

GROWTH CHARTS BASED ON LONGITUDINAL STUDY OF MALAYSIAN CHILDREN FROM BIRTH TO SIX YEARS

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SUMMARY

Percentile growth charts of weight, length and head circumference, from birth to six years of age, for boys and girls, are presented. These can be used to monitor the growth of Malaysian children.

INTRODUCTION

A child's growth achievement is a useful indicator of his well-being and nutritional status. This can easily be assessed by comparing his growth parameters such as weight, length and head circumference, with norms or standards derived from a relatively healthy population of genetically similar children. Such standards are essential to professionals working with children, for example paediatricians, general practitioners, health officers and nurses.

Chen and Dugdale,¹ and Chen^{2,3} have published norms for weight, height, mid-arm circumference and triceps skinfold in the form of growth charts for Malaysian school children from six to 12 years of age, while Dugdale⁴

and Dugdale *et al.*,⁵ have published weight norms for Malaysian infants and weight, height, head circumference, midarm circumference, triceps skinfold and midarm muscle circumference norms for Malay children between six months to five years of age respectively. There is however no published information for the age group from five to six years and no information regarding the length and head circumference of infants below six months of age. Further, in Dugdale⁴ and Dugdale *et al.*,⁵ growth norms, the data for boys and girls were combined. Since there are differences in growth between boys and girls during early childhood, growth norms for boys and girls should be separate.⁶ This paper presents separate growth charts for Malaysian boys and girls for weight, length and head circumference from birth to six years of age.

MATERIALS AND METHOD

Data were obtained from records of 227 children born between March 1968 and June 1974, and who had no gross physical defects and who were followed-up regularly in the University Hospital Child Health Clinic. There were 106 boys and 121 girls of which 51 were Malay, 104 Chinese, 65 Indian and seven Eurasian (Table I). These children were followed-up for a variable period from birth to six years of age with a median duration of 39 months.

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TABLE I
DISTRIBUTION OF CHILDREN
BY ETHNIC GROUP AND SEX

Ethnic group	Number of children		Total
	Boys	Girls	
Malay	20	31	51
Chinese	52	52	104
Indian	30	35	65
Eurasian	4	3	7
Total	106	121	227

The children were from a mixed socioeconomic background. The occupation of the parents is

shown in Table II. Of the 227 fathers, 63 (27.7%) were clerical or technical workers, 52 (23.0%) were professional workers, 34 (15%) were administrative officers, 32 (14.1%) were unskilled workers, 22 (9.7%) were sales and service workers, 17 (7.5%) were skilled workers, five were unemployed and two were university students. Of the 226 mothers, 126 (55.8%) were housewives, 50 (22.1%) were professional workers, 34 (15.0%) were clerical or technical workers, 11 (4.9%) were unskilled workers, three (1.3%) were administrative officers and two were telephone operators. The median household income was above M\$500/- per month.

TABLE II
DISTRIBUTION OF PARENTS OF 227 CHILDREN BY OCCUPATION

Job category	Fathers			Mothers		
	No.	Subtotal	(%)	No.	Subtotal	(%)
Professional workers	—	52	(23.0)	—	50	(22.1)
Teachers in schools and higher institutions	16	—	—	23	—	—
Engineers	11	—	—	—	—	—
Medical, dental or veterinary officers, pharmacists	7	—	—	3	—	—
Accountants, economists, lawyers	5	—	—	—	—	—
Scientists	4	—	—	—	—	—
Officers in armed forces	3	—	—	—	—	—
Nurses	1	—	—	23	—	—
Others	5	—	—	1	—	—
Administrative officers such as executive officers, managers, business owners	—	34	(15.0)	—	3	(1.3)
Clerical or technical workers such as stenographers, clerks, typists, technicians	—	63	(27.7)	—	34	(15.0)
Skilled workers such as mechanics, drivers, painters	—	17	(7.5)	—	—	—
Unskilled workers such as labourers, attendants, factory workers, rubber tappers	—	32	(14.1)	—	11	(4.9)
Sales and service workers such as salesmen, shop assistants, waiters, soldiers, telephone operators	—	22	(9.7)	—	2	(0.9)
Housewives	—	—	—	—	126	(55.8)
Unemployed, students	—	7	(3.0)	—	—	—
Total		227	(100)		226*	(100)

* 1 child's mother died.

