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Research Article

Changes in Relative Height of Children in Northeast Asian Countries in Fifty Years Since 1960

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Abstract

Economies in Northeast Asia made rapid and steady progress in the past half century, since 1960. Food consumption improved remarkably. Total calorie intakes increased first, followed by steady increments in animal sourced foods. Children became appreciably taller in height. In the mid-2000s, teens in South Korea were the tallest, 3cm taller than their Japanese and Taiwanese peers. In terms of per capita consumption of animal products, S. Korea was apparently the lowest. Genetics, however, fails to explain. A century ago, young men in Korea were 2 cm taller than Japanese but 3 cm shorter than Taiwanese. Since the mid-1970s, S. Koreans have been taking 2-300 kcal/day more overall food calories and twice as much vegetables than both Japanese and Taiwanese.

Keywords: Body height; Standard of living; Animal-sourced foods; Vegetables; Japan; Taiwan; South Korea

Introduction

Stature is a net measure that captures not only the supply of inputs to health but demands on those inputs (Stature and the Standard of Living) [1]. Japan's economy recovered from the war devastation to the pre-war level in 1955 and made rapid and steady growth toward the 1990s, despite the two world-wide oil-crises. The standard of living increased and food consumption improved appreciably in quantity and quality. Per capita meat consumption, for example, increased from 7-8 kg/year in the pre-war years to 27.5 kg in 1960, and 91.3 and 159.4 kg in 1970-74 and 1990-94, respectively [2]. Accordingly, children grew remarkably taller in height, i.e. mean height of boys in high school senior grade, 17 years of age, increased from 161.0 cm in 1930 and 161.8 cm in 1950, respectively to 165.0 cm in 1960, 168.8 cm in 1975, and 170.4 cm in 1990, respectively and ceased to grow significantly taller in the early 1990s.

Young men in Japan may have reached racial/genetic potentials. In 1980, young men, 20 years of age, in the Netherlands were 184 cm tall in mean height and 10 and 15 cm taller, respectively than those in France and Portugal. Some 100 years ago, in 1860-70, those in the Netherlands were 165 cm in mean height, only 1-2 cm taller than their peers in France and Portugal [3]. The author surmises that it should be too easy to attribute the differences in height observed at the given period of historical time between countries in the same region on the earth to racial or genetic traits. In terms of per capita caloric intakes from animal products, Portugal was 500 kcal/day, as compared to 1112 kcal/day for the Netherland in 1970 [4], for example. It is widely recognized in the arena of human biology that consumption of "high-quality proteins" is highly correlated to human height [5-7]. Little questions remain about this. When the cases of three countries in Northeast Asia are examined, however, attributing human height developments to animal proteins alone seems to have proved empirically questionable [8,9].

Secular Changes in Child Height in Japan, South Korea and Taiwan

School health surveys have been conducted on the nationwide scale since 1900 in Japan and since 1960, to the author's command, in South Korea and Taiwan, respectively. Table 1 provides mean height of boys in the elementary 1st grade (6 years of age), junior high school 1st grade (12 years old) and high school 3rd grade (17 years old) in Japan, S. Korea and Taiwan by 5 year-intervals from 1960 to 2010 [10-12]. Boys in the three countries grew significantly taller in height in the past 50 years since 1960. Fine details set

aside, Japanese boys were 2-3cm taller, regardless of age groups, than their peers in S. Korea and Taiwan in the 1960s through the mid-1970s, only slightly, 1 cm or less, taller in the mid-1980s and then ceased to grow significantly taller in height, whereas boys in S. Korea and Taiwan kept growing taller appreciably to overtake their peers in Japan by 2 cm in the mid-1990s. Boys in S. Korea kept growing further to surpass their Japanese peers by at least 3cm in the mid-2000s. Boys in Taiwan, however, became slightly shorter since the late-1990s, to be as tall as their Japanese peers in the late-2000s, for unidentifiable reasons.

