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Height Growth of School Boys, Japan and South Korea in the Past Half Century, Analyzed by Bayesian A/P/C Model

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1. Introduction

Japan's economy recovered to the pre-war level in 1955 and started to grow very fast to the end of the century. South Korea was some 20 years behind Japan, due to Korean War (1950-53) but grew fast to be on a par with Japan in the first of the current century. Children in the two countries grew in height appreciably in accordance with the economic development but Japanese children ceased to grow to plateau in height in the 1990s and the Korean peers also quit growing taller at all after having overtaken their Japanese peers by 3-4 cm in mean height in the mid-2000s, when the economy still prospered. One tends to assume that Japanese and Koreans as well had depleted their gene potentials in height [1]. There may lie unspoken consensus that the Koreans should carry greater potentials in gene than the Japanese, to which the author does not agree.

2. Data

Japan has two data sources on human height by age and sex: National Nutrition Surveys [2], every year from 1946 and on and National School Health Surveys [3] since 1900, whereas Korea initiated National Health and Nutrition Surveys [4] only in 1998, then in 2001 and 2005 and had been conducted National School Health Surveys [5] since 1961. The author obtained dependable data since 1962 and on for Korea. In order to smooth annual fluctuations, three year moving averaging was applied for both countries. Surveys are conducted in the first month of school years, April in Japan and March in S. Korea, respectively. Children in the 1st year of primary schools contain children, 6 years old, 6.0 to 6.99, in both countries. Middle schools have 3 grades and high schools 3 grades. In the first month of school years of high schools, children are 15, 16 and 17 years old in order. No children younger than 17 years old are allowed to be high school seniors in both countries.

We have 12 ages, from 6 to 17. The author attempted A/P/C [6] analyses on trends in mean height of school children in Japan, South Korea, from 1965 to 2010 and China, from 1985 to 2019, at 5 years intervals, with unsuccessful results, probably because the number of ages was too many for standard cohort table analyses. The author decided not to include China and also to divide the entire ages into primary school years, 6 to 11 and middle (or) junior and senior high school years, 12 to 17 in age, respectively. (Figure 1) displays secular changes of mean height of school boys of 6, 12 and17 years of age in Japan and South Korea over the period from 1965 to 2010 at 5 year-intervals, derived from National School Health Surveys, by respective countries.

The typical A/P/C is illustrated in the equation (1) below. The working programs based on Nakamura's Bayesian assumption that the successive parameters are to change only gradually (parameter no zenshinteki henka) [7] was placed into the programs by D. Clason [8] in SAS and Saegusa [9] in Visual Basics.

$$Hit = B + Ai + Pt + Ck + Eit \quad (1)$$

where:

B: grand mean effect

Ai: age effect to be attributed to age i

Pt: period effect to be attributed to period t

Ck: cohort effect to be attributed to cohort k

Eit: random error

Subject to $\Sigma Ai = \Sigma Pt = \Sigma Ck = 0$

To minimize:

$$\omega i\Sigma(Ai-Ai+1)^2 + \omega t\Sigma(Pt-Pi+1)^2 + \omega k\Sigma(Ck-CK+1)^2$$

to reach the solution.

3. Estimating Age, Period and Cohort Effects of Mean Height of School Boys in Japan and South Korea Over the Period from 1965 to 2010

(Tables 1 and 2) show the results of the cohort analyses for boys in primary schools, 6 to 11 in age, Japan and South Korea, respectively and (Tables 3 and 4) the results for boys in mid-high schools, 12 to 17 in age, Japan and South Korea, respectively, over the period from 1965 to 2010, every five school-year. In view of the fact that Korean school boys from 1st grade of primary school to seniors in high school, 6 to 17 in age, were 3/4 cm taller than their Japanese peers (Figure 1), the author had anticipated that Korean boys in primary schools and junior-high schools, as well should carry apparently larger grand-mean effects, structural differences, than their Japanese peers. In the case of primary school boys, Japanese children are estimated to carry 129.32(0.02), slightly larger than 128.87(0.05) for Korean children. Japanese children are estimated to carry slightly wider age effects than their Korean peers, statistically significant differences. In regard to period effects from 1965 to 2010, Japanese children increased by 4.19 cm from -2.75 to 1.44, whereas Korean children increased by 13.27 cm from -6.40 to 6.87 over the same period. As regards cohort effects, the two countries are similar in pattern and insignificant statistically. In the case of middle-high school boys, Japanese children are estimated to carry 163.09(0.04), slightly larger than 162.07(0.15) for Korean children. Japanese children are estimated to carry slightly narrower age effects than their Korean peers, statistically insignificant differences. In respect of period effects from 1965 to 2010, however, Japanese children increased by 5.08 cm from -4.42 to 0.66, whereas Korean children increased by 12.36 cm from -7.58 to 4.78 over the same period. As regards cohort effects, the two countries are similar in pattern and insignificant statistically[*1]. The A/P/C analyses have revealed that Japanese children in both primary school and junior-high school are slightly taller than their Korean peers by 0.45 cm and 1.02, respectively in terms of grand mean effect but Japanese children in primary school grew substantially less: from 6.87-(-6.40) vs 1.44-(-2.75)=9.08 cm and 4.78-(-7.58) vs 0.66-(-4.42)=12.36-5.08=7.28 cm, respectively. [*1] Honestly, the author has no idea of what "cohort effects" should imply in the case of growth of children's height.

