Original Paper
原著論文

The growth of height in early childhood determines the height of Japanese people (From the school health survey, 1900-2017)

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Abstract

Since the Second World War, the height of Japanese 17 year-olds has increased 10cm for boys and 6cm for girls. This is a well-known fact. This marked increase in height is commonly believed to be a "phenomenon occurring during the school-age period", and following this reasoning, it is suggested to be a result of an acceleration or advancement of growth during this interval, and especially during puberty.

However, we reviewed school health statistics surveys since 1900 to 2017 and discovered that the prevailing explanation is incorrect. Furthermore, we found that the increased size of the Japanese people is brought about before children attend school (in early childhood), and that there is a complimentary/negative correlation (boys r=－0.958, girls r=－0.989) between growth during the school-age period and early childhood.

1. Introduction

The height of the Japanese people has increased dramatically since the end of the Second World War. The average height of 17 year-olds has increased 10cm for boys and 6cm for girls. This is a well-known fact. This marked increase in height is commonly believed to be a "phenomenon occurring during the school-age period", and following this reasoning, it is suggested to be a result of an acceleration or advancement of growth during this interval, and especially during puberty. Reinforcing this view, the Annual Report of School Health Statistics contains charts that compare annual increases in weight and height (velocity of growth) of the current generation vs. their parents' generation, 30 years previous, and states that the current generation reaches the age of maximum growth rate earlier (MEXT, 2017[1]). It is repeatedly reported that children currently reach puberty earlier than their parents did. This emphasis on advanced puberty and growth, paired with the increased height of 17 years old, naturally leads people to conclude that the increased height of the Japanese people occurs during the school-age period.

However, in this paper we reviewed school health statistics surveys since 1900 to 2017 and discovered that the prevailing explanation is incorrect. Furthermore, we found that the increased size of the Japanese people is brought about before children attend school (in early childhood), and that there is a complimentary/negative correlation between growth during the school-age period and early childhood.

2. Definition of total growth during the school-age period

To prove the above claims, this paper used the concept of total growth. In the Annual Report of School Health Statistics, this is expressed as the total growth from age 5-17 (MEXT, 2017[1]), but in this paper we excluded

kindergarten, and defined total growth as the amount that height increased from 1st grade until the end of high school, or age 6-17.

The total growth during the school-age period was determined using the tracking values for each cohort; for example, 6 year-olds in 1948 turn 17 in 1959 and the data from this period is needed. In addition, the total growth from birth to school-age is thought of as 'early childhood growth', and so the height at 6 years old can be substituted (Ohsawa, 2012[2]). Previously, Ohsawa (2003[3]) used the same approach to make comparisons between countries or different groups, but defining total growth as that occurring from age 5 to 18. In this research the range is limited to 6-17 years old. Total growth is defined in the following way: **cohort's total growth during school-age period (A) = average height of cohort at age 17 (B)－average height of cohort at age 6 (C)**

When we refer to the '1900 cohort', we mean 'the group of children who were 6 years-old in 1900'.

3. Observations on the total growth of boys during school-age period since 1900 to 2017

Using the above definitions, we determined the total growth of boys during the school-age period. In **Figure 1**, we plotted a blue line, the year (x-axis, 1900 to 2017) against total growth during the school-age period (y-axis). The scale is on the left side of the figure. We observed that the height of the cohort of 6 year-olds in 1900 increased by 52.4cm by the time they were 17 years old. This value increased with fluctuations, reaching 54.8cm by 1923. Since the Meiji era 1900-1923 and a few years after the war were the only intervals in which total growth during the school-age period increased consistently for boys for 10 years or more. Aside from these times, total growth did not consistently increase. Because of the war, from the latter 1920s until 1948, statistical values for the cohorts are not available. Total growth values require 11 years of data, so total growth values are missing for a 19-year period. The calculations became possible again from 1948 on. (It is not that there were no statistics for anyone during this period, but the values exhibited such large variations that they were deemed unreliable and therefore not used in our analysis.)

