Anthropometry of Newborn Infants Born in 14 Teaching Centers in Indonesia

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Abstract Percentile curves representing intrauterine growth of Indonesian infants ranging from 34 to 43 weeks of gestation in 14 teaching centers were constructed from birth weight, birth length, and head, mid-upper arm, and chest circumferences. The gestational age was determined based on the last menstrual period. Mothers with probable chronic diseases or pregnancy complications were excluded. Included for analysis were 5844 singleton newborns. The mean birth weight of Indonesian babies was higher for gestational age of 34-38 weeks, but lower at 40-42 weeks of gestation compared with that of the Denver study. The results showed that the mean birth weight of Denver's newborns was significantly different than that of the Indonesian infants, therefore the Denver intrauterine growth curve cannot be used as reference curve for Indonesian newborns. Baby boys in general had a higher mean birth weight, birth length, head circumference, and chest circumference. No difference was found for arm circumference. For every gestational age and percentiles, later born infants were heavier than first born infants. Birth weight at 42 weeks was lower for first born infants, this was not shown in later-born infants which showed higher weight for each percentiles. Parity affected birth weight more than birth length. Birth length became more stable at 39 weeks. Chest circumference of < 29 cm had the highest sensitivity and positive predictive value for low birth weight, followed by arm circumference of < 9 cm. The use of intrauterine growth chart in studying the nutritional status of babies at birth was described. **[Paediatr Indones 1994; 34: 62-123]**

Introduction

Norms, definition, and classification form the foundations on which all scientific endeavor must be built, and yet we still have not achieved agreement on many medical aspects, including growth in the perinatal period. In November 1984, a multidisciplinary international workshop was held in Cairo to discuss the methodology of measuring and recording infant growth in the perinatal period.

Until recently researchers and program implementators in Indonesia have been using the intrauterine growth curve from Denver[1] as the reference curve for

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ABBREVIATIONS USED IN THIS REPORT

GA	=	gestational age
BW	=	birth weight
BL	=	birth length
HC	=	head circumference
CC	=	chest circumference
LMP	=	last menstrual period
LBW	=	low birth weight
AC	=	arm circumference
AC/HC	=	arm / head circumference ratio
Unsyiah	=	Syah Kuala University, Aceh
USU	=	University of Sumatra Utara, Medan
Unand	=	Andalas University, Padang
Unsri	=	Sriwidjaja University, Palembang
Unsrat	=	Sam Ratulangi University, Manado
Unhas	=	Hasanudin University, Ujung Pandang
Unair	=	Airlangga University, Surabaya
Unbraw	=	Brawidjaja University, Malang
UGM	=	Gadjah Mada University, Yogyakarta
Undip	=	Diponegoro University, Semarang
UNS	=	Sebelas Maret University, Solo
UI	=	University of Indonesia, Jakarta
Unpad	=	Padjadjaran University, Bandung
RSHK	=	Mother and Child Hospital Harapan Kita, Jakarta

Indonesian newborns, because no national data were available. Developing an intrauterine growth curve is handicapped by the difficulty in collecting data on gestational age in Indonesian women. Previous survey has shown that less than 20% of women delivering in the general hospitals knew the exact date of the last menstrual period. For women in rural areas it is even worse, because they are not familiar with calculating the expected date of birth using the first date of the last menstrual period.

Birth weight and length of babies are closely related to race and the physical measurements of mothers; some authors also mention a difference of birth weight in relation to ethnic group. For those reasons, several authors recommend that each country should have its own intrauterine growth curves. However many researchers mention a better relation between birth weight and length* with the nutritional status of the women rather than with ethnic groups. Therefore it is still debatable whether a national standard intrauterine growth curve should be used for all Indonesian newborns, considering the difference in ethnic groups and nutritional status of women in urban and rural areas.

It is well known that birth weight is a good indicator for the health and nutritional status of a community.[2] Birth weight has long been a subject of clinical and epidemiological investigations, and a target for public health interventions. Considerable efforts have been focussed on the determinants of birth weight, especially of low birth weight. The WHO reports on the use of simple anthropometric measurement for predicting birth weight conducted in 22 centers throughout the world not including Indonesia, recommend that chest rather than arm circumference should be used as a surrogate for birth weight.[3] It means that if a reliable measuring instrument for weighing infants is not available, then chest circumference can be used to replace birth weight. Unless an appropriate study is conducted in Indonesia on birth weight and birth weight surrogates, the WHO recommendation should be applicable; the question is only whether the cut-off points for both measurements are the same as for other developing countries. There is a need for a large population of mothers and infants surveyed in order to have enough subjects which would permit analyses of anthropometric measurements for the purpose of a national reference curve for Indonesian newborns.

Aims of the present study

The specific aims of this study were:

1. To present anthropometric data on newborn infants who were free from all known factors influencing intrauterine growth retardation. This was obtained by examining the infants at birth and by reveiwing their mother's medical and obstetric records.
2. To collect information on five different anthropometric measurements of live born infants, e.g., birth weight, birth length, head circumference, chest circumference, and mid upper arm circumference, and to develop standard intrauterine growth curves based on those measurements.
3. To compare five anthropometric measurements with respect to their correlation to gestational age.
4. To present confidence limits for estimating gestational age from anthropometric measurement of the infants
5. To identify a suitable surrogate for birth weight that correlates well with birth weight, to enable to identify low birth weight baby accurately and easily using a simple instrument.

Definitions

Mean was defined as average of values. Standard deviation was the distribution on either side of the mean that encompassed 66.7% of the observations (mean $\pm$ 2 SD encompassed 95% of the observations). Median was defined as the middle observation in a group. Percentile was defined as a value in a series of observations when the series was defined into 100 groups of equal frequency; assignment of such rank thus indicated that the value given was greater than the specified percentage of the values for the entire group. Gestational age referred to age in weeks from the first day of the mother's last menstrual period until the day of birth. Low birth weight referred to a birth weight of less than 2500 grams (2500 grams excluded), irrespective of the gestational age.

Methods

The study was undertaken in 14 teaching hospitals in Indonesia (see Table 1). These centers were the contributors of the survey. Data from each center were collected according to a detailed protocol so as to ensure their comparability.

Criteria for inclusion

Only infants whose mothers had a reliable information about gestational age were included in the study. The mothers were interviewed by the investigator at each center soon after delivery. All records of the prenatal visits were checked. The following criteria had to be fulfilled for inclusion; these have been suggested by Finstrom[4] and Miller.[5]

1. At interview the mother could state the exact date of the beginning of her last menstrual period (LMP). This date should have been the same as that earlier given at the first antenatal visit;
2. The menstrual cycles had been regular at intervals of 28 $\pm$ 3 days before pregnancy;
3. The LMP should have been normal with respect to duration and amount, and occurred on the expected date;
4. If oral contraceptives had been used, at least one spontaneous menstruation should have occurred before pregnancy;
5. There should have been no bleeding during the first 2 months after the last LMP;
6. The time elapsed from the LMP to the recognition of fetal movement should have been within the following limits; for primipara, fetal movements not earlier than 18th week and not later than the 22nd; for multipara, not earlier than the 16th week and not later than the 20th week;
7. Abnormal factors influencing fetal growth (e.g., fetal abnormalities or medical complications of pregnancy) were to be excluded.

Procedures

A midwive weighed the infant immediately after birth on a balance scale (which was readjusted using standardized weight as part of routine care). The weight was registered and recorded to the nearest 10 grams. The birth length or crown-heel length was measured using a measuring board with supports for the head and feet. The length, head circumference, mid upper arm circumference, and chest circumference were recorded using a measuring tape and recorded to the nearest mm. The measurements of arm and chest circumferences were done according to the instructions outlined in the section on "Instruction for completing the questionnaire" of the WHO study protocol for birth weight surrogates.[6] All measurements were recorded within one to three hours after birth. In addition, sex and gestational age at birth were also recorded. The main problem with respect to data quality was that of digital preference. There was a strong tendency for measurements to be recorded in round hundred grams or whole centimeters.

The Study Subjects

The study involved 6110 infants of various gestational ages, admitted to 14 selected teaching hospital during one year period from July 1, 1990 to June 30, 1991. Gestational age, sex, and ethnic group were recorded, and anthropometric measurements on birth weight, birth length, and chest, upper arm, and head circumferences were performed. The number of infants who had reliable information on gestational age is depicted in Table 1. Of the 6110, 36 forms were not completed, and 6074 had all the information required. From those, there were 5884 singletons and 190 twins. For the purpose of this report only singleton infants were included. Outliers were excluded, and after readjustment, 5844 infants were left for analyses.

