

A Study on the Progress of Growth Promotion in Koreans by Maximum Growth Age for Height

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I. Introduction

Since growth promotion was defined by Koch(1935), numerous surveys on it have been conducted for identifying of puberty growth.

Growth promotion occurs in the age puberty, and several researchers have reported that the more becomes economic growth, the more becomes growth promotion. Thereupon, this study was attempted to find Maximum Growth Age(M.G.A.), that can be used as an index of height growth promotion in Korea. These index were obtained by cross-sectional observations of the same group, for explaining its earlier tendency.

However, since a longitudinal observation involves many difficulties, there have been many discussions on growth promotion on the basis of the result that the height increased in the end of the growth(Line; 1972) or that the age reaching the height in the end of the growth decreased(Annotation; 1953) by means of cross-sectional observation.

Researches on the growth promotion - even of 19C - have been carried out in Germany, U.K., U.S., Canada(Grinder; 1973) and Japan (Kenji, et al; 1977, Yoko, et al; 1977). Those studies have been performed rather after the liberation than before the liberation. However, there has been no research of M.G.A. in Korea. Thus, this study tried to investigate domestic changes in

M.G.A., M.G.A. in this study was calculated by using the results of cross-sectional researches 25 representative papers between 1940-1953 including measurements by Lee in 1940 and data by Kim in 1953 in this study.

M.G.A. in this study used the growth records between 6 and 17 years old.

This study reports the result of M.G.A. to cross-sectionally calculate for height, clarify the whole aspect of growth promotion in height of Koreans from around the liberation to 2000, and estimate M.G.A, the index of growth promotion in height of Koreans, till 2030s.

II. Subject and Method

1. Subject

As shown in Table 1, the mean values of height by ages and sex which were quoted from the research data from 1940(Lee) before the liberation to 2000 were used in this study.

2. Period

The period of this study was one and half years from Mar. 1, 2000 to Aug. 31, 2001.

3. Method

Maximum Growth Age(M.G.A.) was calculated with the mean values of height growth of 6~17 year males in 「A Study on the Physique and Physical Constitution of

Koreans」 by Lee and Park(2001), and it was expressed into the height growth curves as shown in Figure. 1-a, 1-b. The growth rate becomes the greatest on the inflection point in the curve, so the age of the point corresponds to M.G.A. Since a regression equation of the curve shall be fixed to get such inflection point, involving very complex calculations. The annual height increment, the basic data for drawing the growth curves, was expressed into a histogram as shown in the lower part of Figure. 1, showing changes in ages, and M.G.A. corresponds to mode on the annual increment distribution curve.

Therefore, Maximum growth age (M.G.A.)(Kenji, et al; 1977, Yoko, et al; 1977) was calculated by finding this mode approximately following the undermentioned equation in this study;

$$MGA = A_{max} + \frac{L_{max} - L_{-1}}{(L_{max} - L_{-1}) + (L_{max} - L_{+1})} - \frac{1}{2}$$

Here,

M.G.A.; Maximum Growth Age

A_{max} ; Median of ages to L_{max}

L_{max} ; Maximum value of annual increment
in physique

L₋₁ ; Annual increment 1 year before L_{max}

L₊₁ ; Annual increment 1 year after L_{max}

Since there is a gap of about 2 years between males and females in the ages of initiation of puberty growth, the subjects born

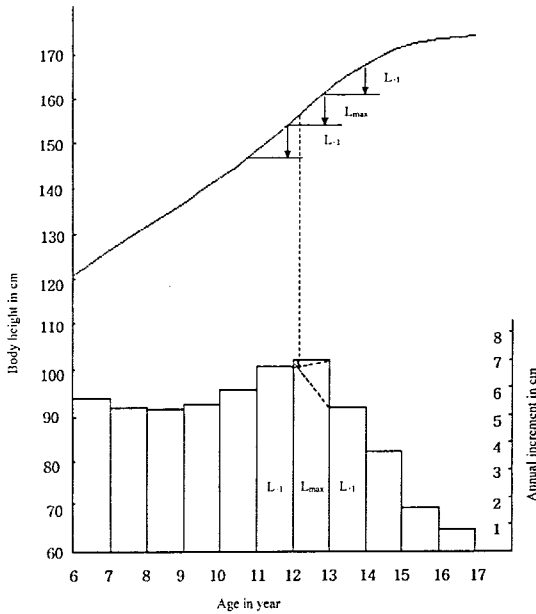


Figure 1-a. Growth in Height of Korean Male (2000, M.O.E.)

