

## Growth Charts-Curves of Children's Height - How to Construct Them

Mori H\*

Professor Emeritus, Senshu University, Chiyoda-ku, Tokyo, Japan

### \*Corresponding author:

Hiroshi Mori,  
Professor Emeritus, Senshu University, Chiyoda-ku,  
Tokyo, Japan,  
E-mail: [hymori@isc.senshu-u.ac.jp](mailto:hymori@isc.senshu-u.ac.jp)

Received: 02 Aug 2022

Accepted: 11 Aug 2022

Published: 16 Aug 2022

J Short Name: ACMCR

### Copyright:

©2022 Mori H. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially

### Citation:

Mori H, Growth Charts-Curves of Children's Height - How to Construct Them. *Ann Clin Med Case Rep.* 2022; V9(12): 1-14

### Keywords:

Growth chart; cross sectional vs longitudinal data; S. Korea; Japan

### 1. Abstract

A person born in 1990, for example, grew to one year old on his/her birth day in 1991 and 17 years old in 2007. No one grows to their 17 or 20 years old instantaneously. It takes a long-capricious time of mental and physical activities to grow. As regards children's milk consumption, for example, school lunch programs were put into in practice on national scale only in the late 1990s. Those in their late adolescence in 2007 were not the beneficiaries of free milk, when they were in primary school. On the other hand, they were provided with much longer hours for physical training in and after school then. To comprehend how the mean height of the late adolescents in 2007 was attained, it should be desirable to observe children's growth process throughout the entire childhood, from the early 1990s to the mid-2000s by tracing birth cohorts. It is not a matter of statistical smoothing. It is simply a natural recognition of the fact that one ages one year annually and it takes nearly two decades to reach young adulthood after birth. In stabilized economies/societies, population may tend to plateau in height or even to decline. When the economies prosper and animal food consumption increases measurably, population would grow only in weight and occasionally decline in height. Growth charts serve as valuable tools when built on the sheer biological fact that one does not grow instantly in the year when the individual is born or when one reaches young adulthood.

### 2. Introduction

Korea Centers for Disease Control and Prevention, Republic of Korea, conducted Korea National Health and Nutrition Examination Survey in 1998, followed by the 2nd survey in 2001, and the 3rd one in 2005. KNHNS has been conducted nearly every year since 2007. "Change in the height of Korean children and adoles-

cents: analysis from the KNHNS II and V", 2015 [1] and "The 2017 Korean national growth chart for children and adolescents: development, improvement, and prospects", 2018 [2] are academic publications on growth charts of children's stature, mainly height and weight, by two groups of noted MDs, as a guide for the use of pediatricians in practice. The two reports are common in constructing growth charts, based on various issues of KNHNS [3]. In South Korea and Japan, there exist two sources of data for children's stature: National Health and Nutrition Surveys and School Health Examination Surveys [4, 5, 6]. As mentioned above, health and nutrition surveys have not been conducted continuously every year since 1998, when KNHNS I was conducted and similar surveys related to health and nutrition conducted prior to KNHNS are not available to the reviewer, because they were not widely circulated.

For the past six years, the author has been involved in comparative analyses of children's height development in Japan and South Korea from the perspectives of food supply [7, 8], "inputs to health" (Steckel, 1995 [9]) in the past half century. For changes in children's height by age, School Health Surveys have been used, due to the consistent and continuous data availability in both countries. For food supply, Food Balance Sheets, FAOSTAT [10], were used, and Household Expenditure Surveys [11, 12], classified by age groups of household head, were utilized, as needed.

The following Discussion Section will rely on School Health Surveys for the two countries. Individually, male children grow a couple of centimeters taller, after the age of 17. The author, himself, grew a few centimeters, after his age of 17, to catch-up for the severe starvation during and soon after the war. In terms of mean height, however, male children do not grow any taller after the age

of 17 in Asian countries.

### 3. Discussion

Two reports in review present growth charts of Korean children, both sexes, based on cross-sectional data, from Korea National Health and Nutritional Examination Surveys. Japan started nationwide health and nutrition surveys in 1947 and has conducted every fiscal year consistent surveys of nutritional intakes and outcomes, food consumption by variety, physical condition such as blood pressures, decayed teeth, ---, in addition to statures, by age groups of examinees. South Korea initiated equivalent surveys only in 1998, followed by the 2nd one in 2001, and the 3rd one in 2005.

Intensive statistical data on statures, height, weight by age groups from age 6 to 17 are available to the author in National School Health Surveys for Korea since 1961. Changes in food supply/consumption are provided in FBS, FAOSTAT [10], complemented by Food Balance Sheets, prepared independently by Department/Ministry of Agriculture of the two countries.

Japan was a forerunner in economic development after WWII, with South Korea two decades behind Japan due to the Korean War (1950-53). As regards per capita supply of animal products, milk in particular, South Korea was substantially lower than Japan but Korean children caught-up with Japanese peers in height in the early 1990s and overtook the latter by 3.0 cm in the mid-2000s. Children in Japan plateaued in height in the early 1990s and likewise their Korean peers plateaued in the mid-2000s. The author and his colleagues have done much in comparative analyses, mainly from the food supply perspectives. Two years ago, he was shocked to discover that Korean children have kept declining drastically in growth velocity of height from 1st graders in primary school (age 6 yr.) to 3rd graders in high school (17 yr.) over the period from 2000 to 2017(JF&N, 2020 [13]).

