

## Secular change of physical growth in Korean children and youth between 1999 and 2005

Myung Kim\*, Hye Kyeong Kim\*\*, Yoshiyuki Matsuura\*\*\*

\* Department of Health Education and Management, Ewha Womans University

\*\* Health Promotion Research Institute, Korea Association of Health Promotion

\*\*\* University of Tsukuba

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### I. Introduction

Secular change has been well recognized in most kinds of phenomena taken place in human society(Matsuura, 2002, 2005; Tanner, 1966; Ven Vieringen, 1978). In physical growth, secular change is by nature taking place and has been studied and discussed by many researchers for several reasons. It is a marker of the public health of the population as it changes over time(Tanner, 1992), and provides insight into the link between growth and environment(Cole, 2000). Furthermore,

it illustrates aspects of the physiology of intergenerational relationships in growth and size(Emanuel et al., 1992).

In relation to children and youth, the growth status is perhaps the best indicator of the overall health and nutritional circumstances in a community(Malina and Bouchard, 2004; Raphael, 2000). Therefore, secular change of the physical growth status may suggest what problems children and youth are facing on their physical growth and how they are different from those in the past. These kinds of information can help to identify the health

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Corresponding Author: Hye Kyeong Kim, Korea Association of Health Promotion  
1097 Hwagok 6-dong, Gangseo-gu, Seoul, 157-704, Korea  
Tel: 82-2-2601-6142, Fax: 82-2-2601-2370, E-mail: hkkim@kahp.or.kr

promotion need of children and youth.

Our previous study(Kim et al., 2002) analysed the secular trend of physical growth in Korean children and youth from 1964 to 1999. Results indicated that the measures of adolescents' physical growth including stature, weight, chest girth, and sitting height were shown to be gradually increased between 1964 and 1999. In case of 17 year-old youth in 2005, boys grew 9.1cm and gained 10.1kg more and girls grew 4.6cm and gained 3.2kg more than in 1999.

In this study, we continue to investigate the secular change of physical growth in Korean children and youth between 1999 and 2005. In general, such a concept as secular change points the change taken place in rather long duration. However, significant differences can be found in growth distance of children and youth between two different periods, even though the difference between those periods is small. Particularly, in recent days, it has widely been felt by most of people that everything surrounding us is changing so rapidly and even such natural phenomena as climate, sea current, temperature of air, and so on, which were thought to the law of nature for a long time, seem to be changed so furiously. Therefore, even a little gaps between periods may result in differences in physical growth.

In this respect, the purpose of this study is to clarify the traits of differences supposed

as secular differences in physical growth between samples of children and youth in 1999 and 2005, and to identify the need of children and youth for health promotion.

## II. Methods

### 1. Samples

Two samples of youth were selected by convenience sampling. The first one was consisted of 231 boys and 346 girls who were 16 years of age in a senior high school located in Seoul in 1999. And the other was consisted of 171 boys and 400 girls who were 16 years old in two senior high schools located in Seoul in 2005. Then the longitudinal growth distance data were collected from their cumulative health examination records. The missing data were interpolated with spline or divided difference methods.

### 2. The derived growth variables

Peak age, peak velocity, growth amount, growth ratio and growth potential at 15 years of age were derived as growth variables, Owing to the growth distance data aged from 6 to 16 years of age, the growth velocity at 15 may suggest how much growth potential may remain in each individual.

Peak age was determined as follows: let  $Y_i$ ,  $i = 1, 2, 3, \dots, 10$  be the series of annual

Table 1. The Differences in growth distance between 1999 and 2005

Age	Stature		Body weight		Sitting height		Chest girth	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
6	-1.78**	-1.58**	-1.52**	-1.51**	-0.9**	-0.47**	-1.68**	-1.31**
7	-1.84**	-1.87**	-2.52**	-1.58**	-0.67**	-0.44**	-2.3**	-1.52**
8	-1.82**	-1.92**	-2.74**	-1.97**	-0.65**	-0.48**	-2.41**	-1.76**
9	-1.63**	-1.93**	-3.27**	-2.35**	-0.46*	-0.60**	-2.69**	-1.69**
10	-1.52**	-2.26**	-3.39**	-2.57**	-0.29	-0.71**	-3.17**	-1.77**
11	-1.63**	-2.23**	-4.16**	-2.67**	-0.33	-0.60**	-3.46**	-1.66**
12	-2.72**	-2.15**	-4.65**	-2.47**	-1.08**	-0.44*	-4.33**	-1.59**
13	-2.06**	-1.82**	-4.35**	-2.47**	-0.9*	-0.42*	-4.04**	-1.71**
14	-1.36**	-1.48**	-4.98**	-2.25**	-1.01**	-0.42*	-3.8**	-1.96**
15	-0.8	-1.18**	-5.9**	-1.69**	-1.11**	-0.36*	-2.88**	-2.37**
16	0.28	-1.17**	-5.23**	-1.70**	-0.76**	-0.35*	-1.16*	-2.26**
Mean	-1.535	-1.781	-3.883	-2.112	-0.742	-0.481	-2.902	-1.782
SD	0.761	0.385	1.317	0.432	0.290	0.111	0.985	0.310

