INTRAUTERINE GROWTH OF LIVEBORN MALAYSIAN INFANTS BETWEEN GESTATION OF 28 TO 42 WEEKS

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ABSTRACT

A cross-sectional study was carried out on 8,478 consecutive normal singleton Malaysian neonates born in the Maternity Hospital, Kuala Lumpur. The objectives were to compare the mean birth-weights, crown-heel lengths and head circumferences of Malay, Chinese and Indian infants at gestation age from 28 to 42 weeks, and to construct the Malaysian growth charts. Above the gestation age of 34 weeks, the birthweights were significantly influenced by maternal gravida status ($p<0.03$), ethnic origin ($p<0.001$) and/or sex of the neonates ($p<0.026$). Above this gestation age, neonates of multigravida mothers were significantly heavier than those of primigravida mothers; Indians were significantly lighter than Malays and Chinese; and males were significantly heavier than females. The head circumferences and body lengths of neonates were significantly influenced by ethnic origin, sex and/or maternal gravida status at gestation above 35 and 36 weeks respectively ($p<0.05$). It was most likely due to the small sample size which explained our inability to detect statistically significant difference in all measurements (birthweight, length and head circumference) by sex, ethnicity and maternal gravida status at gestation below 35 weeks. Based on the measurements obtained in this study, percentile charts for the Malaysian population were constructed and made available for the first time. These charts will be useful for the assessment of Malaysian neonates during the perinatal period.

Keywords: *Malaysian neonates, anthropometric measurements*

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INTRODUCTION

The intrauterine growth standards of a population have many uses[1,2]. They serve as references for prenatal measurements of foetal growth. They reveal a great deal concerning the intrauterine environment of a particular neonate when its measurement is compared with the standards of the population. They provide baseline criteria for epidemiological study of intrauterine growth retardation in the population. They are also useful as baseline data in the evaluation of the postnatal growth of the infants. In Malaysia, at the time of this study, no intrauterine growth standard for the local population was available. The only local growth charts available were those of older infants and children[3]. The diagnosis of the small-for-gestation or large-for-gestation Malaysian neonates was based on the standards obtained from Caucasian infants[4-9]. Because the standards of growth of different population are influenced by numerous factors such as socio-economic status, ethnicity, gender, maternal body size and maternal parity[6], there is a need to develop our own growth standards.

The objectives of this study were to determine: (a) the mean and standard deviation of the birthweight, head circumference and crown-heel length of the normal singleton Malaysian neonates born between 28 to 42 weeks of gestation, (b) the values of these measurements at 10th, 25th, 50th, 75th and 90th percentiles for the different gender groups, and (c) whether there was any significant difference in these measurements by sex, ethnicity (Malay, Chinese and Indian) and maternal gravida status.

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METHODS

A cross-sectional study was conducted on consecutive Malaysian neonates born in the Maternity Hospital, Kuala Lumpur between 16 July 1990 to 28 February 1991. The birthweight, body length and head circumference of the neonates were measured using standardised techniques during the first 36 hours of life. Each infant was weighed shortly after birth with the use of automatically indicating weighing scales (SECA, West Germany). The weighing scales were calibrated daily by one of the authors using a standard 50 gm weight. The birthweight was recorded to the nearest gram. The head circumference was measured with a measuring tape applied over the greatest fronto-occipital protuberances. Measurement of crown-heel length was made with the infant lying supine against a baby measuring rod (SECA, West Germany). The mothers were interviewed by trained research assistants to verify their antenatal records (including their menstrual history and the date of the last menstrual period), their medical history and intrapartum events. The gestational age of each infant was calculated from the first day of the maternal last menstrual period. Gestational ages were reported in completed weeks. Infants with the following criteria were excluded from the study: those whose mothers were Malaysians of other ethnic groups (not Malay, Chinese or Indian) or non-Malaysians, those whose mothers were unsure of the dates of the last menstrual period or had irregular menstrual periods; those who were products of multiple pregnancy; those who were of undetermined sex, or had major congenital anomalies, clinically recognisable chromosomal anomalies, erythroblastosis, or evidence of intrauterine infection (such as positive history of maternal infection during pregnancy, neonatal hepatosplenomegaly or petechie, or positive for specific IgM against fluorescent Treponema pallidum absorption test or specific IgM against TORCHES antibodies in the neonate). Neonates whose mothers had medical problems during the present pregnancy (such as hypertension, renal diseases or diabetes mellitus) were also excluded from the study.