Figure 1 clearly shows that Korean school boys rose very sharply from 54.0 cm to 56.5 cm in respect of height growth velocity from

age 6 to 17 in the 1980s, and then began to fall sharply in the first half of the 1990s, kept constant in the following decade and then kept declining sharply again toward the end of the 2010s.

Korea was very poor a half century ago. Per capita supply of animal products was 108 kcal/day in 1970 (3 year moving average of 1969-1971), rapidly rose to 317 kcal in 1990 and 545 kcal in 2010, respectively [10].

Children increased rapidly in height accordingly. Young adults or late adolescents at age 19-20 in the early 1990s spent their “early years of life” [14] before the mid-1970s, when the economy was very poor and their “pubertal spurt” in the mid-1980s, when the living standards were just beginning to rise. If you follow mean height of all ages from zero or 6 years old, 1st graders in primary school to late adolescents in the early 2000s, the increments in height may or may not represent true aging effects. But 1st graders in primary school in the early 2000s will have grown to their late adolescence only in the mid-2010s. In order to determine the actual growth from 1st graders in primary school to 3rd graders in high school, the only natural way is to follow the birth cohorts. We will present natural, or true growth charts for the 3rd graders in high school, as of 1976, 1995, 2000, 2009, and 2017 in South Korea, based on “longitudinal data”, in place of “cross-sectional data” [1, 2] (Table 1).

As contrasts, a few cases of growth charts of Japanese school children at the 3rd grade in high school, as of 1973, 1995, and 2017 are provided. Only in the first case of 1973, the curve based on “longitudinal data” proves apparently lower in vertical location than the curve based on “cross-sectional data”, followed by no apparent differences between the two approaches, in 1995 and 2017. However, notice that the growth chart which traces birth cohort is located apparently above the chart based on cross-section data in the final year of 2017 in South Korea (Figure 6).

**Table 1:** Excerpts of mean height and number of examinees: by age, KNHNES and School Survey, age 10 to 21, 2010

Age (yr)	KNHNES V		School H S	
	No.	Height(cm)	No.	Height(cm)
10	182	141.9	7,598	144.0
11	171	148.7	7,669	150.2
12	191	157.3	9,389	157.9
13	164	163.4	9,294	164.2
14	187	168.9	9,107	168.9
15	151	171.5	9,220	171.8
16	134	173.7	8,952	173.0
17	142	174.0	7,094	173.7
18	120	173.6	NA	NA
19	74	174.5	NA	NA
20	31	173.0	NA	NA
21	54	174.4	NA	NA

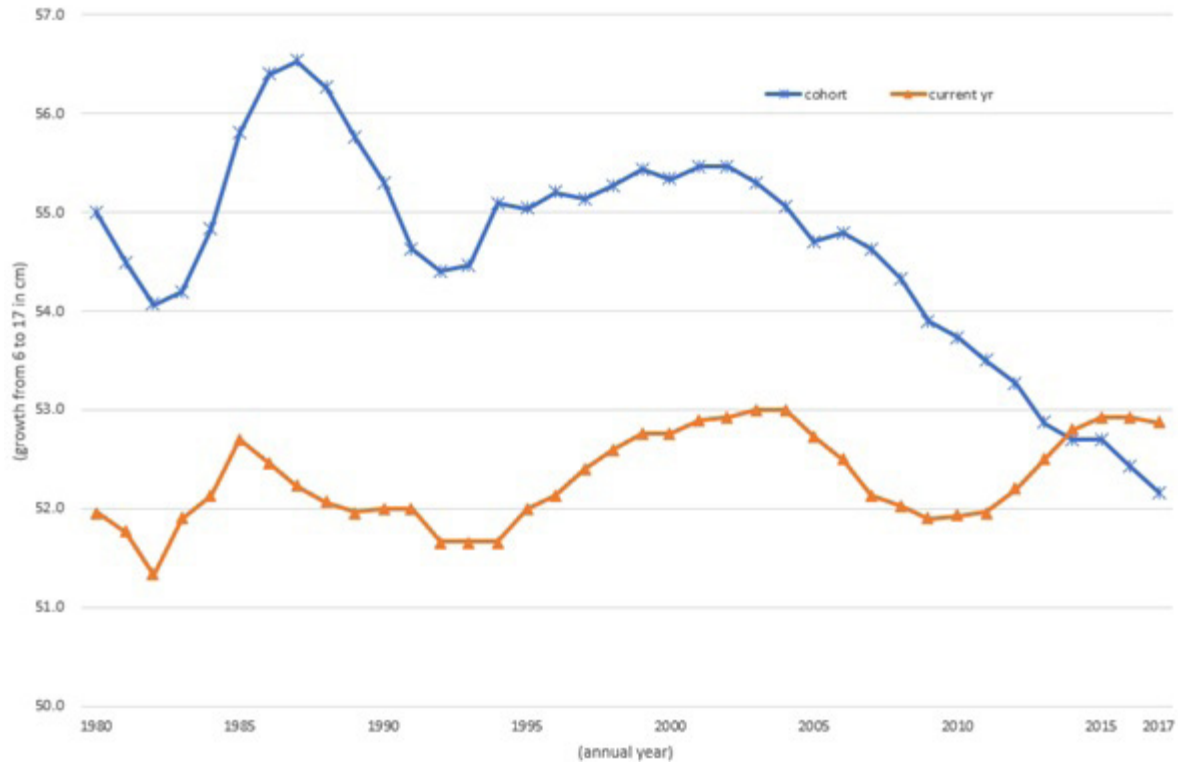


Figure 1: Kr school boys' height growth from age 6 to 17: cohort vs. current year, 1980 to 2017