\*p<=0.05, \*\* p<=0.01

1) The figures in cells are the differences in growth distance between 1999 and 2005: (growth distance of 1999)-(that of 2005)

growth amount,  $Y_{max}$  be the maximum growth amount and  $X_{max}$  be the age corresponding to  $Y_{max}$ , and  $Y_1$  and  $Y_2$  be the growth amounts at  $X_{max-1}$  and  $X_{max+1}$ , and an quadratic equation be fit to three points:  $(X_{max-1}, Y_1)$ ,  $(X_{max}, Y_{max})$  and  $(X_{max+1}, Y_2)$  and then a quadratic equation is determined and the equation determined be  $Y = aX^2 + bX + c$ , and then the  $X^*_{max} = c - b^2/4a$  and  $X^*_{max} = -b/2a$ . The peak age is given by  $X^*_{max}$  and peak velocity by  $Y^*_{max}$ .

Growth amount was given by (growth distance at 16 years of age)-(the one at 6

years of age). Growth ratio was given by growth amount/growth distance at 6 years of age and growth potential is equal to the growth amount at 15 years old.

In order to investigate how much the children and youth in 2005 are in advance of those in 1999 in physical growth, the following means were made. Let  $Y_{2005}$  be any given growth distance in 2005 and  $X_1$  and  $X_2$  be the lower bound and upper bound of the interval of age in which  $Y_{2005}$  exists, and  $Y_1$  and  $Y_2$  be the growth distance corresponding to these ages, and then  $X^*_{2005}$  be the age corresponding to  $Y_{2005}$

on the 1999 growth curve.

Then,  $X^*_{2005}$  is given by the following formula:

$$X^*_{2005} = (Y_{2005} - Y_1) / (Y_2 - Y_1) + X_1$$

This formula was derived based upon the assumption that the growth trend in the interval of a year is linear.

For statistical examination of differences in measures between these two years, t-test was utilized.

### III. Results

#### 1. The changes in growth distance

Fig. 1 and 2 show the 1999 and 2005 growth distance curves of stature and body

weight from 6 to 16 years of age for both sexes. As shown in figures, the 2005 growth distances are larger than the 1999 ones at all ages for both sexes. The significance of differences were shown in table 1. Boys' body weight and chest girth were significantly larger at all ages in 2005 than in 1999. But significant differences were not found at 15 and 16 years of age for boys' stature and at 10 and 11 years of age for sitting height. Boys' stature and sitting height in 2005 were larger at other ages than in 1999. However, in girls, significant differences were found at all ages. As table 1 shows, all differences were negative and significant. That means girls in 2005 were significantly larger at all ages than those in 1999.

Table 2. The estimated differences in age by secular change between 1999 and 2005  
unit: years old

Age	Stature		Body weight		Sitting height		Chest girth	
	boys	girls	boys	girls	boys	girls	boys	girls
6	0.3	0.29	0.59	0.53	0.3	0.17	0.66	0.56
7	0.32	0.32	0.82	0.54	0.25	0.18	0.91	0.63
8	0.34	0.33	0.78	0.57	0.28	0.20	0.92	0.54
9	0.3	0.3	0.85	0.55	0.2	0.20	0.99	0.49
10	0.25	0.33	0.81	0.50	0.12	0.21	1.14	0.43
11	0.23	0.41	0.69	0.61	0.12	0.21	1.08	0.43
12	0.36	0.62	0.82	0.89	0.3	0.24	1.13	0.49
13	0.35	0.91	0.81	1.07	0.3	0.34	1.14	0.95
14	0.4	1.52	1.47	1.47	0.53	0.42	1.03	-
15	0.36	1.80	0.83	1.23	0.89	0.82	0.94	-
16	-0.12	2.06	0.76	1.33	0.94	0.56	0.35	-
Mean	0.281	0.808	0.839	0.845	0.385	0.323	0.935	0.631
SD	0.142	0.670	0.222	0.368	0.285	0.205	0.240	0.169

- 1) These figures mean the years which 2005 boys(girls) are ahead of 1999 boys(girls) in growth.
- 2) Chest girth of girls at 14, 15 and 16 years old could not be estimated, because the actual values of 2005 were over the extrapolated growth distance.