Above : Growth Curve, Height Attained at Each Age
 Below : Annual Body Height Increments

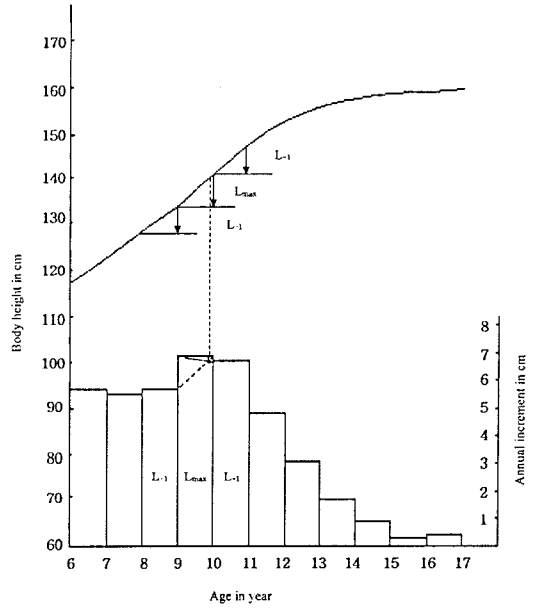


Figure 1-b. Growth in Height of Korean Female (2000, M.O.E.)

Above : Growth Curve, Height Attained at Each Age
 Below : Annual Body Height Increments

in 1925 who were 15 years in 1940 and the subjects born in 1983 who were 17 years in 2000 were a possible group to find Maximum Growth Age with the data of each researcher and M.O.E. following the above equation from 1940 to 2000.

III. Results

1. Biometric Value

It is well known that form and structure of a living body including man can be changed to some degree to be adapted to surrounding

conditions and by nutritive conditions, so physical conditions of peoples from ancient times to the present age have been much changed(Park; 1979).

It was found that such change in man showed clear difference between the past record and the recent record among races(Kwon and Park; 1968), and specially it is also definite that there has been severe change in physical condition due to sharp change in life style, improvement in nutritive conditions and traffic development after the World War II.

Therefore, biometry for Koreans shall be

performed over and over by times, and socioeconomic condition, place of birth and place of growth of subjects shall be considered in evaluation of it(Park; 1980).

The researches on physical conditions of Koreans have been reported by Lee(1940) before the liberation and by Kim(1953) and Jang(1945) after the liberation. There are 25 researches between 1967-2000 on the changes in physical conditions of Koreans thanks to improvement in economic conditions and living standards by industrialization after 1960s such as Kwon and Park(1967), Park(1979, 1980).

Height is a general index of growth, showing the length of human body, and is basis of producing several index. Height records by age and sex were suggested for the purpose of M.G.A.

2. Changes in Maximum Growth Age (M.G.A.) by Years

As shown in Table 1., the calculated M.G.A. decreased by years; for males, 14.28 years in 1940(Lee) before the liberation, 14.23 in 1953(Kim) after the liberation, 13.65 in 1959(Yang), 14.40 in 1962(Kim., agricultural district), 14.45 in 1965(Ministry of Education & Human Resources Development, M.O.E.), 13.86 in 1965(Kwon and Park), 12.89 in 1968(Chang), 13.22 in 1969(Nam), 11.46 in 1970(M.O.E.), 12.71 in 1975(K.P.A.), 11.64 in 1978(Park), 12.63 in

1983(Park), 12.74 in 1985(K.P.A.), 12.36 in 1990(Son and Park), 10.49 in 1994(Kim and Park), and 11.71 in 2000(Lee and Park).

While, for females, it decreased also; 12.0 years in 1940 before the liberation, 11.20 in 1953, 12.63 in 1959, 11.52 in 1965, 11.50 in 1970, 12.42 in 1975, 12.63 in 1983, 10.75 in 1985, 10.23 in 1990, and 9.77 in 2000. It was found that M.G.A. for females was 1~2 years lower than that for males.

As a result of calculating M.G.A. with research results of each researcher for height between 1940-2000, a consistent trend was hardly observed due to severe irregular changes. However, this study intended to find a consistent tendency with indifferent change in a narrow range along with a long term period.

3. Regression Line of M.G.A.

For the period, it seems that M.G.A. was linearly decreased by years from 1940 to 2000. A regression line was obtained following the least square method for the males and females. As a result of finding correlation between year and M.G.A. $r=-0.763$ ($p<0.001$) for male and $r=-0.699$ ($p<0.001$) for female were obtained, and as a result of getting regression line equations, $F(x_1) = 17.21-0.059x_1$ ($Y_1 = 15.21-0.059X_1$) for male and $F(x_2) = 13.81-0.042X_2$ ($Y_2 = 13.81-0.042 X_2$) for female were obtained on the condition of X_1 =year,