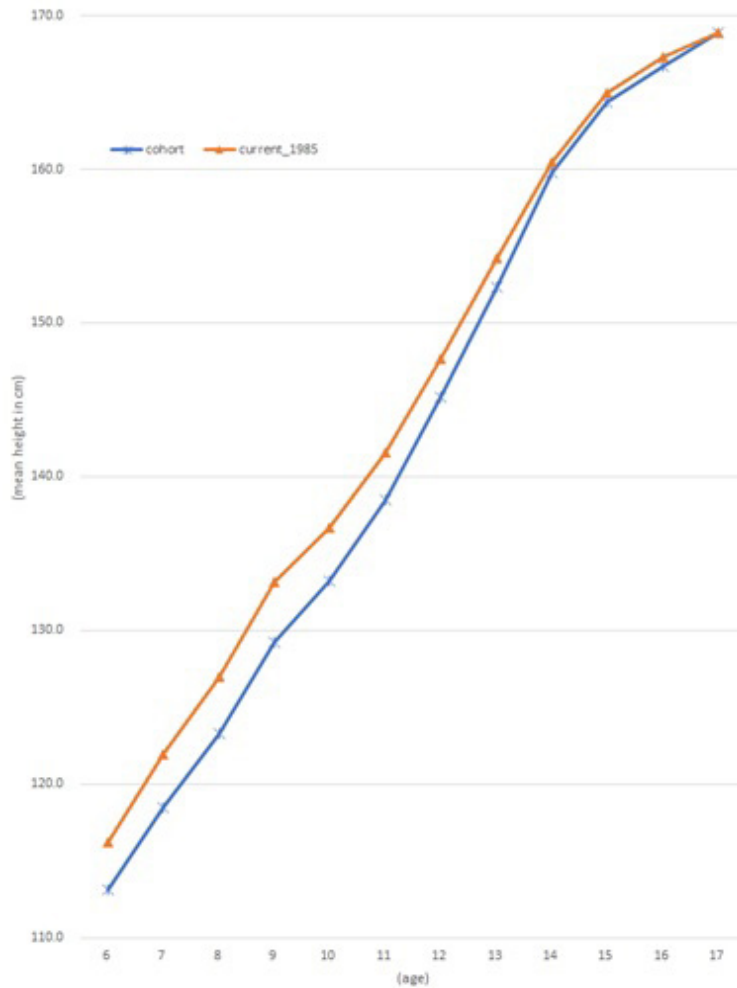
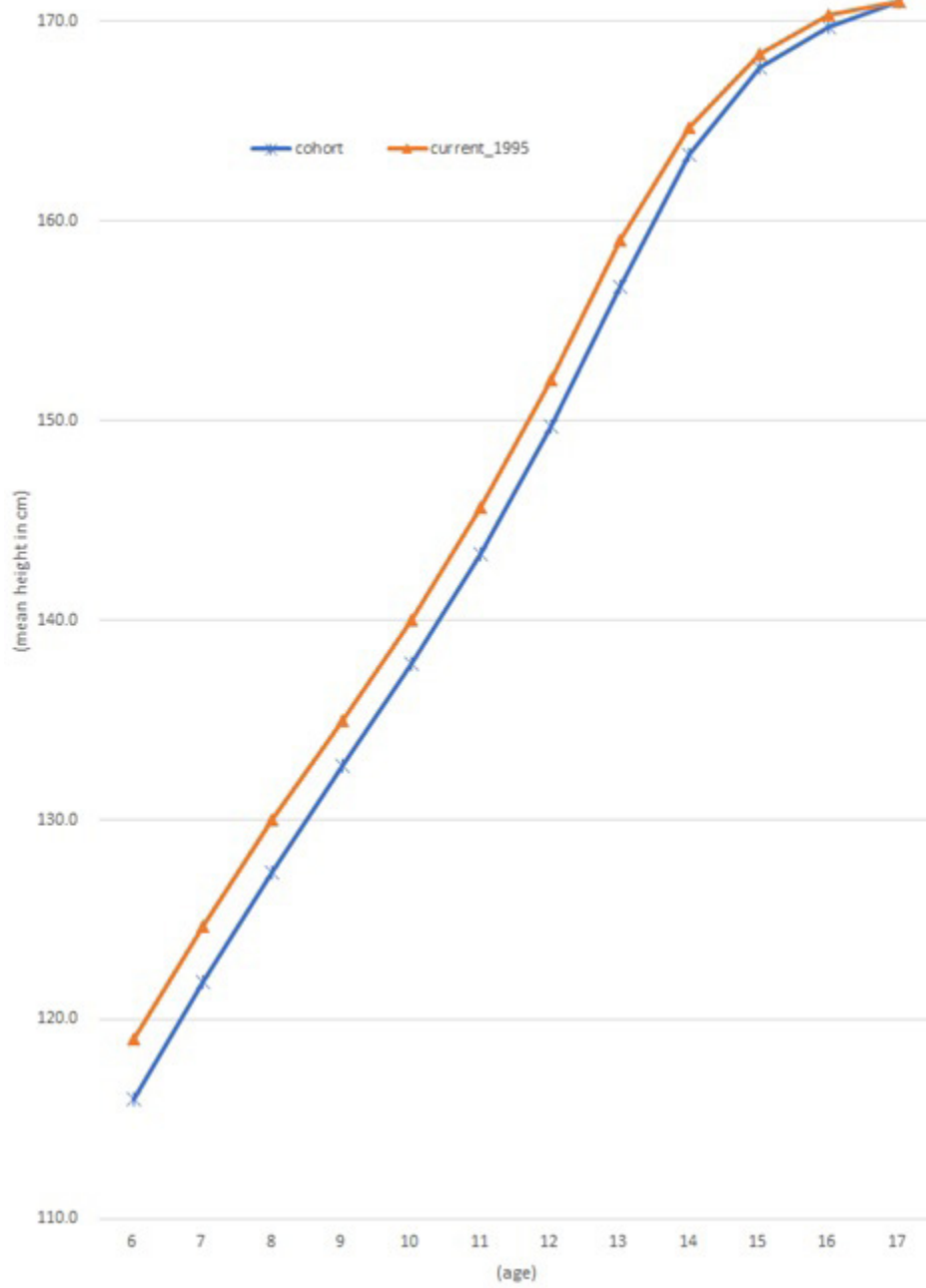