Table 1: Changes in Mean Height of School Boys by Age, 1960 to 2010, mean height of schoolboys by age in Taiwan, 3 year moving averages.a

Table 1a: Mean height of schoolboys by age in Japan, 3 year moving averages (cm) [10].

age/year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
6	111.9	113.3667	114.5	115.2	115.7333	116.4	116.7667	116.7667	116.6667	116.6667	116.6667
12	142.1	144.6667	146.9667	148.6	149.5	150.0667	151.5	152.0333	152.8333	152.5667	152.4
17	165.1	166.7333	167.9	168.8333	169.6	170.2333	170.5	170.8667	170.8667	170.8333	170.7333

Table 1b: Mean height of schoolboys by age in S. Korea, 3 year moving averages (cm) [11].

age/year	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
6	110.95	111.9	112.8667	114.1333	116.4333	116.7333	117.6667	119	120.1667	120.9667	121.8
12	140.3	141.7667	143.7333	144.4333	146.3	148.1667	149.6667	152	154.8	156.9	157.9667
17	163.3	163.8	166.0667	167.2333	168.4	169.4333	169.6667	171	172.9333	173.7	173.7333

Table 1c: Mean height of schoolboys by age in Taiwan, 3 year moving averages (cm) [12].

age/year	1960-62	1964-66	1969-71	1974-76	1979-81	1984-86	1989-91	1997	2000-01	2007-08	2009-11
6		111.1	112.7667	114.9333	116.6	117.6	118.9667	118.4	117.35	117.6	117.7852
12	139.7	140.7	142.4333	144	145.9	148.0333	151.3	152.5	151.15	151.25	151.3451
17	164.3	165.9333	166.7333	167.4667	168.4333	169.1667	170.5333	172	171.55		

As the economy grew, the inputs to health improved and stature increased accordingly. This happened unequivocally in the past half century in Northeast Asian countries. In respect of per capita GDP, however, Japan was the richest, followed by Taiwan, with S. Korea very far behind in the1980s. The bubble burst in Japan's economy at the outset of the 1990s, followed by the decade long stagnation. In the beginning of this century, however, Japan was 25 % larger than Taiwan and more than 50% larger than S. Korea in per capita GDP (in purchasing parity US$), as shown in Figure 1 [13]. Table 2 demonstrates that per capita caloric intake from animal products in S. Korea was very low at 56 kcal/day in in 1961, as compared to 251 and 233 kcal/day in Japan and Taiwan, respectively (for reference: 931 kcal/day in Netherlands at the same time). Intakes from animal products rose sharply in S. Korea to 272 and 472 kcal/day in the mid-1980s and the mid-2000s, respectively, but remained substantially lower than 580 and 590 kcal/day, and 586 and 673 kcal/day, respectively in Japan and Taiwan over the corresponding period [4].

Table 2: Changes in per capita caloric intakes from food products in Japan, Taiwan, and South Korea, 1961-2010 (kcal/day) [4].

All foods	Taiwan	S. Korea	Japan 日本	Nederland
1961	2526	2141	2525	3037
1970	2599	2816	2737	3025
1980	2771	3025	2798	3103
1990	2947	2956	2948	3280
2000	3119	3094	2899	3265
2010	2962	3281	2685	
Animal Pr	**Taiwan**	**S. Korea**	**Japan 日本**	**Nederland**
1961	233	56	251	931
1970	334	103	423	1026
1980	478	212	537	1112
1990	647	320	616	1089
2000	716	447	604	1182
2010	639	535	550	