Table 1-a. Mean Values of Height by Years, Authors and Sex between 1940-2000

Age	1940		1953		1959		1962		1965		1965		1967	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
6	-	-	110.6	109.2	109.8	109.1	109.9	108.9	112.2	110.8	106.7	106.6	116.0	114.5
7	-	-	115.2	114.3	112.8	111.9	112.4	111.5	115.8	114.0	112.5	112.0	120.1	117.7
8	-	-	121.3	120.8	117.3	116.2	116.5	115.6	119.7	118.9	118.1	117.3	123.9	122.3
9	-	-	126.6	127.1	121.4	120.3	121.2	119.2	124.1	125.1	123.7	122.6	126.6	125.7
10	-	-	131.6	133.8	126.1	125.1	124.6	124.0	128.1	127.5	128.3	128.6	132.1	132.5
11	-	142.3	136.1	138.9	130.2	130.2	128.7	130.0	132.0	131.1	132.6	133.5	137.3	137.8
12	140.0	145.9	141.1	143.7	135.2	135.9	132.2	134.8	142.5	141.4	136.7	138.7	140.6	143.0
13	144.4	149.4	146.1	140.2	140.9	142.8	136.6	140.6	145.2	145.4	143.4	144.8	144.9	147.6
14	150.2	152.2	151.5	150.3	148.9	147.6	142.8	146.4	149.9	147.6	149.4	149.0	151.1	151.0
15	155.6	154.4	157.2	153.2	155.4	151.8	150.3	151.1	158.7	154.0	156.2	152.9	157.0	153.6
16	160.3	154.5	161.3	154.4	160.2	153.7	155.8	153.3	162.6	155.4	162.5	154.7	162.1	154.8
17	163.3	154.5	163.9	154.9	163.6	154.8	159.9	155.0	163.7	156.9	165.9	155.5	165.0	155.5
18	165.5	154.2	165.7	154.9	166.2	155.5	163.1	154.8	-	-	169.8	155.7	166.3	155.7
No. of exam.	5,408	2,286	7,462	5,332	25,453	18,684	7,128	5,441	?	?	?	?	10,810	9,459
Researcher	Lee, B.N.		Kim, I.D.		Yang, J.M.		Kim, K.S.		M.O.E.		K.P.A.		Kwon, E.H.	Park,

Table 1-b. Mean Values of Height by Years, Authors and Sex between 1940-2000

Age	1968		1969		1970		1975		1978		1978		1978	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
6	-	-	113.7	111.9	112.9	111.9	110.6	109.2	112.1	113.2	117.0	115.8	118.6	116.9
7	115.3	114.7	117.6	115.9	117.9	117.5	117.5	116.8	116.6	114.8	121.5	120.3	120.9	120.6
8	120.3	119.1	122.4	120.8	121.9	122.6	122.6	121.6	122.8	121.9	128.1	127.5	126.6	126.4
9	125.2	123.7	125.6	126.2	126.3	127.3	127.3	126.5	127.0	126.5	133.8	133.6	133.3	132.9
10	128.8	128.9	132.1	131.6	130.3	131.9	131.9	131.8	131.8	130.9	138.5	139.4	138.7	139.4
11	134.6	134.2	135.8	138.8	134.4	136.0	136.0	137.5	137.8	139.0	143.6	145.0	143.5	144.8
12	139.1	139.6	143.0	143.8	143.7	140.0	140.0	142.0	140.9	144.5	150.2	149.9	151.0	150.4
13	146.7	146.8	150.3	150.3	148.2	147.5	147.5	148.1	146.7	149.6	156.0	152.5	157.4	151.4
14	153.9	151.6	158.5	153.2	152.0	153.6	153.6	152.0	152.8	152.9	170.0	154.9	164.4	155.1
15	158.6	154.3	163.5	154.6	160.8	158.2	158.2	154.0	157.7	153.7	165.3	155.9	167.4	156.8
16	163.9	156.6	166.3	155.3	163.7	164.1	164.1	155.6	164.6	155.8	167.2	156.6	168.8	157.0
17	166.6	157.1	167.9	156.1	165.9	166.4	166.4	156.3	162.5	155.3	168.8	157.0	168.3	157.3
18	167.5	156.8	168.0	157.0	-	167.3	167.3	156.6	167.9	150.0	169.3	156.8	-	-
No. of exam.	4,100	3,045	4,776	4,178	3,228,035	2,743,202	?	?	2,563	2,046	25,494	17,056	4,022	3,633
Researcher	Chang, S.H.	Nam, K.Y.			M.O.E.		K.P.A.		Park, S.Y.		Park, S.Y.		Park, S.Y.	