In order to obtain estimates of the measurements of the neonates with adequate precision, sample sizes for each gestation, gender and racial groups were calculated before the study. Based

on the measurements derived from the study of Usher[7], the sample sizes were calculated using the formula:

$$n = \frac{(Z_{\alpha/2})^2\sigma^2}{d^2}$$

where $\alpha = 0.05$, $Z_{\alpha/2} = Z_{0.025} = 1.96$, σ = standard deviations of mean values in the study of Usher[7], and d=±5% of the mean values. The total number of neonates required for the study was 4,488. However, during the study, it was found that there was insufficient number of neonates in the preterm groups below 33 weeks gestation. As a result, the study was continued until 10,000 neonates were measured and their mothers interviewed. For logistic reasons, the study had to be terminated even though the number of neonates of gestation less than 33 weeks was still small.

For each of the outcome variables of birthweight, body length and head circumference in each gestational age group, analysis of variance was performed with sex, ethnic origin and maternal gravida status as factors. The Duncan's method was conducted for multiple range analysis. P values of less than 0.05 were considered statistically significant. The values for 10th, 25th, 50th, 75th and 90th percentile of the birthweight, body length and head circumference measurement of each gestational age was obtained with the help of the Statgraphic programme (version 3.5). The results were then smoothed by calculation of 2-point moving averages.

RESULTS

During the study period, 12,527 neonates were born in the hospital. Of these, 2,527 (20.2%) neonates were not studied because 1,017 (8.1%) of them were non-Malaysians while the remaining 1,510 (12.1%) neonates and their mothers went home before they could be interviewed. Of the 10,000 Malaysian neonates interviewed, there were 6,151 Malays, 2,087 Chinese, 1,686 Indians and 76 of other ethnic origins. Eight thousand seven hundred and thirty-nine normal singleton Malaysian neonates were available for analysis after excluding 1,261 neonates based on the exclusion criteria. The ethnic origins of these normal neonates were: 5,374 Malays (61.5%), 1,849 Chinese (21.2%) and 1,516 Indians (17.3%). After excluding neonates whose gestational ages were less than 28 weeks or more than 42 weeks, the data of 8,478 Malaysian neonates were analysed.

Above gestational age of 34 weeks, the birthweights were significantly influenced by maternal gravida status ($p<0.03$), ethnic origin ($p<0.001$) and/or sex of the neonates ($p<0.026$). Neonates of multigravida mothers were significantly heavier than those born to primigravida mothers. Between 38 to 41 weeks, Indian neonates were significantly lighter than both the Malays and the Chinese ($p<0.05$). Chinese neonates were significantly heavier than the Malay neonates only at 39 weeks gestation ($p<0.05$). From 37 weeks onwards, the males were significantly heavier than the females ($p<0.01$). Two-way interaction between ethnic and maternal gravida status was statistically significant only at gestation of 39 ($p=0.002$) and 40 weeks ($p=0.028$) where Indian neonates of primigravida mothers were significantly lighter than Malay ($p<0.05$) and Chinese neonates ($p<0.05$) of multigravida mothers.

The body lengths of neonates were significantly influenced by ethnic origin, sex and maternal gravida status only at gestation above 36 weeks gestation ($p<0.05$). Between gestation of 37 to 40 weeks, neonates of multigravida mothers were significantly longer than those of primigravida mothers ($p<0.01$). Male neonates had significantly longer body lengths than females at gestation above 37 weeks ($p<0.001$). Between gestation of 38 to 41 weeks, Chinese neonates had significantly longer body lengths than Indian and Malay neonates ($p<0.05$). Malay neonates had significantly longer body lengths than Indian babies at gestations between 39 and 40 weeks only ($p<0.05$).