Results

Anthropometric Measurements

Some basic factors have to be considered in evaluating fetal growth in a normal uncomplicated pregnancy, these include race, age, parity, weight, and habitus (weight for length) of the mother and the sex and gestational age of the fetus. These factors might affect crown heel length, head size, and weight of the fetus in different degrees, depending on the factor and parameter involved. These factors taken together would appear to make the evaluation of fetal growth a complex matter. The primary objectives of collecting anthropometric data were to determine whether the newborn infant

Table 1. Teaching centers and number of infants studied

No	Teaching hospital	No of infants
1	Unsyiah	727
2	USU	246
3	Unand	96
4	Unsri	503
5	Unsrat	402
6	Unhas	394
7	Unair	293
8	Unbraw	280
9	UGM	662
10	Undip	678
11	UNS	192
12	UI	386
13	Unpad	560
14	RSHK	425
	Total	5,844

was underweight, normal, or overweight for height, and if the individual is short, medium, or tall for her gestational age.

About 85% of all infants born during the period of observation were excluded because of unknown gestational age or growth-retarding factors. No full term dying in the perinatal period was included. Data on birth weight, birth length, head circumference, and mid upper arm circumference were grouped according to sex and percentiles at successive weeks of gestation. Values for the 10th, 25th, 50th, 75th, and 90th percentiles were read from the curves. The resulting figures were graphed at the mid-point of the proper week and smoothed arithmatically.[1]

The mean and standard deviation of anthropometric measurements of all infants studied are depicted in Table 2. Mean birth weight and length for boys were on the average higher compared with those for girls. Baby boys were almost 60 g heavier than girls; the difference was significant ($p<0.001$); baby boys were 0.5 cm longer than girls, this difference was not significant. The difference for head circumference was 0.3 cm higher for boys. The differences for mid upper arm circumference and chest circumference were smaller. The chest circumference of boys was 0.2 cm and significantly larger than that of girls ($p<0.002$). No difference was found for arm circumference of boys who was 0.1 cm larger than that of girls ($p=0.69$).

Birth weight

The weight at birth of the infant is one of the most fundamental measurements, and its technique of measurements is less prone to observer error than any other measurements. Birth weight is a useful indicator for neonatal survival, and is affected by gestational age and gender of the infant and maternal age and parity.

Birth weight for boys and girls in percentiles in this series can be seen in Tables III, IV, and V and the growth curves are shown in Figures 1, 2, and 3 of the Annex. Baby boys were on the average heavier than baby girls; the difference was consistent for any value of each percentiles although some variations were found. A comparison was made for first born and later-born infants for full term infants and sex combined. For every gestational age and percentiles, later-born infants were heavier than first-born infants (Table 3). Birth weight at 42 weeks gestation was lower in first-born infants, this was not shown in the later-born infants which showed higher weight at each percentile.

Birth length

Birth length or crown-heel length is a measure for linear growth. The same result as for birth weight can be seen for birth length, i.e., boys were longer than girls. The mean difference between both sexes was 0.5 cm, or baby girls are about 1 percent shorter than boys. A difference in length was found at each percentile of the growth curve (see Annex, Tables VI, VII, and VIII, and Figures 4, 5 and 6). After 39 weeks of gestation the growth curve showed a straight line while for infants of more than 44 weeks of gestation the growth curve declines, probably due

Table 2. Mean and standard deviation of anthropometric measurements of newborns infants at 14 teaching centers in Indonesia (singletons only)

	No of Infants	BW, gram (SD)	BL, cm (SD)	HC, cm (SD)	AC, cm (SD)	CC, cm (SD)
Total	5844	3085 (444)	49.1 (2.1)	33.5 (1.8)	10.9 (1.3)	32.5 (2.1)
Male	3052	3118 (449)	49.4 (2.1)	33.6 (1.8)	10.9 (1.3)	32.5 (2.2)
Female	2792	3049 (437)	48.9 (2.0)	33.3 (1.8)	10.8 (1.2)	32.4 (2.0)

Table 3. Percentile distribution of birth weight (g) of firstborn and later-born full term infants (sex combined)

	Gestational age (weeks)											
Percentile	First born						Later born					
	37	38	39	40	41	42	37	38	39	40	41	42
90	3259	3294	3460	3510	3645	3600	3405	3450	3600	3750	3850	3896
75	3000	3070	3241	3250	3370	3315	3190	3200	3350	3500	3500	3600
50	2700	2890	2970	3000	3100	3050	2920	2905	3100	3200	3200	3300
25	2500	2600	2720	2800	2840	2800	2600	2650	2850	2980	2980	3000
10	2293	2448	2541	2551	2605	2598	2320	2481	2620	2700	2728	2800
N	122	245	499	638	354	157	139	320	808	1065	606	287

Table 4. Percentile distribution of birth length (cm) offirst born and later-born full term infants in the study (sex combined)

	Gestational age (weeks)											
Percentile	First born						Later born					
	37	38	39	40	41	42	37	38	39	40	41	42
90	50.5	51.0	51.0	51.0	51.5	51.5	50.9	51.0	51.0	51.5	52.0	52.1
75	49.0	50.0	50.0	50.0	50.2	50.2	50.0	50.0	50.2	50.6	51.0	51.0
50	48.0	48.5	49.0	49.3	49.5	49.5	48.6	48.6	49.2	50.0	50.0	50.0
25	46.5	47.2	48.0	48.2	48.1	48.2	47.0	47.0	48.0	48.5	48.2	48.5
10	45.5	46.0	47.0	47.1	47.0	47.0	46.0	46.0	47.0	47.0	47.0	47.5
N	122	245	499	638	354	157	139	320	807	1,065	606	287

to the small number of infants at this gestational period. Another possibility is the effect of placental dysfunction in postmature infants. Here again first-born and later-born full term infants for both sexes were compared (Table 4). For both groups of infants it showed that length was relatively stable after 40 weeks of gestation, however for infants at the 10 percentile, length started to stabilize already at 39 weeks, probably due to early dysfunction of the placenta in borderline small for date infants. It was also evident that parity of mother did not affect the length of the infant.

Head circumference

The mean head circumference of boys was 3 mm longer than that of girls (about 1 percent). The growth curve of head circumference flattened after 40 weeks of gestation in both sexes, showing that intrauterine growth in head circumference has reached it maximum at 40 weeks of gestation. The exact figures are seen in subsequent tables and graphs (Annex; Tables IX, X, and XI, and Figures 7, 8, and 9).

There is usually a direct relation between growth in head circumference and crown-heel length during the fetal period, but not in all infants. In perhaps 5-10% of infants the head is large or small in proportion to a normal body length or the latter is short or long in proportion to a normal head circumference.[5] The clinical significance of these disproportions has not been investigated.

Table 5 shows that parity of mother did not consistently affect the infant's head circumference.

Chest circumference

Compared to other anthropometric measurements, almost no difference between the mean chest cicumference of baby boys and girls was found. Chest circumference of boys was 0.2 cm or 0.3% longer than that of girls. Also here the intrauterine growth curve for chest circumference was relatively stable after 40 weeks of gestation (see Annex; Tables XII, XIII, and XIV, and Figures 10, 11, and 12).

Arm circumference

The mean arm circumference of boys was 0.1 cm longer than that of girls, or girls had 2% shorter arm circumference than that of boys. Arm circumference was relatively constant after 40 weeks of gestation while a difference between boys and girls was found at 36 weeks of gestation (see Annex; Tables XV, XVI, XVII, and Figures 13, 14, and 15).

Relationship of Birthweight to other Anthropometric Measurements

Some determinations of whether newborn infants are obese, normal, or lean can be made by observation, inspection, and palpation. Determinations of different degrees of obesity and thinness can be made by calculating weight-height ratios or ponderal indices.