Table 1-c. Mean Values of Height by Years, Authors and Sex between 1940-2000

Age	1983		1983		1983		1984		1985		1987	
	M	F	M	F	M	F	M	F	M	F	M	F
6	-	-	-	-	-	-	122.5	122.5	113.9	113.4	-	-
7	130.0	127.7	125.8	127.6	123.9	123.3	128.0	127.7	120.4	119.4	122.2	119.5
8	132.9	132.4	128.1	132.3	128.5	128.3	132.9	132.4	125.6	124.9	126.9	126.7
9	139.7	140.0	136.9	140.0	134.8	135.3	139.7	140.0	130.5	130.1	131.8	130.6
10	143.7	144.8	143.0	144.8	140.4	140.4	143.7	144.8	135.2	135.5	135.5	135.7
11	148.8	150.5	150.8	150.5	146.6	146.4	148.8	150.5	140.3	141.8	142.4	143.2
12	155.1	153.7	153.7	153.7	150.9	151.5	155.1	153.7	144.9	147.8	151.1	150.7
13	162.4	155.7	160.0	155.6	157.9	154.2	162.4	155.7	152.6	152.1	157.0	156.0
14	166.4	156.5	163.4	156.5	162.4	155.3	166.4	156.5	159.2	154.9	162.4	157.4
15	168.2	157.2	165.7	157.1	166.1	156.4	168.2	157.2	164.0	155.8	166.5	158.0
16	169.2	157.6	169.0	157.6	168.4	156.9	169.2	157.6	167.2	156.7	167.7	158.1
17	169.6	157.7	169.3	157.6	169.1	157.6	169.2	157.2	168.3	156.6	170.3	158.1
18	-	-	-	-	-	-	-	-	168.9	157.3	169.8	159.0
No. of exam.	2,011	2,065	2,011	2,065	6,355	6,304	16,138	16,783	?	?	16,764	16,211
Researcher	Park, S.Y.		Park, S.Y.		Park, S.Y.		Lim, S.S. Park, S.Y.		K.P.A.		Suh, Y.S. Park, S.Y.	

Table 1-d. Mean Values of Height by Years, Authors and Sex between 1940-2000

Age	1987		1990		1994		1996		2000		2000	
	M	F	M	F	M	F	M	F	M	F	M	F
6	-	-	118.3	117.2	-	-	118.0	113.9	120.1	118.6	118.6	118.3
7	124.7	123.6	123.8	122.7	120.7	117.5	122.1	119.5	125.7	124.3	124.6	122.8
8	129.0	127.5	128.8	128.1	126.2	124.9	127.2	126.2	131.0	129.8	129.1	128.2
9	134.1	133.2	133.8	133.6	130.1	129.9	132.1	131.1	136.2	135.5	135.8	133.7
10	138.5	139.6	138.6	139.3	136.0	135.1	137.4	136.6	141.6	142.4	140.3	140.9
11	142.2	144.9	144.1	145.8	141.0	140.6	142.0	142.4	147.5	149.1	146.0	147.6
12	148.9	151.8	150.1	149.9	148.5	149.0	147.2	148.0	154.3	153.9	152.5	152.1
13	157.6	152.2	157.0	154.6	153.5	152.5	151.7	151.3	161.3	157.0	158.7	156.2
14	162.4	156.2	162.5	156.6	160.0	157.0	159.4	156.5	166.6	158.7	164.3	157.9
15	167.2	157.2	166.8	157.6	166.3	158.5	165.4	158.2	170.3	159.6	168.6	159.4
16	168.3	158.2	168.9	158.1	170.0	159.0	169.6	158.8	171.9	159.9	171.3	160.2
17	169.4	158.8	170.1	158.6	171.0	160.4	170.8	160.1	172.7	160.6	172.1	159.8
18	170.1	159.5	-	-	-	-	172.3	160.2	-	-	173.0	160.1
No. of exam.	10,461	10,001	51,864	51,252	3,665	3,570	17,102	14,049	?	?	6,825	6,552
Researcher	Park, C.B. Park, S.Y.		Son, B.H. Park, S.Y.		Kim, W.S. Park, S.Y.		Kim, D.B. Park, S.Y.		M.O.E.		Lee, J.H. Park, S.Y.	

Table 2. Maximum Growth Age for Height by Years and Authors between 1940 and 2000

Year of study	Author	Subject	Maximum growth age	
			Male	Female
1940	Lee, B.N.	Korean(Whole country)	14.28	12.00
1953	Kim, I.D.	Korean(W.C.)	14.23	11.20
1959	Yang, J.M.	Korean(W.C.)	13.65	12.36
1962	Kim, K.S.	Korean(rural area)	14.40	10.50
1965	Ministry of Education	Korean student	14.45	11.52
1965	Korean Pediatric Association	Korean(W.C.)	14.61	12.31
1967	Kwon, E.H. and Park, S.Y.	Korean(W.C.)	13.86	11.69
1968	Chang, S.H.	Korean(W.C.)	12.89	12.43
1969	Nam, K.Y.	Korean(Seoul city)	13.22	10.45
1970	M.O.E.	Korean student	11.46	11.50
1975	K.P.A.	Korean(W.C.)	12.71	12.42
1978	Park, S.Y.	Korean(W.C.)	11.64	10.55
1978	Park, S.Y.	Korean(Urban area)	11.69	10.50
1978	Park, S.Y.	Korean	11.71	10.00
1983	Park, S.Y.	Korean student(W.C.)	13.01	9.97
1983	Park, S.Y.	Korean student(Seoul city)	12.63	10.01
1983	Park, S.Y.	Korean student(Middle city)	9.20	8.93
1984	Lim, S.S. and Park, S.Y.	Korean student(W.C.)	12.23	10.27
1985	K.P.A.	Korean student(W.C.)	12.74	10.75
1987	Suh, Y.S. and Park, S.Y.	Korean(W.C.)	11.39	10.18
1987	Park, C.B. and Park, S.Y.	Korea student(W.C.)	12.33	10.32
1990	Son, B.H. and Park, S.Y.	Korea student	12.36	10.23
1994	Kim, W.S. and Park, S.Y.	Korea student	10.49	10.37
1996	Kim, D.B. and Park, S.Y.	Korean(W.C.)	11.46	10.60
2000	M.O.E.	Korea student(W.C.)	12.11	9.86
2000	Lee, J.H. and Park, S.Y.	Korea(W.C.)	11.71	9.77