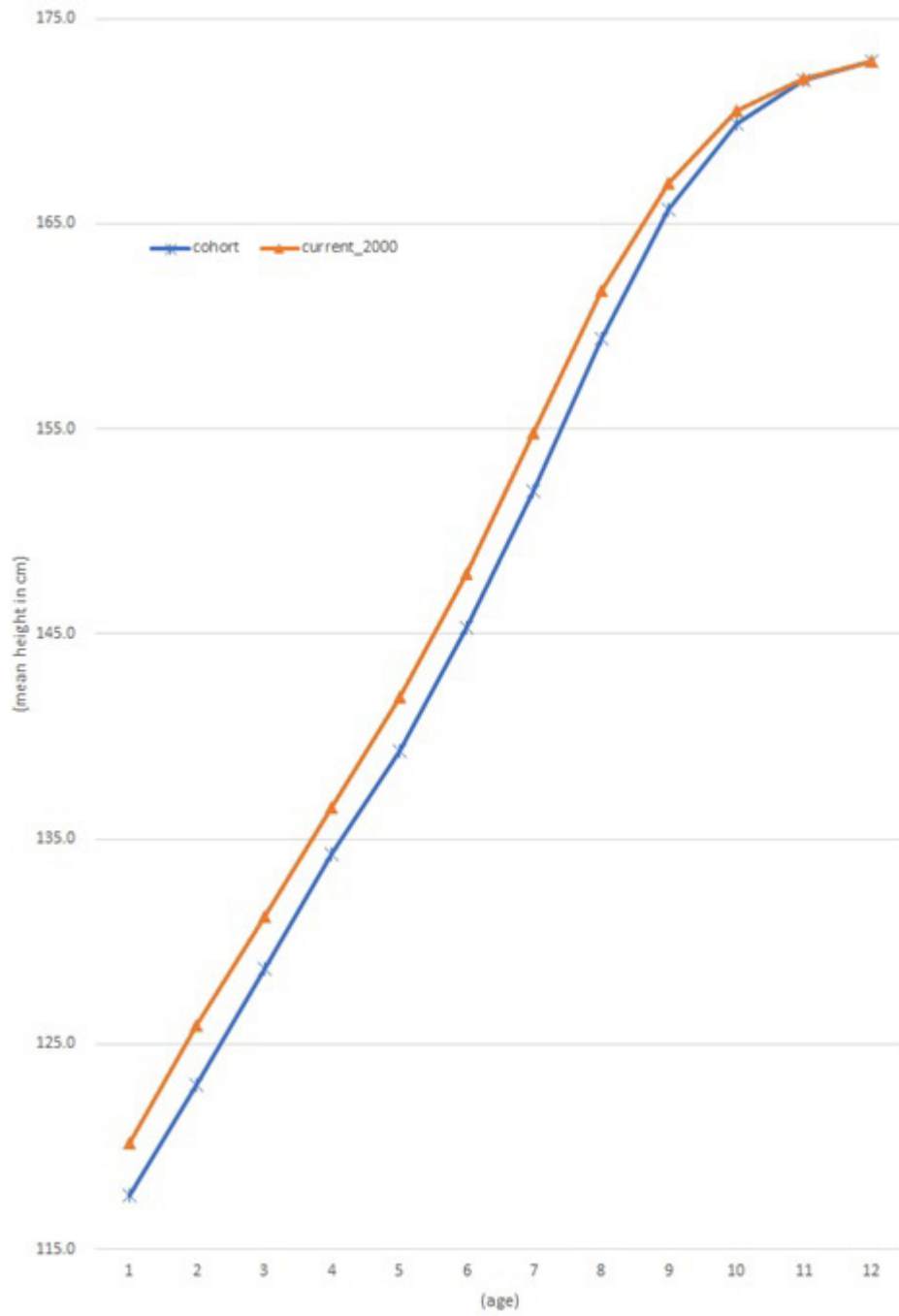