The number of living siblings, at the time of birth of the studied children, ranged from none to seven with a median of one.

The methods of measurements used were based on those of Jelliffe.⁷ The scale used for weighing was a Wayalex beam balance. Length was taken with the child held supine on a measuring board. Head circumference was measured with a fibre-glass tape which was replaced when necessary.

Data from all the measurements were punched on to IBM cards and analysed with the aid of a computer. Data for boys and girls were analysed separately. Since the children were measured at specific ages, the data had been grouped such that the mode, that is the ages where most of the children were measured, formed the midpoint.

For each type of measurement the values at the 10th, 25th, 50th, 75th and 90th percentiles at the various age groups were obtained. Since the mean and median for each measurement at each age group was found to be similar, normalised percentile values at the 10th, 25th, 50th, 75th and 90th percentiles were also obtained. These normalised percentiles were used for the construction of growth curves which were drawn with a minimum of visual smoothing.

RESULTS

Tables III to VIII give the standard deviation and normalised percentiles of weight, length and head circumference by age of the 106 boys and 121 girls separately.

TABLE III
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF WEIGHT OF BOYS BY AGE

Mean age (months)	Normalised percentiles of weight (kg)					S.D.
	10th	25th	50th	75th	90th	
0.0	2.50	2.77	3.08	3.38	3.66	0.45
1.6	3.37	3.99	4.68	5.38	6.00	1.03
2.9	4.74	5.24	5.80	6.36	6.86	0.83
4.0	5.37	5.89	6.46	7.04	7.56	0.86
5.5	6.15	6.65	7.21	7.77	8.26	0.82
6.6	6.58	7.10	7.68	8.25	8.77	0.85
8.2	6.94	7.49	8.10	8.71	9.27	0.91
9.9	7.36	7.98	8.68	9.37	9.99	1.03
11.9	7.65	8.29	9.02	9.74	10.39	1.07
14.4	8.12	8.77	9.50	10.22	10.88	1.07
16.9	8.43	9.17	10.00	10.82	11.56	1.22
19.3	9.11	9.84	10.66	11.48	12.22	1.21
21.4	9.63	10.26	10.95	11.64	12.26	1.02
24.4	9.95	10.74	11.62	12.49	13.28	1.30
28.3	10.54	11.35	12.26	13.16	13.97	1.34
31.5	11.06	11.80	12.62	13.44	14.17	1.21
36.0	11.48	12.44	13.51	14.57	15.53	1.58
41.0	12.03	12.92	13.90	14.89	15.77	1.46
45.5	12.03	13.21	14.51	15.82	16.99	1.94
51.0	13.27	14.34	15.53	16.73	17.80	1.77
56.4	13.50	14.66	15.95	17.24	18.40	1.91
62.7	14.59	15.70	16.94	18.18	19.30	1.84
69.0	14.84	16.13	17.56	19.00	20.29	2.13

TABLE IV
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF WEIGHT OF GIRLS BY AGE

Mean age (months)	Normalised percentiles of weight (kg)					S.D.
	10th	25th	50th	75th	90th	
0.0	2.41	2.71	3.04	3.37	3.67	0.49
1.8	3.49	3.89	4.33	4.77	5.16	0.65
3.0	4.19	4.84	5.56	6.29	6.94	1.07
4.1	4.96	5.51	6.11	6.72	7.26	0.90
5.5	5.64	6.07	6.55	7.03	7.46	0.71
6.7	6.09	6.65	7.27	7.88	8.44	0.92
8.2	6.21	6.84	7.53	8.22	8.85	1.03
10.0	6.60	7.32	8.12	8.92	9.64	1.18
12.0	7.17	7.87	8.65	9.43	10.13	1.15
14.1	7.51	8.11	8.77	9.43	10.03	0.98
16.8	7.64	8.48	9.43	10.37	11.22	1.40
19.2	8.07	8.93	9.88	10.84	11.69	1.42
21.7	8.71	9.56	10.50	11.44	12.29	1.40
24.9	8.70	9.77	10.96	12.15	13.22	1.76
28.3	9.37	10.39	11.53	12.67	13.70	1.69
31.9	9.76	10.82	12.00	13.18	14.24	1.75
36.0	10.62	11.63	12.76	13.89	14.91	1.67
41.0	10.67	12.07	13.63	15.19	16.59	2.31
45.5	11.43	12.45	13.60	14.74	15.77	1.70
50.6	10.94	12.78	14.83	16.88	18.72	3.03
56.9	12.21	14.09	16.18	18.27	20.14	3.09
63.0	12.79	14.83	17.09	19.36	21.40	3.36
69.5	14.92	16.21	17.63	19.06	20.35	2.12

