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Short Communication

Body Height Development of Japanese and South Korean School Boys in the Past Half Century: A/P/C Approach

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Introduction

Steckel states, "Stature is a net measure that captures the supply of inputs to health", Econ. Literature, 1995, p.1903[1]. Japan and South Korea achieved rapid and steady economic progress after WWII, with S. Korea some two decades behind Japan due to the Korean War (1950-53). Fig. 1 clearly manifests it. Korean schoolboys were apparently shorter in mean height than their Japanese peers in the earlier period, 1960 to 1990, caught-up with their Japanese peers in the mid-1990s and overtook them by 3-5 cm in the mid-2000s [2,3]. However, Table 1, FAOSTAT Macro-Economic Indicators [4], shows that Japan was twice as big as S. Korea in the mid-1990s in terms of per capita GDP in const US dollars, and 55% bigger even in the mid-2000s. It looks as though Korean people should carry taller "gene potentials" than Japanese peers [5]. The author didn't accept this hypothesis [6]. In this research note, standard cohort approach is applied to identify the differences in height development between Japanese and S. Korean populations in the past half century.

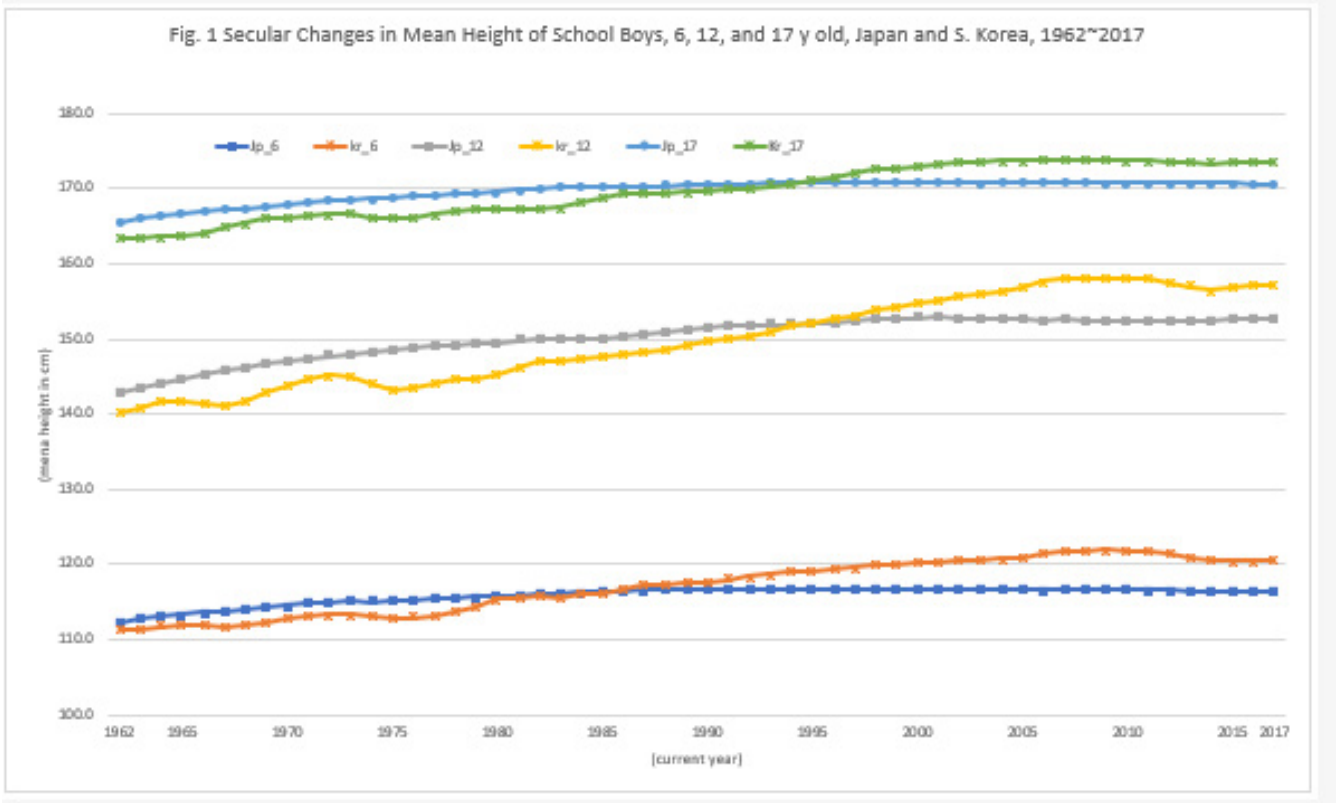

Table 1 Changes in per capita GDP Japan and Rep. Korea, 1970~2015

Year	Japan	S. Korea
1970	13900	1960
1975	16200	2850
1980	19200	4050
1990	28500	9100
1995	30200	13300
2000	31400	17100
2005	33100	21300
2010	32900	25800
2015	34900	28700

Source: FAOSTAT, Macro-Economic

Age/Period/Cohort Analyses as Applied to Boys' Height in Japan and South Korea

Japan and South Korea are nearly identical in school system: children enter primary school at age 6 in April, Japan, and in March, S. Korea, followed by three-year middle school and three-year high school. One thing common in the two countries: it is quite easy to graduate high school but quite hard to enter good universities, requiring long-hour, intensive after school preparations.