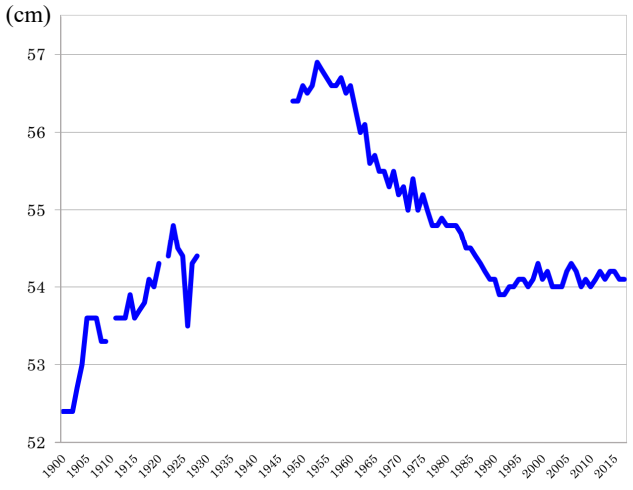

Figure 1. Total growth during school-age period (boys), by year (1900-2017)

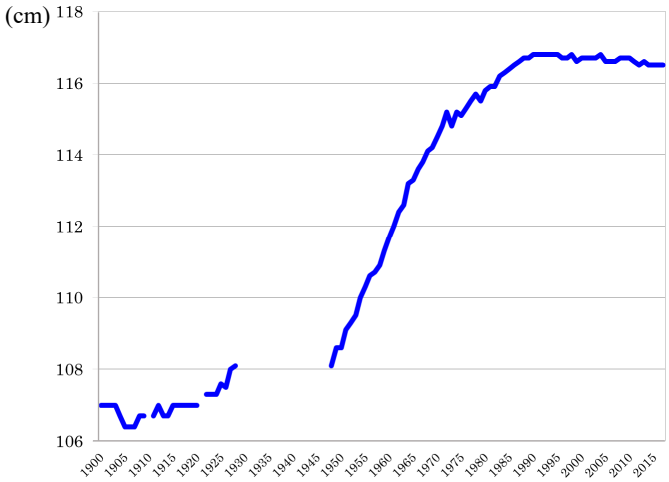

Figure 2. The Height of 6 year-olds (boys), by year (1900-2017)

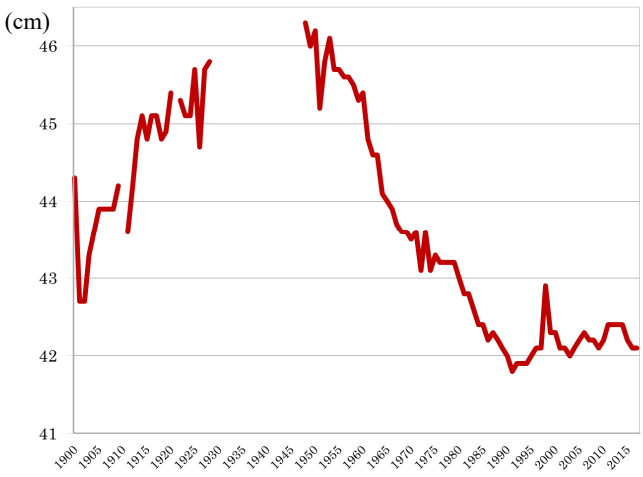

Figure 3. Total growth during school-age period (girls), by year (1900-2016)

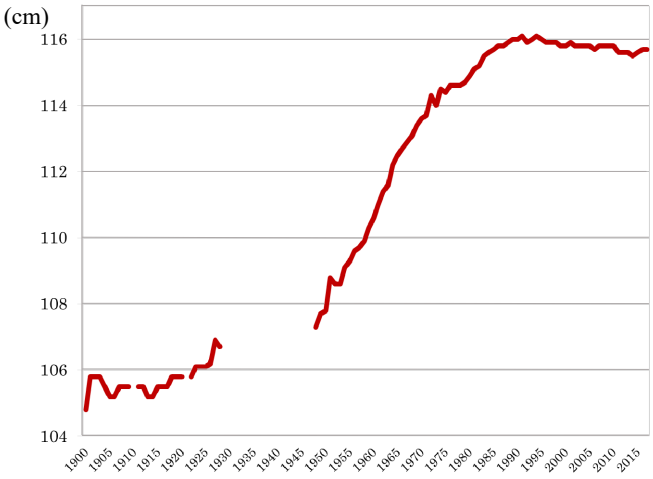

Figure 4. The Height of 6 year-olds (girls), by year (1900-2016)

From 1948, the total growth for boys begins at 56.4cm. 16 years after the war, growth reached 56cm, and by 1953 it had reached 56.9cm. This is the peak value for Japanese total growth during the school-age period. This means that among Japanese people, the cohort of 6 year-olds in 1953 displayed the largest growth during the school-age period.

