THE HEAD MEASUREMENTS IN LIVING KOREANS

(In relation to age, weight and stature)

(Part One)

by

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INTRODUCTION

That measurements of the head, stature, weight and other somatic characteristics of the Korean adult differ in some measure from adults of other races has been recognized by even superfacial observes. The rate of development of the head, features, stature, weight and certain other characteristics have been investigated at certain ages but no attempt has apparently been made to investigate them through the whole period of growth. To fill in this defect in our anthroplogical data the writer has investigated both the somatic characteristics and rate of development of Koreans by certain criteria which have already been applied to other races. He wishes to make a first report on this extended study.

For cooperation in making this study possible I wish to acknowledge my indebtedness to the principal and staffs of the following institutions: Severance Union Medical College and Nurses training school, the Methodist Seminary for men and women, Chosen Christain College (men), Ewha College (women), and four middle schools, namely, Paichai, Kyungsin (boys), and Paiwha, Ewha (girls), two boys common-schools Kongok and Hyupsin, two girls common-schools Paiwha and Ewha, as well as the Kingdergartens at Ewha, Paiwha, Chungang, Kyungsung, Choyang and three Christain Child Welfare Stations at Namdaimoon, Taiwha, and Tongdaimoon in the city of Seoul (Keijo). I also am very grateful Dr. Prof. Ueda for suggestions offered during the preparation of the graphs and tables.

DATA AND METHODS

The number of individuals examined from infancy, to college adults was found to be 2320 males and 1855 females the distribution being shown in Table I. In such anthropometric investigation of racial

characteristics, age, presence or absence of disease and seasonal variations in rate of growth are all important factors to consider. In the grouping of individuals according to age Martin's 'Lebensjahr' was used as a guide. At certain ages numbers are too few to give satisfactory results. Especially between the ages of 1 to 5 and over 20 however the numbers seem ample. The details of the use of the formula $n \pm \frac{1}{2}$ are shown in Table I.

Table I. Age and sex-distribution of individuals.

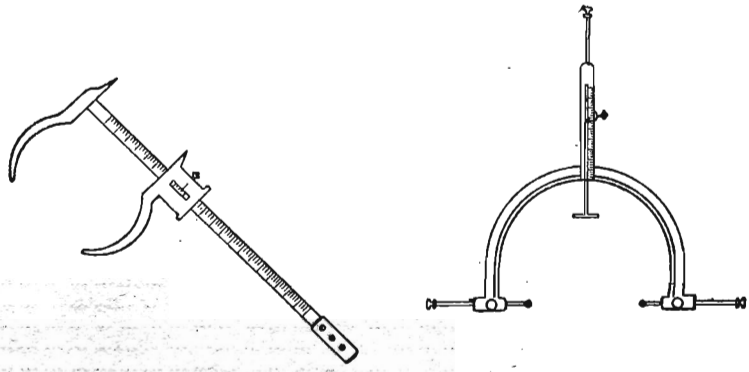
(n ± 1/2) Number of observed							
Age \ Sex	♂	♀	Total	Age \ Sex	♂	♀	Total
0.5— 1.5	29	13	42	17.5—18.5	166	107	273
1.5— 2.5	24	23	47	18.5—19.5	120	67	187
2.5— 3.5	16	10	26	19.5—20.5	101	37	138
3.5— 4.5	20	15	35	20.5—21.5	74	42	116
4.5— 5.5	26	17	43	21.5—22.5	76	35	111
5.5— 6.5	64	36	100	22.5—23.5	57	23	80
6.5— 7.5	67	66	133	23.5—24.5	39	11	50
7.5— 8.5	59	109	168	24.5—25.5	26	8	34
8.5— 9.5	68	100	168	25.5—26.5	27	6	33
9.5—10.5	79	126	205	26.5—27.5	25	9	34
10.5—11.5	99	124	223	27.5—28.5	13	11	24
11.5—12.5	100	119	219	28.5—29.5	8	5	13
12.5—13.5	129	125	254	29.5—30.5	15	4	19
13.5—14.5	140	137	277	(30.5—31.5)			
14.5—15.5	178	132	310	(31.5—75.5)	109	46	154
15.5—16.5	192	175	367	(22.5—75.5)	319	123	542
16.5—17.5	174	117	291		**2320**	**1855**	**4175**

All measurements were made in the spring. The method of measuring the Length, Breadth, Height of the head and Stature and Weight of the body is that universlly accepted method described by Martin viz.

1. The maximum length of the head (Martin's Längenmaße No. 1) is measured from the most prominent point of the glabella to the most prominent occipital point. (Opisthrocranion) (Martin's Tasterzirkel)
2. The maximum breadth of the head (Martin's Breitenmaße No. 3) is measured from the highest bilateral temporal point. (Martin's Tasterzirkel)
3. The maximum height of the head (Martin's Höhenmaße No. 15) is measured from the vertex to the highest point of the tragus of the ear. (Stangenzirkel mit Ohrhöhennadel)
4. The stature (standing height) is measured vertically from the sole to the vertex when the individual is standing.
5. The weight in Kilograms represents the weight without clothing.

The instruments: For the measurements of the head two kinds of sliding compass were used, one for the length and breadth of the head and the other for the height of the head. These two kinds of compass are slightly modified from Martin's spreading caliper as shown in the following figures. Also I used Martin's steel graduated rod for measuring the body height except that tape was some time used for measuring the body height of infants. The Dial type of weighting scales was used for measurements of the body weight but some times the balance type was used for measuring the body weight of infants.