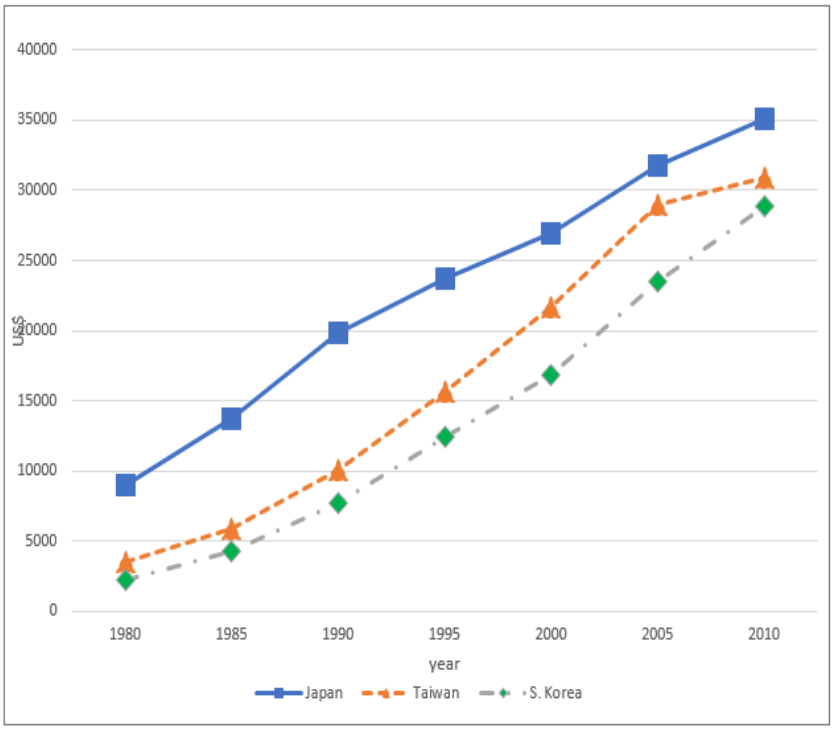

Figure 1: Changes in per capita GDP in Japan, Twaiwan and S Korea, 1980 to 2010 [13].

In respect of per capita milk consumption, S. Korea was extremely low at 5.4 kg/year, just one tenth that in Japan in the mid-1970s, rose to 26.0 kg in the mid-1980s, when South Korean children grew nearly equal in height as their Japanese peers, and then steadily increased to 49.5 kg in the mid-1990s and 56.9 kg in the mid-2000s, still 40% less than in Japan in 2005 [4]. On the other hand, South Koreans have long been eating substantially greater amounts of vegetables than either Japanese or Taiwanese. Per capita consumption of vegetables in S. Korea was 197.9 kg/year in 1980, rose to 235.7 kg in 2000, whereas that in Japan was 122.6 and 112.8 kg/year and that in Taiwan was 130.2 and 134.4 kg/year, respectively in 1980 and 2000 [4]. Koreans eat a lot of rice with vegetables in all sorts of kimchi [14,15]. As mentioned earlier, South Koreans have been taking 2-300 kcal/day more food calories than either Japanese or Taiwanese since the early 1970s and yet, obesity has not been a serious social problem in South Korea in the mid-2000s, as the author has heard of.

Per capita net supply (=consumption) of milk excluding butter for Republic of Korea is abnormally undercalculated by FAOSTAT, Food Balance Sheets, particularly for the period after the mid-1980s. The author recalculated per capita milk consumption for the three countries, by dividing total supply by population as reported in Population, FAOSTAT Table 3.

Table 3: Changes in per capita supply of cereals, vegetables and Fruit, 1965 to 2010 (kg/year) [4].

Ceareal	Taiwan	Japan	S Korea	Nederland
1964-66	157.78	154.6833	182.84	84.77333
1974-76	164.3	142.5	232.8	82.9
1984-86	115.7933	131.4633	192.2833	77.21
1994-96	100.47	123.55	167.68	80.22
2004-06	104.1533	114.2	146.12	76.01667
2009-11	103.78	110.0967	149.1467	89.41667
Vegetable	**Taiwan**	**Japan**	**S Korea**	**Nederland**
1964-66	59.18	119.87	82.18667	77.35667
1974-76	98.6	121.6833	146.1433	74.12333
1984-86	122.74	121.3533	188.75	77.36667
1994-96	118.57	115.51	212.78	76.22667

2004-06	120.0	106.5	223.8	92.0
2009-11	112.9667	100.2733	211.9867	83.30667
Fruit	Taiwan	Japan	S Korea	Nederland
1964-66	29.98667	40.40333	9.146667	77.84333
1974-76	59.10333	59.42667	15.38667	87.42667
1984-86	76.11	50.49333	33.14667	103.82
1994-96	115.8933	51.78333	64.62333	134.2933
2004-06	118.82	57.70333	71.49333	128.56
2009-11	115.8767	50.91333	69.17667	127.5633