The Ponderal Index

The ponderal index is based on Rohrer's formula as follows:

$$\text{Birth weight in g/(crown-heel length in cm}^3\text{)} \times 100$$

This formula is derived from the observation that the weight of an object of uniform density and dimensions increases as the cube of its length. The advantage of using this formula is that in full term infants of >38 weeks or > 48.5 cm in body length, the ponderal index apparently is not significantly affected by race, sex, or gestational age.[5] However care needs to be taken in interpreting ponderal index in infants with disproportional large or small head. The head of an infant is such a large part of the body weight that the ponderal index will be distorted if the head is disproportionately large or small, as it occasionally is in a small percentage of fetuses and newborn infants. The percentile distribution of ponderal indices of the study sample is presented in Annex, boys and girls separated. Interpreting ponderal index is more difficult in premature infants, because of the relatively larger head, the ponderal index may become distorted. According to Miller and Merritt[5] infants are considered extremely obese who have ponderal indices above 2.93 (95%) and extremely malnourished if their ponderal indices is below 2.26 (5%).

Comparison of indices of first-born and later-born infants can be seen in the Table 6, it shows that at the ninetieth percentiles the ponderal indices of later born infants were greater than those of first-born infants, indicating that more infants of multiparae were likely to be obese. The explanation for the increased incidence of obesity among later-born infants may relate to the well recognized weight of multiparous in general and with added years and weight in some multiparous. In our study values for extreme thinness could be found in the 10 percentile of first born infants of less than 40th weeks of gestation (10%) and at 38th week (10%) of later born infants. Extreme obesity was found for later born infants with more than 39th weeks of gestation (90%).

Weight to Height Ratios

For those who prefer weight/height ratios to ponderal indices in the evaluation of infants nutritional status, data on the percentile distribution of birthweights of more than 3539 full term infants are shown in Table 7. Full term infants whose weight-height ratios fall below the 10th percentile for their heights should be considered thin and were probably already malnourished intrauterine.

Relationship between Birthweight and Arm and Chest Circumferences

In developing countries it is often not possible to weight the baby accurately. This may be due to lack of appropriate and robust weighting scales that can withstand the constant use in the field. Few authors have addressed this problem;[6] they are able to identify suitable birth weight [illegible]es. However if use of a surrogate is to be widely recommended, it is necessary that it should be appropriate across national and ethnic boundaries. Before studying the cut-off points, it was necessary to study the relationship between birth weight and arm and chest circumference.

Table 5. Percentile distribution of head circumference (cm) of first born and later-born full term infants in the study (sex combined)

Percentile	Gestational age (weeks)											
	First born						Later born					
	37	38	39	40	41	42	37	38	39	40	41	42
90	34.5	35.0	35.0	35.0	35.6	35.5	35.0	35.0	35.3	35.6	36.0	36
75	33.9	34.0	34.0	34.2	34.6	34.5	34.0	34.1	34.5	34.8	35.0	35.2
50	32.8	33.0	33.2	33.5	33.6	33.5	33.0	33.0	33.5	34.0	34.0	34.0
25	31.7	32.0	32.4	32.5	32.9	32.6	32.0	32.3	32.8	33.0	33.0	33.0
10	30.5	31.0	31.5	31.5	32.0	31.5	31.5	31.8	32.0	32.0	32.0	32.2
N	122	245	499	638	354	157	139	320	807	1065	606	287

Table 6. Percentile distribution of ponderal indices of first born and later-born full term infants in the study (sex combined)

Percentiles	Gestational age-weeks											
	First born						Later born					
	37	38	39	40	41	42	37	38	39	40	41	42
90	2.78	2.81	2.83	2.84	2.91	2.79	2.91	2.95	2.94	3.00	3.02	3.01
75	2.61	2.64	2.70	2.67	2.77	2.70	2.70	2.75	2.76	2.82	2.82	2.87
50	2.49	2.50	2.54	2.51	2.58	2.54	2.55	2.56	2.58	2.63	2.64	2.66
25	2.31	2.33	2.39	2.36	2.41	2.41	2.38	2.38	2.44	2.46	2.49	2.49
10	2.17	2.22	2.25	2.24	2.28	2.29	2.24	2.25	2.32	2.31	2.34	2.34
N	122	245	499	638	354	157	139	320	807	1065	606	287

Table 7. Birthweight (g) to crown-heel length by percentiles (sex combined)

Percentile	Crown-heel length (mm)										
	47.0	47.5	48.0	48.5	49.0	49.5	50.0	50.5	51.0	51.5	52.0
90	3200	3201	3300	3242	3405	3285	3650	3514	3800	3750	4000
75	3000	2973	3100	3048	3250	3285	3450	3400	3600	3515	3800
50	2800	2800	2900	2905	3035	3055	3230	3200	3400	3400	3567
25	2600	2590	2700	2763	2880	2948	3040	3000	3143	3090	3350
10	2500	2500	2550	2610	2700	2745	2900	2837	3000	2960	3200
N	345	48	571	84	694	98	928	72	436	54	206

Table 8. Correlations between birthweight, arm circumference, and chest circumference for boys and girls

	Center University	BW/AC		BW/CC		AC/CC		Sample Size	
		Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
1	Unsyah	49	53	49	44	44	41	382	345
2	USU	63	69	80	75	58	56	123	123
3	Unand	77	64	76	60	65	57	56	40
4	Unsri	25	79	71	79	30	72	279	224
5	Unsrat	68	69	84	81	67	69	220	182
6	Unhas	74	63	83	77	81	61	197	197
7	Unair	86	90	59	91	51	85	146	147
8	Unibraw	63	66	66	72	61	61	145	135
9	UGM	49	44	82	79	40	38	349	313
10	Undip	60	37	63	60	. .	28	350	328
11	UNS	77	74	85	88	77	77	100	92
12	UI	70	72	75	67	59	56	213	173
13	Unpad	71	67	68	67	54	53	280	280
14	RSHK	38	77	67	85	-24	75	212	213

Note: Decimal points are omitted.

Table 8 shows the correlations between birthweight and arm and chest circumference. The correlations between birthweight and chest circumference ranging from 0.46-0.82 was higher compared with birthweight and arm circumference (ranging from 0.37-0.75). In 11 out of 14 centers the correlations between birthweight and chest circumference were higher than those with arm circumference, probably due to the fact that chest circumference was more easily and reliably measured that arm circumference. The latter was therefore more subject to measurement error and result in a lower correlation.

Table 9 shows the regression of birth weight on arm and chest circumference for all data combined. A better relationship between birth weight and chest circumference than between birth weight and arm circumference was observed.

Table 9. Regression of birth-weight on arm and chest circumference for all data combined

	Coefficient	Standard Error	R^2
Constant	1,078,032	43.41	
AC	182,150	3.96	0.27
Sex	54.16	9.94	
Constant	-1,530,964	66,235	
CC	141,129	2,032	0.46
Sex	51.84	8.59	
Constant	-1,721,279	63,289	
AC	95,081	3,628	0.51
Chest	116,046	2,157	

Birth Weight Surrogates

In developing countries suitable surrogates for birthweight is important because the difficulty to weight the infant accurately. This is particularly important to identify low birth weight babies using a simple measuring instrument. It must be consistenly accurate over the first few days of life as in rural areas a baby may not be seen by a health worker until it is a few days old.[6]

The Prediction of Low Birth Weight

The prediction of low birth weight using arm and chest circumference requires the choice of cut-off and end points. The end was chosen at <2500 grams for all centers according to the definition of the World Health Organization.[6]

Some centers had small numbers (less than 5 infants). The result shows that at arm circumference of <9.0 and <9.5 centimeters and chest circumference of < 28 cm and < 29 cm both the sensitivity and positive predictive values were relatively high. It also shows that a chest circumference of < 29 cm was a better predictor for birth weight and tended to be higher than for arm circumference of < 9 cm.

As recommended by WHO[6] to identify the optimum cut-off point for each center it is necessary to estimate the probability of a LBW infant for a range of specific points and choose the best for the particular center using a logistic regression model as seen on Tables 15 and 16.