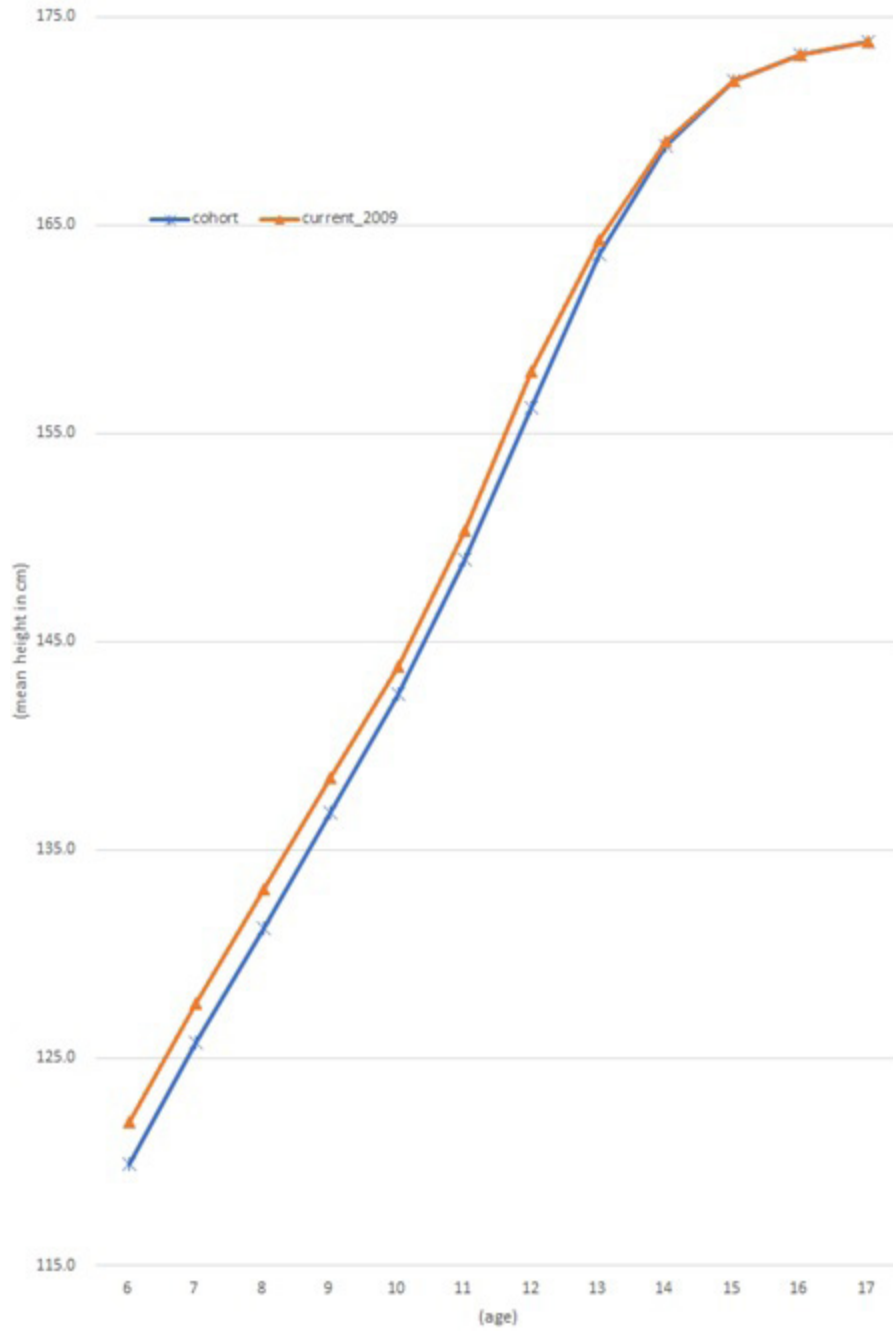
Figure 2: Height growth chart from age 6 to 17, Korean school boys: current year vs. birth cohort, 1976