From gestation of 35 weeks onwards, neonates of multigravida mothers had significantly larger head circumferences than those of primigravida mothers ($p<0.01$). Both the Malays and the Chinese had significantly larger head circumferences than the Indian neonates ($p<0.05$). However, there was no significant difference in head circumferences between the Malays and the Chinese. The male babies had significantly larger head circumferences than the female babies at gestation of between 37 to 41 weeks.

The mean and smoothed percentile values of the birthweights, body lengths and head circumferences of the normal Malaysian male and female neonates derived from the combined data of the three ethnic groups are shown in Table I and II and the smoothed percentile charts are shown in Figs 1 to 4.

Fig 1 – Percentile chart of birthweights of Malaysian male infants between gestation of 28 and 42 weeks

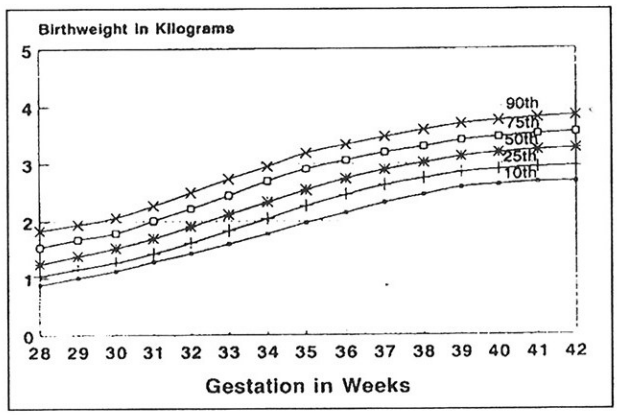


Fig 2 – Percentile chart of body lengths and head circumferences of Malaysian male infants between gestation of 28 and 42 weeks

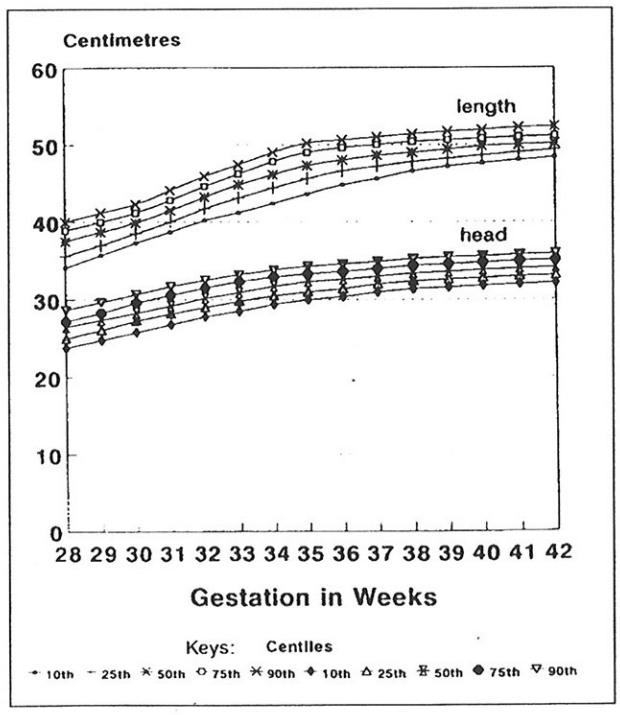


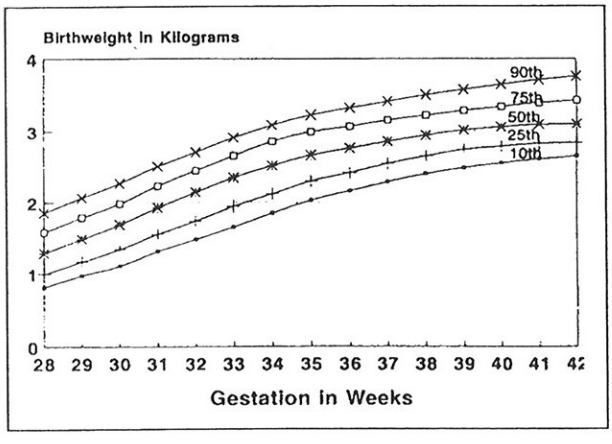
Table I – Intrauterine growth of Malaysian male neonates