4. How Korean Boys Grew So Faster in Height than their Japanese Peers?

(Table 5) shows per capita supply(=consumption) of protein from animal products in Japan and South Korea from 1965 to 2010. Animal protein increased drastically from 6.9 gr to 33.8 gr in S. Korea for 30 years from 1965 to 1995. Korean school boys caught-up with Japanese peers in mean height in 1995. No question that animal protein should play crucial roles in increasing human height. Japanese school boys ceased to grow taller in the mid-1990s and were overtaken by Korean peers by 3-4 cm in mean height in the mid-2000s, when per capita supply of animal protein was 51.3 gr in Japan, 30% greater than in S. Korea. Substantial differences in period effects (Tables 1-4) can't be attributed to animal protein alone. S. Korea is twice as much as Japan in per capita supply of vegetables. S. Korea consumed 229.6 kg of vegetables in 2000, twice as much as Japan in the same year. Traditionally, Korea was not a fruit-eating nation. In 1965, per capita supply of fruit was 9.1 kg/year in S. Korea, less than 1/4 in Japan. When Japan reached its peak of 59.4 kg in 1975, S. Korea's per capita fruit supply(=consumption) was 15.4 kg. While Japan decreased fruit consumption gradually, Korea kept increasing fruit consumption toward the end of our survey period of the mid-2000s. When nation's per capita consumption is on the increase, the younger generations tend to be the leader of the market, according to the author's observations [10]. When Japan's young consumers were steering/turning away from fruit (Japan's White Paper on Agriculture, 1994) [11;12], S. Korea's children in growing ages were starting to eat fruit. South Korea overtook Japan in terms of per capita consumption of fruit in 1990, at 52.8 kg. In the end of our survey period, S. Korea consumed 69.2 kg of fruit on per capita basis, nearly 40 % more than Japan. According to the analyses of at-home consumption of fruit by household members by age, Japanese children under 20 are estimated to eat far less fruit than those in the middle-elderly age groups in the latest decades (Table 6, 7). The author referred to Mathias Blum who stated, "a high consumption of animal protein does not result in increasing body height, if overall consumption of calories and other essential nutrients is insufficient" in Historical Method, 46(1), 2013 [13]. The author is a micro-economist, with very little know-hows in human-biology. However, he suspects that big-hamburgers, with a few slices of lettuces/tomatoes should not be well-balanced diets.

Table 1: Mean Height of Primary School Boys in Japan, Decomposed into Age, Period and Cohort Effects,1965~2010

Grand Mean Effect ~ 129.32(0.02)

ABIC=56.93

Age Effects		SE	Period Effects		SE	Birth Cohort effects		SE
6	-13.68	0.21	1965	-2.75	0.37	1	-1.7	0.55
7	-8.08	0.13	1970	-1.71	0.29	2	-0.96	0.5
8	-2.61	0.06	1975	-0.93	0.21	3	-0.35	0.41
9	2.63	0.06	1980	-0.47	0.13	4	0.1	0.33
10	7.9	0.13	1985	0.13	0.07	5	0.31	0.25
11	13.84	0.75	1990	0.76	0.07	6	0.48	0.17
ΣAi	0		1995	1.04	0.13	7	0.58	0.1
			2000	1.18	0.21	8	0.65	0.06
			2005	1.31	0.29	9	0.59	0.1
			2010	1.44	0.37	10	0.44	0.17
			ΣPt	0		11	0.29	0.25
						12	0.11	0.33
						13	-0.03	0.41
						14	-0.16	0.5
						15	-0.34	0.57
						ΣCk	0.01	