Figure showing of two kinds of Sliding compass



Sliding compass for use
Length, Breadth

Sliding compass for used
Height

The methods of calculation: The frequency of distribution of each index were tabulated and for each character the mean values (M), standard deviation (σ), coefficients of variations (v) and their probable errors were calculated for each year of age, also the general developmental rate was represented by the author's formula. Finally these measurements of the head and the indices obtained were compared with the stature and weight of the same individuals.

HEAD MEASUREMENTS

I. HEAD LENGTH

1. Frequency of distribution of the head length:

The frequency of distribution of head length in 2320 Korean males and 1855 females aged 1 to 75 years and the maximum and minimum head length is shown in Table No. II and III. Under the age of 5 and over the age of 23 the apparent fluctuation is due to the small number of individuals. The middle values of the distribution of

the groups seems to gradually rise according to the increase in age whether we consider males or females. The average difference between maximum and minimum is 20 to 40 mm. in males and 10 to 30 mm. in females. Generally speaking the difference between maximum and minimum at any age is about 20 mm. in either male or female. Details are shown in Table II and III.

Table II. Frequency-distribution of Head Length in 2320 Korean Males.

L. \ n.	29	24	16	20	26	64	67	59	68	79	99	100	129	140	178	192	174	166	120	101	74	76	57	39	26	27	28	13	8	16	109	319
205—210	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
200—205	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	1	...	...	4	...
195—200	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1	1	4	2	5	...	2	1	1	2	...	1	1	1	...	1	5
190—195	...	...	...	...	...	...	1	...	1	...	2	3	4	2	6	13	3	7	11	9	3	9	6	1	4	3	...	...	...	...	7	21
185—190	...	...	...	...	1	...	2	...	3	6	2	10	12	20	32	21	22	18	24	16	21	15	3	6	8	10	4	2	2	26	76
180—185	...	...	...	2	3	4	5	6	9	9	14	17	24	40	49	58	48	36	29	22	19	19	12	9	9	11	3	3	6	28	100
175—180	...	...	...	3	3	10	14	12	19	19	24	28	34	32	43	46	43	47	38	20	19	13	13	13	4	3	1	3	1	4	24	65
170—175	...	...	2	2	4	14	16	17	18	21	33	23	35	35	40	37	30	24	10	9	9	9	2	6	...	2	1	1	2	3	16	32
165—170	...	4	6	3	9	22	23	14	16	15	16	19	20	24	22	13	12	12	3	2	5	3	1	3	1	2	1	...	...	...	2	10
160—165	2	5	3	9	6	9	6	8	7	10	9	10	6	10	5	1	1	1	2	1	...	...	...	...	...	...	...	...	...	...	2	2
155—160	5	8	3	1	2	2	2	...	2	2	1	1	2	...	1	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
150—155	11	3	...	2	...	...	1	1	...	...	...	...	1	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
145—150	5	4	2	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
140—145	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
135—140	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
130—135	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
125—130	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31-75	23-75

Table III. Frequency-distribution of Head Length in 1855 Korean Females.

L. \ n.	13	23	10	16	17	36	68	109	100	126	124	119	128	137	132	178	117	107	67	37	42	35	23	11	8	6	9	11	5	4	46	123
205—210	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
200—205	...	...	...	...	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1
195—200	..	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
190—195	...	...	...	...	...	...	...	...	...	1	...	...	...	...	3	1	1	...	...	...	...	1	...	...	...	...	1	...	...	...	2	4
185—190	...	...	...	...	...	...	...	...	2	...	3	3	4	2	6	10	3	8	4	1	2	2	3	...	...	...	1	...	...	...	6	10
180—185	...	...	...	...	...	1	4	3	3	10	11	11	16	19	28	33	28	26	14	7	9	10	4	3	2	1	1	2	1	1	9	24
175—180	...	...	...	...	1	2	3	12	14	19	20	30	23	33	40	45	37	35	20	10	15	10	7	4	5	1	4	4	2	1	13	41
170—175	...	...	...	1	4	13	23	37	30	37	35	42	46	41	34	62	37	28	21	11	13	9	8	3	1	4	2	3	1	2	12	36
165—170	...	1	...	5	6	14	17	33	29	39	28	23	26	26	21	18	11	9	6	6	2	4	...	1	...	...	...	2	...	...	1	4
160—165	1	3	2	3	4	8	11	19	19	13	24	7	9	10	3	4	1	...	2	2	1	...	...	...	...	...	...	...	1	...	2	3
155—160	1	5	2	3	2	...	8	3	1	7	1	3	1	6	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
150—155	4	10	5	3	...	...	...	2	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
145—150	2	4	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
140—145	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
135—140	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
130—135	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
125—130	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31-75	23-75

2. Mean values of the head length:

In Table IV is shown the mean values of the head length at different ages. The mean values of the head length show a gradual rise from 150.09±1.47 (at one year) to 182.42±0.39 after 23 years and the growth ratio of each year interval averages about 1.08% in males. The standard deviation of the head length is from 4.79 to 8.94 and the coefficient of variation is from 2.66 to 5.29. Figure I clearly indicates the head length at the various ages from 1 year old up to 75 years old. In general the development of the head length follows a curve. Thus from 1 to 6 years old the average variation is more rapid 2.22% per year, and in the 7 to 13 years period is slightly less than 0.36% per year. From 14 to 20 years there is development averaging 0.74% per year representing a slight increase. After this the size of the head become practically fixed in males 182.42±0.39 (M), 7.07 (σ), 3.84 (v), Max. 200.00 and Min. 166.00

The mean values of the head length in 1855 females measured according to their ages is shown in Table IV. The mean values of the head length show a gradual rise from 148.27±2.03 (at one year) to 177.83±0.58 after 23 years and the growth during each year interval averages about 1.27%. The standard deviation of the length of the head various from 2.12 to 7.72 and the coefficient of variation from 1.35 to 4.96. The development of the head length from year to year (as shown in figure II.) follows a definite curve in the female as in the male. Thus between 1 to 5 years growth is rapid averaging 2.72% per year, between 6 to 12 years it averages only 0.46% per year and between 13 to 18 years the average is again slightly increased at 0.66% per year. From the 18th year the size of the head becomes practically fixed at 177.83±0.58 (M), and 6.45 (σ), 3.63 (v), Max. 203.00 and Min. 160.00 in the female.