X_2 =year. Conditions of such lines are as shown in Table 3 and Figure. 2, 3. M.G.A. for height decreased both in males and females; for males, 14.28 years in 1940, 14.24 in 1953, 13.65 in 1959, and 11.71 in 2000; for females, 12.0 in 1940, 11.52 in 1965, 9.77(10) in 2000. From this, it can be found

that M.G.A. for height for female was 2 year lower than that for male. As shown in Figure 4, there is difference between male and female from the relation between the distribution of M.G.A. for male and female height and the regression line equation.

4. Transition of M.G.A. for Height

On the basis of the distribution of M.G.A. for height by years from 2005 to 2030 and the regression line equation, as shown in Table 3, M.G.A. was 11.02 years in 2005,

10.72 in 2010, 10.13 in 2020 and 9.54 in 2030 for male, and M.G.A. was 9.40, 9.19, 8.77, and 8.35 for female; M.G.A. for height has decreased and come to that of advanced countries.

Table 3. Parameter of Regression Curves for Change in Maximum Growth Age for Height

Formula of Regression Curve	Male	Female
$F(x) = ax + b$	$r_1 = -0.763(p<0.001)$	$r_2 = -0.699(p<0.001)$
	$S_{Y_1X_1} = \pm 0.62$	$S_{Y_2X_2} = \pm 0.64$
	$a_1 = -0.059$	$a_2 = -0.042$
	$b_1 = 17.21$	$b_2 = 13.81$
	$x_1 = 1940 \sim 2000$ years	$x_2 = 1940 \sim 2000$ years
Male	$Y_1 = 17.21 - 0.059 X_1$	
Female	$Y_2 = 13.81 - 0.042 X_2$	

Note ; Y : Maximum growth age for height
 X : Year(From 1940 to 2000)
 S_{YX} : Standard error of estimate

1940-2000(M.G.A.)

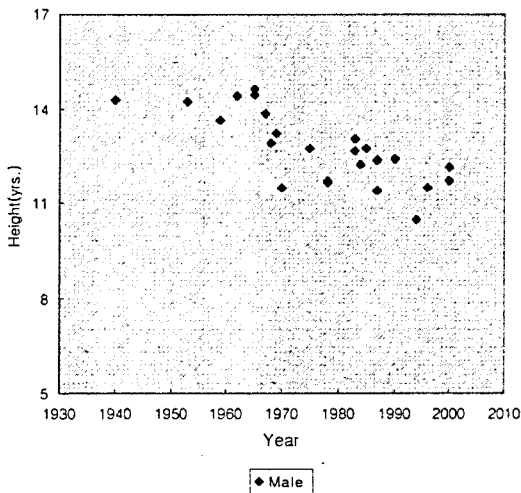


Figure 2. Scatter Diagram of Correlation Regression Line - Maximum Growth Age for Height by Years from 1940 to 2000(Male)

1940-2000(M.G.A.)

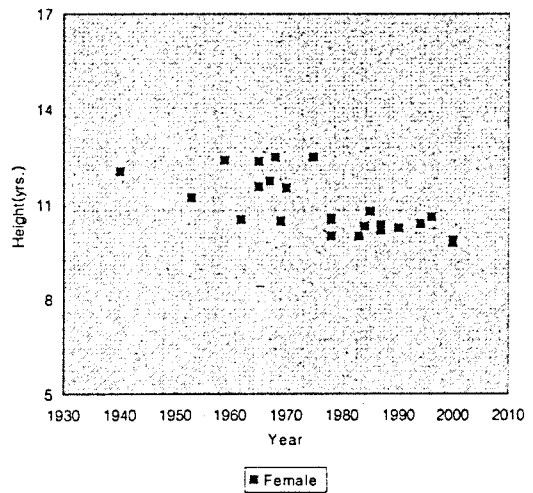


Figure 3. Scatter Diagram of Correlation Regression Line - Maximum Growth Age for Height by Years from 1940 to 2000(Female)