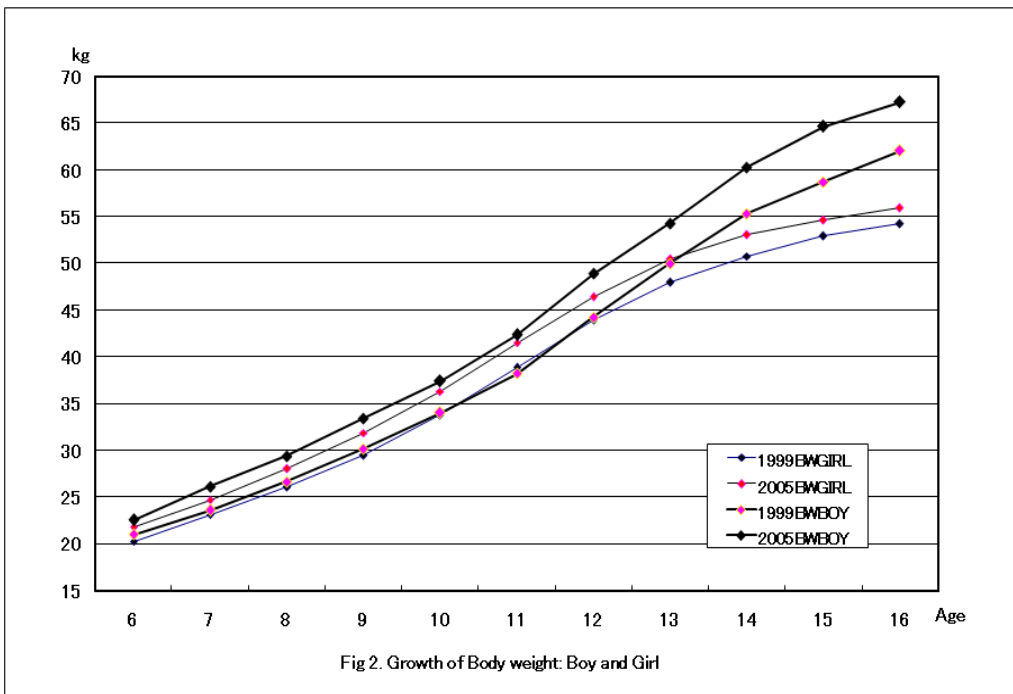
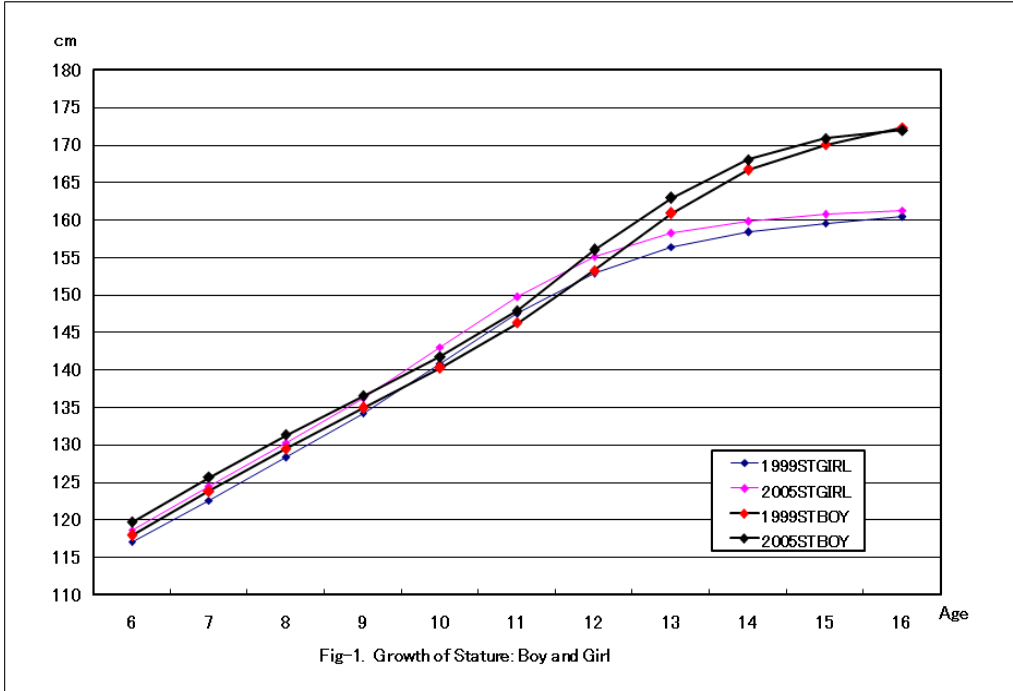


Table 2 shows the estimated differences in age which were supposed to be brought about by secular change, and these tables may suggest how much boys and girls in 2005 were in advance of those in 1999 in physical growth. Thus, it can be inferred that 2005 boys were 0.808 years in advance of the 1999 for stature growth, 0.759 for body weight growth, 0.323 for sitting height growth, and 0.565 for chest girth growth, and 0.281 for stature, 1.021 for body weight, 1.385 for sitting height, 0.935 for chest girth in girls. It can be inferred that the body growth is likely to be more ahead of than the linear growth in both sexes. In other words, secular change may be brought about more in the body bulk growth than in the linear. This may be why the body bulk growth is thought to be influenced more strongly by various environmental conditions than the linear growth. It must be noticed that the 2005 boys were a little more than one year in ahead of the 1999 boys in body weight growth even in such a short duration as 6 years. In girls, the equivalent ages could not be obtained in ages over 13 years old, because the 2005 growth distances were over the extrapolated growth curves and the age interval of 1999 in which the 2005 distances existed could not be found. This may suggest that the secular differences are bigger than expected.

## 2. The changes in growth traits

Table 3 shows the differences in peak velocity, growth amount, growth ratio, and growth potential between 1999 and 2005. Any significant differences were not found in peak age of all physique elements for boys and girls, except the boys' chest girth. So it can be inferred that secular change might not be appeared in peak age of physical growth.