Table IV (1).

Mean Values of Head Length according to Ages in Male.

$$M = A + \frac{\Sigma fk\sigma k}{N}, \quad \sigma^2 = \frac{\Sigma fk\sigma k^2}{N} - d^2, \quad V = 100 \times \sigma \div M, \quad \pm m = \frac{\sigma}{\sqrt{N}}$$

♂					
Age	M ± m	σ	V	Max.	Min.
1	150.09 ± 1.47	7.94	5.29	160	126
2	157.70 ± 1.32	6.46	4.09	168	145
3	162.82 ± 1.85	7.39	4.54	165	145
4	165.25 ± 1.59	7.14	4.32	178	150
5	168.65 ± 1.31	6.69	3.97	182	155
6	169.84 ± 0.84	6.73	3.96	186	147
7	171.08 ± 0.91	7.44	4.35	182	153
8	171.99 ± 0.89	6.81	3.96	185	154

9	172.50 ± 0.80	6.64	3.85	194	159
10	172.82 ± 0.79	6.99	4.04	187	156
11	173.61 ± 0.89	8.94	5.15	191	155
12	174.10 ± 0.71	7.14	4.10	191	157
13	175.29 ± 0.44	5.03	2.86	193	150
14	175.53 ± 0.63	7.40	4.21	195	160
15	177.75 ± 0.55	7.28	4.09	199	160
16	179.84 ± 0.50	6.90	3.84	198	165
17	179.11 ± 0.49	6.48	3.62	199	164
18	180.00 ± 0.54	7.01	3.89	200	161
19	181.38 ± 0.59	6.46	3.56	195	160
20	**182.40 ± 0.79**	**7.95**	**4.36**	**198**	**151**
21	180.48 ± 0.73	6.26	3.47	190	164
22	182.83 ± 0.81	7.04	3.85	195	165
23	181.62 ± 0.77	5.78	3.18	196	169
24	179.17 ± 1.01	6.34	3.54	200	170
25	185.00 ± 1.31	6.68	3.61	196	167
26	182.67 ± 1.30	6.73	3.68	195	166
27	183.70 ± 1.02	5.11	2.78	195	167
28	185.58 ± 2.13	7.72	4.16	200	174
29	183.12 ± 2.69	7.68	4.19	198	170
30	179.84 ± 1.24	4.79	2.66	189	171
31–75	182.09 ± 0.73	7.62	4.18	200	160
23–75	**182.42 ± 0.39**	**7.01**	**3.84**	**200**	**166**

Table IV (2).

Mean Values of Head Length according to Ages in Females.

♀					
Age	M ± m	σ	V	Max.	Min.
1	148.27 ± 2.03	7.35	4.96	160	135
2	154.67 ± 1.12	5.38	3.48	165	145
3	155.00 ± 1.28	4.63	2.99	162	145
4	161.84 ± 1.62	6.30	3.89	168	150
5	169.92 ± 1.42	5.91	3.54	179	155
6	169.44 ± 0.76	4.61	2.72	181	160
7	168.56 ± 0.80	6.48	3.84	183	155
8	168.83 ± 0.51	5.32	3.15	182	153
9	170.35 ± 0.65	6.54	3.84	190	153
10	170.59 ± 0.57	6.39	3.74	184	155
11	172.29 ± 0.63	7.08	4.11	188	155
12	173.13 ± 0.56	6.10	3.52	188	155
13	173.30 ± 0.55	6.15	3.55	188	156
14	172.97 ± 0.57	6.69	3.87	188	155
15	175.91 ± 0.50	5.75	3.27	187	153
16	176.13 ± 0.45	6.02	3.42	192	160
17	176.17 ± 0.53	5.75	3.26	186	166
18	**177.55 ± 0.53**	**5.51**	**3.10**	**188**	**165**
19	175.49 ± 0.75	6.18	3.52	185	160
20	174.80 ± 0.88	5.99	3.43	185	160
21	176.67 ± 0.80	5.22	2.95	185	160
22	177.07 ± 0.94	5.47	3.09	188	164
23	178.76 ± 1.18	5.68	3.18	192	170
24	176.59 ± 1.49	4.92	2.79	180	165
25	178.12 ± 1.04	2.99	1.68	183	172
26	175.00 ± 1.27	3.82	2.18	182	170
27	179.72 ± 2.09	6.28	3.49	191	170
28	175.22 ± 1.18	3.90	2.22	180	166
29	176.50 ± 1.73	3.87	2.19	180	160
30	176.25 ± 2.07	4.14	2.35	184	170
31–75	178.80 ± 1.14	7.72	4.32	203	160
23–75	**177.83 ± 0.58**	**6.45**	**3.63**	**203**	**160**

Fig. I.

Graph of Head Length Variation with Age in Males.