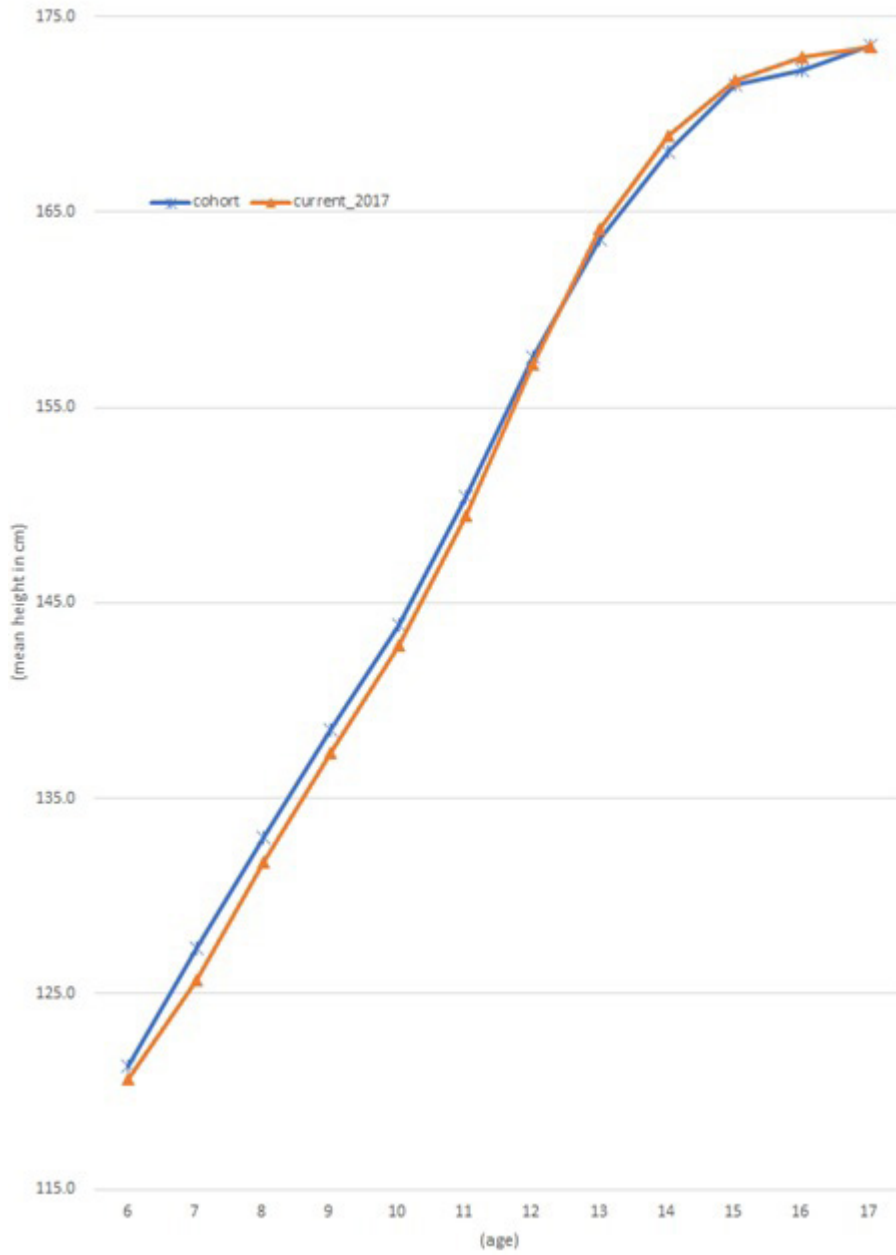
**Figure 3:** Height growth chart of from age 6 to 17, Korean school boys: current year vs. birth cohort, 1995