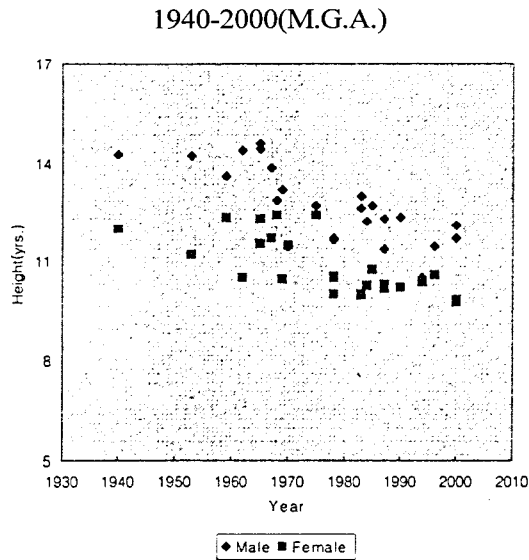


Figure 4. Scatter Diagram of Correlation Regression Line - Maximum Growth Age for Height by Years from 1940 to 2000(Male and Female)

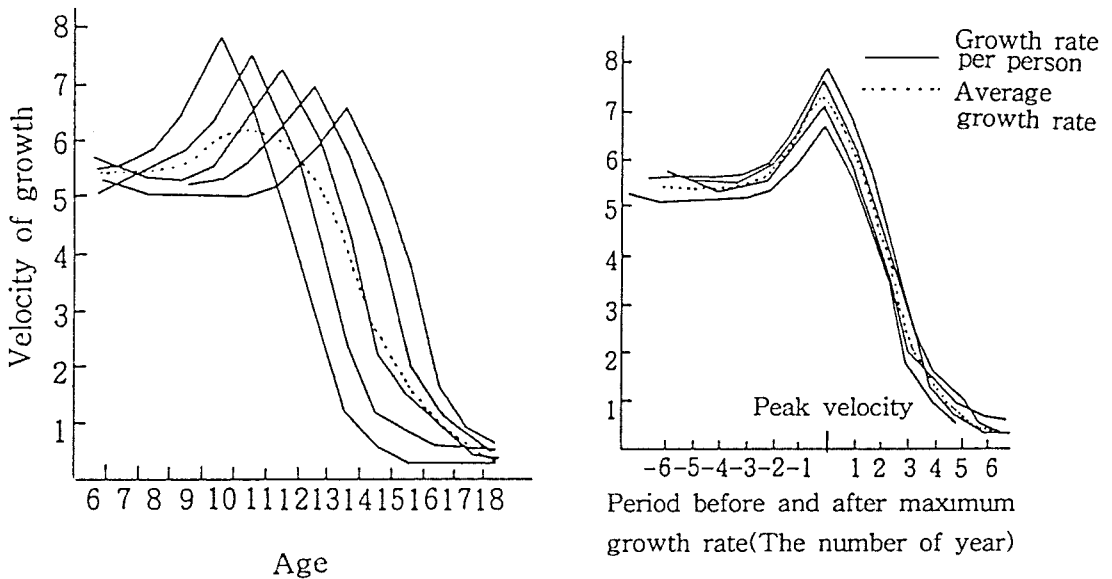


Figure 5. The Relation of Growth Rate per Person and Average Growth Rate with Maximum Growth Time of Height

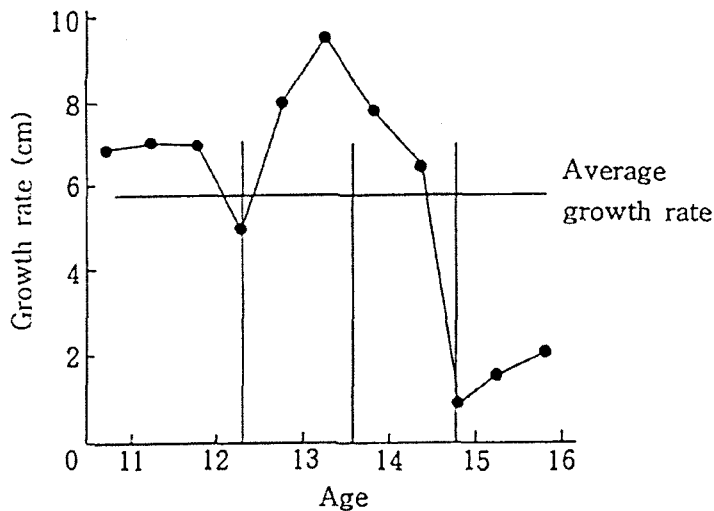


Figure 6. The Estimate Method of Puberty with Growth of Height by Growth Rate per Person

IV. Discussion

From 1960 to 2000, our living environment has been rapidly changed, and M.G.A. for height decreased according to the 4 phase - 14 years, 13 years, 12 years, 11 years for male, and 12 years, 11 years, 10 years, 9 years for female - as published in the research data.

The sharp growth phase of height is much applied to measure growth age as it the acceleration phase of height growth can be used as a significant index of puberty. Tanner (1971) explained significance of this method as shown in Figure 5. Longitudinal method with mean values of age and height cannot suggest correctly the average growth rate and

specially decrease the peak values compared to the actual values. However, average growth rate can reflect well the mean values of the group by arranging height increments in order that their peak points can be consistent as shown in Figure 5, 6. In this aspect it, Faust(1977) suggested a concrete method to define puberty in the aspect of height growth as follows;

- ① To determine puberty in terms of height growth, each individual's height growth is measured every half year, which is then divided by the number of measurement intervals(each year in decimal) to calculate the height growth rate.
- ② The peak phase(apex) shall be set to the middle point(3 months = 0.25 years) in

the half year showing the largest height increasing rate.

