Annals of Clinical and Medical Case Reports

Short Communication ISSN 2639-8109 Volume 10

Why Korean Teens Started Declining in Height Growth in The Midst of Economic Prosperity: Despite Increasing Supply of Animal Protein?

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Received: 15 Oct 2022
Accepted: 29 Oct 2022
Published: 04 Nov 2022
J Short Name: ACMCR

Citation:

Mori H, Why Korean Teens Started Declining in Height Growth in The Midst of Economic Prosperity: Despite Increasing Supply of Animal Protein?. Ann Clin Med Case Rep. 2022; V10(4): 1-4

1. Introduction

In ten years after the end of WWII, Japan's economy recovered to the prewar level and achieved fast and steady progress toward the 1990s. People, the young in particular learned to eat animal products and the teens grew in height nearly 10 cm by the early-1990s and plateaued in stature after that. South Korea was two decades behind Japan in economic development due to the Korean War (1950-53) and then has achieved uninterrupted progress to parallel with Japan in respect of living standard by the turn of the century. Teens in Korea caught up with their Japanese peers in height in the mid-1990s and overtook them by 3 cm in the mid-2000s and then plateaued in height. With respect to per capita caloric supply from animal products, Japan was 546 kcal, 147 kcal greater than Korea in the mid-1990s. In the mid-2000s, when Korean teens overtook Japanese peers, Japan was still 82 kcal greater than Korea (Table 1). There is probably nothing odd about this. Both may have depleted their reserve gene potential for height (Kopcyzinsky, 2016) [1]. Japan and South Korea have the same school system, with 6 grades of primary school (6.5 years old for 1st grade), 3 grades of middle school (12.5 years old for 1st grade) and 3 grades of high school (15.5 years old for 1st grade), all of which start in early spring. Their Ministry/Department of Education conducts nationwide School Health Surveys (stature and health conditions, such as eyesight) in the first month of school year and publishes the survey statistics on the internet/printed report [2;3]. In human biology, the importance of "first years of life", or "first 1,000 days" is stressed for determining future adult height (A. Deaton; T. Cole; Prentice et al.) [4;5;6]. School Health Surveys do not cover the first 5 years. In this short communication, the author attempts to analyze the growth patterns of male students from 1st grade of middle school (12.5 years old) to final grade of high school (17.5 years old) in South Korea in comparison with Japan from the mid-1980s to the most recent year, as published data available,

Before undertaking actual analyses, the author would like to remind the audience of the key concept of growth, a longitudinal phenomenon: one does not grow from 6 years of age to 17 years of age cross-sectionally, or instantaneously in the same year. To construct growth chart, age 6 in 1990 is to be connected to age 7 in 1991, age 12 in 1996, ----, and age 17 in 2001, in turn.

2. Changes in Growth Patterns and Inputs to Health over Time

With respect to the mean height of males in the Northeast Asia, they tend to cease growing taller after the age of 17, in contrast to Caucasians in northern Europe who seem to grow another 1 or 2 cm taller toward their 20th in age. Young adults in the Netherlands, Sweden, and most neighboring counties grow above 180 cm in mean height in recent years, whereas the early teens, 12 or 13 years of age are reported about the same or not appreciably taller in mean height than their Korean peers in the early 2000s (Holmgren, Anton, 2019; Mori, 2021) [7;8]. It looks as though Korean male adolescents should grow appreciably less or slower in mean height than their European peers. With no background in anthropology, however, the author suspects that it might be plausible for Korean

teens to attain the mean height level, prevalent currently in Europe, should they eat the more properly, if not substantially more milk*1.

*1 Nearly 80% of the Asian populations are reported to lack lactose, after infancy. Due to the availability of official data on mean height by age and per capita food supply/consumption formatted in the same fashion, the author will provide secular changes in growth patterns in terms mean height in cm from 12 years of age (in 1980) to 17 years of age (in 1985) over the subsequent 30 years in South Korea, and Japan as a control (Figure 1). In the same fashion, mean height growth in cm from 6 years of age (in 1979) to 12 years of age (in 1985) over the same period will be provided as a reference. **Figure 1:** Teens in Korea grew approximately 2 cm greater or faster than their Japanese peers over the period from the early 1980s to the early 2000s but they began to decline gradually but distinctly in growth speed in the early 1990s, whereas Japanese peers keep falling only moderately and levelled off in the early 2000s. As a result, Korean teens are nearly 3 cm less or lower than Japanese peers in growth speed in the end of the survey period, the 2010s, despite the Korean high school seniors still keeping 3.0 cm lead in mean height above their Japanese peers decline. Through Figure 1. Korean boys both in primary school (6 to 12*2) and junior and senior high school (12 to 17) have proved a couple of cm less or slower in height growth than their Japanese peers toward the end of the survey period. *2 First month of junior high school 1st grade≒end month of primary school 6th grade.