However, since 1953 values continued to decrease, this trend slowly progressing below 56cm, and falling to 55.6cm by 1964. By 1977 it dropped to 54.8cm, and gradually decreased to 53.9cm by 1991. Currently（2000 to 2017）, the total growth during the school-age period hovers around 54cm, and there are no signs that it will rise again. Boys have declined 5% from their peak value in this consistent decrease in growth in the postwar period.

4. Observations on the total height growth of girls during the school-age period since 1900 to 2017

Next we considered girls' growth during the school-age period. According to Figure 3, the annual change in total growth closely resembles the pattern exhibited by boys. A point of difference with boys is that girls' growth today is approximately 2cm less than it was 100 years ago (the 1910's). Girls' total growth during the school-age period today is less than it was during the Meiji era. In contrast, 6 year old girls' height is currently 11cm taller than during the Meiji era in Figure 4. This indicates that the total growth during early childhood has become extremely large.

In Figure 3, similar to boys, girls' total growth reached the apex of 46.3cm in 1948, and from there dropped consistently, dipping below the 46cm mark after the war, and arriving at 44.8cm by 1961. In 1966, total growth was 43.9cm, but continued to decline, reaching 42.8cm in 1981.

There was no slowing in this trend, and in 1991 total growth fell below 42cm, and currently(2000 to 2017) holds steady around 42cm. Compared to the peak growth value, Japanese girls' growth has fallen 9%, while the height of adults has increased dramatically since the war. Boys have gone from 160.6cm to 170.7cm, or approximately 10cm taller, while women have gone from 152.1cm to 158cm, or approximately 6cm taller. This abrupt increase in height is commonly thought to occur in the school-age period, leading to strong interest in the fields of school health studies and adolescentology. There has been a tendency to link this increased height with an advancement or acceleration of puberty, however our analysis shows that in fact this increase in height did not occur during the school-age period, and that growth during this period has consistently decreased since the war.

In that case, to which period do we attribute the Japanese people's height increase? This must have occurred before age 6, in early childhood.

Next, we investigated the relationship between total growth during the school-age period and total growth in early childhood. Referring to Figure 2, the height of 6 year old boys is represented by a blue line. We can see that for the first 20 years after 1900, the height stays relatively unchanged at 107cm, then there is a 5mm increase through the 1920's until the period of missing data begins at the end of that decade.

Most notable is the height of 6 year-olds after the war. The postwar values begin at 108.1cm, and then rapidly increase until the 1980's. In other words, the trend runs opposite to the decrease in total growth during the school-age period beginning in 1953, the height of 6 year-olds reaching 115cm by the 1970s and 116cm by the 1980s. Current values (2000 to 2017) have stayed around 116.5-116.7cm. This is an 8% increase since 1953.

Looking at the change in height of 6 year old girls in Figure 4, we see a very similar curve to that of boys; beginning with 107.3cm after the war, quickly reaching 108.8cm in 1951, 109.1cm in 1954, followed by steady increases—111cm in 1961, 112.2cm in 1964, 113.1cm in 1968, 114.3cm in 1972, 115.1cm in 1981, and 115.8cm by 2000. In the postwar period, girls' height has increased 7.9%.

5. The relationship between total growth during the school-age period and during early childhood

Next we investigated the relationship between the two variables: total growth during the school-age period and total growth during early childhood (or the height of 6 year-olds). We used the data from after the war until present day.

Figure 5 (boys) and 6 (girls) illustrate this relationship. With height at 6 years old on the x-axis, and the total growth during the school-age period on the y-axis, we see how data falls in an almost straight line on both Figures. The correlation coefficient for boys was −0.958 and −0.989 for girls. In other words, for both girls and boys, the larger the total growth during early childhood, the smaller the total growth during the school-age period.