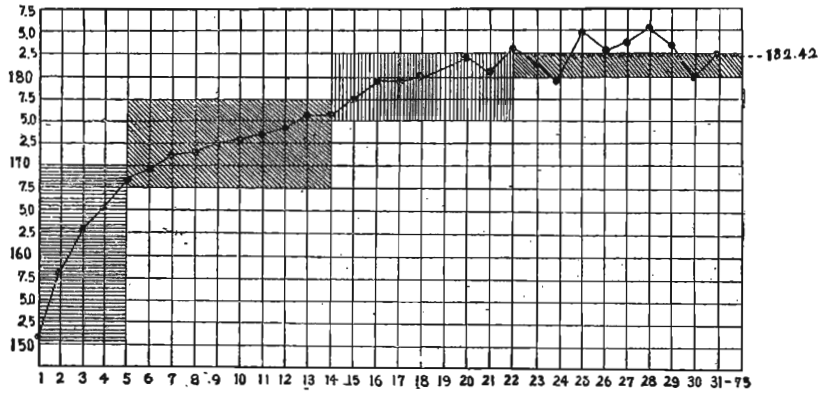
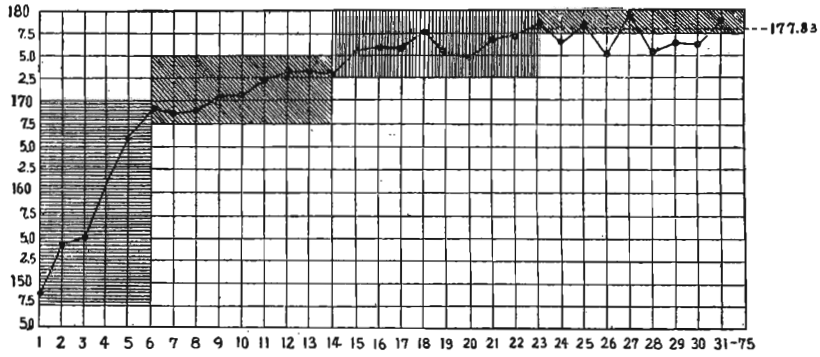


Fig. II.

Graph of Head Length Variation with Age in Females.



3. Comparison of males with females as regards length of the head :

The details are shown in Table V. Up to 12 years there is no marked difference between male and female but after that a marked difference appears because after this age the male rapidly develops while the female shows no such acceleration. This is well shown in Graph III. The male is in fact always larger than the female at eachage and the final difference after full growth amounts to 6.56 (m-dif.). Under 6 years the rate of development is slightly greater in the female averaging 2.72% per year as compared with 2.22% per year in the male but the absolute measurements shows that the female is always smaller than the male. Therefore the development of the head

length in the female progresses rapidly and finishes earlier than in the male. Namely the female head length has reached the adult average at 18 years while the male continues to grow up to 20 years.

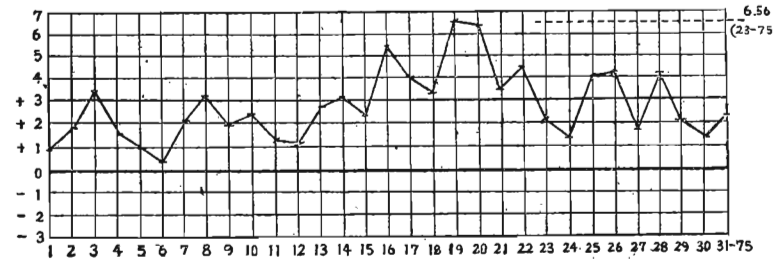
Table V. Ratio of Differences of two Means (♂, ♀) to its Probable error of the Head Length.

$$\text{m dif.} = \sqrt{m_1^2 + m_2^2}$$

Age	$M_1 - M_2$	m. dif.	$\frac{M_1 - M_2}{\text{m. dif.}}$	$> = 3 <$	Age	$M_1 - M_2$	m. dif.	$\frac{M_1 - M_2}{\text{m. dif.}}$	$> = 3 <$
1	1.82	2.51	0.72	< 3	17	2.94	0.72	4.08	> 3
2	3.03	1.73	1.75	< 3	18	2.45	0.75	3.27	> 3
3	7.82	2.25	3.48	> 3	19	6.34	0.95	6.67	> 3
4	3.41	2.27	1.50	< 3	20	7.60	1.18	6.44	> 3
5	1.73	1.93	0.90	< 3	21	3.81	1.08	3.53	> 3
6	0.40	1.13	0.35	< 3	22	5.76	1.23	4.68	> 3
7	2.52	1.21	2.08	< 3	23	2.86	1.40	2.04	< 3
8	3.16	1.02	3.10	> 3	24	2.58	1.80	1.43	< 3
9	2.15	1.13	1.90	< 3	25	6.88	1.67	4.12	> 3
10	2.23	0.97	2.30	< 3	26	7.67	1.82	4.21	> 3
11	1.32	1.09	1.21	< 3	27	3.98	2.32	1.72	< 3
12	0.97	0.90	1.08	< 3	28	10.36	2.36	4.39	> 3
13	1.99	0.70	2.84	< 3	29	6.62	3.20	2.07	< 3
14	2.56	0.84	3.05	> 3	30	3.59	2.41	1.49	< 3
15	1.84	0.74	2.45	< 3	31–75	3.29	1.35	2.44	< 3
16	3.71	0.67	5.54	> 3	23–75	4.59	0.70	6.56	> 3

Fig. III.

Graph showing influence of Sex on Head Length according to Age.