Governments of the two countries publish every year statistics on statures and health conditions of a large numbers of primary through high school students, National School Health Surveys [2,3]. Six years of primary school and three years of middle school are compulsory. Prior to the mid-1980s, the rates of entering high schools after graduating from middle schools were not very high, particularly among girls in rural South Korea, resulting in upward tendencies in mean height of high school students, 15 through 17 years of age in the survey. Mean height of high school boys (seniors, 17 years of age) in the early years of the survey period may have been slightly upward biased.

In the realm of food consumption, cohort analyses have not been popular. Schrimper raised an issue: "How much of the differences associated with age in any given cross-section are the results of economic influences or partly cohort effects as compared to pure age effects? Is it reasonable to expect all generations to follow the same transformation of eating habits over the life cycle" [7][*1]. Only two decades ago, a few economists started to introduce cohort analyses to changes in food consumption by age for a certain period of time [8,9]. It was customary then to follow the equation, (1), as shown below.

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

where:
Hit: mean height of i years of age at period t
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 $\Sigma Ai = \Sigma Pt = \Sigma Ck = 0$

School Health Surveys furnish 45 observations, from 1965 to 2010. The author has tried to analyze every grade of 12 school years, starting from 1st grade in primary school to 3rd grade in high school for the entire survey period from 1965 to 2010: general cohort table at the outset. In this analysis, school years are divided into two divisions: primary school of from 1st grade, 6 years of age to 6th grade, and another 6 years of middle and high school years of 6 grades, 12 years to 17 years of age[*2].

Since the data are so stable that "standard cohort model", every five years, from 1965 to 2010, is applied. In order to avoid the identification problem inherent in cohort analyses [10], Nakamura's Bayesian model [11], designed for popular uses by D. Clason in SAS [12], and further refined by Y. Saegusa in Visual Basics [13], was put into practice.

[*1] American Economic Review has not carried even single research paper, with "cohort" in the title.

[*2] Health Surveys are conducted in the first month of school year. Mean height of the 6th grade of primary school measures the mean height of the first month of 6th graders, with eleven months of 6th graders uncovered. Mean height of the 1st graders of middle school is close to that of graduates of primary schools only a half month ago .

Discussions

Table 2-A-Mean Height of Primary School Boys in Japan, Decomposed into Age, Period and Cohort Effects,1965~2010 Grand Mean Effect=134.94(0.03) ABIC=78.41

Age Effects		SE	Period Effects		SE	Birth Cohort effects		SE
7	-13.79	0.26	1965	-2.93	0.47	1	-2.4	0.72
8	-8.34	0.16	1970	-1.83	0.37	2	-1.37	0.63
9	-3.15	0.07	1975	-1.01	0.27	3	-0.59	0.52
10	2.08	0.07	1980	-0.56	0.17	4	-0.05	0.42
11	7.98	0.16	1985	-0.05	0.08	5	0.31	0.32
12	15.21	0.94	1990	0.73	0.08	6	0.6	0.22
ΣAi	-0.01		1995	1.1	0.17	7	0.73	0.12
			2000	1.4	0.27	8	0.87	0.07
			2005	1.53	0.37	9	0.85	0.12
			2010	1.63	0.47	10	0.68	0.22
			ΣPt	0.01		11	0.43	0.32
						12	0.22	0.42
						13	0	0.52
						14	-0.1	0.63
						15	-0.17	0.72
						ΣCk	0.01	

Table 2-B-Mean Height of Primary School Boys in S. Korea, Decomposed into Age, Period and Cohort Effects,1965~2010 Grand Mean Effect=134.53(0.08) ABIC=185.16

Age Effects		SE	Period Effects		SE	Birt Cohort Effects		SE
7	-13.34	0.5	1965	-6.41	0.81	1	-1.9	1.24
8	-8.36	0.3	1970	-4.42	0.65	2	-2.71	1.09
9	-3.04	0.17	1975	-4.1	0.48	3	-2.62	0.92
10	1.98	0.17	1980	-2.14	0.33	4	-1.89	0.74
11	7.58	0.3	1985	-0.70	0.21	5	-0.79	0.57
12	15.18	1.63	1990	0.33	0.21	6	0.03	0.40
ΣAi	0		1995	1.97	0.33	7	0.78	0.27
			2000	3.77	0.48	8	1.56	0.20
			2005	5.29	0.65	9	1.64	0.27
			2010	6.42	0.81	10	1.69	0.40
			ΣPt	0.01		11	1.54	0.57
						12	1.21	0.74
						13	0.78	0.92
						14	0.48	1.09
						15	0.22	1.24
						ΣCk	0.02	