Steering Away from Fruit and Vegetables by Japanese Children

The author has been calling for attention to the wide-spread tendency of wakamono no kudamono banare in Japan (steering away from fruits by Japanese young) as a possible mal-impacts on child height growth. According to a few empirical cohort studies, consumption of fruit and vegetables have measurable impacts on bone mineral accrual for prenatal and growing children [16-19]. Boys reach their maturity in height at age of 17-18 years and girls a little younger, 16-17 years of age. "Inputs to health", or intakes of nutrients, both in quantity and quality, past these maturity ages rarely affect the human height development. When we discuss changes in child height between countries or over time, changes in per capita consumption by age groups, infants, pre-adolescence, and adolescence, and young adults, ---, should be desirable.

National Health and Nutrition Surveys by Japanese government Ministry of Health and Welfare started to publish daily nutrition intakes by age groups, 0~6, 7~14, 15~19, 20~29, --, 70~, in 1995 [20]. S. Korea's counterpart, Korea National Health and Nutrition Examination Survey (KNHANES) was first published in 1998, followed by the 2nd survey in 2001, the 3rd one in 2005 [21]. Regrettably, these nutrition surveys, classified by exact age groups, seem to be too late in timing to identify child height development since 1960 to 2010. Cole and Mori (2017) state "most of the height increment seen in adults had already accrued by age 1.5 years" [22]; Mori (2019), reprising Cole and Mori, states "most of the height increment seen in high school senior graders had accrued by 1st-2nd graders in elementary school" [9].

Starting in the early 1970s, Family Income and Expenditure Surveys (FIES) [23], Japanese government the Bureau of Statistics publishes household purchases (=at-home consumption) of various goods and services, classified by age groups of household head (HH). The author and his associates designed a simple but robust model to derive per capita at-home consumption by household members by age from FIES annual data, by explicitly incorporating family age structure by HH age groups [24,25]. Tables 4 and 5 provide the author's estimates of per capita at-home consumption of fresh vegetables and fresh fruit by age groups of family members, from the early 1970s to 2010 in Japan.

Table 4: Changes in per capita at-home consumption of fresh fruit by age groups, 1971 to 2010, Japan (kg/year).Sources: derived from FIES by the author, using the TMI model.

age/year	1971	1980	1990	2000	2010
0-9 y.o.	36.3	26.5	8.9	2.3	2.4
Oct-19	45.57295	30.5	14.85965	5.686104	4.376357
20-29	48.31552	31.50948	16.84742	11.83294	9.764182
30-39	46.10016	43.77604	30.39034	21.75012	14.80987
40-49	50.96859	52.6072	44.90907	33.36987	20.47785
50-59	54.4	59.9	54.01409	48.45235	32.12303
60+	42.9	56.3	61.1	63.3	56
Gran_ave	45.6	41.6	33.8	31.1	27.7

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

Table 5: Changes in per capita at-home consumption of fresh veges by age groups, 1971 to 2010, Japan.Sources: derived from FIES by the author, using the TMI model.

age/year	1971	1980	1990	2000	2010
0-9 y.o.	44.8	33.65791	23.03348	18.27068	17.1
Oct-19	62.2	51.09743	38.75984	30.04169	30.63513

20-29	67.8	56.05903	45.47098	40.83257	37.6112
30-39	68.45672	65.63662	54.2852	49.77388	45.68017
40-49	77.41821	80.28245	71.74984	62.0048	54.68878
50-59	89.04784	90.49981	83.98644	82.25902	66.18655
60+	79.2	86.6	85.7	90.1	81.1
Gran_ave	67.1	63.6	58.3	57.2	55.4