Gestation weeks		Birthweight in grams					Crown-Heel Lengths in centimetres						Head Circumference in Centimetres					
	n	Mean	Smoothed Percentiles					Mean	Smoothed Percentiles					Mean	Smoothed Percentiles				
			10th	25th	50th	75th	90th		10th	25th	50th	75th	90th		10th	25th	50th	75th	90th
28	6	1313	877	1040	1253	1543	1838	38.4	34.1	35.6	37.5	38.9	40.0	26.5	23.8	25.0	26.5	27.2	28.7
29	8	1690	1005	1161	1391	1680	1943	39.9	35.7	37.0	38.7	40.0	41.2	28.6	24.8	26.1	27.4	28.3	29.7
30	10	2035	1125	1278	1528	1796	2064	43.9	37.3	38.5	39.9	41.2	42.3	31.3	25.8	27.3	28.3	29.6	30.7
31	12	1783	1289	1434	1670	2012	2270	42.7	38.7	40.0	41.5	42.8	44.1	29.5	26.8	28.2	29.2	30.6	31.7
32	21	1929	1435	1623	1910	2221	2495	43.1	40.2	41.7	43.2	44.6	45.9	30.3	27.6	29.0	30.2	31.5	32.5
33	46	2203	1602	1837	2115	2448	2724	45.1	41.2	43.1	44.8	46.2	47.4	31.1	28.5	29.8	30.9	32.3	33.2
34	49	2532	1780	2043	2336	2690	2946	46.6	42.4	44.4	46.1	47.8	49.0	31.5	29.4	30.5	31.7	32.9	33.8
35	109	2630	1976	2270	2542	2905	3191	47.0	43.6	45.6	47.3	49.0	50.2	32.2	30.0	31.0	32.3	33.3	34.3
36	179	2885	2148	2461	2734	3059	3339	48.2	44.8	46.6	48.0	49.6	50.6	33.0	30.4	31.4	32.6	33.6	34.6
37	437	2938	2328	2621	2890	3201	3477	48.3	45.6	47.2	48.6	50.0	51.0	33.2	31.0	32.0	33.0	34.0	34.9
38	850	3079	2464	2737	3013	3303	3597	49.0	46.6	47.8	49.0	50.4	51.4	33.4	31.4	32.4	33.4	34.4	35.3
39	1046	3170	2584	2841	3126	3414	3701	49.4	47.2	48.2	49.4	50.6	51.7	33.7	31.6	32.6	33.6	34.6	35.5
40	871	3230	2628	2891	3193	3473	3756	49.8	47.6	48.6	49.8	50.8	51.9	33.9	31.8	32.8	33.8	34.8	35.6
41	614	3257	2667	2930	3238	3525	3807	49.9	48.0	49.0	50.0	51.0	52.2	33.9	32.0	33.0	34.0	35.0	35.8
42	166	3221	2671	2946	3267	3551	3838	49.8	48.3	49.3	50.1	51.1	52.3	33.7	32.1	33.1	34.1	35.1	35.9

