The "bubble" burst in the early-1990s in Japan's economy but Korean economy kept growing very vigorously in the 2000s to match Japan in respect of per capita GDP in the end of the 2010s (IMF database) [3]. Supply(=consumption) of animal sourced-foods kept increasing in the 1980s and 1990s in Japan and consumption of animal protein continued to increase in South Korea until the end of the 2010s. Did the two countries attain their respective "genetic potentials" in height, with Koreans commanding a 3.0 cm advantage over their Japanese peers?

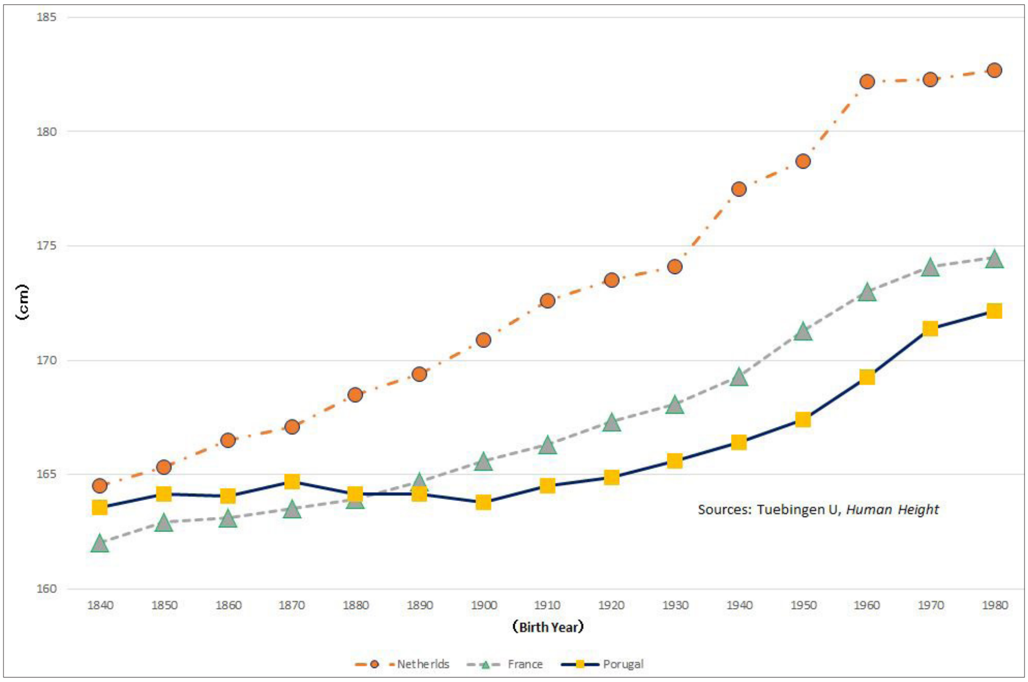

Figure 1: Changes in men's height in Netherlands, France and Portugal, Birth Cohorts, 1840 to 1980

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)

Comparisons in Growth Velocity

Data

Japan and South Korea have conducted national nutrition surveys, in which mean the height of subjects from 1 to 25 years old, and 26-29, 30-39, so on by age are published. However, the size of survey samples in Japan is not very large, 46 boys for the age group, 17 years old in 2000, for example, with mean height=170.9 cm, and SD=6.4[4]. *School Health Examination Surveys* have been conducted in the two countries for years, with nationwide samples, with some data limitations, with preschool children under 5 years of age and college students, above 18 years of age not covered [5;6]. Accordingly, this article will analyze changes in mean height of 1st graders in primary school, 6 years of age through seniors in high school, 17 years of age.

Growth Curves or Velocity

Children born in 2017, for example, grew to 1 year old on their birthdays in 2018 and it will be the year 2034 when they will reach age 17 years. No one grows from 1 year old to 17 years old instantly in the same year. The year 2000 birth cohort, grew to 1st graders, 6 years of age in 2006, 1st graders in middle school, 12 years of age in 2012 and seniors in high school, 17 years of age in 2017, the end year in this analysis. Similarly, children 6 years-old, in 2000, the 1994 birth cohort, grew to middle school 1st graders in 2006 and reached their last school years as, seniors in high school in 2011. No one grows instantly from 1st graders in primary school to seniors in high school in the same survey year, say in 2000 or 2011.