Children in South Korea and Japan have proved variously different so much in respect of height growth patterns over the recent decades of survey period, which can not to be attributed to ethnicity. Stature is a net measure that captures not only the supply of inputs to health but demands on those inputs (R. J. Steckel, 1995) [9]. Empirically, increases in supply of animal products played a crucial role in increasing population's height. Increases in animal protein alone, however, cannot result in taller height (Table 1), unless supply of overall food calories and essential nutrients are sufficient (Blum, 2013) [10]. The author, based on cohort analyses of consumption of various food products in the past two decades, is fully aware that individual food consumption varies significantly by age/generation at the same time in the same nation [11]. (Table 2) clearly demonstrates that the newer generations, currently young in age, consume very little fruit in Japan. Korea has long been known for Kimchi. The author and his associates have discovered that the younger generations in South Korea have turned away from vegetables(≒Kimchi) in recent decades (Table 3). In respect of per capita consumption, available from Food Balance Sheets, FAOSTAT, United Nations [12], and Food Balance Sheets, Department of Agriculture, individual governments [13;14], secular changes in individual consumption by age groups, preferably infants through adolescents, cannot be identified. Korea National Health and Nutrition Examination Survey, which provides individual food intakes by age groups was conducted in 1998 for the first time, followed by the 2nd one in 2001 and the 3rd one in 2005 [15]. Secular changes in individual food intakes: "inputs to health" need to be identified by major segments of childhood, if not every year of age, to comprehend changes in growth patterns of human height, particularly in developing societies or countries where cohort effects are dominant. Individual at-home consumption of various food products, Tables 2-3 were derived from Household Income and Expenditure Surveys [16] classified by age groups of household head by the author. With the technical helps of Inaba, Kawaguchi, and M. Tanaka, the author developed robust econometric models to derive per capita at-home consumption of various food products by individual household members by age from household expenditure surveys (Mori and Inaba, 1997; Tanaka, Mori and Inaba, 2004; etc.) [17;18]. Individual consumption of fresh fruit by age groups in Japan, 1971~2010, was derived from Family Income and Expenditure Surveys [19] and individual expenditures of vegetables, including Kimchi, by age groups in South Korea, 1990~2019, was derived from Household Income and Expenditure Surveys. Children in Japan started to steer away from fruit in the mid-1970s and are estimated to eat less than one-tenth of fruit consumed by the older adults in 2010 (Table 2). Children in Korea started to turn away from vegetables(≒Kimchi) in the early 1990s and are estimated to eat one-tenth of vegetables consumed by the older adults in the end of the 2010s (Table 3). (Table 4) demonstrates that children in Korea increased at-home consumption of meats (in terms of real expenditure) nearly 30% over the same period. Considering the older people prefer beef to pork, the more expensive cuts, children in Korea are surmised to eat nearly the same amount of meat as the older consumers.

Table 1: Changes in caloric supply from anaiam products, 1985~2017 (kcal/day).

	1985	1990	1995	2000	2005	2010	2015	2017
Japan	463	508	546	541	528	503	508	522
S. Korea	260	335	399	428	446	475	512	530

Sources: Food Balance Sheets, respective governoments.

Notes: 3 Year averages.