Table II – Intrauterine growth of Malaysian female neonates

Gestation weeks		Birthweight in grams					Crown-Heel Lengths in centimetres						Head Circumference in Centimetres					
	n	Mean	Smoothed Percentiles					Mean	Smoothed Percentiles					Mean	Smoothed Percentiles				
			10th	25th	50th	75th	90th		10th	25th	50th	75th	90th		10th	25th	50th	75th	90th
28	6	1395	809	997	1288	1586	1855	36.9	34.0	35.8	37.5	39.4	41.3	26.8	24.5	25.4	26.7	27.7	28.7
29	7	1473	977	1169	1491	1793	2067	40.7	35.6	37.4	39.1	41.2	43.0	28.1	25.5	26.4	27.8	28.7	29.7
30	16	1839	1108	1337	1691	1981	2266	41.6	37.0	38.9	40.7	42.7	44.6	29.9	26.2	27.4	28.7	29.6	30.7
31	14	1882	1309	1553	1924	2231	2506	42.9	38.5	40.5	42.2	44.3	46.2	29.8	27.4	28.6	29.8	30.7	31.7
32	20	1984	1475	1736	2139	2446	2706	43.6	40.0	42.1	43.8	45.9	47.6	30.4	28.1	29.4	30.6	31.5	32.5
33	43	2424	1656	1944	2348	2660	2914	45.5	41.1	43.3	45.2	47.2	49.0	31.8	28.9	30.3	31.4	32.3	33.2
34	66	2538	1850	2118	2518	2858	3093	46.5	42.3	44.5	46.4	48.4	50.3	31.7	29.5	30.9	32.0	33.0	33.8
35	98	2704	2028	2297	2666	2997	3235	47.3	43.1	45.3	47.2	49.2	51.1	32.4	30.2	31.4	32.4	33.4	34.2
36	154	2748	2162	2416	2764	3077	3334	47.4	43.7	45.8	47.8	49.9	51.8	32.5	30.4	31.6	32.6	33.6	34.4
37	331	2850	2288	2548	2859	3166	3425	47.8	44.2	46.2	48.2	50.3	52.4	32.8	30.7	31.8	32.8	33.8	34.6
38	693	2954	2402	2654	2948	3234	3514	48.3	44.7	46.4	48.4	50.5	52.6	32.9	30.8	31.9	32.9	33.9	34.8
39	951	3063	2488	2746	3024	3298	3585	48.7	44.9	46.6	48.6	50.7	52.7	33.3	31.1	32.1	33.1	34.1	35.1
40	905	3159	2554	2789	3066	3354	3655	49.1	45.0	46.8	48.8	50.9	52.9	33.4	31.2	32.2	33.2	34.2	35.2
41	595	3147	2610	2830	3105	3407	3718	49.2	45.2	47.0	49.0	51.0	53.0	33.5	31.3	32.3	33.3	34.3	35.3
42	147	3108	2654	2841	3106	3440	3768	48.8	45.2	47.1	49.1	51.1	53.1	33.5	31.5	32.5	33.5	34.5	35.5

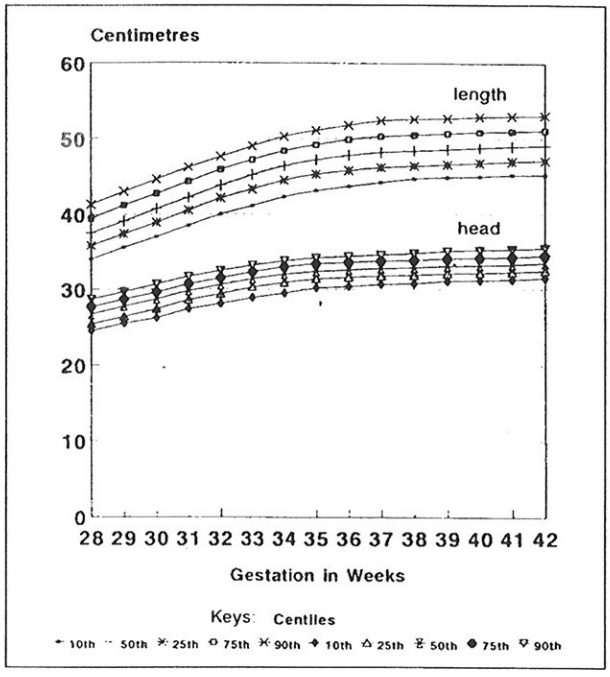
Fig 3 – Percentile chart of birthweights of Malaysian female infants between gestation of 28 and 42 weeks