- ③ The average increasing rate is obtained by dividing the absolute increasing value(height in the 12th examination - height in the 1th examination) into the period(2.75 years) of 6 examinations before the peak phase and the period(5.5 years) of 6 examinations after the peak phase.
- ④ The puberty in height growth means that a period the height growth rate exceeds the average increasing rate.
 - The opening phase(b) of puberty shall

be set to the middle point in the first examinations, which is under the average increasing rate before the peak phase.

- The ending phase(d) of puberty shall be set to the middle point in the first examinations, which is under the average increasing rate after the peak phase.
- The middle phase(c) of puberty shall be fixed to the middle point between b and d.
- ⑤ The opening phase of prepuberal was defined as the 3rd examination time(b-3)

Table 4. Estimate of Maximum Growth Age for Body Height from 2005 to 2030

Year of estimate	Male	Female
2,005	11.02	9.40
2,010	10.72	9.19
2,015	10.43	8.98
2,020	10.13	8.77
2,025	9.84	8.56
2,030	9.54	8.35

Table 5. The Comparison of Maximum Growth Age in Body Height by Each Country

Country	Research date (Year)	Researcher	M.G.A.(years)		Source
			Male	Female	
Korea	2000	Lee, J.H. & Park, S.Y	11.71	9.77	A Study on the Body Composition in Korean, Korean J. of Clinical Geriatrics, 2(4), 2001
USA(White)	1950-1960	Krogman	9.69	9.44	Grinder;Adolescence 1973, USA
USA(Negro)	1950-1960	Krogman	9.58	9.81	Grinder;Adolescence 1973, USA
USA(Whole)	1950-1960	Krogman	9.50	9.50	Grinder;Adolescence 1973, USA
England	1950-1960	Krogman	11.43	11.43	Grinder;Adolescence 1973, USA
Germany	1950-1960	Krogman	11.83	11.83	Grinder;Adolescence 1973, USA
Switzerland	1950-1960	Krogman	11.69	11.69	Grinder;Adolescence 1973, USA
Japan	1977	M.O.E.	9.67	9.67	Ministry of Education, Japan

before puberty, and the ending phase of postpuberal was defined as the 3rd examination time(b+3) after puberty.

M.G.A. for height was obtained by means of measuring growth age by developmental degrees of body shape in this study. A general way for finding a tendency of height growth is to suggest the mean value of height by ages. This way has been frequently used in domestic studies.

As shown in Table 1, data of each researcher from 1940 to 2000 were used. It was found that there is difference in juvenile height by factors of country, race, sex and area from the trend of their height growth. Meredith(1978) concluded that Western children are taller than children of underdeveloped countries, Asia and Africa, white children are taller than black children, male children were taller than female children, and urban children were taller than rural children after investigating the 200 researches about height growth of 3.5-year children, which had been carried out world wide between 1960-1970.

According to the research(1970-1972) by Tanner, the most typical researcher on the sharp height growth phase of puberty, it was reported that the phase was 12.5~15.5 years for male and 10.5~13.5 for female, and annual height growth rate for the phase was 7~12cm for male and 6~11cm for female;

it is nearly same as the increment in the age of 2 years. And, the peak height growth phase was 13, 14 years for male and 12 years for female. Each grew 10.3cm, 9.0cm, and female height surpassed male one in 11~14 years, and females already came to adult height in 14 years.

Krograman performed a follow-up survey on the height of 7-17 year 700 children in Philadelphia for 10 years from 1950s and found that the males increased 8.6cm in 12~13 years and the females increased 6.3cm in 9~10 years(Grinder; 1973).

Besides, Papalia and Olds(1975) reported that the age of the sharp growth phase was 13~15 years for male and 11~13 for female, and Park(1979) reported that it was 13~15 years for male and 11~13 for female and the height of males and females of 9~14 years was crossed in Korea.

According to the result of this study, it was found that M.G.A. for height significantly decreased rather after the liberation than before the liberation specially after 1960s, and rather in urban areas than in rural ones or islands. When it was compared with the foreign results, M.G.A. of males born in 1959~1961 was 12.28 years in city, 13.37 in rural area and that of females was 10.01 and 11.58 respectively in Japan(Kenji et al.; 1977). This result was nearly same as the result - it was each 12.82 years, 10.29 years - of M.O.E. in 1981.

The comparison with U.S., U.K., and Germany is shown in Table 5 and it was found that there was somewhat difference among them. It can be deemed that changes in life pattern of young people by social changes greatly influence their growth. It is well known that social changes of factors to change their life pattern are called modernization, industrialization, popularization and urbanization. Such influence has been analyzed and announced by several researchers in Japan and Korea(Kenji et al; 1977).