4. Rate and types of development of the head length.

A. Rate of development of the head length :

From Table VI. and Figure IV. we can as certain the absolute and relative increase in head length during each year and also the mean values. The maximum head length for males is fixed at 182.42 at 20 years and for the females is 177.83 at about 18 years. The rate of development of the head length averages 1.08% per year in the male between 1 and 20 years and 1.27% per year in the female between 1 and 18 years. But as the age rises the rate of increase of the head length

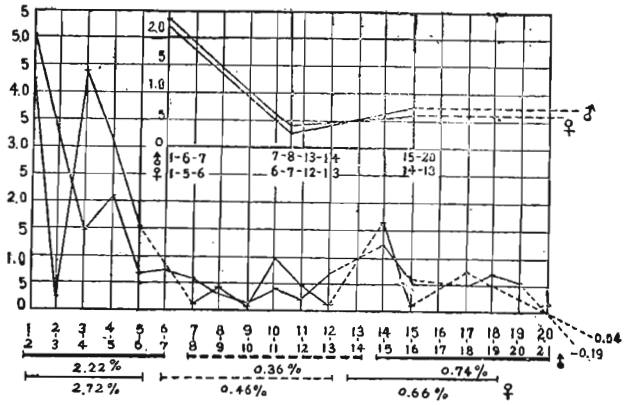
gradually diminishes. Therefore the maximum rate of increase always occurs in male and female infants and the minimum rate always occurs just before the male or female head reaches adult demensions. Neither male nor female shows any evidence of growth after 20 years (the rate is -0.19% in male, 0.04% in the female).

Table VI. Ratio of Differences of the Developmental rate of Head Length between Male and Female.

Ratio t (Age)	♂		♀		Ratio t (Age)	♂		♀	
	$Ltx-Ltx'$	$\frac{Ltx-Ltx'}{Ltx}$	$Ltx-Ltx'$	$\frac{Ltx-Ltx'}{Ltx}$		$Ltx-Ltx'$	$\frac{Ltx-Ltx'}{Ltx}$	$Ltx-Ltx'$	$\frac{Ltx-Ltx'}{Ltx}$
1–2	7.61	5.07	6.40	4.32	17–18	0.89	0.50	1.38	0.78
2–3	5.21	3.25	0.33	0.21	18–19	1.38	0.77	−2.06	.....
3–4	2.43	1.49	6.48	4.41	19–20	1.02	0.56	−0.69	.....
4–5	3.40	2.06	5.08	3.14	20–21	−0.92	.....	1.87	.....
5–6	1.19	0.70	2.52	1.51	21–22	2.35	.....	0.40	.....
6–7	1.24	0.73	−0.88	.....	22–23	−1.21	.....	1.69	.....
7–8	0.91	0.53	0.27	0.16	23–24	−2.45	.....	−2.17	.....
8–9	0.51	0.30	1.52	0.90	24–25	5.83	.....	1.53	.....
9–10	0.32	0.19	0.24	0.14	25–26	−2.33	.....	−3.12	.....
10–11	0.79	0.46	1.70	1.00	26–27	1.03	.....	4.72	.....
11–12	0.49	0.28	0.84	0.49	27–28	1.88	.....	−4.50	.....
12–13	1.19	0.68	0.17	0.10	28–29	−2.46	.....	1.23	.....
13–14	0.14	0.08	−0.33	.....	29–30	−3.28	.....	−0.25	.....
14–15	2.22	1.26	2.94	1.70	30–31	2.25	.....	2.55	.....
15–16	1.09	0.61	0.22	0.13	(20-75)	−0.19(average 18-75)		0.04	.....
16–17	−0.67	.....	0.04	0.02	.....	.....	.....	.....	.....

Fig. IV.

Graph showing Differences of Developmental rate of the Head Length in Male and Female.



B. The curve of rate of development of the head length:

Indicates that there are three period with different rates before the adult size is reached. In males the first period is up to 7 years

during which time the average rate is 2.22% per year, from 7 to 13 years inclusive the average is 0.36% per year, and from 14 to 20 years the average is 0.74% per year. In females from 1 to 5 years the average is 2.72% per year, from 6 to 12 years the average is 0.46% per year, and in the third period from 13 to 18 years the average is 0.66% per year. The development of the head length in male and female thus runs almost parallel. The actual increase per year is almost the same but the development of the female progresses more rapidly and is completed earlier. In both male and female the first period is one of rapid growth, growth in the middle period is quite slow and the last period rather more rapid. In the male the first period extends up to the end of the 7th year but only to the end of the 6th year in the female. In the male the second period is from 7 to 13 years and from 6 to 12 years in the female. The third period in the male extends from 14 to 20 and in the female is from 13 to 18 years.

From our knowledge of functional biology, we would expect a smooth curve to represent the growth of the head length through the whole duration of body growth. Many investigators have tried to reduce to a formula this hypothetical curve of growth and apply it to different organisms. There is for instance T. B. Robertson's 'Master reaction', and the formula of W. Ostwald, and S. Brody, Sachs, Driesch, Donaldson, Quetelet, Davenport, A. P. Anderson, and Vierordt. I also tried to base such a formula upon the principle of the 'Action of the monomolecularautocatalysis' and co-relate it with previously announced formula. My formula in its latest form is little different from the formula given by S. Brody. The method of the calculation and some other details was shown in Table VII, VIII, IX and Figure V, VI.