Figure 2 displays changes in growth velocity of school boys in Japan and Korea, from 1st grade in primary school, 6 years old to senior grade in high school, 17 years old, for the period from 2000 to 2017. Upper left in the graph, 55.3 cm for Korean boys, measures the differences in the mean height of senior high school boys in 2000, 172.9 cm from primary school 1st graders in 1989, 117.6 cm. At the lower end of the same graph, 52.7 cm represents the difference between senior high school boys and 1st graders in primary school in 2000, 120.2 cm, which is by no means actual, or longitudinal growth at all.

High school seniors in Korea in the beginning of the 2000s have grown 1.1 cm faster than their Japanese peers but they began to grow appreciably slower than their Japanese peers and Korean boys have grown nearly 2 cm, less or slower in velocity than their Japanese peers in the end of the survey period, 2017. This raises the questions: why has growth velocity declined steadily among Korean school boys since the early 2000s, whereas their Japanese peers have kept almost constant in growth velocity, growing appreciably faster than their Korea peers toward the end of the 2010s? South Korea's economy kept rapid prosperity since the early 1990s, when the "bubble burst" in Japan's economy and people's food consumption improved only modestly.

Figure 2: Comparison of growth velocity, same year data vs birth cohorts, 6 to 17 years, schoolboys in Korea and Japan, 2000 to 2017

A few years ago, when the author began to be involved in the comparative analyses of child height development, he surmised that Korean children tended to grow appreciably faster than their Japanese peers in their adolescent years, say after 12-13 years of age, likely because of their ethnic traits, although data were very limited. To verify his initial impression, Fig. 3 was prepared, showing height growth velocity from 1st graders in middle school, 12 years of age to high school seniors, over the slightly expanded period from 1995 to 2017.

As the author presumed, Korean boys grew much faster than their Japanese pears in velocity in adolescence, from middle school 1st graders to high school seniors in the 1990s through the early 2000s but they kept declining persistently in growth velocity to 2012, nearly 3 cm slower than their Japanese peers (Figure 3). The same question is raised here again: what factors may have caused these changes?

Height as a Net Measure of Inputs to Health

Per capita supply of animal products kept increasing steadily in the 2000s and 2010s in South Korea (Table 2) [7]. Per capita supply of vegetables kept remaining at high level after the turn of the century (Table 3) [8, 9]. It was discovered by the author, however that children in South Korea started to turn away from vegetables in the mid-1990s at their household food consumption, including boxed-lunch brought to school before nation-wide school lunch programs launched in the early-2000s. Children in growing ages, 0-9 and 10-19 began to reduce their at-home consumption of vegetables drastically, along with their rice consumption at home, including boxed-lunch. In the end of 2010s, children in Korea are estimated to consume only 10% of vegetables as compared to the older cohorts in their 50s, although per capita national consumption of vegetables kept quite high in the international context.