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

Per person household or at-home consumption of fresh vegetables gradually declined from 67.1 kg(/year) in the early 1970s to 58.3 kg in 1990 and then to 55.4 kg in 2010 in Japan. That of fresh fruit declined more sharply from 45.6 to 33.8 and 27.7 kg over the same period. In the early 1970s, teens ate at home 62.2 kg of vegetables, only slightly lower than national average, 67.1 kg but they began to decrease their at-home consumption of vegetables to 30.0 kg in 2000, whereas the older adults in their 50s and over kept their consumption at the initial level, some 80 kg. The case for fresh fruit is quite dramatic, i.e., teens ate 45.6 kg of fresh fruit at home in the early 1970s, comparable to the national average but they began to decrease their fruit consumption rapidly to 5.7 kg/person, less than one tenth the level the older household members in their 60s and over in 2000. Children and young adults in Japan have drastically steered away from fresh fruit. Some of the industry experts claim that young students on the university campus do not care for fresh fruit, because they find it of nuisance to peel the skin off. Instead, they drink fruit juice [26]. This contention is not founded statistically. Total shipments of fruit juice and drinks declined from 2,000 kilo-litters in the early 1990s to 1,500 kilo-litters in the late 2000s [27]. Todays' Japanese children simply do not care for fruit, fresh or juice. In these regards, children and young adults in South Korea do not seem to have steered away from either vegetables or fruit in the turn of the century, as shown in Table 6 [28]. This statement does not imply the betterment or worsening in nutritional intakes past these early years of life has nothing to do with the final development of human height. See [2,9].

Table 6: Per capita intakes of fruits and vegetables by age groups, 1998 and 2001 in South Korea [28].Original Sources: KNHANES.

(1) 7-14 years old children (gr/day)				
	1998		2001	
	Q	SE	Q	SE
Fruits	201.9	10.4	197.7	9.79
Vegetables	190.6414	6.975366	183.1491	4.647642
(2) 15-19 years old adolescents (gr/day)				
	1998		2001	
	Q	SE	Q	SE
Fruits	192.1684	13.74806	169.5615	13.06577
Vegetables	227.834	6.00462	234.2219	7.092403
(3) 20-29 years old adults (gr/day)				
	1998		2001	
	Q	SE	Q	SE
Fruits	220.4254	11.43503	208.6209	12.14811
Vegetables	299.7581	6.830555	296.9733	6.678314
(4) 30-39 years old adults (gr/day)				
	1998		2001	
	(g)	SE	(g)	SE
Fruits	228.7703	9.793948	227.0491	10.3879
Vegetables	345.5007	6.533875	361.7025	7.082299
(5) 40-49 years old adults (gr/day)				
	1998		2001	
	Q	SE	Q	SE
Fruits	202.9	8.503472	222.4146	12.37281
Vegetables	360.6	9.431522	369.1455	7.823509

Notes: age groups, 1-6, 50-59, and 60+ are not listed.

Conclusion

Children in Northeast Asia have grown remarkably taller in height in the past half century, since 1960. Teens in South Korea have grown the most, i.e., 3cm taller than their Japanese and Taiwanese peers in the mid-2000s. The economic development has been fantastic in the three countries, with South Korea distinctly behind Taiwan and Japan in terms of per capita GDP. In respect of per capita caloric intakes from animal products, South Korea was distinctly lower than Japan and Taiwan. Are Koreans genetically taller than Japanese? Probably so. But young men in Korea were 3cm shorter than their peers in Taiwan a century ago, when the two countries were under Japan's colonization.

People in South Korea have been taking 2-300 kcal/day more food calories than people in Japan and Taiwan and eating nearly twice as much vegetables in various forms of kimchi as people in both Japan and Taiwan since the mid-1970s. "Population consuming larger amounts of animal protein reach higher average height than countries with less animal protein consumption" [29]. "However, a high consumption of animal proteins alone does not result in increasing body height if the overall consumption of calories and other essential nutrients is insufficient" [30]. This statement could apply to Japan and Taiwan in contrast with South Korea in the past few decades. Japanese children may have been insufficient in consumption of "essential nutrients" from vegetables and fruit in the past few decades in contrast with South Korea.

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