In peak velocity, however, it was found that in all physique elements, significant differences, such as the 2005 being significantly larger than the 1999, were found in all physique elements for both sexes. So it can be inferred that peak velocity was influenced by secular change even in such a short duration as 6 years. In growth amount, significant differences were found for stature and body weight in boys and only for chest girth in girls. In boys' stature growth, the 2005 showed significantly smaller amount than the 1999, and in girls, although the difference was not significant, the 2005 was less in growth amount than the 1999.

The growth ratio in 2005 were significantly less than that in 1999 for both sexes. Significant differences were found in boys' chest girth growth and girls' body weight growth. These significant differences point that the 2005 were significantly smaller in growth amount in the age interval of 6 through 16. For growth potential, any significant differences was not found in all traits for girls. It shows that the growth of

Table 3. The Secular change in five growth traits between 1999 and 2005  
unit: Mean±SD

		Stature			Body weight			Sitting height			Chest girth		
		1999	2005	Sig.	1999	2005	Sig.	1999	2005	Sig.	1999	2005	Sig.
B O Y S	Peak age	11.53±1.28	11.46±1.40		11.72±1.57	11.59±1.72		11.21±2.27	11.46±1.75		11.73±2.44	10.59±2.39	**
	Peak velocity	9.06±1.08	10.88±2.47	**	8.48±1.68	9.66±2.94	**	5.26±0.82	5.50±1.28	*	6.70±1.62	7.24±1.99	**
	Growth amount	54.35±3.37	52.29±8.14	**	41.02±4.95	44.72±10.59	**	25.29±2.43	25.14±2.54		30.47±4.43	29.94±5.98	
	Growth ratio	0.46±0.04	0.44±0.07	**	1.96±0.28	1.99±0.41		0.39±0.04	0.38±0.05		0.53±0.09	0.51±0.10	*
	Growth potent.	2.23±1.50	1.15±2.38		3.29±2.37	2.61±2.32	**	1.25±1.32	0.90±0.85	**	3.06±2.41	2.16±1.80	**
G I R L S	Peak age	9.40±1.34	9.45±1.35		10.25±1.36	10.29±1.51		9.41±1.71	9.36±1.78		9.91±1.57	9.94±1.79	
	Peak velocity	8.22±3.48	8.67±1.30	*	7.27±1.68	7.66±1.89	**	4.68±1.14	4.89±0.98	**	6.29±1.56	7.12±1.66	**
	Growth amount	43.03±3.29	42.63±3.57		33.94±5.13	34.13±7.02		21.40±2.06	21.29±2.35		25.72±4.23	26.66±4.85	**
	Growth ratio	0.37±0.03	0.36±0.04	**	1.68±0.28	1.58±0.31	**	0.33±0.04	0.33±0.05		0.46±0.08	0.47±0.09	
	Growth potent.	0.59±0.02	0.59±0.58		1.27±0.04	1.29±1.48		0.45±0.08	0.43±0.48		0.61±0.23	-	

\*p<=0.05, \*\* p<=0.01

- 1) Growth amount=(growth distance at 16 years old)-(growth distance at 6 years old)
- 2) Growth ratio=(growth amount)/(growth distance at 6 years old)
- 3) Growth potent. stands for growth velocity at 15 years old.

most physical elements may stop around the age of 16.

In boys, it can be reasonably assumed that the physical growth continues until about 20 years of age. Thus, significant differences were found in rest of three physique elements except stature, and these significant differences may suggest that the 1999 was larger in growth potential at 15 years old than the 2005. The secular change may function to make physical growth stop earlier in boys. If so, it may suggest that the 2005 boys are

significantly in advance of the 1999 ones in peak age; morphological maturation.

### 3. The changes in growth velocity

Fig. 3(stature) and Fig. 4(body weight) show changing trends of growth velocity which were estimated with annual increment. In both sexes and in both periods; 1999 and 2005, showed similar pattern in the changing trend of growth velocity by age. Table 4 shows the significant differences between both periods. Such differences that the 2005