My empirical formula is:

$$y = \frac{a}{1 + be^{-cx}}$$

Reciprocal equation of the above formula:

$$Y = A + Be^{-cx}$$

y ..... length of head (increasing)

a .....
b ..... } all constant
$-c$ .....

e·····2,7183=log (0.43429) (natural logarithum)

x·····age (time)

The data of the constants a, b, $-c$, and methods of their calculations are as follows:

$$y=\frac{a}{1+be^{-cx}}=\frac{1}{y}=\frac{1+be^{-cx}}{a}=\frac{1}{y}=\frac{1}{a}+\frac{b}{a}e^{-cx}$$

$$\frac{1}{y}=Y,\quad \frac{1}{a}=A,\quad \frac{b}{a}=B,\cdots\cdots Y=A+Be^{-cx}\cdots\cdots$$

$$\cdots\cdots Y-A=Be^{-cx},\quad (Be^{-cx})=Z\cdots\cdots 1$$

$$Y-A=Z\cdots\cdots=\frac{1}{y}-\frac{1}{a}=Z$$

$$\text{Log10Z}=\text{Log10B}-cx\log 10e\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\quad (1)$$

$$\text{Log10Z}=\eta,\quad \text{Log10B}=\beta,\quad -c\log 10e=\alpha$$

The method of the calculation of α, and β, based upon the method of "LEAST SQUARE".

$$\alpha=\frac{(\sum(x))(\sum(\eta))-n(\sum(x\eta))}{(\sum(x))^2-n(\sum(x)^2)}$$

$$\beta=\frac{(\sum(x))(\sum(x\eta))-(\sum(x^2))(\sum(\eta))}{(\sum(x))^2-n(\sum(x)^2)}$$

$$B=\text{Antilog }\beta,\quad -c=\frac{a}{\log 10e}=\frac{a}{0.43429},\quad b=aB,$$

The results of the $-c$, b, in the empirical formula of male:

$-c=-0.2089$, $b=0.3364$

The results of tbe $-c$, b, in the empirical formula of female:

$-c=-0.1944$, $b=0.2223$

In the male: $y=\dfrac{182.42}{1+0.3364e^{-0.2089x}}$

In the female: $y=\dfrac{177.83}{1+0.2223e^{-0.1944x}}$

Table VII. Calculation of Mean Values of the Heal Length in Male.

$a_0 = 182.42$ ♂ $\frac{1}{a} = 0.00548 = A$

a	y	$\frac{1}{y} = Y$	$\frac{1}{y} - \frac{1}{(Z)}\frac{1}{a}$	log10 Z	η	x	$(x)^2$	$x\eta$
1	150.09	0.00666	0.00118	0.0719	-2.9281	1	1	-2.9281
2	157.70	〃 643	0.00086	0.9435	-3.0655	2	4	-6.1310
3	162.82	〃 614	〃 66	0.8195	-3.1805	3	9	-9.5415
4	165.25	〃 605	〃 57	0.7559	-3.2441	4	16	-12.9764
5	168.65	〃 593	〃 45	0.6532	-3.3468	5	25	-16.7340
6	169.84	〃 589	〃 41	0.6128	-3.3872	6	36	-20.3232
7	171.08	〃 584	〃 36	0.5563	-3.4437	7	49	-24.1059
8	171.99	〃 582	〃 34	0.5315	-3.4685	8	64	-27.7480
9	172.50	〃 580	〃 32	0.5051	-3.4949	9	81	-31.4541
10	172.82	〃 579	〃 31	0.4914	-3.5086	10	100	-35.0860
11	173.61	〃 576	〃 28	0.4472	-3.5528	11	121	-39.0808
12	174.10	〃 574	〃 26	0.4150	-3.5850	12	144	-43.0200
13	175.29	〃 572	〃 24	0.3802	-3.6198	13	169	-47.0574
14	175.53	〃 571	〃 23	0.3617	-3.6383	14	196	-50.9362
15	177.75	〃 563	〃 15	0.1761	-3.8239	15	225	-57.3585
16	179.84	〃 556	0.00008	0.9031	-4.0969	16	256	-65.5504
17	179.11	〃 558	0.00010	0	-4.0000	17	289	-68.0000
18	180.00	〃 556	0.00008	0.9031	-4.0969	18	324	-73.7442
19	181.38	〃 552	〃 4	0.6020	-4.3980	19	361	-83.5620
20	182.40	〃 549	〃 1	0	-5.0000	20	400	-100.0000
21	180.48	〃 554	〃 6	0.7782	-4.2218	21	441	-88.6578
22	182.83	〃 548	〃 0	0	-6.0000	22	484	-132.0000
n = 22					**-83.1013**	**253**	**3795**	**-1035.9955**
					$\Sigma(\eta)$	$\Sigma(x)$	$\Sigma(x)^2$	$\Sigma(x\eta)$

Table VIII. Calculation of Mean Values of the Head Length in Female.

$a_0 = 177.83$ ♀ $\frac{1}{a} = 0.00563 = A$

a	y	$\frac{1}{y} = Y$	$\frac{1}{y} - \frac{1}{(Z)}\frac{1}{a}$	log10 Z	η	x	$(x)^2$	$x\eta$
1	148.27	0.00674	0.00111	0.0453	-2.9547	1	1	-2.9547
2	154.67	〃 646	0.00083	0.9191	-3.0809	2	4	-6.1618
3	155.00	〃 645	〃 82	0.9133	-3.0862	3	9	-9.2586
4	161.84	〃 618	〃 55	0.7408	-3.2597	4	16	-13.0388
5	166.92	〃 599	〃 36	0.5563	-3.4437	5	25	-17.2185
6	169.44	〃 590	〃 27	0.4314	-3.5686	6	36	-21.4116
7	168.56	〃 593	〃 30	0.4771	-3.5229	7	49	-24.6603
8	168.83	〃 592	〃 29	0.4624	-3.5376	8	64	-28.3008
9	170.35	〃 589	〃 26	0.4150	-3.5850	9	81	-32.2650
10	170.59	〃 586	〃 23	0.3617	-3.6383	10	100	-36.3830
11	172.29	〃 581	〃 18	0.2553	-3.7447	11	121	-41.1917
12	173.13	〃 578	〃 15	0.1761	-3.8239	12	144	-45.8868
13	173.30	〃 577	〃 14	0.1461	-3.8539	13	169	-50.1007
14	172.97	〃 579	〃 16	0.2041	-3.7959	14	196	-53.1426
15	175.91	〃 569	0.00006	0.7781	-4.2219	15	225	-63.3285
16	176.13	〃 567	〃 4	0.6020	-4.3980	16	256	-70.3680
17	176.17	〃 568	〃 5	0.6990	-4.3010	17	289	-73.1170
18	177.55	〃 563	〃 0	0	-6.0000	18	324	-108.0000
19	175.49	〃 570	〃 7	0.8451	-4.1549	19	361	-78.9431
20	174.80	〃 572	〃 9	0.9542	-4.0458	20	400	-80.9160
21	176.67	〃 566	〃 3	0.4771	-4.5229	21	441	-94.9809
22	177.07	〃 565	〃 2	0.3010	-4.6990	22	484	-103.3780
n = 22					**-85.2395**	**253**	**3795**	**-1055.0064**
					$\Sigma(\eta)$	$\Sigma(x)$	$\Sigma(x)^2$	$\Sigma(x\eta)$