Table 10. Regression of birth weight on arm circumference (cm)

	University	n	Constant	Sex	Arm. Circ.	Arm Sex	R^2
			(SE)	(SE)	(SE)	(SE)	
1	Unsyiah	727	-24,797	253441	281621	-19851	0.263
			285,339	392,807	24,693.	33,924	
2	USU	246	-630,560	763,082	355,109	-66,942	0.437
			382,963	517,881	34,631	46,926	
3	Unand	96	95,301	-327,451	260,777	44,337	0.541
			499,637	645,667	45,703	58,819	
4	Unsri	503	-772,800	3,179,968	365,922	-306,461	0.289
			284,493	310,668	27,588	29,970	
5	Unsrat	402	-1,492,956	-189,024	391,427	25,006	0.467
			383,034	503,461	33,408	44,082	
6	Unhas	394	621,357	-1,379,623	236,124	142,362	0.480
			206,166	329,129	20,396	32,453	
7	Unair	293	-1,620,165	441,362	451,806	-34,173	0.783
			190,076	271,308	18,904	27,094	
8	Unibraw	280	-370,399	154,262	304,315	-6,416	0.420
			345,422	481,813	30,670	42,926	
9	UGM	662	1,698,842	-202,009	116,536	26,488	0.223
			150,872	211,074	13,855	19,405	
10	Undip	678	1,902,773	-1,749,902	103,987	166,987	0.265
			145,640	282,611	13,192	25,349	
11	UNS	192	-238,973	-564,687	295,115	55,483	0.578
			315,097	440,116	29,282	40,696	
12	UI	386	-40,964	-72,353	308,508	8,637	0.501
			236,789	330,747	23,237	32,225	
13	Unpad	560	-237,920	-221,653	286,992	23,258	0.484
			210,264	304,861	18,382	26,472	
14	RSHK	425	-617,255	2,750,175	360,844	-262,983	0.36
			280,449	317,089	26,849	30,207	

Table 11. Regression of birth weight on chest circumference (cm)

Center University	n	Constant (SE)	Sex (SE)	Chest circ. (SE)	Chest/ Sex (SE)	R^2
1 Unsyah	727	-949340	-218450	68,584	7,805	0.220
		250,347	342,526	7,531	10,308	
2 USU	246	-2,485,307	-291,876	174,302	9,514	0.594
		444,067	630,121	13,392	19,025	
3 Unand	96	-3,252,586	-548,821	194,384	18,266	0.507
		1,211,152	1,501,001	38,035	46,765	
4 Unsri	503	-2,820,549	455,651	181,652	-12,430	0:551
		346,598	457,080	10,826	14,291	
5 Unsrat	402	-3,246,898	-547,760	191,221	18,381	0.680
		349,683	458,155	10,713	14,034	
6 Unhas	394	-3,620,503	29,199	207,757	0.441	0.650
		384,661	503,675	12,071	15,766	
7 Unair	293	-3,777,096	4,236,807	213,629	-133,836	0.610
		372,805	438,231	11,897	13,949	
8 Unibraw	280	-2,624,566	100,138	173,485	-2,371	0.489
		491,323	709,386	15,008	21,597	
9 UGM	662	-2,322,846	-420,089	163,242	15,913	0.649
		234,486	321,227	7,239	9,927	
10 Undip	678	-2,140,866	137,336	158,349	-2,380	0.392
		369,421	515,926	11,277	15,638	
11 UNS	192	-2,543,595	-434,402	169,799	14,157	0.744
		358,277	494,796	11,106	15,280	
12 UI	386	-1,602,779	-1,408,064	144,396	43,921	0.513
		375,670	547,366	11,540	16,752	
13 Unpad	560	-2,299,617	298,853	162,167	-7,347	0.462
		352,026	485,774	10,691	14,705	
14 RSHK	425	-3,688,869	2,831,345	212,534	-86,821	0.573
		375,253	458,991	11,667	14,282	

Table 12. Percentage of infants weighing less than 2500 gram by center

Center	Total no. of infants	< 2500 g n	< 2500 g %
1 Unsyiah	727	17	2.3
2 USU	246	1	0.4
3 Unand	96	13	13.5
4 Unsri	503	42	10.5
5 Unsrat	402	42	10.4
6 Unhas	394	40	10.2
7 Unair	293	38	13.0
8 Unibraw	280	1	0.4
9 UGM	662	58	8.8
10 Undip	678	38	5.6
11 UNS	192	17	8.9
12 UI	386	9	2.3
13 Unpad	560	22	3.9
14 RSHK	425	20	4.7
Total	5,844	369	6.3

The estimated probabilities for low birth infants using different cut-off points can be seen in Table 17. As can be seen from this table, the probability for low birth weight became smaller as the measurements higher. A cut off point of < 9 cm for arm circumference was probably appropriate for all centers as well as a cut-off point of < 29 cm for chest circumference, for indicating low birth weight.

Discussion

The major objective of this study is the need for a reference intrauterine curve based on measurements of newborn infants who have been unencumbered by known growth retarding influences in uteri, so far as could be determined from review of their mothers medical and obstetric histories and from examination of the infants. By excluding all infants with known growth retarding conditions from the sample size a better opportunity is afforded in diagnosing excessive fetal undergrowth and overgrowth and in elucidating their causes in future studies.

Indonesian pediatricians have almost always been using the Denver Intrauterine growth which is in fact different to our result. The Denver data conducted in 1948-1961 shows a mean birth weight of 35 g higher compared to the Indonesia data. While the data from Gruenwald[10] in Baltimore and McKeon in Birmingham[11] have higher mean birth weights. The main reason of using the intrauterine growth curve from Denver was that a comprehensive survey to study birth weight in Indonesia is difficult because more than 80% of babies are born outside the hospital.

This lead to the question whether infants born in the hospital as conducted in this survey, is a representative sample for the population. However, at this moment this may be the only way to collect anthropometric data of newborns using a very tight inclusion criteria.

Previous investigators had not excluded all infants associated with any intrauterine growth-retarding factors from their published data which probably may

Table 13. Test sensitivities and positive predictive values using different cut-off values for a birth weight below 2500 grams by chest circumference

Center	Chest < 28 cm		n	Chest < 29 cm		n	Chest < 30 cm		n
	Sens. %	PPV %		Sens. %	PPV %		Sens. %	PPV %	
Unsyah	17.6	7.1	3	17.6	6.7	3	23.5	6.7	4
USU	-	-	-	-	-	-	100.0	50.0	1
Unand	-	-	-	7.7	100.0	1	23.1	100.0	3
Unsri	20.8	78.6	11	52.8	77.8	28	69.8	62.7	37
Unsrat	16.7	100	7	26.2	100.0	11	54.8	95.8	23
Unhas	32.5	92.9	13	50.0	90.9	20	65.0	68.4	26
Unair	31.6	85.7	12	57.9	91.7	22	84.2	64.0	32
Unibraw	-	-	-	-	-	-	-	-	-
UGM	29.3	100.0	17	48.3	100.0	28	69.0	74.1	40
Undip	5.3	66.7	2	7.9	75	3	28.9	78.6	11
UNS	35.3	100	6	76.5	100	13	88.2	78.9	15
UI	-	-	-	33.3	42.9	3	55.6	29.4	5
Unpad	4.5	100.0	1	22.7	83.3	5	27.3	46.2	6
RSHK	30	85.7	6	60	92.3	12	80.0	47.1	16
Total	21.1	61.4	78	40.4	71.0	149	59.3	56.3	219

Sens. = sensitivity
PPV = positive predictive value
n = number of infants

Table 14. Test sensitivities and positive predictive values using different cut-off values for a birth weight below 2500 grams by arm circumference

Center	Arm < 9 cm			Arm < 9.5 cm			Arm < 10 cm		
	Sens (%)	PPV (%)	n	Sens (%)	PPV (%)	n	Sens (%)	PPV (%)	n
Unsyah	5.9	100	1	17.6	100.0	3	17.6	100.0	3
USU	-	-	-	-	-	-	100.0	6.7	1
Unand	15.4	100.0	2	30.8	50	4	38.5	50.0	5
Unsri	54.7	72.5	29	77.4	46.1	41	84.9	32.6	45
Unsrat	2.4	100.0	1	11.9	83.3	5	26.2	84.6	11
Unhas	60.0	60.0	24	82.5	37.1	33	92.5	21.4	37
Unair	65.8	83.3	25	86.8	45.2	33	100.0	26.2	38
Unibraw	-	-	-	-	-	-	-	-	-
UGM	27.6	80.0	16	63.8	62.7	37	72.4	44.7	42
Undip	10.5	100.0	4	21.1	42.1	8	50.0	38.0	19
UNS	47.1	88.9	8	70.6	85.7	12	100	68	17
UI	66.7	26.1	6	66.7	8.0	6	88.9	5.4	8
Unpad	22.7	71.4	5	31.8	77.8	7	40.9	36.0	9
RSHK	30.0	85.7	6	75.0	28.8	15	85.0	25.0	17
Total	34.4	69.0	127	55.3	40.9	204	68.3	27.6	252