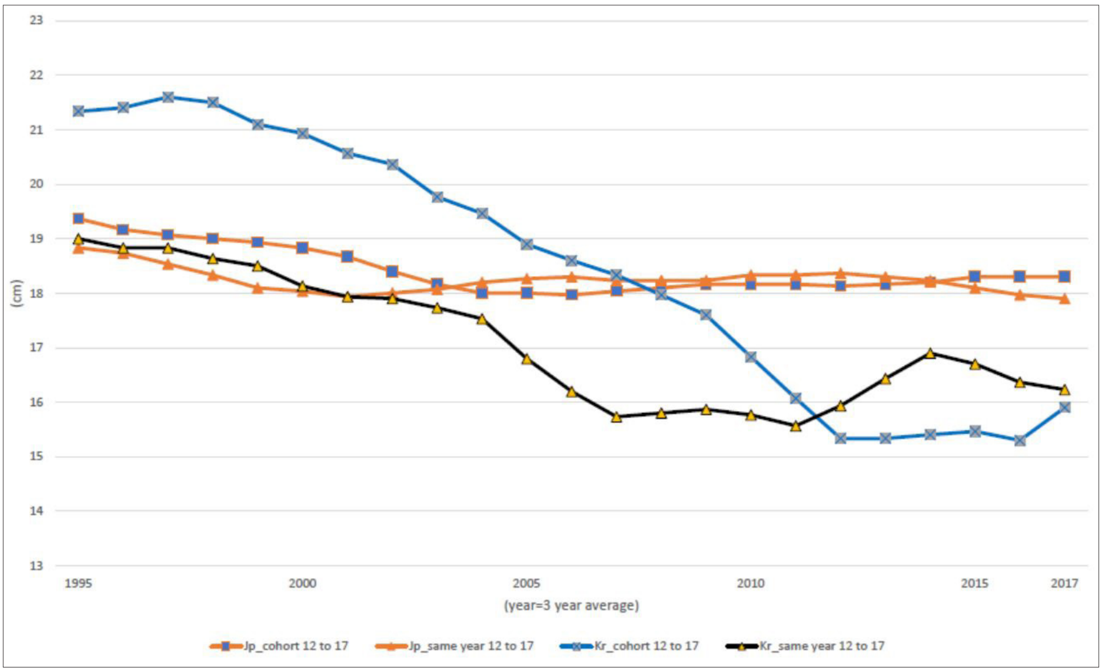

Figure 3: Comparison of growth velocity, same year data vs birth cohorts, from 12 to 17 years, school boys in Korea and Japan, 1995 to 2017

Table 2: Changes in per capita caloric intakes:

grand total and animal products, 1960 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

Sources: FAOSTAT, *Food Blance Sheet*, various issues, on the internet.

Table 3: 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*.

Household Income and Expenditure Surveys, Statistics Korea [10], provide household expenditures (in won) on major food items, grains, meats, fruit, vegetables, etc. classified by age groups of household head (HH). The author derived per capita household expenditures on vegetables, grains (≒polished rice) and meats (processed meats included) by individual members of household by age groups, 0-9, 10-14, 15-19, 20-29, --, by means of the TMI model [11], every year from 1990 to 2019. The estimates of per capita expenditures on vegetables, rice and meats, by 2 year-averages, from 1990-91 to 2017-19 are provided in Table 5, in terms of percentage of the control age group in their 50s every year.

Traditionally, bowls of rice with lots of kimchi [12-16], plus some meat/fish typify Korean dishes. As more meats/fish added, children grew taller in height, as shown in Table 1. Children seem not grow taller in height, or tend to decline in height, however, if consumption of kimchi is reduced appreciably in accordance with greater meat intakes. The author was told by native Korean colleagues that some burger-chains launched "kimchi-burgers" some time ago, with no success.

Table 4: Changes in per capta at-home consumption of fresf fruit

by age groups, 1971 to 2000 in Japan						(kg/year)
	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 by the author from *FIES*, various issues, the TMI model.

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

	A. vegetables						**(% of the 50's)**
age group	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							(kg/year)
	131.7	156.4	154.5	149.7	143.4	145.6	142.5
	B: grain≒rice						**(% of the 50's)**
age group	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							(kg/year)
	121.4	111.5	101.2	84.9	82.4	74.6	72.6
	C. meat-all(processed meats included)						**(% of the 50's)**
age group	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							(kg/year)
	24.2	33.4	37.9	37.5	44.0	52.2	56.4

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

Conclusion

"A high consumption of animal protein does not result in increasing body height, if overall consumption of calories and other nutrients is insufficient" [1] (Blum, 2013). The author has been arguing that children in Japan began to slow-down in body height growth in the 1980s, when the national economy prospered and they ceased to grow taller at any age in the early-1990s, when consumption of animal products was still on the steady increase but per capita consumption of fruit had been radically reduced among children and younger generations [17,18].

Per capita fruit consumption among Korean children was plentiful but consumption of vegetables started to decline steadily in the mid-1990s and the Korean children consumed only one-tenth of vegetables as the older adults in their 50s in the mid-2010s. Consumption of 'essential nutrients' was apparently insufficient among the Korean children and pregnant mothers in their 20s and 30s (Table 5). Cole and Mori concluded a few years ago that most of the height increment seen in adults had already accrued by age 1.5 years of age [19].

It is possible that the reduced fruit consumption by young Japanese and the reduced vegetable consumption by young Koreans influenced the extent and timing of the declines in height growth velocity that are documented here. Further research on these possible associations is encouraged.

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