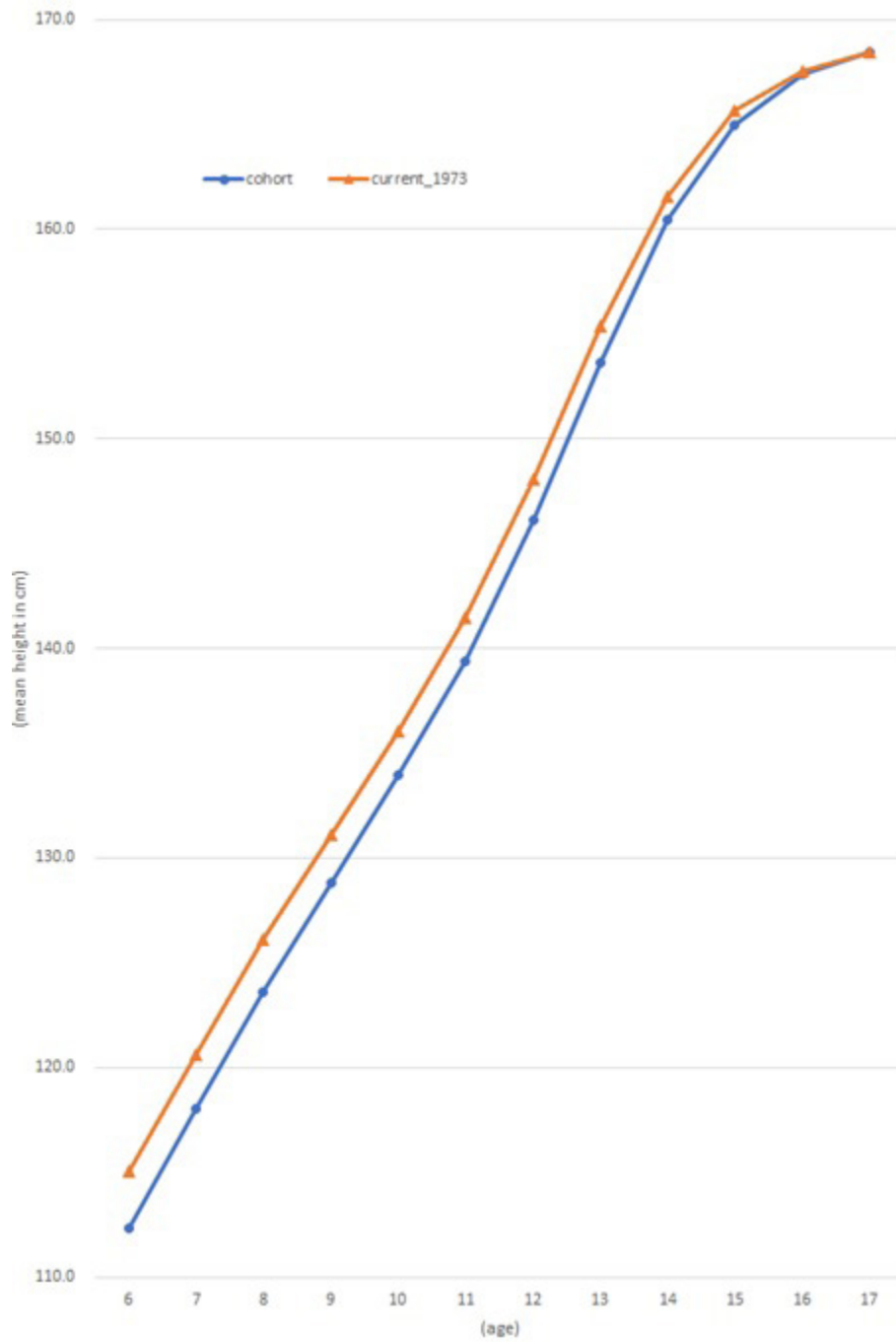
**Figure 4:** Height growth chart from age 6 to 17, Korean school boys: current year vs birth cohort, 2000