Table 15. Logistic regression of birth weight on chest circumference

Center	Constant	Coefficient	S.E. (coeff)	OR	Signif.
Unsyiah	-3.2578	0.2197	0.5500	1.1161	***
USU	-70.9760	2.4631	1.4491	3.4265	NS
Unand	-76.7579	2.5373	0.7135	3.5564	***
Unsri	-33.9568	1.1749	0.1393	1.7993	***
Unsrat	-59.4266	1.9773	0.2865	2.6972	***
Unhas	-40.3657	1.3797	0.1923	1.9934	***
Unair	-32.4295	1.1288	0.1740	1.7584	***
Unibraw	32.0790	-0.0724	0.5444	0.6762	NS
UGM	-47.6385	1.6226	0.1911	2.2508	***
Undip	-30.7293	1.0509	0.1424	1.6912	***
UNS	76.5377	2.6179	0.7233	3.7025	***
UI	-14.8198	0.5836	0.1795	1.3388	***
Unpad	-30.2579	1.0536	0.1693	1.6935	***
RSHK	-23.3016	0.8515	0.1524	1.5307	***

OR = Odds ratio = e (coeff. 20.5)
* = significant at 0.05
** = significant at 0.01
*** = significant at 0.000
NS = not significant

Table 16. Logistic regression of birth weight on arm circumference

Center	Constant	Coefficient	S E (coeff)	OR	Signif.
Unsyiah	-18.6963	2.0352	0.4071	2.7667	***
USU	-20.6135	2.5175	1.6393	3.5219	NS
Unand	-17.0371	1.83	0.4898	1.4865	***
Unsri	-5.8064	0.7927	0.1504	1.4865	***
Unsrat	-23.5288	2.3740	0.3107	3.2333	***
Unhas	-22.7480	2.6386	0.3727	3.7408	***
Unair	-34.1172	3.8295	0.6135	6.7852	***
Unibraw	19.6625	-1.2114	1.1680	0.5662	NS
UGM	-23.0845	2.5431	0.2871	3.5662	***
Undip	-16.9798	1.8951	0.2650	2.5794	***
UNS	-41.2537	4.4507	1.0970	9.2581	***
UI	-20.2046	2.5116	0.6164	3.5106	***
Unpad	-14.4031	1.6298	0.2570	2.2589	***
RSHK	-22.1513	2.5591	0.4606	3.6658	***

Table 17. Estimated probabilities of BW below 2500 gram for a range of arm and chest circumferences

University	AC	Prob. LBW	CC	Prob. LBW
Unsyah	8.0	0.92	28	0.05
	8.5	0.80	29	0.04
	9.0	0.59	30	0.03
	9.5	0.35	31	0.03
	10.0	0.16	32	0.02
	10.5	0.06	33	0.02
USU	8.0	0.62	28	0.88
	8.5	0.31	29	0.39
	9.0	0.11	30	0.05
	9.5	0.04	31	0.00
	10.0	0.01	32	0.00
	10.5	0.00	33	0.00
Unand	8.0	0.92	28	1.00
	8.5	0.81	29	0.96
	9.0	0.63	30	0.65
	9.5	0.41	31	0.13
	10.0	0.22	32	0.01
	10.5	0.10	33	0.00
Unsri	8.0	0.37	28	0.74
	8.5	0.28	29	0.47
	9.0	0.21	30	0.22
	9.5	0.15	31	0.08
	10.0	0.11	32	0.03
	10.5	0.07	33	0.01
Unsrat	8.0	0.99	28	0.98
	8.5	0.97	29	0.89
	9.0	0.90	30	0.53
	9.5	0.73	31	0.13
	10.0	0.45	32	0.02
	10.5	0.20	33	0.00
Unhas	8.0	0.84	28	0.85
	8.5	0.58	29	0.59
	9.0	0.27	30	0.26
	9.5	0.09	31	0.08
	10.0	0.03	32	0.02
	10.5	0.01	33	0.01
Unair	8.0	0.97	28	0.69
	8.5	0.83	29	0.42
	9.0	0.41	30	0.19
	9.5	0.09	31	0.07
	10.0	0.02	32	0.02
	10.5	0.00	33	0.01
	10.5	0.20	33	0.00
UGM	8.0	0.94	28	0.90
	8.5	0.81	29	0.64
	9.0	0.55	30	0.26
	9.5	0.25	31	0.07
	10.0	0.09	32	0.01
	10.5	0.03	33	0.00
Undip	8.0	0.86	28	0.79
	8.5	0.71	29	0.56
	9.0	0.48	30	0.31
	9.5	0.28	31	0.14
	10.0	0.12	32	0.05
	10.5	0.05	33	0.02
UNS	8.0	1.00	28	0.96
	8.5	0.97	29	0.65
	9.0	0.77	30	0.12
	9.5	0.26	31	0.01
	10.0	0.04	32	0.00
	10.5	0.00	33	0.00
UI	8.0	0.53	28	0.18
	8.5	0.24	29	0.11
	9.0	0.08	30	0.06
	9.5	0.03	31	0.04
	10.0	0.01	32	0.02
	10.5	0	33	0.01
Unpad	8.0	0.80	28	0.68
	8.5	0.63	29	0.43
	9.0	0.43	30	0.21
	9.5	0.25	31	0.08
	10	0.13	32	0.03
	10.5	0.06	33	0.01
RSHK	8.0	0.84	28	0.37
	8.5	0.60	29	0.20
	9.0	0.29	30	0.10
	9.5	0.10	31	0.04
	10.0	0.03	32	0.02
	10.5	0.01	33	0.01

Table 18. A comparison of mean birth weight at 40 weeks of gestation between several study results

Country	Year & Place of study	Author	Mean BW (gram)
Denver (USA)	1948-1961, Hospital	Lubchenco	3220
Baltimore		Gruenwald	3318
Birmingham		McKeown	3434
Indonesia	1990-1991, 14 Hospitals	Alisyahbana	3085

reflect the investigators desires to present data representative of a given population rather than statistics on normally growth fetuses.[5] The exclusion of all infants with unknown gestational age and with any fetal or maternal growth retarding factors result in the large number of infants who were excluded from the survey. This is expected in teaching hospitals and a tertiary medical center. The other consequence is that the result of the study represent women from better socioeconomic and educational levels than the total population. It probably will also give a picture of infants born from better nutrional status as women tend to come from better conditions. Considering the limitation of the study the research team have analyzed the data for inter-center as well as international comparison. The present material of 5844 newborn infants were selected to contain a low proportion of preterm and high proportion of term infants. The summary statistics for birth weight, upper arm circumference and chest circumference can be seen in Table 19. It shows that the Indonesian data differed not very much to other countries in Asia, racial and nutritional factors may be the some of the reasons for lack of difference.

While Indonesian Pediatrician have always use the Denver intrauterine growth curve it is important to analyze whether the Denver Curve is really appropriate for the Indonesian tables. To provide the answer to this question the mean birth weight and standard deviation of both studies were compared showing the following result.

The number of infants included for comparison were from gestational age 34 weeks until 42 weeks. The reason is that for infants less than 34 weeks the number of Indonesian infants were too small and over 42 weeks there were no information from the Denver study. It is interesting to find babies with higher birth weights in the Indonesian sample compared to the Denver babies. After 40 weeks birth weight for Denver babies were higher while Indonesian babies were showing a slower increase. The mean birth weight for each group was compared (3081.5 gram, SD 248.96 of Denver study versus 3073.3 gram, SD 132.75 for the Indonesian infants) a significant difference was found (student T test, $p< 0.035$). Based on this finding, the Denver intrauterine growth curve can not be used as reference for Indonesian babies. We also have to consider that

Table 19. A comparison between mean birth weight, upper arm circumference, and chest circumference and the tenth percentile at each country