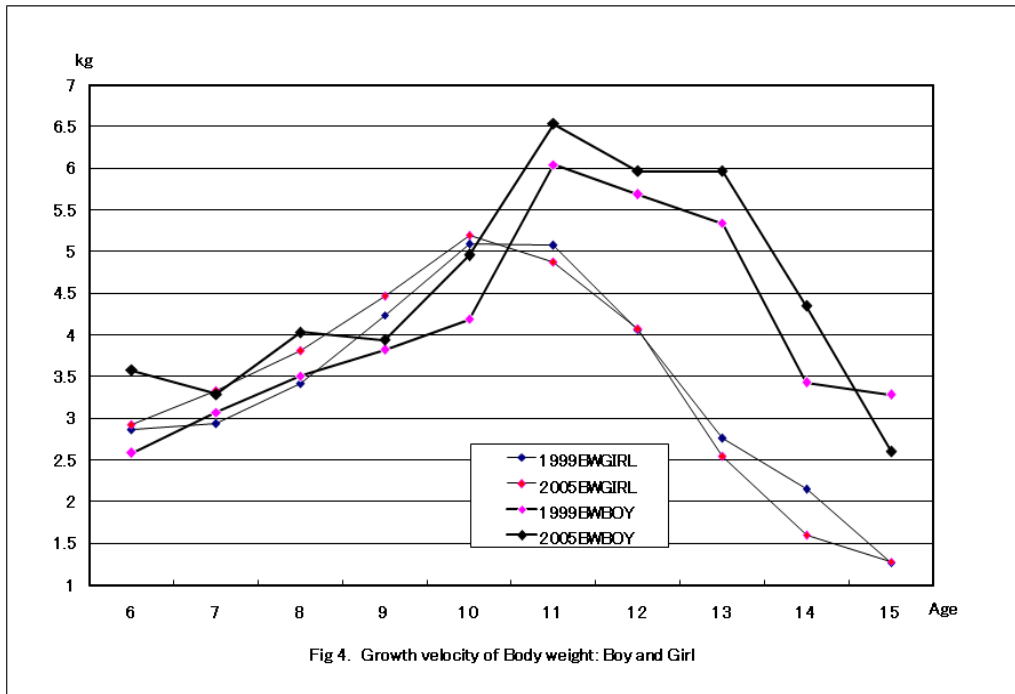
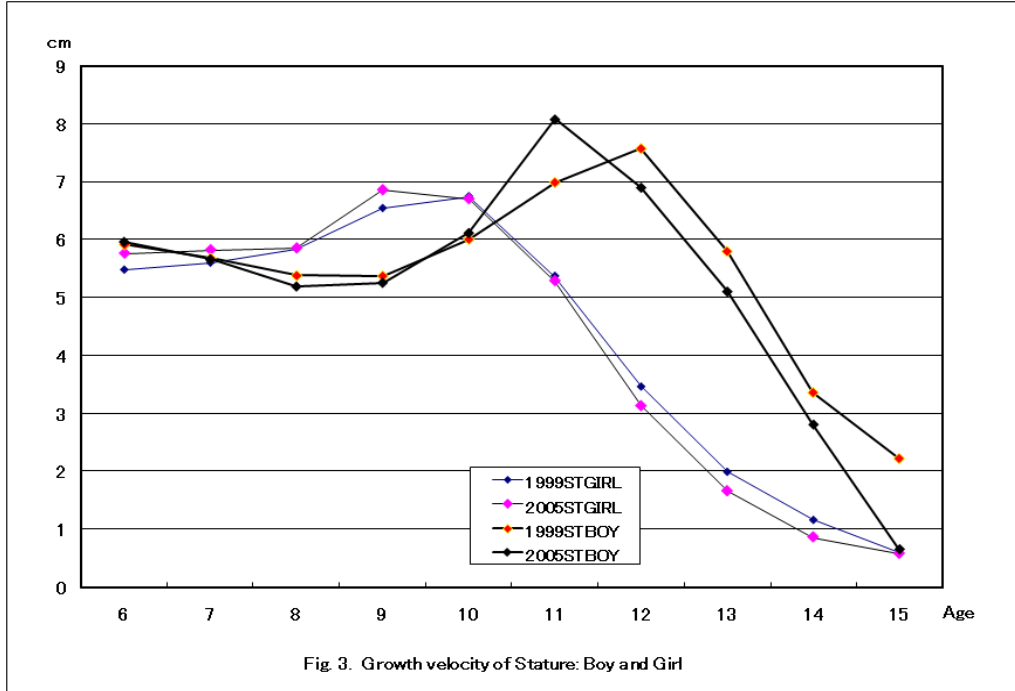
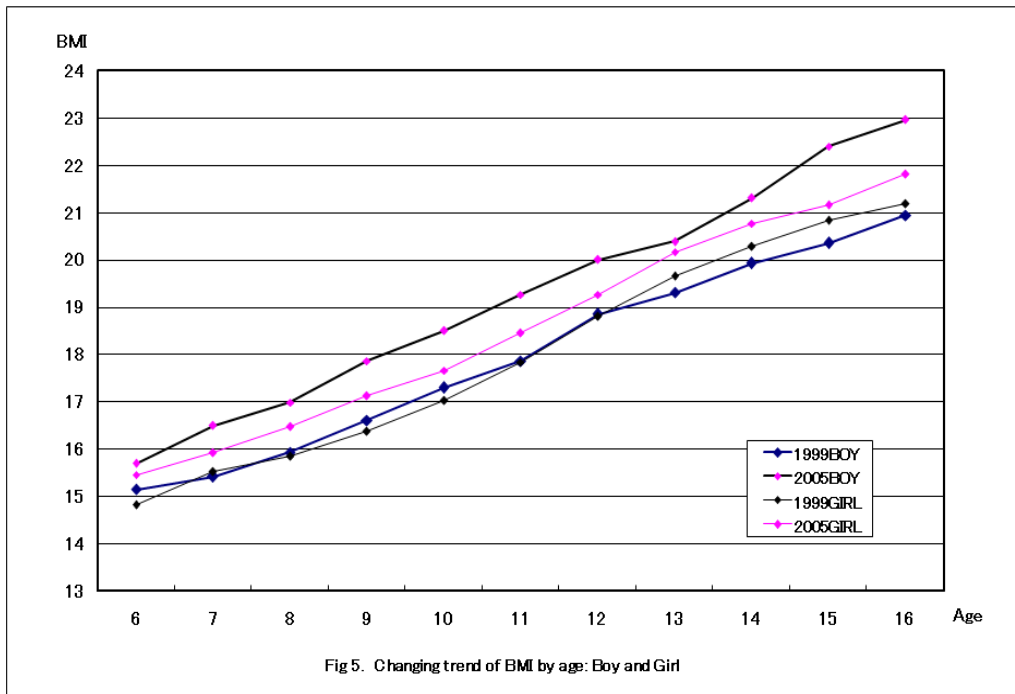