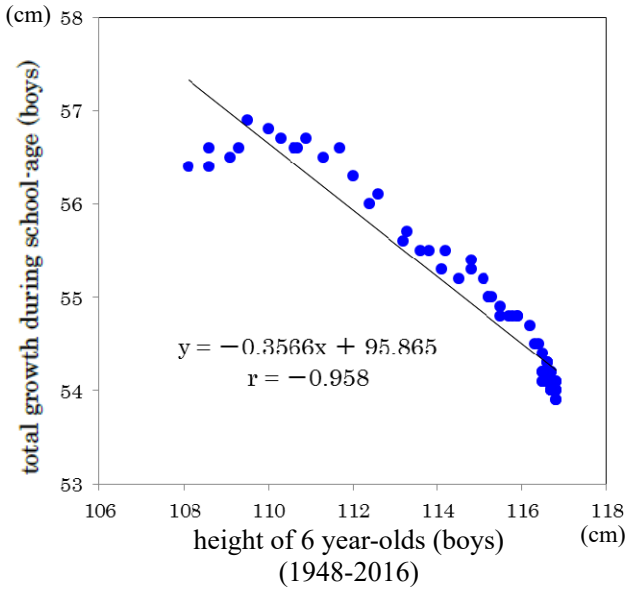

Figure 5. Relationship between total growth during school-age period and height of 6 year-olds (boys)

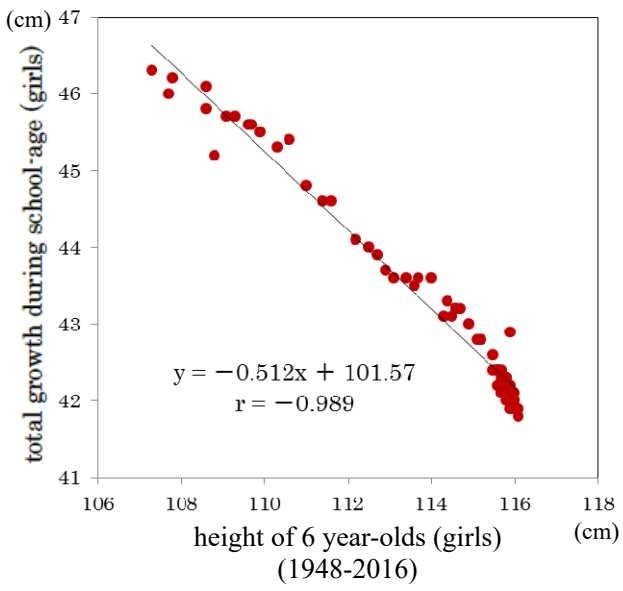

Figure 6. Relationship between total growth during school-age period and height of 6 year-olds (girls)

This phenomenon was observed for all regions of Japan, post-war until the present day.

The significance of these Figures is that the taller the height at 6 years old (a large total growth during early childhood, until the age of 6), the growth after that is suppressed. The inverse is also true; that when the growth during early childhood is larger, the growth afterward is smaller. There is a 'trade-off' relationship between the two growth periods.

In the 50 years since the war, the height of Japanese adults has increased despite the continued decrease in growth during the school-age period, and thus the cause must be explained by the height increase in early childhood/the period before reaching school-age.

6. Conclusion

From our observations and analysis we can make the following conclusions:

1) There was an increase in the total growth during the school-age period during the Meiji era, peaking dramatically directly after the war, but afterward there was a long decline. This phenomenon can be seen in boys and girls. In recent years, growth during this period has remained constant.

2) In contrast, in the 50 years since the war, the height of 6 year old boys and girls has continually increased.

3) The more growth during early childhood increases, the more growth during the school-age period decreases. The trade-off relationship between growth during these two periods for both boys and girls has a very high negative correlation (−0.958 and −0.989).

4) While the increased height of post-war Japanese adults has been previously understood as occurring during the school-age period or puberty, this is not true; the cause is significant growth during early childhood.

Note: This paper is based on a previous effort to evaluate growth on a large scale (countries or ethnic groups) using the school health index of total growth from ages 5 to 18 (Ohsawa, 2003[3]). Furthermore, it builds on previous research (Ohsawa, 2012[2], 2014[4]) that analyzed growth from the Meiji era until present day using total growth from age 6-17. This paper shows the trade-off relationship between growth during early childhood and school-age period. This research was supported by the "Japan Society for the Promotion of Science Grants-in-Aid for Scientific Research (KAKENHI); Category: Scientific Research (A), ID=23240098, Research Director: Seiji Ohsawa".

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