Tables 2 A-B present statistical findings derived from the standard cohort analyses as applied to height developments of primary school boys, 7 to 12 years of age*3 in Japan and South Korea, from 1965 to 2010. In view of the fact that Korean primary school boys were about 4 cm taller than their Japanese peers in the 2000s, the author was almost certain to detect that Korean boys in primary school would turn out to carry apparently greater grand mean effects than their Japanese peers. The latter proved, on the contrary, to carry slightly bigger grand mean effect, 135.0 over 134.5 cm for the former. As regards age effects, Japanese primary school boys proved slightly narrower than Korean peers: -13.7~15.1 over -14.0~15.8, from 1st grade to 6th grade in the end of school year. Remarkable differences have been discovered in period effects: Korean primary school boys grew by 9.6 cm from -4.8 to 4.8, whereas Japanese peers grew 4.7 cm from -3.0 to 1.7 over the period from 1965 to 2010. Distinct differences were located in growth velocity.

Table 3-A Mean Height of Middle School Boys in Japan, Decomposed into Age, period, and Cohort Effects, 1965-2010 Grand mean effect=163.09(0.04) ABIC=123.96

Age Effects		SE	Period 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 3-B Mean Height of Middle 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 Effects		SE	Birth Cohort Effects		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	

Tables 3 A-B represent middle through high school boys over the same period. As regards grand mean effects, Japanese senior students proved 163.1 cm, slightly larger than Korean peers, 162.1 cm. In respect to age effects, Korean students proved slightly wider, -13.0 to 8.2 than Japanese peers, -13.0 to 7.0, not significantly different. In respect of period effects, Korean students grew from -7.6 to 4.8 =12. 4 cm, while Japanese peers grew by -4.4 to 0.7= 5.1 cm, significantly much wider.

The author doesn't find significant differences in the basic structure of body height of male students in the two nations but does admit that Korean students grew significantly faster than Japanese peers over the period of 1965 to 2010.

*3 As mentioned above, most of the 6th graders are 12 years old at the time of graduation from primary school.

Conclusions

S. Korean male high school seniors caught-up in body height with Japanese peers in the mid-1990s and overtook them by 4 cm in the mid-2000s, when Japan was 55% greater than S. Korea in respect of per capita GDP, in US constant dollars. When those high school seniors in 2005 entered primary school, in the end of the 1980s, per capita GDP of S. Korea was a little less than 1/3 of Japan. Accordingly, per capita consumption of animal protein in S. Korea was substantially less than in Japan. An easy, common-sense explanation could be sought in pottential racial differences [5,6].

Children in Japan started steering away from fruit in the end of the 1970s, as remarked by White Paper on Agriculture, 1994, Ministry of Agriculture [14]. In-depth cohort analyses of Japanese food consumption in postwar Japan revealed that the newer generations have turned away from fruit and vegetables in their diet [8]. Baten, Grasgruber, and many other bio-historical researchers unanimously assert that a higher consumption of animal protein tends to result in taller body height [15,16]. Blum, however, mentions that a high consumption of animal proteins does not result in increasing body height, if overall consumption of calories and other essential nutrients is insufficient [17].

The author has been contending for some time that children in Japan started turning away from fruit in the end of the 1970s and they consumed in the beginning of the 2010 far less than one twenties of fruit eaten by the older generations (Tables 4-5, derived from Family Income Expenditure Surveys, by means of the TMI model [18,19]). Abnormally insufficient consumption of fruit by Japanese children is suspected to have hindered their normal development of body height since the mid-1980s (Tables 4-5).

Table 4: Per capita at-home consumpsion of fruit by age groups in Japan 1971 to 2010 (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 by the author, from *Family Income and Expenditure Surveys*.

Table 5: Per capita at-home consumpsion of vegatables by age groups in Japan 1971 to 2010 (kg/year)

age/ year	1971	1980	1985-86	1990	1995-96	2000	2010
0~9 yo	44.8	33.7	27.3	23.0	20.2	18.3	17.5
10~19	62.2	51.1	44.7	38.8	36.0	30.0	30.6
20~29	67.8	56.1	52.5	45.5	46.2	40.8	37.6
30~39	68.5	65.6	60.2	54.3	52.3	49.8	45.7
40~49	77.4	80.3	78.2	71.7	67.3	62.0	54.7
50~59	89.0	90.5	91.9	84.0	83.7	82.3	66.2
60~69	87.5	93.3	99.0	91.2	91.0	94.0	80.8
70~	71.0	80.0	89.4	80.1	81.3	86.9	81.5
Grand ave.	67.1	63.6	62.4	58.3	59.0	57.2	55.4

Most of those who adore Stigler and Becker, two Nobel Prize winners, who state, "tastes neither change capriciously nor differ importantly between people" [20], are not interested in investigating why/how younger generations in Japan eat substantially less fruit and vegetables.

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