Table 4. The differences in growth velocity and BMI between 1999 and 2005

Age	growth velocity				BMI	
	Stature		Body weight		Boys	Girls
	Boys	Girls	Boys	Girls		
6	-0.05	-0.29	-0.99**	-0.07	-0.55**	-0.64**
7	0.02	-0.23	-0.22	-0.39	-1.08**	-0.40*
8	0.19	-0.02	-0.53**	-0.39**	-1.06**	-0.63**
9	0.12	-0.33	-0.12	-0.22	-1.26**	-0.74**
10	-0.11	0.03	-0.77**	-0.10**	-1.21**	-0.65**
11	-1.09**	0.08**	-0.49	0.20	-1.41**	-0.61**
12	0.67**	0.33**	-0.28	0.00	-1.16**	-0.47*
13	0.69**	0.34**	-0.63*	0.22*	-1.08**	-0.51**
14	0.56	0.30	-0.92**	0.56**	-1.38**	-0.49*
15	1.58**	0.01**	0.67**	-0.01**	-2.04**	-0.33
16	-	-	-	-	-2.01**	-0.63
Mean	0.258	0.022	-0.428	-0.020	-1.295	-0.555
SD	0.693	0.250	0.483	0.292	0.426	0.124

\*p<=0.05, \*\* p<=0.01



were significantly larger than the 1999 were found only at a few ages, although such significant differences were found at a little more ages in body weight. In stature, at the ages after peak age, significant differences were found, but they were such ones that the 1999 were larger than the 2005. At the ages of younger than 11, any significant differences were not found in stature for both sexes, but this was not case in body weight for both sexes. That is, as shown in table 4, at the ages of younger than 11, significant

differences were found for both sexes. However, at 15 years of age at which growth seems to end for both sexes, the growth velocity was significantly larger in the 1999 than the 2005 for both sexes in both stature and body weight. This may suggest that the 2005 boys and girls seemed to be in advance of the 1999 in morphological maturation.

#### 4. Changes in physical indices

Fig. 5 shows the changing trends of body mass index (BMI) by age in 1999 and 2005

Table 5. The Secular change in three physique quotation between 1999 and 2005

	Age	RBW			RSH			RCH		
		1999	2000	Sig.	1999	2000	Sig.	1999	2000	Sig.
B O Y S	6	17.85	18.81	**	55.59	55.52		48.71	49.38	**
	7	19.08	20.75	**	55.39	55.12	**	48.45	49.55	**
	8	20.62	22.35	**	55.01	54.75	**	48.26	49.41	**
	9	22.4	24.44	**	54.54	54.23	**	48.28	49.65	**
	10	24.26	26.3	**	54.4	53.74	**	48.37	50.06	**
	11	26.12	28.55	**	53.5	53.14	**	48.25	50.03	**
	12	28.87	31.25	**	52.88	52.66		48.11	50.06	**
	13	31.05	33.25	**	52.65	52.55		48.25	50.13	**
	14	33.2	35.82	**	52.6	52.78		48.68	50.54	**
	15	34.57	37.92	**	52.69	53.25		49.9	51.49	**
G I R L S	16	36.04	39.15	**	52.74	53.47	**	51.01	51.95	**
	6	17.34	18.35	**	55.61	55.26	**	48.05	48.51	*
	7	18.92	19.84	**	55.48	54.91	**	47.90	48.31	
	8	20.33	21.49	**	54.84	54.41	**	47.54	48.19	**
	9	21.98	23.34	**	54.29	53.96	**	47.72	48.27	
	10	23.96	25.32	**	53.86	53.50	**	47.95	48.42	
	11	26.31	27.65	**	53.65	53.26	**	48.67	48.95	
	12	28.73	29.89	**	53.64	53.18	**	49.42	49.77	
	13	30.72	31.90	**	53.62	53.27	**	50.40	50.90	
	14	32.09	33.18	**	53.72	53.49	*	50.91	51.66	**
15	33.20	33.99	*	53.96	53.79		50.02	52.12	**	
16	33.83	34.67	*	54.01	53.86		51.22	52.24	**	

- 1) RBW stands for body weight quotient, RSH for sitting height quotient, and RCH for chest girth quotient.
- 2) Sig. is significance on the differences of quotient between 1999 and 2005, and \*\* means significant at  $p \leq 0.01$  and \* significant at  $p \leq 0.05$ , and positive \*\* and \* mean the quotient of 2005 is significantly larger than that of 1999.

for both sexes, and table 4 shows the results of statistical test given to these differences. The differences between 1999 and 2005 were significant at all ages for boys, but after 14 years of age, they were not significant for girls. This suggest that most of girls reach the ending stage of morphological increase. In boys, however, morphological increase as growth process still continues at these ages.