TABLE V
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF LENGTH OF BOYS BY AGE

Mean age (months)	Normalised percentiles of length (cm)					S.D.
	10th	25th	50th	75th	90th	
0.0	45.2	47.0	49.0	51.0	52.8	2.95
1.6	51.5	53.5	55.8	58.0	60.0	3.30
2.9	56.7	58.3	60.1	61.9	63.5	2.63
4.0	59.4	60.8	62.4	64.0	65.4	2.33
5.5	62.7	63.9	65.3	66.7	68.0	2.06
6.6	64.1	65.6	67.4	69.1	70.7	2.59
8.2	66.1	67.5	69.0	70.6	72.0	2.32
9.9	68.9	70.4	72.1	73.8	75.3	2.49
11.9	70.2	71.8	73.6	75.5	77.1	2.70
14.4	72.8	74.5	76.4	78.2	79.9	2.75
16.9	74.4	76.5	78.9	81.3	83.4	3.52
19.3	78.6	80.4	82.4	84.4	86.3	3.00
21.4	79.1	81.1	83.3	85.5	87.5	3.25
24.4	81.6	83.9	86.3	88.8	91.1	3.69
28.3	83.8	86.2	88.8	91.4	93.8	3.90
31.5	86.7	88.9	91.3	93.7	95.8	3.55
36.0	88.9	91.2	93.8	96.5	98.8	3.89
41.0	91.6	93.8	96.2	98.6	100.8	3.57
45.5	93.4	96.0	98.9	101.8	104.5	4.32
51.0	96.1	99.0	102.2	105.4	108.3	4.78
56.4	99.1	101.4	103.9	106.5	108.8	3.80
62.7	101.3	103.5	105.9	108.4	110.6	3.62
69.0	106.5	108.4	110.6	112.8	114.7	3.22

TABLE VI
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF LENGTH OF GIRLS BY AGE

Mean age (months)	Normalised percentiles of length (cm)					S.D.
	10th	25th	50th	75th	90th	
0.0	45.4	47.1	48.9	50.8	52.5	2.74
1.8	51.9	53.2	54.7	56.2	57.6	2.21
3.0	53.8	56.3	59.0	61.8	64.3	4.09
4.1	57.8	59.4	61.3	63.1	64.7	2.70
5.5	61.6	62.6	63.7	64.9	65.9	1.69
6.7	62.8	64.1	65.6	67.2	68.5	2.25
8.2	64.2	65.8	67.5	69.3	70.9	2.59
10.0	65.8	67.7	70.0	72.2	74.2	3.28
12.0	68.4	70.3	72.4	74.5	76.4	3.11
14.1	70.5	72.4	74.5	76.6	78.5	3.09
16.8	72.6	74.7	77.1	79.4	81.5	3.49
19.2	75.0	77.2	79.6	82.0	84.1	3.56
21.7	77.4	79.6	82.1	84.5	86.7	3.63
24.9	78.9	81.5	84.4	87.3	89.8	4.27
28.3	81.7	84.2	86.9	89.6	92.1	4.02
31.9	83.4	86.1	89.1	92.1	94.7	4.43
36.0	87.0	89.6	92.6	95.5	98.1	4.33
41.0	89.3	92.4	95.8	99.2	102.3	5.10
45.5	91.8	94.2	96.9	99.5	101.9	3.96
50.6	89.4	94.4	100.0	105.6	110.6	8.30
56.9	98.4	101.5	104.9	108.3	111.4	5.09
63.0	102.2	105.4	108.9	112.4	115.6	5.23
69.5	104.0	106.8	109.9	112.9	115.7	4.55