Fig. V. Graph showing Values of (Z) almost a rectilinear figure.

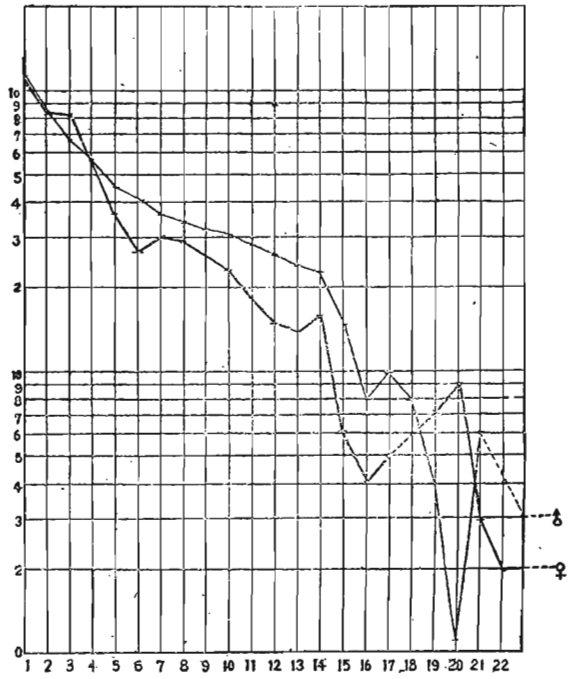
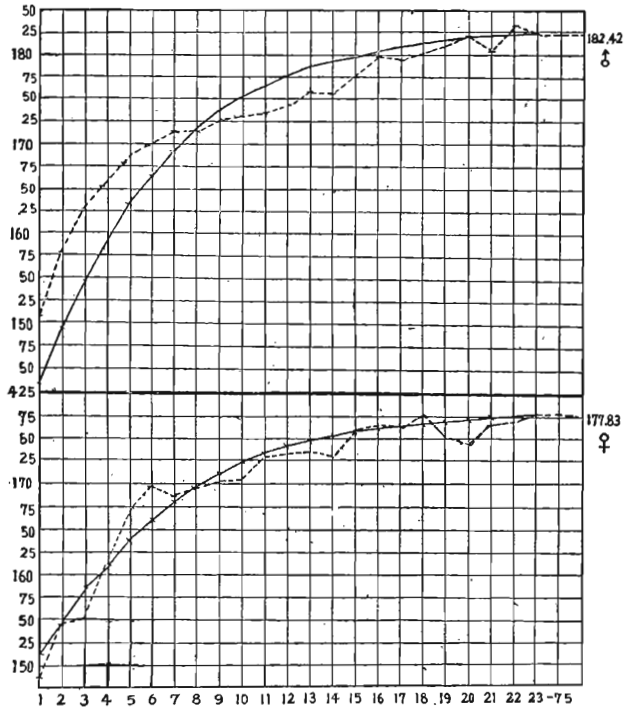


Table IX. Comparison of Mean Values both Experimental and calculated of the Head Length in Male and Female according to Age.

	♂		♀	
Age	Experimental	Calculated	Experimental	Calculated
1	150.09	143.30	148.27	150.32
2	157.70	149.34	154.67	154.54
3	162.82	154.67	155.00	158.20
4	165.25	159.19	161.84	161.34
5	168.65	163.11	166.92	164.03
6	169.84	166.43	169.44	166.30
7	171.08	169.22	168.56	168.24
8	171.99	171.56	168.83	169.85
9	172.50	173.52	170.35	171.22
10	172.82	175.12	170.59	172.35
11	173.61	176.46	172.29	173.29
12	174.10	177.55	173.13	174.07
13	175.29	178.44	173.30	174.72
14	175.53	179.18	172.97	175.18
15	177.75	179.78	175.91	175.72
16	179.84	180.27	176.13	176.09
17	179.11	180.67	176.17	176.38
18	180.00	181.00	177.55	176.64
19	181.38	181.26	175.49	176.87
20	182.40	181.48	174.80	177.02
21	180.48	181.66	176.67	177.16
22	182.83	181.80	177.07	177.28

Fig. VI. Graph showing of differences of Mean Values both Experimental and Calculated in ♂ and ♀.



5. Comparison with other races:

Review of reports from the literature about the head length of adults show that measurements of the head length during the period of development are decidedly rare. We have so far only reports on the European and the American white. Generally speaking the Korean head length is less than that of the races about which we have information. Comparing the adult Korean with other Asiatic races we find his head measurements about the same as the central Asiatic races and the southern Chinese, less than the south Asiatic races and the Japanese and the North Chinese. The European head and especially the head of the north Europeans is almost the same as the Korean but smaller than the central and south European. Comparing with American races Koreans are a little smaller than the south American and much smaller than the American white. On the races of Africa and Osea there are Korean head length always smaller than that races both Africa and Osea. Details shown in Table X, XI, and Figure VII.