Table 5 shows the means and significance of the differences in several morphological indices between 1999 and 2005. In body weight index, the differences were significant at all ages for both sexes. And in chest girth index, only boys showed significant differences at all ages. This suggests that significant differences seemed to appear in body bulk growth in boys. In girls, however, significant differences were found in body weight index at all ages. but this trend were not found in chest girth index. For sitting height and chest girth index, significant differences were found only in the terms of before and after peak age.

#### **IV. Discussion**

This study tried to find appearance of secular change in physical growth in the short term. Under the assumption that sample difference included the difference produced by secular changes, two longitudinal samples

of physical growth were collected from senior high students in Seoul. Ljung et al. (1974) reported that the recent children were larger in stature than others from the study of comparison in stature using longitudinal data of Swedish school children aged 9-17 year from 1965 to 1971. They confirmed appearance of secular change with existence of differences in stature between three sample which were collected in different periods.

From the differences in the attribute of interest between the samples obtained in different periods, secular changes have been studied by many researchers; Brundtland et al. (1975) using the samples of Oslo school children, Van Wieringen(1978) using the Netherland samples, and so on. Matsuura (2002) reported and discussed some interesting inference about secular change in physical growth of school children and youth, using long-term annual data of 1928-1996. This study divided the term 1928-1996 into 6 short terms and studied the secular changes for each term. Among 6 terms, such term as 5 to 10 years, after World War II ended, was named as the recovery term; the catch-up process. In even such a short period, a certain drastic positive change appeared on physical growth. Matsuura estimated the grade of secular change and reported them. Furthermore, he reported the grade of secular change in recent days. The

mean gradients from 6 to 16 years of age were estimated 1.110 for boys and 0.088 for girls in stature from Matsuura's estimation. Based on the estimated grades, the mean secular change estimated was 0.66cm for boys and 0.48cm for girls, but the actual mean changes were 1.536cm for boys and 1.78cm for girls. Thus, the secular changes were much larger than predicted in recent Korean children and youth, although Japanese data were used for prediction. This large discrepancy between the actual differences and predicted ones may be partly due to the appearance of secular change in even such a short term, as investigated in this study. This study confirmed that secular changes appeared clearly on such physical indices as BMI, body weight index, sitting height index and chest girth index.

Broman et al. (1942) inferred from decrease in  $W/H^3$  that, from 1883 to 1939, the increment in height in Sweden was larger than that in weight. Van Wieringen(1978) reported that although a few authors suggested that the weight-height relationship might possibly show a secular shift, he did not so positively confirm secular changes in some kinds of derived variables on physical growth. But this study could introduce some robust evidence of appearance in such derived physical index as BMI, body weight index( $W/H$ ), sitting height index( $SH/H$ ), and chest girth index( $CH/H$ ).

Ljung et al. (1974) made comparison in stature growth velocity between three samples of school boys and girls of different periods; 1883, 1938-39, 1965-71. He reported that the gain per decade was greater in the interval 1883 to 1938-39 than in the interval 1938-39 to 1965-1971. And he pointed that the differences between the samples obtained in different periods were produced by secular change. This study showed that significant differences were found only in the term after peak age of stature for both sexes. Moreover, the significant differences implied that the 1999 were larger in growth velocity than the 2005 with an exception of 11 years old for both sexes. In body weight, however, the 2000 were larger in growth velocity than the 1999, regardless of peak age. In other study by Matsuura(2005), he constructed large scaled cohort data sets of growth from cross-sectional data sets from 1926 through 2000, and pointed that secular change of peak age was not found in such a short interval of 5 or 10 years. This study showed on guarantee of positive appearance of change on peak age. This study also investigated in growth amount, and showed a certain evidence of appearance of secular change in growth amount, such as the 2005 being larger in growth amount than the 1999. Thus, this study tried to investigate secular change between different periods, just in the

same way that many studies on secular changes have made.

## V. Conclusion

From investigating in the differences in physical growth between two samples of children and youth extracted from senior high school located in Seoul in 1999 and 2005. Then, from comparison in various growth variables between two groups of different cohort, this study tried to clarify the appearance of secular change and its characteristics. Then the followings could be concluded:

1) The growth distances of stature, body weight, sitting height, and chest girth in 2005 were larger than those in 1999 at all ages for both boys and girls. It could be concluded that a certain positive shift in growth process appeared in such a short duration.

2) The growth velocity of weight in 2005 were significantly larger than that in 1999 at before and after peak age. But, in case of stature, significant secular differences were found only in the term after peak age for both sexes.

3) The boys in 2005 were in advance of those in 1999, average 0.28 years in stature growth, 1.02 in body weight, 0.39 in sitting height, and 0.93 in chest girth. The girls in 2005 were in advance of those in 1999,

average 0.81 years in stature, 0.76 in body weight, 0.32 in sitting height, and 0.57 in chest girth. As far as the growth distance concerned, the boys in 2005 were ahead of the boys in 1999 from 0.28-1.02 years and the girls in 2005 from 0.32 to 0.81 years. Thus, it could be concluded the secular change appeared between 1999 and 2005 and it was increasing shift in growth distance.