TABLE VII
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF HEAD CIRCUMFERENCE OF BOYS BY AGE

Mean age (months)	Normalised percentiles of head circumference (cm)					S.D.
	10th	25th	50th	75th	90th	
0.0	31.9	32.8	33.7	34.7	35.6	1.43
1.6	35.3	36.5	37.9	39.2	40.4	2.02
2.9	38.0	38.8	39.8	40.8	41.6	1.42
4.0	39.0	39.9	40.8	41.8	42.7	1.42
5.5	40.6	41.4	42.2	43.1	43.9	1.31
6.6	41.3	42.1	43.0	43.9	44.7	1.34
8.2	42.3	43.1	44.0	44.9	45.7	1.32
9.9	42.9	43.9	44.9	46.0	46.9	1.56
11.9	43.9	44.7	45.6	46.6	47.4	1.38
14.4	44.3	45.2	46.3	47.3	48.2	1.54
16.9	44.7	45.6	46.7	47.7	48.6	1.53
19.3	45.7	46.6	47.5	48.4	49.2	1.33
21.4	45.9	46.7	47.6	48.5	49.3	1.33
24.4	46.3	47.2	48.1	49.1	49.9	1.42
28.3	46.7	47.6	48.6	49.6	50.5	1.48
31.5	46.9	47.8	48.7	49.7	50.5	1.43
36.0	47.1	48.1	49.2	50.3	51.3	1.66
41.0	47.1	48.2	49.4	50.6	51.7	1.80
45.5	47.5	48.3	49.3	50.3	51.1	1.41
51.0	48.0	49.2	50.5	51.8	52.9	1.93
56.4	47.7	48.7	49.8	50.8	51.8	1.57
62.7	47.7	48.7	49.9	51.0	52.0	1.70
69.0	48.4	49.1	49.9	50.7	51.4	1.16

TABLE VIII
STANDARD DEVIATIONS AND NORMALISED PERCENTILES OF HEAD CIRCUMFERENCE OF GIRLS BY AGE

Mean age (months)	Normalised percentiles of head circumference (cm)					S.D.
	10th	25th	50th	75th	90th	
0.0	31.7	32.5	33.5	34.4	35.2	1.38
1.8	35.2	36.0	36.9	37.8	38.6	1.33
3.0	37.0	38.1	39.3	40.5	41.6	1.77
4.1	38.7	39.4	40.3	41.1	41.8	1.23
5.5	39.5	40.4	41.4	42.4	43.3	1.46
6.7	40.7	41.4	42.3	43.1	43.8	1.21
8.2	41.4	42.2	43.1	44.0	44.9	1.35
10.0	41.9	42.8	43.8	44.8	45.7	1.49
12.0	42.9	43.8	44.7	45.6	46.5	1.40
14.1	43.4	44.2	45.2	46.2	47.0	1.41
16.8	43.6	44.5	45.5	46.5	47.4	1.48
19.2	44.2	45.1	46.1	47.2	48.1	1.54
21.7	44.7	45.6	46.5	47.4	48.2	1.36
24.9	45.0	46.0	47.1	48.2	49.2	1.65
28.3	45.4	46.3	47.4	48.4	49.3	1.54
31.9	46.0	46.9	47.9	48.9	49.8	1.51
36.0	46.3	47.2	48.2	49.2	50.1	1.47
41.0	46.7	47.6	48.7	49.7	50.7	1.56
45.5	46.9	47.8	48.8	49.9	50.8	1.54
50.6	45.5	47.1	48.9	50.7	52.3	2.65
56.9	48.0	48.7	49.4	50.2	50.8	1.10
63.0	47.6	48.6	49.8	50.9	51.9	1.69
69.5	47.9	49.0	50.1	51.3	52.3	1.71

Normalised percentile distance growth curves of weight, length and head circumference from birth to six years of age for boys and girls are shown in Figs. 1-6.