There have been several discussions on the prospects of growth promotion. For instance, there was a discussion that growth promotion would be pushed to the limit in U.K. or U.S.(Yoko et al; 1977), and there was the same discussion in Japan, seeing from the fact that height growth has gradually decreased by ages. For our country, judging from the fact that the physical condition has been significantly improved thanks to the rapid elevation of dietary life around the liberation, specially after 1960s, it seems that the problem in question is open to further discussion, although the researcher expects that M.G.A. will decrease more on the basis of the attempt of calculating M.G.A. for height.

Although, as described in the above consideration, there is a foundation that M.G.A. will decrease more following the progress, a limitation from genetic factors

shall be deliberated. Therefore, it shall be reviewed again after development of coming several years is investigated.

V. Conclusion

This study was an attempt to look over the growth promotion in Koreans by examining Maximum Growth Age(M.G.A.) obtained from the measurements of height of Korean young males with an indirect method, cross-sectional study.

The period of this study was one and half years from Mar. 1, 2000 to Aug. 31, 2001, and the statistical data obtained with research results of each researcher were processed with computer.

Based on the research data published from 1940 to 2000, height and M.G.A. of males and females who were born for 1925 to 1983 were gotten by years, and a trend of growth promotion for height in Koreans was suggested by examining them.

Results of this study are as follows;

1. M.G.A. for height decreased both in males and females; for males, 14.28 years in 1940, 14.24 in 1953, 13.86 in 1967, 12.74 in 1985, and 11.71 in 2000; for females, 12.0 in 1940, 11.52 in 1965, 10.00 in 1978 and 9.77 in 2000.
2. Regression equations and standard errors

of estimate concerning M.G.A. for height by years were obtained; for males, $Y_1(\text{M.G.A.}) = 17.21 - 0.059X_1$, $S_{Y_1X_1}$ (standard error of estimate about the regression line) = ± 0.62 ; for females, $Y_2(\text{M.G.A.}) = 13.81 - 0.042X_2$, $S_{Y_2X_2}$ (standard error of estimate about the regression line) = ± 0.64

3. As a result of finding correlation between year and M.G.A. $r = -0.763$ ($p < 0.001$) for male and $r = -0.699$ ($p < 0.001$) for female were obtained
4. From a view that the growth promotion has been continued before 2000, M.G.A. decreased 0.6 years for male and 0.4 for female per 10 years.
5. M.G.A. for height is as shown in Table 2.
6. It is thought that the future trend of growth promotion for height will follow the progress from 1940s to now. It shall be reviewed again after development of coming several years is investigated.

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ABSTRACT

Since growth promotion was defined by Koch(1935), many researches like Benholdt and Thomsen(1942) have conducted studies for understanding problem of puberty growth.

Growth promotion means that growth is developed in puberty, and several researchers have reported that the more becomes economic growth, the more becomes growth promotion. Thereupon, this study was attempted to find Maximum Growth Age(M.G.A.), as an index of height growth promotion in Korea, which was obtained by longitudinal observations of the same group. Thus, this study can explain the earlier tendency of growth.

To investigate domestic changes in M.G.A., M.G.A. was calculated with the results of cross-sectional researchs using 25 representative papers between 1940-1953 including measurements by Lee(1940) and data by Kim(1953) in this study.

Based on the research data published between 1940 and 2000, height and M.G.A. of males and females who were born between 1925 and 1983 were gotten by years, and a trend of growth promotion for height in Koreans was suggested by examining study subjects.

Findings of this study are as follows;

1. M.G.A. for height decreased both in males and females; for males, 14.28 years in 1940, 14.24 in 1953, 13.86 in 1967, 12.74 in 1985, and 11.71 in 2000; for females, 12.0 in 1940, 11.52 in 1965, 10.00 in 1978 and 9.77 in 2000.
2. Regression equations and standard errors of estimate concerning M.G.A. for height by years were obtained; for males, $Y_1(\text{M.G.A.}) = 17.21 - 0.059X_1$, $S_{Y_1X_1}$ (standard error of estimate about the regression line) = ± 0.62 ; for females, $Y_2(\text{M.G.A.}) = 13.81 - 0.042X_2$, $S_{Y_2X_2}$ (standard error of estimate about the regression line) = ± 0.64
3. As a result of finding correlation between year and M.G.A. $r = -0.763$ ($p < 0.001$) for male and $r = -0.699$ ($p < 0.001$) for female were obtained
4. From a view that the growth promotion has been continued before 2000, M.G.A. decreased 0.6 years for male and 0.4 for female per 10 years.
5. M.G.A. for height is as shown in Table 2.
6. It is thought that the future trend of growth promotion for height will follow the progress from 1940s to now. It shall be reviewed again after development of coming several years is investigated.

Key Words : Maximum Growth Age(M.G.A.), Body Height, Regression Equation, Standard Error of Estimate, Correlation Coefficient