Table X. Comparison of Development of the Head Length (Mean Value) with other Races both Male and Female.

Races / Age	Korean				White American		Europian					
	Choi		Kajimura		West		Schweden		Schweizer		Holsteiner	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
1	150.09	148.27	...	...	...	...	...	...	...	...	143	139
2	157.70	154.67	...	...	...	...	...	...	...	...	166	160
3	162.82	155.00	...	...	...	...	...	...	...	...	170	165
4	165.25	161.84	...	...	...	...	...	...	...	...	173	170
5	168.65	166.92	...	...	...	...	...	...	...	...	173	170
6	169.84	169.44	16.3	16.2	176	172	170.3	167.0	173	170	177	176
7	171.08	168.56	16.4	16.2	179	175	172.9	169.1	174	170	178	174
8	171.99	168.83	16.6	16.4	180	174	174.0	170.2	174	172	178	175
9	172.50	170.35	16.6	16.5	181	176	175.4	171.4	177	172	180	177
10	172.82	170.59	16.7	16.5	182	177	176.4	172.7	177	172	181	179
11	173.61	172.29	16.9	16.7	183	180	177.3	173.8	174	175	183	178
12	174.10	173.13	17.0	16.8	183	180	178.6	174.8	179	175	182	179
13	175.29	173.30	...	...	184	181	179.4	176.2	180	176	183	179
14	175.53	172.97	...	...	187	183	180.6	177.2	181	177	184	180
15	177.75	175.91	...	...	188	184	...	...	181	177	185	180
16	179.84	176.13	...	...	191	184	...	...	183	177	...	...
17	179.11	176.17	...	...	189	...	...	...	183	...	...	...
18	180.00	177.55	...	...	192	...	...	...	186	...	...	...
19	181.38	175.49	...	...	192	...	...	...	188	...	...	...
20	182.40	174.80	...	...	195	...	...	...	188	...	...	...
21	180.48	176.67	...	...	...	...	...	...	...	...	...	...
22	182.83	177.07	...	...	...	...	...	...	...	...	...	...
23-75	182.42	177.83	...	...	...	...	...	...	...	...	...	...

Fig. VII. Graph showing the Developmental rate of the Head Length Compared with other Races both Male and Female.

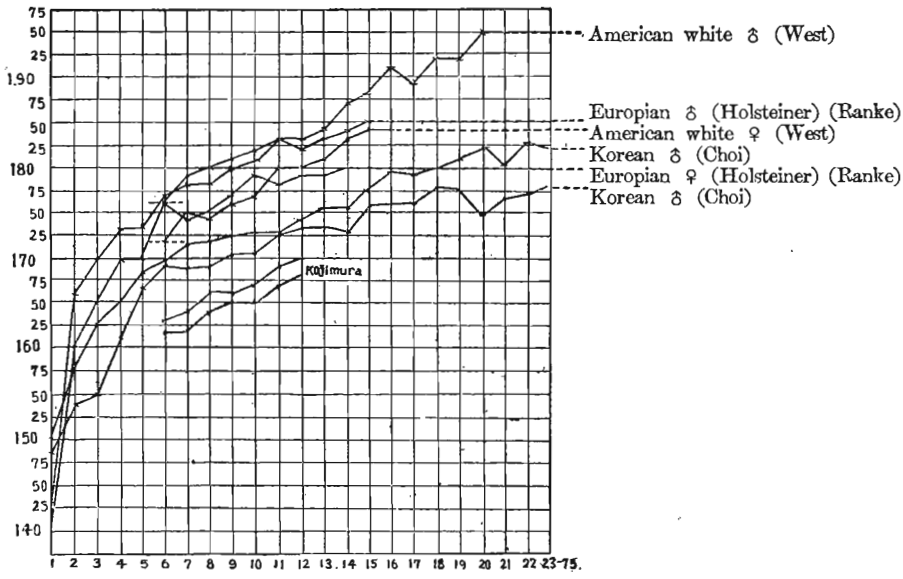


Table XI. Comparison of Head Length (Mean Value) with other Races both Male and Female in Adult (Full grow up).

Races	♂	♀	Observer	Races	♂	♀	Observer
Asia				**Europ.**			
Andamanen-North	173	165	Census of India	Grogrussen	179	172	Galai
〃 South	〃	166	〃 〃	Litauer	184	178	Baronas
Kayan	181	176	Haddon	Weizrussen	185	177	Roshdestwenski
Birmanen	〃	...	Census of India	Dänen	193	184	Hansen
Manjurian	181.20	173.69	Takamure	**Africa**			
Korean	181.4	175.7	Kubo	Mawanbi-Pigt.	183	181	Czekanowski
〃	182.42	177.83	Choi	Agypter	189	...	Hrdlicka
Chinese South	180–183	...	Hagen	**America**			
Land-Dajak	183	...	Haddon	Chiliguan	184	173	Lehmann-Nitsche
Japanese	188.55	179.31	Matsumura	Schingu-Indianer	185	177	K. Ranke
Chineses North	188.5	184	Koganei	Mataco	188	180	Lehmann-Nitsche
Tschuktschen	188	182	Bogoras	Shochoni	192	184	Boas
Koriaken	189	183	Tochelson	**Osea**			
Asiatic Eskimo	190	184	Bogoras	Toricelli-gebirge	183	...	Schlaginhaufen
Tungusen	194	185	Jochelson	Jakumul	191	...	〃
Turkestan (Loplik)	〃	...	Joyce				

Literature cited will be listed in the last report of the series.