Table 2: Mean Height of Primary School Boys in S. Korea, Decomposed into Age, Period and Cohort Effects,1965~2010

Grand Mean Effects＝128.87(0.05)

ABIC=155.13

Age Effects		SE	Period Effects		SE	Birt Cohort Effects		SE
6	-12.70	0.51	1965	-6.40	0.91	1	-3.99	1.40
7	-7.59	0.31	1970	-5.04	0.71	2	-2.46	1.22
8	-2.75	0.14	1975	-4.62	0.52	3	-1.26	1.02
9	2.46	0.14	1980	-2.33	0.33	4	-0.16	0.82
10	7.44	0.31	1985	-0.80	0.16	5	0.48	0.62
11	13.14	1.82	1990	0.42	0.16	6	1.37	0.42
ΣAi	0		1995	2.25	0.33	7	1.82	0.24
			2000	4.08	0.52	8	1.56	0.13
			2005	5.57	0.71	9	1.58	0.24
			2010	6.87	0.91	10	1.27	0.42
			ΣPt	0		11	1.00	0.62
						12	0.49	0.82
						13	0.04	1.02
						14	-0.59	1.22
						15	-1.15	1.40
						ΣCk	0	

Table 3: Mean Height of Middle-High School Boys in Japan, Decomposed into Age, Period, and Cohort Effects, 1965~2010

Grand Mean Effects＝163.09(0.04)

ABIC=123.96

Age effects		SE	perid effects		SE	Birth Cofort Effects		SE
12	-12.99	0.28	1965	-4.42	0.49	1	0.86	0.76
13	-5.42	0.18	1970	-2.43	0.40	2	0.48	0.66
14	0.69	0.10	1975	-0.78	0.29	3	-0.06	0.55

15	4.46	0.10	1980	0.28	0.20	4	-0.70	0.45
16	6.24	0.18	1985	0.77	0.12	5	-0.88	0.35
17	7.02	0.99	1990	1.38	0.12	6	-0.93	0.24
ΣAi	0.00		1995	1.66	0.20	7	-0.85	0.16
			2000	1.70	0.29	8	-0.85	0.12
			2005	1.18	0.40	9	-0.74	0.16
			2010	0.66	0.49	10	-0.41	0.24
			ΣPt	0.00		11	-0.04	0.35
						12	0.37	0.45
						13	0.89	0.56
						14	1.31	0.66
						15	1.55	0.76
						ΣCk	0.00	

Table 4: Mean Height of Middle-High School Boys in S. Korea, Decomposed into Age, Period, and Cohort Effects, 1965~2010
Grand Mean Effect=162.07(0.15)
ABIC=241.89

Age Effect		**SE**	**Period Effect**		**SE**	**Birth Cohort Effect**		**SE**
12	-13.00	0.63	1965	-7.58	1.09	1	0.74	1.63
13	-6.45	0.45	1970	-5.19	0.89	2	0.44	1.44
14	-0.60	0.31	1975	-3.92	0.69	3	-0.35	1.23
15	4.84	0.31	1980	-1.82	0.51	4	-1.45	1.01
16	6.98	0.45	1985	-0.01	0.39	5	-1.86	0.79
17	8.23	2.17	1990	1.24	0.39	6	-1.74	0.59
ΣAi	0.00		1995	2.93	0.51	7	-1.70	0.44
			2000	4.53	0.69	8	-1.71	0.38
			2005	5.04	0.89	9	-1.38	0.44
			2010	4.78	1.09	10	-0.87	0.59
			ΣPt	0.00		11	-0.02	0.79
						12	0.96	1.01
						13	2.19	1.23
						14	3.14	1.44
						15	3.61	1.63
						ΣCk	0.00	

Table 5: Per capita Animal Protein, Japan and S. Korea 1965-2010 (gr/day)
Source: FAOSTAT, Food Balance Sheets, 1961-2013, old methodology.
Note: Year denote three years, moving average.