Country	n	Birth weight			Upper arm circumference			Chest circumference		
	Infants	X	SD	10 pct	X	SD	10 pct	X	SD	10 pct
Yerevan	400	3295	503.9	2700	11.5	1.2	10.0	33.8	2.4	30.0
Beijing	400	3175	543.1	2400	10.4	1.0	9.0	33.8	2.4	30.0
Salvador	100	3394	453.6	2710	11.0	0.9	10.0	33.3	1.9	30.5
Santiago	317	3224	510.2	2596	10.8	1.0	9.6	32.9	2.1	30.0
Havana	442	3253	528.6	2633	11.3	1.1	10.0	33.1	1.8	31.0
Addis Ababa	430	2901	598.8	2160	11.0	1.3	9.4	32.3	2.8	28.9
Gaza	529	3285	533.6	2590	10.4	1.0	9.2	32.3	2.1	29.9
Szeged	1000	3279	461.4	2689	10.5	0.9	9.5	31.8	2.0	29.0
New Delhi (A)	334	2798	540.7	2065	9.2	1.0	8.0	30.0	2.4	27.0
Chandigarh	400	2850	530.6	2102	9.9	1.0	8.9	31.1	1.9	28.8
New Delhi (B)	260	2634	478.6	2040	9.0	0.9	8.0	29.6	2.5	35.1
Seoul	187	3187	402.8	2648	10.3	0.8	9.2	32.4	1.7	30.2
Nairobi	400	2957	600.5	2355	10.4	1.2	9.0	30.8	2.5	28.0
Islamabad	103	3209	437.4	2722	10.8	0.8	10.0	32.9	2.1	30.0
Riyadh	400	3199	421.4	2655	10.8	0.8	10.3	33.2	1.8	31.0
Dakar	140	2964	629.1	1950	9.7	1.4	7.8	30.0	3.1	29.3
Shanghai	400	3244	422.8	2755	10.8	0.9	9.8	32.9	1.8	30.7
Singapore	404	3163	448.9	2615	10.1	0.8	9.1	32.0	1.9	29.8
Bangkok	430	2986	415.9	2411	10.5	0.9	10.5	31.9	1.9	29.5
Istambul	290	3205	597.6	2491	10.5	1.1	9.2	33.3	2.7	32.0
Leningrad	401	3436	430.3	2900	11.3	0.9	10.0	34.0	1.7	32.0
Hanoi	427	2866	524.0	1999	9.8	1.1	8.3	30.4	2.7	26.6
Indonesia	5844	3085	444.0	2429	10.9	1.7	9.3	32.5	2.1	31.4

* Source WHO "Birth weight surrogates" MCH/87.8

Table 20. Birth weight (gram) of the Denver study and the indonesian study (singleton, male and female)

GA (weeks)	Denver Study		Indonesian Study	
	Nof of Infants	Mean BW	No of infants	Mean BW
34	145	2278	43	2553
35	188	2483	70	2704
36	202	2753	136	2849
37	372	2800	262	2819
38	636	3025	565	2903
39	1010	3130	1309	3066
40	1164	3226	1710	3146
41	632	3307	962	3205
42	336	3308	446	3228

the Denver study was conducted on an altitude of 10.000 feet while most of city of pariticaping universities were between 300-1800 feet high.[1,15]

To correlate the five anthropometric parameters to gestational age at birth (linear regression analysis) it was found that crown-heel length did not correlate any better than birth weight to gestational age. Whereas chest circumference and arm circumference had a higher degree of correlation to birth weight. This result is important because chest circumference and upper arm circumference is a simple anthropometric measurements: there are few standard curves relating to gestational age. The high correlation efficient of chest circumference and arm circumference as compared to other parameters was evident for boys and girls separately as well as a group. This result was almost the same for Scandinavian infants.[4] When the Indonesian data is compared to other countries, there are clear differences between the countries in the arithmetical means and percentiles of bothbirth weight and surrogates. The centers in South East Asia have on average the lowest values whereas those in Europe have among the highest. Indonesia values are higher compared to Bangkok but lower than Singapore. (Table19).

The fact that a nearly constant mean weight after 40 completed weeks seems to be a reality found not only in this study. Rooth et al.[7] reported a similar findings; however they found a constant mean weight after 41 weeks. The explanation is probably the supply of nutrients to the fetus.

According to Root, if the results are confirmed -which requires longitudinal measurements before and after birth- for instance by ultrasound technic, they would reinforce the notion that after 41 completed weeks, pregnancies should be watched carefully as growth retardation may be the first step to fetal morbidity, in the Indonesian study it probably started at 40 weeks. Dunn [13] reported the same findings in his study.

Recent evidence suggest that during intra uterine life the fetus is not completely protected form harmful environmental influences.This further support the use of birth weight as an important health and development indicator. Birth weight is a measure of a period of rapid growth which is well defined and can be considered a more sensitive indicator than later stages of development.[8]

Much have been written about low birth weight (LBW) infants (< 2500 gm). They constitute a heterogeneous group, including premature infants (< 37 completed weeks of gestation) and at least the two main types of fetal growth retardation (FGR) seen in infants of 37 weeks or more. Their importance as a group depends on two factors. They are easily diagnosed by the simple process of weighing them and they provide as a group, a good indication of the degree of prenatal care of mothers and their fetuses. It is generally recognized that any substantial reduction in their number will lower infant mortality and dimished long-term morbidity caused by premature birth and severe fetal growth retardation.[9]

Low birth weight is not specially studied because it was not the purpose of this survey, however in this sample size low birth weight infants constitutes only for 6.3% which is much lower than the prevalence in the general population of Indonesia which is 14% according the National Health System (1984). The public health importance of low birth weight is to determine not only by the risk of subsequent morbidity and mortality but alsoby how frequently it occurs e.g.its prevalence in a given population.

The purpose to look for alternative anthropometric measurements is to be able to identify low birth weight in a given population using simple methods, this is important because more than 50% of infants are born at home attended by traditional birth attendans who are illiterate. The study try to test out anthropometric measurements that can be used at village level.Weighing scales for newborn infants are also not always available an alternative method have to be used to be able identify infants at risk based on their birth weight. The WHO have analyzed the multicenter study conducted in 22 countries, they found that chest circumference of 29 and 30 centimeters show high sensitivity and positive predictive values.[3]

Although the cut-off point of 29 cm is in general appropriate it is still recommended to test out the cut-off point for specific population as it may lead to an undesirable level of false negative diagnosis. The Indonesian study found a sensitivity of 40.4%, meaning that 59.6% would not be diagnosed on the other hand using this cut-off point the probability of the diagnosis being correct is 67.2%. The decision to use other cut-off point depends also on the health services whether they can afford to manage more cases, for instance if the cut-off point was taken lower (< 28 cm). Considering the health services in Indonesia at present time, we assumed that it probably cannot afford high number of referrals especially when it is based only on birthweight.

Chest cirrcumference is in many instances desirable compared to arm circumference although both are reliable. Arm circumference shows the highest positive predictive value at < 9 cm, the sensitivity is found to be 34.4% and the positive predictive value of 69.0% was highest compared to other cut-off points. In the practice however chest circumference is easier to measure compared to arm circumference.

The Use of Intrauterine Growth Chart

Fetal growth chart can be used for the screening of high risk newborns at birth. A simple routine procedure, i.e. plotting the newborn weight, length, or head circumference on a fetal growth chart will tell not only whether the infant is light, appropriate, or heavy-for date, but also allows for estimation of the intrauterine environment. Fetal growth chart can also be used for extrauterine growth monitoring of preterm infants. Gestational age and head growth should be considered in following the growth of very premature infants.[13]

The pattern of intrauterine growth and somatic development of infants in a particular population are proven not to be static but changes with time and social condition.[9] These changes, so-called secular growth changes, were first discussed at the beginning of the 19th century. *Secular* means during a prolonged period. Some authors used the word in the sense of "lasting a century".[11] Secular growth in birth weight is widely discussed; periodic measurements of birth weight give a picture of the general health status of the population.[2] Population's growth is subject to change and up to date values should be put for disposal from centers of maternal and child care.

Limitation of the Study

This study suffered from weaknesses frequently found in multicenter surveys. More seriously however was the reliability of gestational assessment which rely heavily of LMP.[16] The investigators have tried to correct the excess of errors by developing a tight inclusion criteria. The use of obstretric ultrasonography for fetal anthropometry was not possible because not every center has an USG equipment.

1. From the incoming data of anthropometric measurements from several centers there was a tendency for measurements to be recorded in round numbers. As a consequence, a heaping was found at the 50 grams and 100 grams for birth weight. The survey protocol had required the survey implementators to record the data to the nearest 10 grams.

2. The survey was not successful in collecting anthropometric data of infants of low gestational age. Because of the very tight inclusion criteria many births have to be excluded from the survey. In referral hospitals many mothers have some kinds of complication during the perinatal or delivery period which result in a very large prevalence of very low birth weight infants. On the other hand it is also questionable whether low birth weight babies constitute a healthy population.[1]

3. Because mother's knowledge about her exact last menstrual period was mandatory, the results showed that all infants included in the survey were born from mothers of a relatively higher educational status and from mid or upper socioec[illegible]vel.