DISCUSSION

Fig. 7 compares the 50th percentile values of weight, from birth to six years of age, of Malaysian boys of the present study with those of American and Singaporean boys.^{8,9} It can be seen that at birth the average American boy was heavier than the Malaysian but the Malaysian boy grew rapidly and was as heavy as the American boy till four months of age when the Malaysian boy again became lighter and the racial difference became more marked with increasing age. The average Singaporean boy was as heavy as the Malaysian boy till six months of age when the Singaporean boy became progressively lighter. The differences in median weight among the girls were similar to those of the boys.

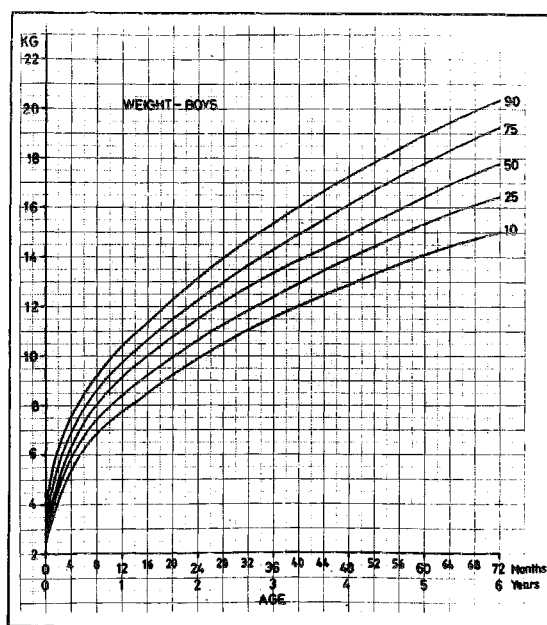


Fig. 1 Normalised distance percentile curves of weight of boys, aged from birth to six years.

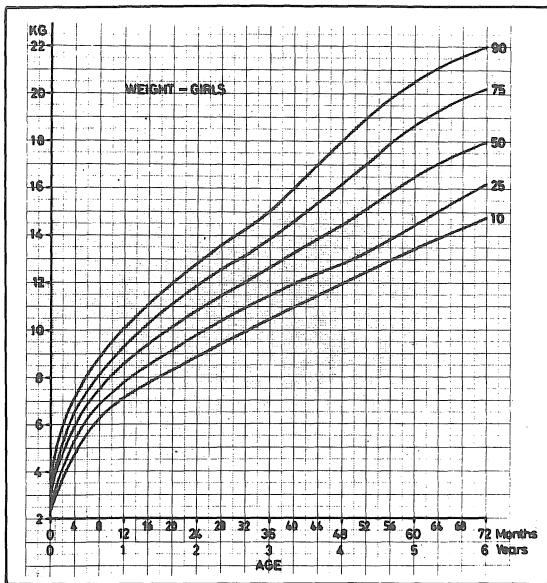


Fig. 2 Normalised distance percentile curves of weight of girls, aged from birth to six years.

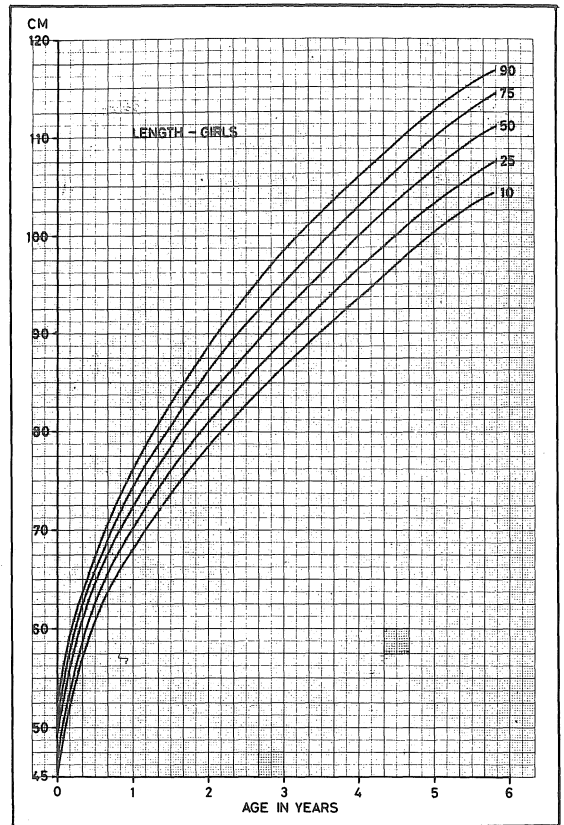


Fig. 4 Normalised distance percentile curves of length of girls, aged from birth to six years.