Year	**Japan**	**S. Korea**
1965	28.6	6.9
1970	36.3	8.6
1975	41.6	14.6
1980	46.9	18.5
1985	50.9	23.0
1990	55.2	26.6
1995	56.1	33.8
2000	55.0	36.8
2005	51.3	39.0
2010	48.6	44.0

Table 6: Per capita Supply of Vegetables and Fruit, Japan and S. Korea (kg/ year)
Source: FAOSTAT, Food Balance Sheets, 1961~2013, old methodology.
Note: Year denote three years, moving average.

	Vegetables		Fruit	
	Japan	S. Korea	Japan	S. Korea
1965	119.9	82.2	40.4	9.1
1970	129.4	106.6	52.6	12.1
1975	121.7	146.1	59.4	15.4
1980	123.3	206.4	56.8	24.6
1985	121.4	188.8	50.5	33.1
1990	117.2	196.1	49.8	52.8
1995	115.5	212.8	51.8	64.6
2000	112.7	229.6	52.7	68.8
2005	106.5	223.8	57.7	71.5
2010	100.3	212.0	50.9	69.2

Table 7: Changes in per capita at-home consumption of fresh fruit by age groups, 1971 to 2000 in Japan (kg/year)
Sources: Derived by the author from FIES, various issues, the TMI model.

	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
Gran Ave	45.6	41.6	36.4	33.8	31.5	31.1

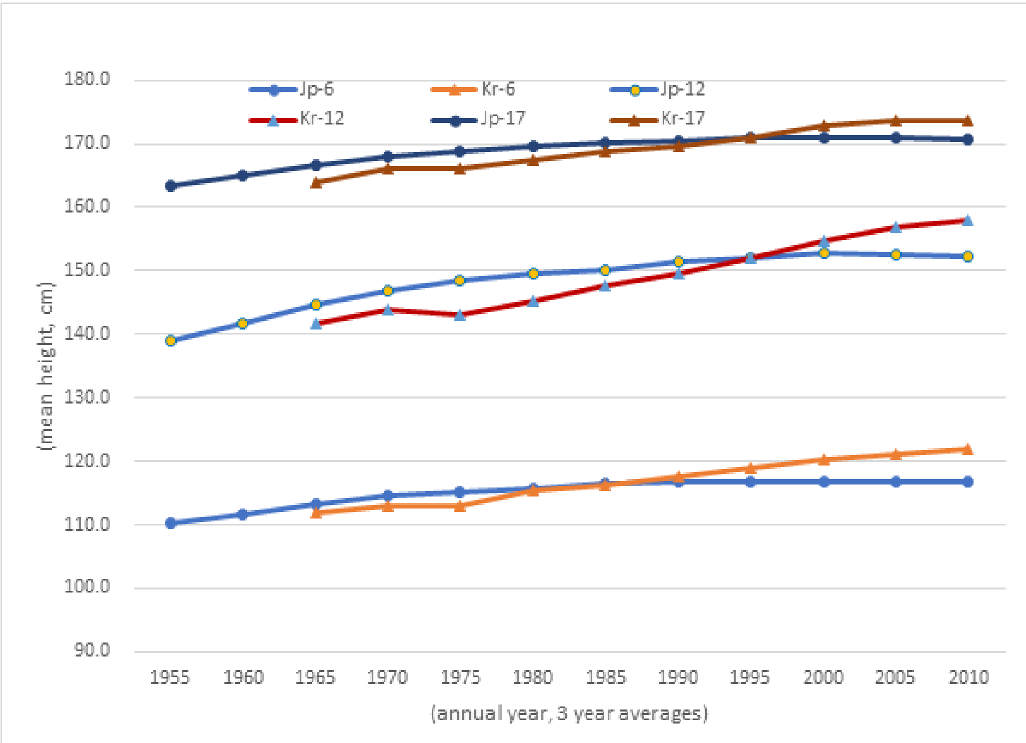

Figure 1: Secular trends of mean height of school boys by age,Japan and South Kores,1955~2010

5. Brief Conclusions

A/P/C analyses applied to growth patterns of school children's height in Japan and South Korea over the past half century have led the author convinced that Japanese and Koreans should carry the same gene-potential in height. Observed facts that Korean children in all school grades were 3/4 cm taller than Japanese peers in the mid-2000s, when Japan was 30% greater in respect of per capita consumption of animal protein, could be explained by the differences in diets: consumption of essential nutrients contained in vegetables and fruit by Japanese people, children in growing ages in particular, should be insufficient in the latest decades, as compared to their Korean peers.

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