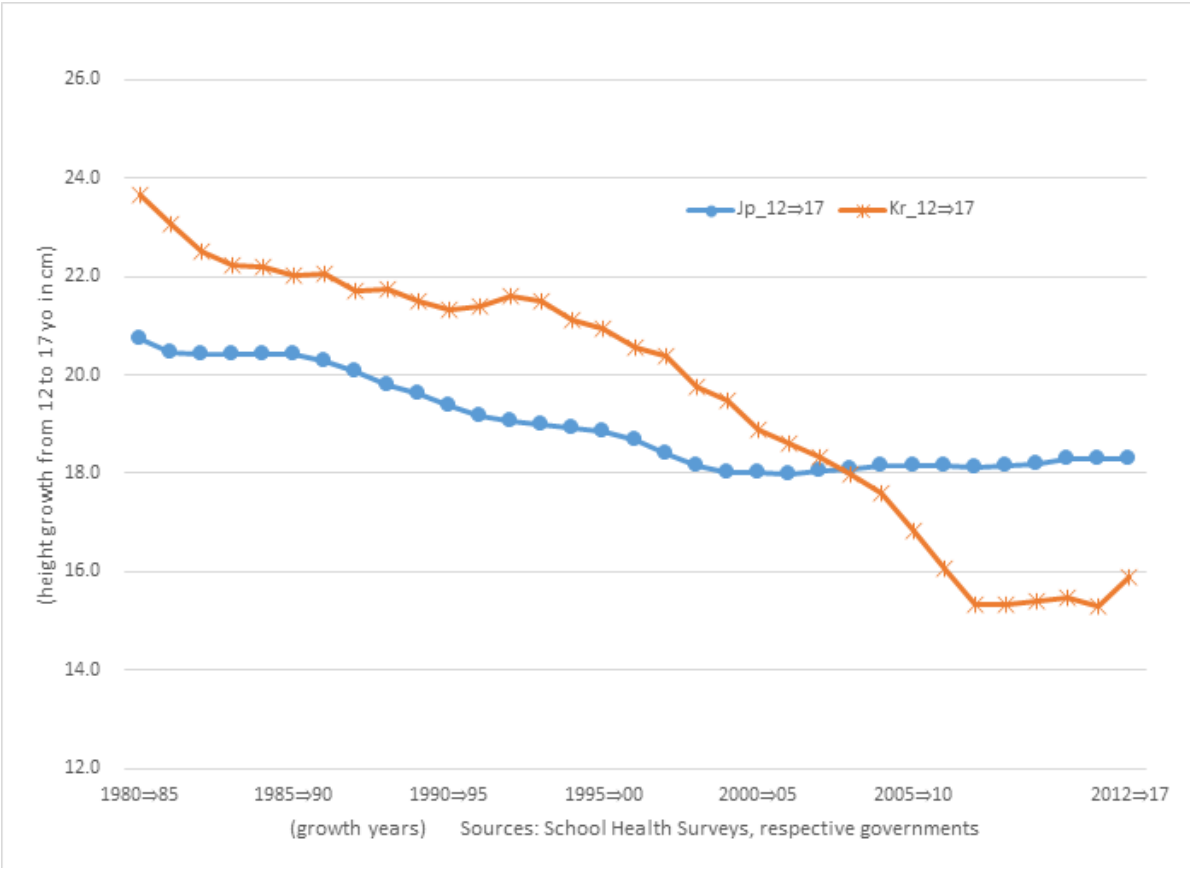

Figure 1: Secular changes in mean height growth from age 12 to age 17, South Korea and Japan, 1985 to 2017

Table 2: Secular changes in at-home consumption of fresh fruit by age groups of fousehold members in Japan, 1971~2010（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	52.6	48.5	44.9	37.2	33.4	20.5
50~59	54.4	59.9	56.6	54	50.5	48.5	32.1
60~69	44.5	58.5	61.1	62	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 FIES, classified by HH age groups, the TMI model.

Table 3: Secular changes in monthly expenditures on vegetables, by age of househol members, 1990~2017-19, South Korea, (2010 Won).

age/year	1990-91	1995-96	2000-01	2005-06	2010-11	2014-15	2017-19
0-9	17857	12261	7352	4505	2519	2847	1856
10~14	18593	13452	8233	6884	3070	2861	2210
15~19	18504	13693	8805	7927	3789	3168	2828
20-29	19801	16414	10563	10568	5558	4823	4915
30-39	26309	25237	15037	16541	9680	9486	9998
40-49	34428	34267	20639	23888	14560	13838	14925
50-59	35876	39010	24140	30639	20062	18889	21914
60~	34134	38357	25114	32786	23314	22884	28603

Sources: Household Income and Expenditure Surveys, classifued by age group of househod head.
Estimated by the author by means of TMI model

Table 4: Secular changes in monthly expenditures on meats, by age of househol members, 1990~2017-19, South Korea, (2010 Won).

age/year	1990-91	1995-96	2000-01	2005-06	2010-11	2014-15	2017-19
0-9	11608	16155	15490	9125	10165	12286	13285
10~14	11949	16997	16270	10180	11153	13074	13373
15~19	10780	15078	15857	10367	11064	13090	12718
20-29	12651	17641	17142	11018	11255	12995	12249
30-39	20255	29725	23091	14675	15713	17387	18739
40-49	26801	38985	29316	20220	22084	23026	25413
50-59	28026	40791	31279	22034	22481	24691	27653
60~	25911	40027	30048	21754	19811	21585	25673

Sources: Household Income and Expenditure Surveys, classifued by age group of househod head.
Estimated by the author by means of TMI model.

3. Conclusion

When the economy develops, population's living standards improve and "inputs to health" would be enhanced, resulting in bigger stature (taller height). The Korean economy has kept developing without serious hazards currently at a par with the Japan's economy. Teens in Korea overtook Japanese peers in height by 3 cm in the mid-2000s and plateaued since then. Have they simply depleted their gene potential in height? When examined in respect of growth pattern from 1st grade of junior high school to 3rd grade of high school, with Japan's case as a control, over the past 4 decades, Korean teens have proved highly unstable in growth, nearly 3 cm faster than their Japanese peers in the early 1980s and in the mid-1990s, and then nearly 3 cm slower than the latter in the 2010s. Similar rise and fall in growth speed are observed in the case of growth from 1st grade of primary school to 1st grade of junior school, before and after the early-2000s, leaving intuitive anticipation that Korean teens could keep growing in comparable magnitude as European teens from now. For this anticipation come true, we are expected to discover why growth speed from 12 to 17 in age has kept declining constantly from the early 1990 to the end of the 2010s in South Korea (Figure 1).

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