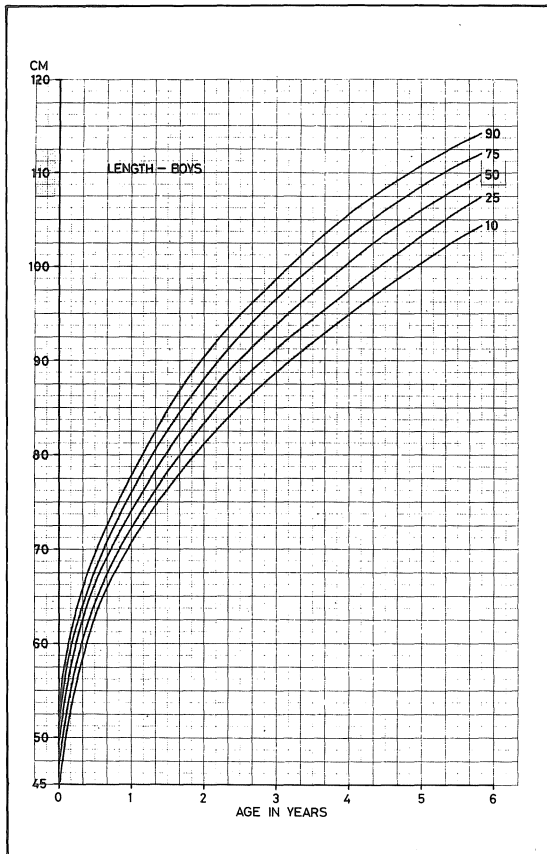


Fig. 3 Normalised distance percentile curves of length of boys, aged from birth to six years.

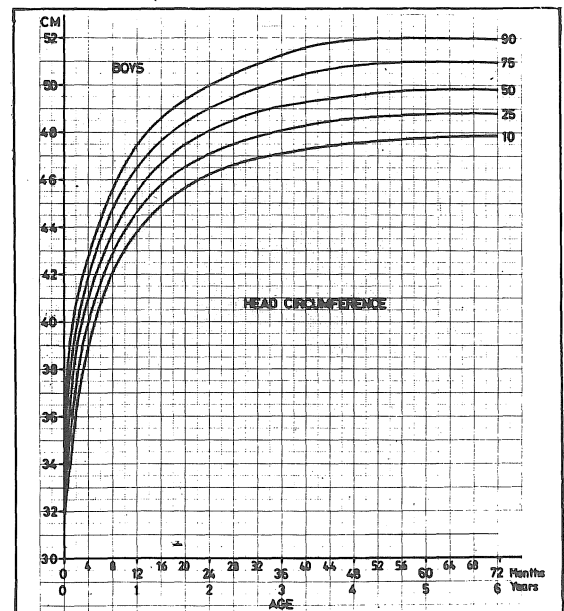


Fig. 5 Normalised distance percentile curves of head circumference of boys, aged from birth to six years.

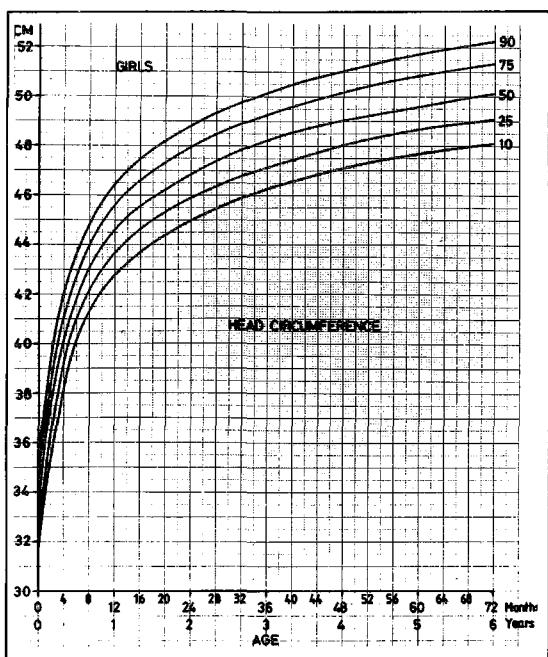


Fig. 6 Normalised distance percentile curves of head circumference of girls, aged from birth to six years.