4) Only in peak velocity, significant secular change was recognized for both sexes. Any appearance of secular change was not found in peak age. So it could concluded that secular change did not have influence on morphological maturation.

5) In peak age, any secular change was not found in stature and body weight for both sexes.

6) Evidences of secular change were found in body weight, BMI and chest girth for boys, and body weight and sitting height for girls. Significant differences were found between the 2005 and the 1999 at all ages.

From the above conclusion, it was inferred that physical growth of Korean children and youth has been constantly improving in recent years. In relation to children and youth, good health is both the absence of health problems and the achievement of optimal growth and development relative to individual capacity. Thus, there is a need for developing new

reference standards on growth(growth chart) and screening abnormal physical growth status early. Determinants of physical growth progress should also be identified for planning health promotion programs.

The environmental factors that have been driving them are an important concern of this secular change(Cole, 2002). Factors such as social class, income, education, family size, location, housing and overcrowding have all been implicated in the secular trend(Cole, 2000). Annual changing trends are also influenced by habits of meal, practice of exercises, overall lifestyle and so on. Therefore, further study would be needed concerning these factors. Identification of lifestyle-related and environmental determinants for physical growth of children and youth will be helpful for planning effective adolescents' health promotion program.

There is limitation of generalization because current study included students in one school in 1999 and two schools in 2005. They were not the representative samples of Korean children and youth. The differences named as secular change also may be named as sample differences. It is impossible to classify the sample differences from the secular ones in this study. Therefore, this study was made under such assumption as sample differences are included in secular differences.

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## ABSTRACT

**Purpose:** The purpose of this study is to clarify the traits of differences supposed as secular differences in physical growth between samples of children and youth in 1999 and 2005, and to identify the need of children and youth for health promotion.

**Methods:** Two samples of different cohort were selected. The first one was consisted of 231 boys and 346 girls in 1999. And the other was consisted of 171 boys and 400 girls in 2005. Then the longitudinal growth distance data were collected from their cumulative health examination records.

**Results:** The 2005 were larger in growth distances of stature, body weight, sitting height, and chest girth a at all ages from 6 to 16 in both boys and girls, so it could be concluded that a certain positive shift in growth process appeared in such a short duration. The 2005 were larger in growth velocity before peak age and also after peak age in body weight, but only in the term after peak age significant secular differences were found in stature for both sexes. As far as the growth distance concerned, the 2005 boys were ahead of the 1999 boys from 0.28-1.02 years and the 2005 girls from 0.32 to 0.81 years. In growth distance. Only in peak velocity, significant secular change was recognized in both sexes, any positive evidences of appearance of secular change were not found in peal age. In such derived physical indices as BMI, body weight index, sitting height index, and chest girth index, obvious evidences of secular change appearance were found.

**Key Words:** Secular change, Physical growth, Growth distance, Growth trait, Growth velocity



## 〈국문초록〉

## 아동 및 청소년 신체발육의 단기적 시대변화

**연구목적:** 본 연구는 1999년과 2005년의 다른 코호트에 있는 아동과 청소년 집단의 신체발육 특징을 비교분석함으로써 한국 아동과 청소년 신체발육의 단기적 시대변화를 파악하고자 하였다.

**연구방법:** 1999년 서울시 고등학교에 재학한 16세 남학생 231명, 여학생 346명과 2005년 서울시 고등학교에 재학한 16세 남학생 171명과 여학생 400명을 대상으로 이들의 건강검사 기록을 통해 종단적 신체발육자료를 수집하여 비교분석하였다.

**연구결과:** 주요 연구결과는 다음과 같다. 첫째, 남학생과 여학생 6세에서 16세까지의 모든 학생들의 2005년도 신장, 체중, 좌고, 흉위가 1999년에 비하여 더 컸다. 따라서 비교적 짧은 기간 동안에도 발육과정에 긍정적인 변화가 있음을 알 수 있었다. 둘째, 체중의 발육속도는 peak age 이전이나 이후 모두 2005년이 컸으나, 신장은 peak age 이후에만 유의하게 컸다. 셋째, 2005년의 남학생들은 1999년에 비하여 신장은 평균 0.28년, 체중은 1.02년, 좌고는 0.39년, 흉위는 0.93년 앞서 있는 것으로 나타났다. 여학생의 경우, 신장은 0.81년, 체중은 0.76, 좌고는 0.32, 흉위는 0.57년 2005년이 앞서있었다. 즉, 2005년의 남학생들은 1999년에 비해 0.28-1.02년, 여학생들은 0.32-0.81년 발육이 앞서 있었다. 넷째, peak velocity에서만 남학생, 여학생 모두 유의한 시대적 변화가 있었고, peak age에서는 시대적 변화가 발견되지 않았다. 다섯째, BMI, 체중, 좌고, 흉위관련 지표에서 시대적 변화가 발견되었다. 특히 남학생의 경우는 체중, BMI, 흉위 관련지표에서, 여학생은 체중, 좌고에서 2005년과 1999년 간 유의한 차이가 발견되었다.

**주제어:** Secular change, Physical growth, Growth distance, Growth trait, Growth velocity