4. The interest of each contributing center was not the same, as was expected. Unfortunately this had an impact on the quality of the study, which resulted that almost 5% of the data had to be excluded because of extreme and illogical measurements, or because of incomplete forms.

Summary and Conclusions

The multicenter survey on newborn anthropometric measurements was conducted to have a reference curve of intrauterine growth for Indonesian newborns. So far Indonesian clinicians had always use the Denver intrauterine growth curve as reference curve.

The study conducted in 14 Teaching centers reveals that:

1. Using a tight inclusion criteria only 8% of total singleton births were included, women who knows the first day of the last menstrual period were better educated and of better socioeconomic status. Therefore the results of this study represent the middle socioeconomic level of the Indonesian women.

2. Mean birth weight for boys was about 60 gram higher compared to girls, mean birth length about 0.5 cm longer, for head it was 0.3 cm greater, while for boys and girls, the mean chest circumference was significant different for arm circumference no difference was found.

3. If birth weight and birth length of the infant were cross tabulated to gestational age it shows that at 40 weeks birth weight and birth length became more stable. This was probably due to the maturity of the placenta. The same result can be seen in other studies. For every gestational age and percentiles, laterborn infants were heavier than first-born infants. Birth weight at 42 weeks gestation was lower in first-born infants, this was not shown in the later-born infants which showed higher weights for each percentile. Parity of the mother affected birth weight more than birth length. Birth length became stable at 39 weeks probably due to early dysfunction of the placenta in borderline small for date infants.

4. Arm circumference of < 9 cm had the highest predictive value and sensitivity, while for chest circumference the cut-off point is < 29 cm. Chest circumference is easier to measure compare to arm circumference.

5. The Indonesian newborns had in general higher mean birthweight for gestational age 34-38 weeks compared to the Denver study, after this gestational age newborns in Denver have higher birth weights. Mean birth weight of the Denver infants differ signifantly from the mean birthweight of Indonesian middle clase newborn infants. Therefore the Denver Intrauterine growth curve cannot be used as a reference for Indonesian newborns.

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ANNEX

TABLE I

SAMPLE SIZE BY GESTATIONAL AGE

			Gestational age (weeks)	
No	University	No. of subjects	Mean	SD
1	Unsyiah	727	39.75	1.42
2	USU	246	39.96	1.44
3	Unand	96	39.20	2.48
4	Unsri	503	39.62	1.79
5	Unsrat	402	39.59	1.99
6	Unhas	394	39.94	1.94
7	Unair	293	39.49	2.01
8	Unbraw	280	39.83	2.13
9	UGM	662	39.65	2.08
10	Undip	678	39.77	1.95
11	UNS	192	38.92	2.61
12	UI	386	39.77	1.95
13	Unpad	560	39.57	1.69
14	RSHK	425	39.60	1.92
	Total	5844	39.67	1.88

TABLE II

SAMPLE SIZE BY ETHNIC GROUP

No	Ethnic Group	n
1	Sumatera	1680
2	Jawa	3217
3	Kalimantan & Sulawesi	724
4	Maluku	21
5	Others	202
	Total	5844

TABLE III

BIRTH WEIGHT IN PERCENTILES AND GESTATIONAL AGE FOR BOYS

No	GA (weeks)	Birth weight (grams)					
		P10	P25	P50	P75	P90	n
1	34	1870	2090	2620	2990	3140	29
2	35	2130	2500	2750	3110	3340	35
3	36	2210	2508	2800	3213	3500	70
4	37	2300	2555	2825	3100	3408	145
5	38	2500	2695	2940	3200	3450	325
6	39	2600	2820	3100	3350	3587	691
7	40	2680	2905	3150	3480	3750	897
8	41	2750	3000	3250	3500	3800	465
9	42	2758	3000	3290	3600	3865	203
10	43	2800	3000	3250	3520	3879	96
11	44	2620	2900	3100	3530	3729	43
							2 999

TABLE IV

BIRTH WEIGHT IN PERCENTILES AND GESTATIONAL AGE FOR GIRLS

No	GA (weeks)	Birth weight (grams)					
		P10	P25	P50	P75	P90	n
1	34	2055	2200	2445	2800	3300	14
2	35	1976	2200	2655	2980	3210	35
3	36	2285	2600	2800	3200	3430	66
4	37	2298	2525	2750	3025	3288	117
5	38	2373	2600	2850	3100	3336	240
6	39	2600	2750	3000	3291	3500	618
7	40	2650	2870	3100	3315	3600	813
8	41	2632	2882	3100	3400	3706	497
9	42	2700	2880	3120	3400	3700	243
10	43	2870	3000	3200	3440	3830	84
11	44	2652	2850	3200	3500	3780	31
							2758

TABLE V

BIRTH WEIGHT INPERCENTILES AND GESTATIONAL AGE FOR BOTH SEXES

No	GA (weeks)	Birth weight (grams)					
		P10	P25	P50	P75	P90	n
1	34	1924	2150	2580	2950	3124	43
2	35	2005	2400	2705	3000	3290	70
3	36	2285	2543	2800	3200	3500	136
4	37	2300	2548	2800	3053	3350	262
5	38	2450	2645	2900	3155	3400	565
6	39	2600	2800	3050	3300	3520	1309
7	40	2650	2900	3100	3400	3694	1710
8	41	2700	2904	3200	3483	3767	962
9	42	2707	2929	3200	3500	3800	446
10	43	2803	3000	3205	3500	3840	180
11	44	2645	2900	3175	3505	3725	74
							5,757

TABLE VI

BIRTH LENGTH IN PERCENTILES AND GESTATIONAL AGE FOR BOYS

No	GA (weeks)	Birth length (cm)					
		P10	P25	P50	P75	P90	n
1	34	43	43	46	49	49	29
2	35	45	47	48	50	51	35
3	36	45	47	49	50	51	70
4	37	46	47	48	50	51	145
5	38	46	47	49	50	51	325
6	39	47	48	50	50	51	691
7	40	48	49	50	51	52	897
8	41	47	49	50	51	52	465
9	42	48	49	50	51	52	203
10	43	48	49	50	51	52	96
11	44	47	49	50	51	52	43
							2,999

TABLE VII

BIRTH LENGTH IN PERCENTILES AND GESTATIONAL AGE FOR GIRLS

No	GA (weeks)	Birth length (cm)					
		P10	P25	P50	P75	P90	n
1	34	42	45	48	50	52	14
2	35	43	45	47	49	50	35
3	36	46	47	49	50	51	66
4	37	46	47	48	50	50	117
5	38	46	47	48	49	50	240
6	39	46	48	49	50	51	618
7	40	47	48	49	50	51	813
8	41	47	48	49	50	51	497
9	42	47	48	50	50	52	243
10	43	48	49	50	51	51	84
11	44	48	49	50	51	52	31
							2,758

TABLE VIII

BIRTH LENGTH IN PERCENTILES AND GESTATIONAL AGE FOR BOTH SEXES

No	GA (weeks)	Birth length (cm)					
		P10	P25	P50	P75	P90	n
1	34	42	45	47	49	51	43
2	35	44	46	47	49	51	70
3	36	46	47	49	50	51	136
4	37	46	47	48	50	51	262
5	38	46	47	49	50	51	565
6	39	47	48	49	50	51	1,309
7	40	47	48	50	50	51	1,710
8	41	47	48	50	51	52	962
9	42	47	48	50	51	52	446
10	43	48	49	50	51	52	180
11	44	48	49	50	51	52	74
							5,757

TABLE IX

HEAD CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOYS

No	GA (weeks)	Head circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	30	31	33	34	34	29
2	35	30	32	33	34	36	35
3	36	30	32	33	34	35	70
4	37	31	32	33	34	35	145
5	38	32	32	33	34	35	325
6	39	32	33	34	35	35	691
7	40	32	33	34	35	36	897
8	41	32	33	34	35	36	465
9	42	32	33	34	35	36	203
10	43	32	33	34	35	36	96
11	44	32	33	34	35	36	43
							2,999