Fig. 8 compares the 50th percentile values of length, from birth to six years of age, of Malaysian boys of the present study with those of American and Singaporean boys. It can be seen that similar to the weight curves, the 50th percentile length curve of the Malaysian boys is similar to that of the American till four months of age when the Malaysian curve deviates away from the American. The average Singaporean boy however was taller than the Malaysian till 15 months of age when the average Singaporean boy became progressively shorter: These length differences were also seen among the girls.

Fig. 9 compares the 50th percentile values of head circumferences of Malaysian boys from birth to six years of age with those of British and Singaporean boys.¹⁰ It can be seen that the average British boy had larger head circumference than the Malaysian or Singaporean.

The head circumference of the average Singaporean boy was similar to that of Malaysian

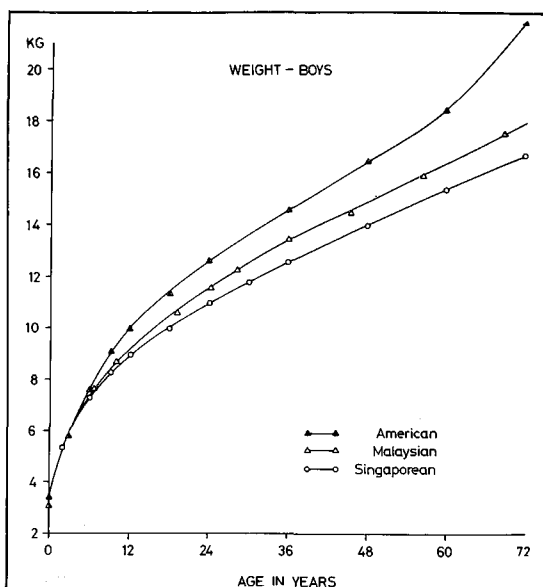


Fig. 7 50th percentile weight for age curves of American, Singaporean and Malaysian boys.

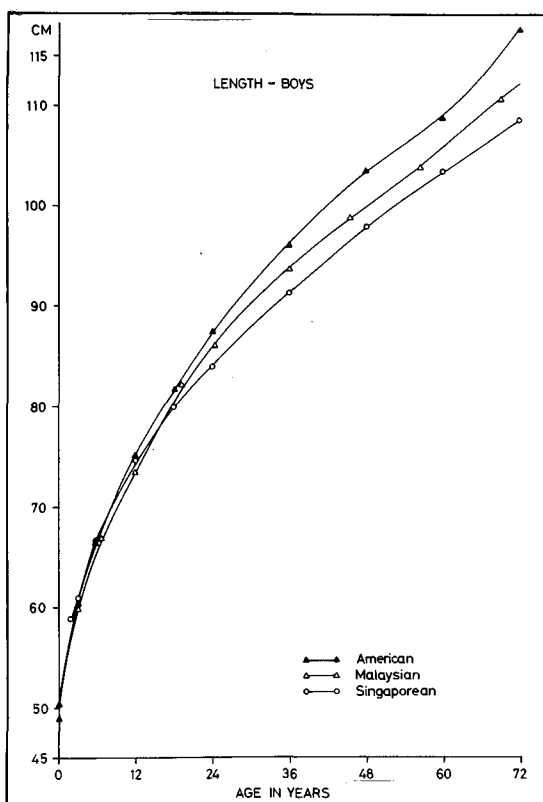


Fig. 8 50th percentile length for age curves of American, Singaporean and Malaysian boys.