**Figure 5:** Height growth chart from age 6 to 17, Korean school boys: current year vs. birth cohort, 2009

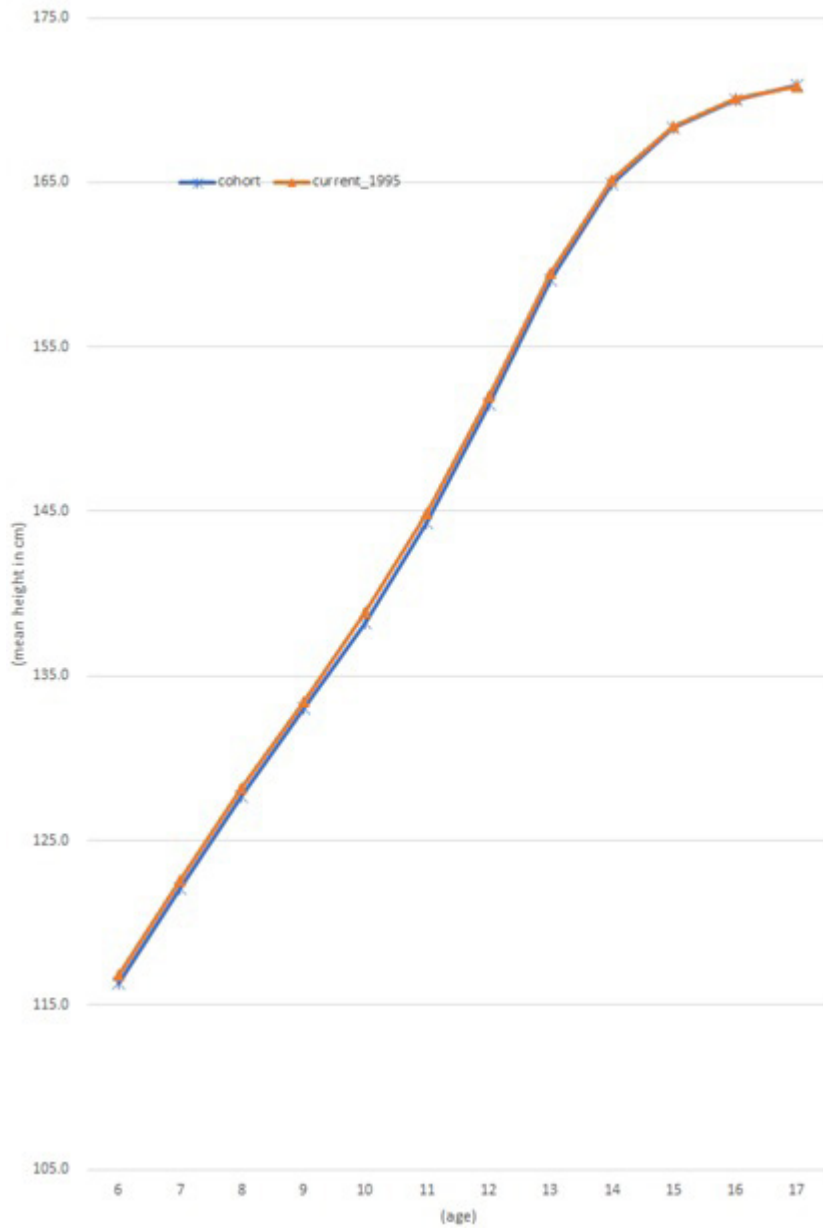


**Figure 6:** Height growth chart from age 6 to 17, Korean school boys: current year vs. birth cohort, 2017

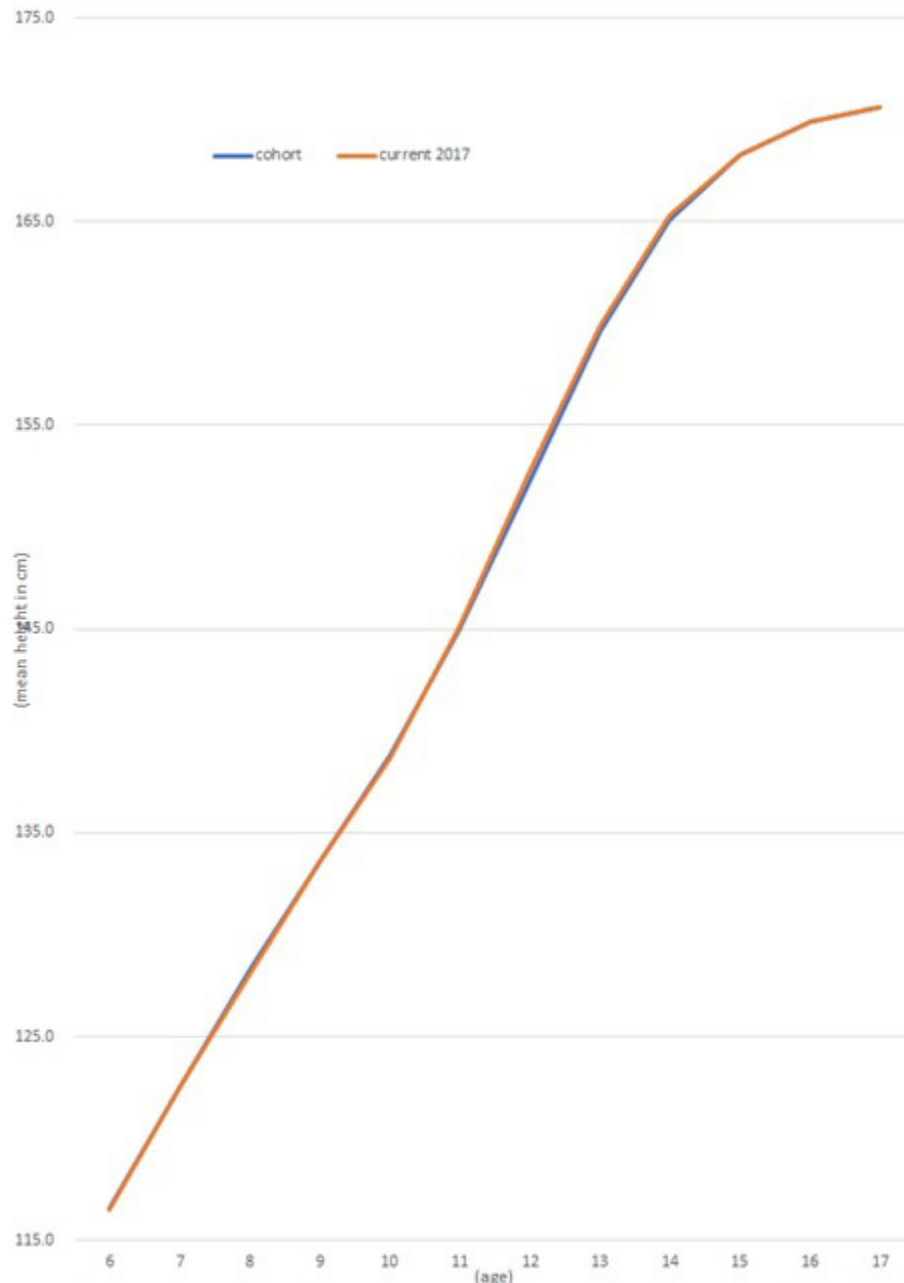


**Figure 7:** Height growth chart from age 6 to 17 of Japanese school boys: current year vs. birth cohort, 1973





**Figure 8:** Height growth chart from age 6 to 17 of Japanese school boys, current year vs. birth cohort, 1995



**Figure 9:** Height growth chart from age 6 to 17 of Japanese school boys: current year vs. birth cohort, 2017

#### 4. Conclusion

Growth curve/chart is a statistical tool, which is designed to demonstrate how children grow in stature as they grow by age. A person, who was 6 years old in 2000, for example, grew to 7 in 2001, and 17 in 2011. He or she does not stay in the same year in 2000, as growing older year by year. To construct the growth chart, it is imperative to follow the “longitudinal data”, instead of “cross-sectional data” either in 2000 or 2011. If no differences are discerned, whether depending on cross-sectional data or longitudinal data, physiologically or conceptually, human growth by age is a longitudinal phenomenon.

#### References

1. Ryoo, Na Yung, Ha Young Shin, et al. Change in height of Korean children and adolescents: analysis from the Korea National Health and Nutrition Survey II and V, *Korean J Pediatr.* 2015; 58(9): 336-40.
2. Kim, Jae Hyun, Sungha Yun, et al. The 2017 Korean National Growth Chart for children and adolescents: development, improvement, and prospects, *Korean J Pediatr.* 2018; 61(5): 135-49.
3. Republic of Korea, Korea National Health and Nutrition Examination Survey, various issues.
4. Japanese government, Ministry of Health and Welfare, National Health and Nutrition Survey, various issues.
5. Republic of Korea, Department of Education, School Health Sur-

veys, various issues.

6. Japanese government, Ministry of Education and Science, National School Health Surveys, various issues.
7. Mori H. Structural changes in food consumption and human height in East Asia, LAMBERT Academic Publishing, Berlin. 2020; 1-156.
8. Mor, H, Cole T, Kim S. Boys' height in South Korea in the past three decades: Why they ceased to grow taller?--Steering away from Kimchi, *Senshu Economic Bulletin*. 2021; 55(3): 29-39.
9. Steckel, Richard, 1995. Stature and the standard of living, *J Economic Literature*, VVVIII. 1903-1940.
10. United Nations, FAOSTAT, Food Balance Sheets, various issues on the internet.
11. Japanese government, Statistics Agency, Family Income and Expenditure Surveys, various issues.
12. Republic of Korea, Statistics Korea, Household Income and Expenditure Surveys, various issues.
13. Mori H. Secular changes in boys' height in South Korea: Comparison with Japan, particularly with respect to growth velocity, *J Food Nutrition*. 2020; 6: 1-7.
14. Deaton A. Height, health and development, *PANAS*. 2007; 104(33): 13232-7.