DISCUSSION

The 1984 Malaysian mid-year population estimate[10] showed that of the total population of 15,262,508 in Malaysia, 59.8% were Malays, 31.3% were Chinese, 8.4% were Indians and 0.5% were other ethnic groups. The proportion of ethnic distribution in our study showed that while the proportion of Malays was similar to that in the general population, the Chinese were under-represented while the Indians constituted a larger proportion of the hospital deliveries than they were in the general population. At gestation of less than 34 weeks, the number of babies obtained in the study was relatively small. As a result, the precision of measurement at these earlier gestation periods (below 34 weeks) in our percentile charts will not be as good as those in the later gestation. The small sample size was the most likely explanation for our inability to detect statistically significant difference in all measurements (birthweight, length and head circumference) by sex, ethnicity and maternal gravida status at gestation below 35 weeks.

Fig 4 – Percentile chart of body lengths and head circumferences of Malaysian female infants between gestation of 28 and 42 weeks



The period of gestation based on the maternal last menstrual period was used in this study because postnatal assessment of gestational age using clinical methods such as the Ballard[11] and the Dubowitz[12] scores were found to be inaccurate in neonates with birthweight of less than 1500 grams[13]. Shukla[14] reported that these clinical methods also tend to overestimate the gestational age of the extremely preterm neonates of less than 32 weeks gestation. In our study, it would also be difficult to minimise interobserver errors during the clinical assessment of gestational age when the number of babies examined was so large. Routine antenatal ultrasound measurement of the biparietal diameters of the foetal skulls was not carried out on the babies born in this hospital. This method of gestation assessment was, therefore, not used in this study.

The limitation of our study lies in its design being cross-sectional. Ideally, serial measurement of the birthweights, head circumferences and body lengths of each of the growing foetuses throughout the intrauterine period should be obtained to produce the growth charts. However, for practical reasons this was not feasible. Given this limitation, two assumptions were made in developing the percentile charts. Firstly, the growth measurements of preterm babies (<37 weeks) were assumed to be no different from those born during the term gestation (between 37 to less than 42 completed weeks) had these preterm babies been able to proceed to term before delivery. Secondly, the growth measurements of the term babies during the preterm gestation period before they were born were assumed to be no different from those babies born preterm.

It is interesting to note that the results of our study were consistent with those carried out on the Caucasian population where it was observed that the gender, birth orders and ethnic origins of the foetuses appeared to have an influence on the intrauterine growth. Although the findings of our study confirmed some heterogenicity in the Malaysian population, we agree with Lubchenco[15] and Goldernberg et al[16] that there was no necessity to construct separate percentile charts for the different subgroups in a racially mixed population. Goldenberg et al pointed out that it was reasonable to use sex-specific standards since the difference in anthropometric measurements between the two sexes was most likely due to genetic factors. However, they found that there was no clear indication to justify the use of ethnic-specific standards or maternal parity-specific standards. They noted that it was not clear whether the difference in intrauterine growth between the different ethnic groups was solely the result of less genetic potential for growth or due to the influence of other factors. They also pointed out that although the infants born to parous women were generally heavier than those born to nulliparous women, there appeared to have no genetic explanation for this inequivalence of foetal growth in the multiparous and primiparous pregnancies. They suggested that there might be factors related to the primiparous state itself which tend to constrict foetal growth. They therefore recommended the use of a single standard based on a population of mixed parity.

In addition to the above reasons, we believe that too many charts will pose practical problems for the busy neonatologists and paediatricians. Furthermore, using different percentile charts for the different subgroups in a mixed population may give a false sense of complacency in the management of the high risk smaller babies, such as the neonates of the Indian multigravida mothers in our study. This is because some of these neonates who were considered "normal" within their subgroups may actually be abnormal in the percentile chart for the mixed population. The percentile chart for the mixed population, on the other hand, is sufficient to provide base-line standards for the assessment as well as the comparison of intrauterine and postnatal growth of the different subgroups. Any neonate in the population whose anthropometric measurements fall outside the 10th and 90th centile of the population charts will be considered at risk and, therefore, will deserve investigation and additional attention. These base-line standards will provide the basis for future studies in the identification of risk factors associated with small-for-gestation age babies in the population.

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