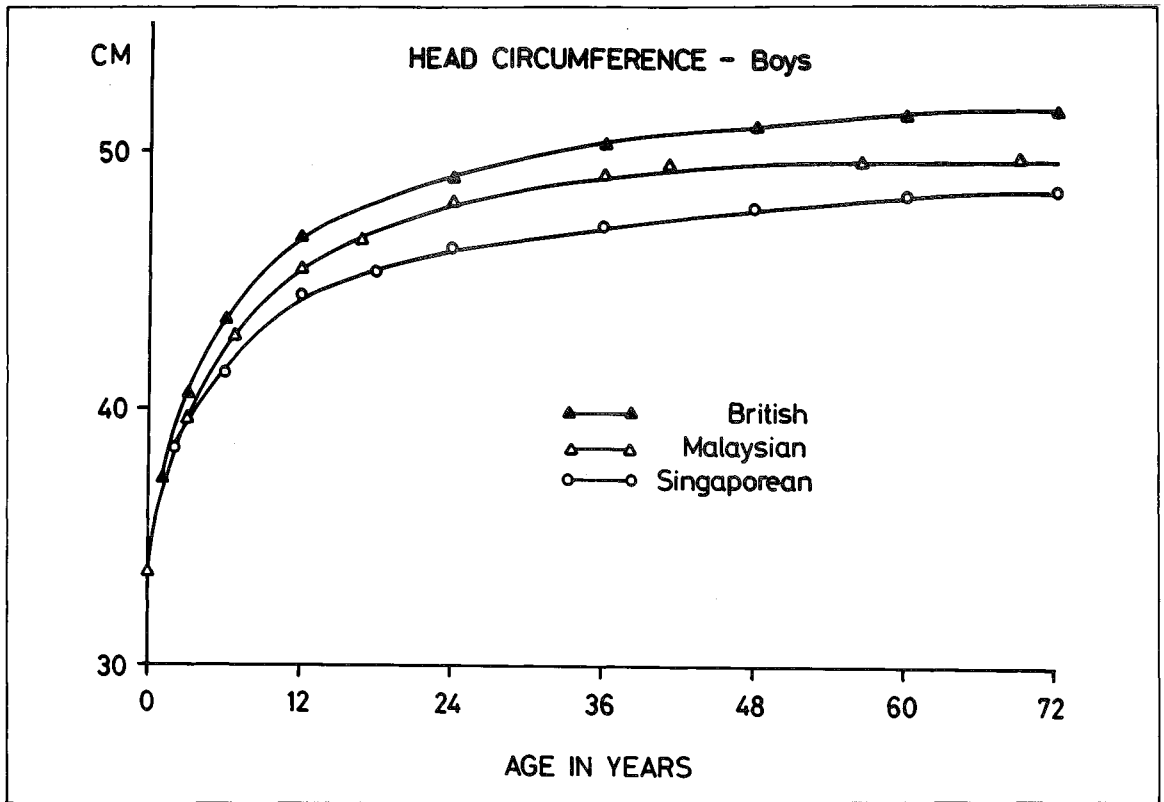


Fig. 9 50th percentile head circumference for age curves of British, Singaporean and Malaysian boys.

till four months of age when it became smaller. The difference in head circumferences among the girls were similar to those of the boys.

The difference in growth achievement between the Malaysian and Singaporean children is probably due to differences in socioeconomic backgrounds of the children rather than genetic differences since they were both of Chinese, Malay or Indian ancestry. 38% of the fathers of the present study were professional or administrative workers and only 14% were unskilled workers, whereas 33% of parents of the Singapore study were unskilled workers and only 12% were of professional workers or businessmen. The excellent growth in length of Singaporean children during the first year of life cannot be explained.

The differences in growth achievement between the Malaysian children of the present study and

those of European ancestry could be due to a combination of genetic and environmental factor. Chen has shown that Malaysians, like other Asians, are smaller in size with relatively shorter legs and have less body fat compared with children of European ancestry.⁶

Since there are genetic differences in size and shape of children, how relevant is it to use growth charts of European standards for children in Asia? Racial effect on mean pre-school weight and height is small compared with environmental effect as demonstrated by Habicht *et al.*¹¹ Such standards are suitable for assessing the nutritional status of the community if allowance is made for differences, if any, for genetic potential. However, if one is assessing the health of an individual child, then for best results, one should use standards applicable to specific populations.^{12,13,14} For example, the American or British standards are fine for children of European ancestry.

However, they may not be suitable if one has to monitor the growth of height of Asian children. Therefore the growth charts of the present series (Figs. 1 to 6) can be used as standards in Malaysia to monitor the growth of Malaysian children from birth to six years of age.

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