TABLE X

HEAD CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR GIRLS

No	GA (weeks)	Head circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	31	31	32	33	35	14
2	35	30	31	32	33	34	35
3	36	31	32	33	34	35	66
4	37	31	32	33	34	35	117
5	38	31	32	33	34	35	240
6	39	32	33	33	34	35	618
7	40	32	33	33	34	35	813
8	41	32	33	34	35	36	497
9	42	32	33	34	35	36	243
10	43	32	33	34	35	36	84
11	44	32	33	34	35	36	31
							2,758

TABLE XI

HEAD CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOTH SEXES

No	GA (weeks)	Head circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	30	31	32	34	35	43
2	35	31	32	33	34	35	70
3	36	30	32	33	34	35	136
4	37	31	32	33	34	35	262
5	38	32	32	33	34	35	565
6	39	32	33	34	34	35	1 309
7	40	32	33	34	35	36	1 710
8	41	32	33	34	35	36	962
9	42	32	33	34	35	36	446
10	43	32	33	34	35	36	180
11	44	32	33	34	35	36	74
							5,757

TABLE XII

CHEST CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOYS

No	GA (weeks)	Chest circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	27	28	30	33	35	29
2	35	28	30	32	33	34	35
3	36	29	30	32	33	34	70
4	37	29	30	32	33	34	145
5	38	30	31	32	33	34	325
6	39	30	32	32	34	35	691
7	40	31	32	33	34	35	897
8	41	31	32	33	34	36	465
9	42	31	32	33	35	36	203
10	43	31	32	33	34	35	96
11	44	31	32	33	34	35	43
							2,999

TABLE XIII

CHEST CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR GIRLS

No	GA (weeks)	Chest circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	27	29	31	32	35	14
2	35	28	29	32	33	33	35
3	36	28	30	32	33	34	66
4	37	29	30	32	33	34	117
5	38	30	31	32	33	34	240
6	39	30	32	32	34	35	618
7	40	31	32	33	34	35	813
8	41	31	32	33	34	35	497
9	42	31	32	33	34	35	243
10	43	32	32	33	34	35	84
11	44	30	32	33	34	35	31
							2758

TABLE XIV

CHEST CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOTH SEXES

No	GA (weeks)	Chest circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	27	29	30	33	34	43
2	35	28	30	32	33	34	70
3	36	29	30	32	33	34	136
4	37	29	30	32	33	34	262
5	38	30	31	32	33	34	565
6	39	30	32	32	34	34	1309
7	40	31	32	33	34	35	1710
8	41	31	32	33	34	35	962
9	42	31	32	33	34	35	446
10	43	31	32	33	34	35	180
11	44	31	32	33	34	35	74
							5757

TABLE XV

ARM CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOYS

No	GA (weeks)	Arm circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	8	9	10	11	12	29
2	35	9	10	11	11	12	35
3	36	9	10	11	11	12	70
4	37	9	10	11	11	12	145
5	38	9	10	11	11	12	325
6	39	10	10	11	12	12	691
7	40	10	10	11	12	12	897
8	41	10	11	11	12	12	465
9	42	10	11	11	12	12	203
10	43	10	11	11	12	12	96
11	44	10	10	11	11	12	43
							2999

TABLE XVI

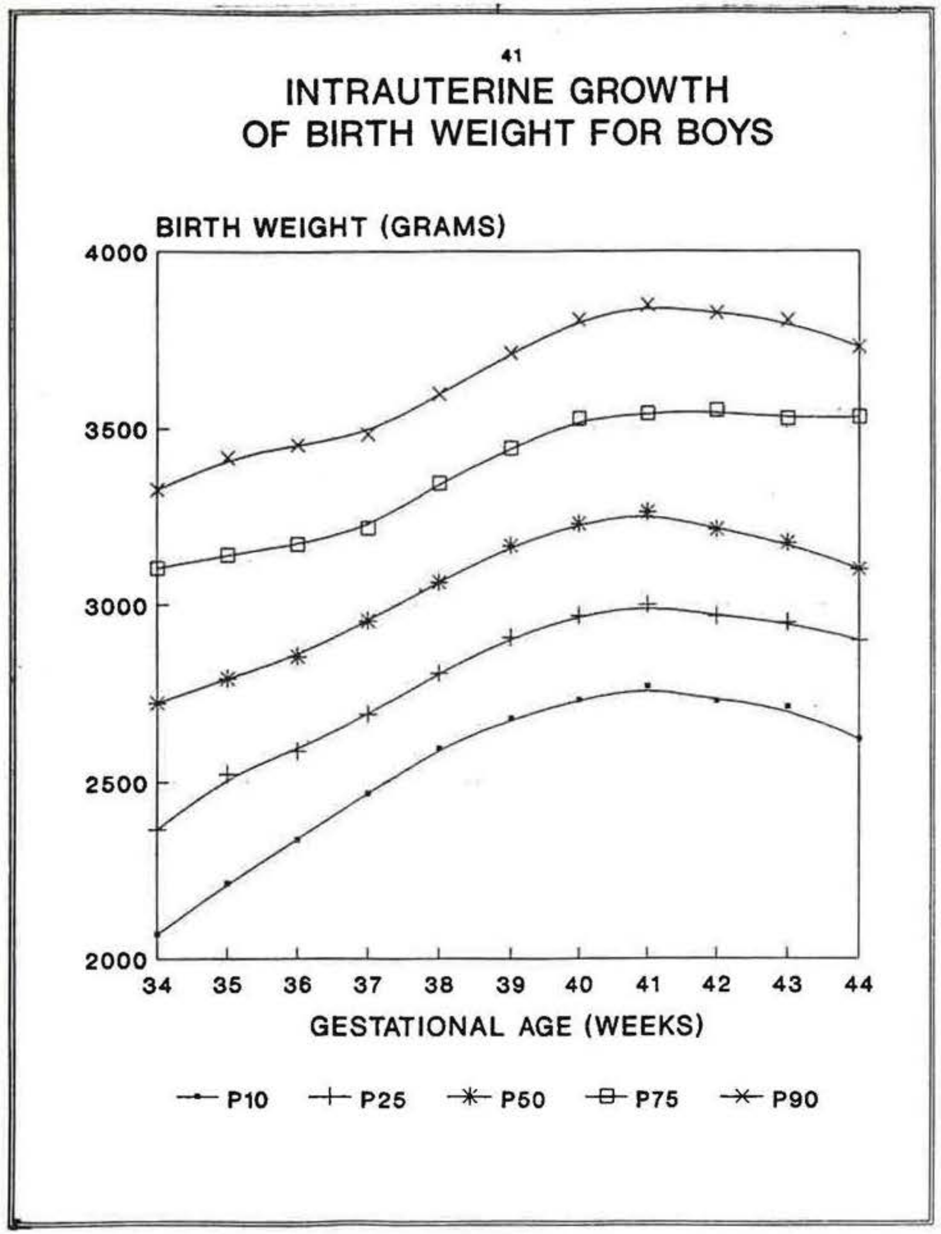
ARM CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR GIRLS

No	GA (weeks)	Arm circumference (cm)					
		P10	P25	P50	P75	P90	n
1	34	8	9	10	11	12	14
2	35	8	9	10	11	12	35
3	36	9	10	11	11	12	66
4	37	9	10	11	11	12	117
5	38	9	10	11	11	12	240
6	39	10	10	11	11	12	618
7	40	10	10	11	12	12	813
8	41	10	10	11	12	12	497
9	42	10	10	11	12	12	243
10	43	10	11	11	12	13	84
11	44	10	10	11	12	12	31
							2758

TABLE XVII

ARM CIRCUMFERENCE IN PERCENTILES AND GESTATIONAL AGE FOR BOTH SEXES

No	GA (weeks)	P10	P25	P50	P75	P90	n
1	34	8.220	9.000	10.000	11.000	11.340	43
2	35	8.500	9.000	10.050	11.000	11.500	70
3	36	9.000	9.500	10.500	11.075	12.000	136
4	37	9.000	9.875	10.500	11.100	12.000	262
5	38	9.000	9.800	10.600	11.200	12.000	565
6	39	9.600	10.000	11.000	11.500	12.000	1309
7	40	9.800	10.275	11.000	11.500	12.000	1710
8	41	9.800	10.300	11.000	11.925	12.000	962
9	42	9.800	10.300	11.000	11.600	12.000	446
10	43	10.000	10.500	11.000	11.750	12.500	180
11	44	10.000	10.000	11.000	11.350	12.000	74
							5757



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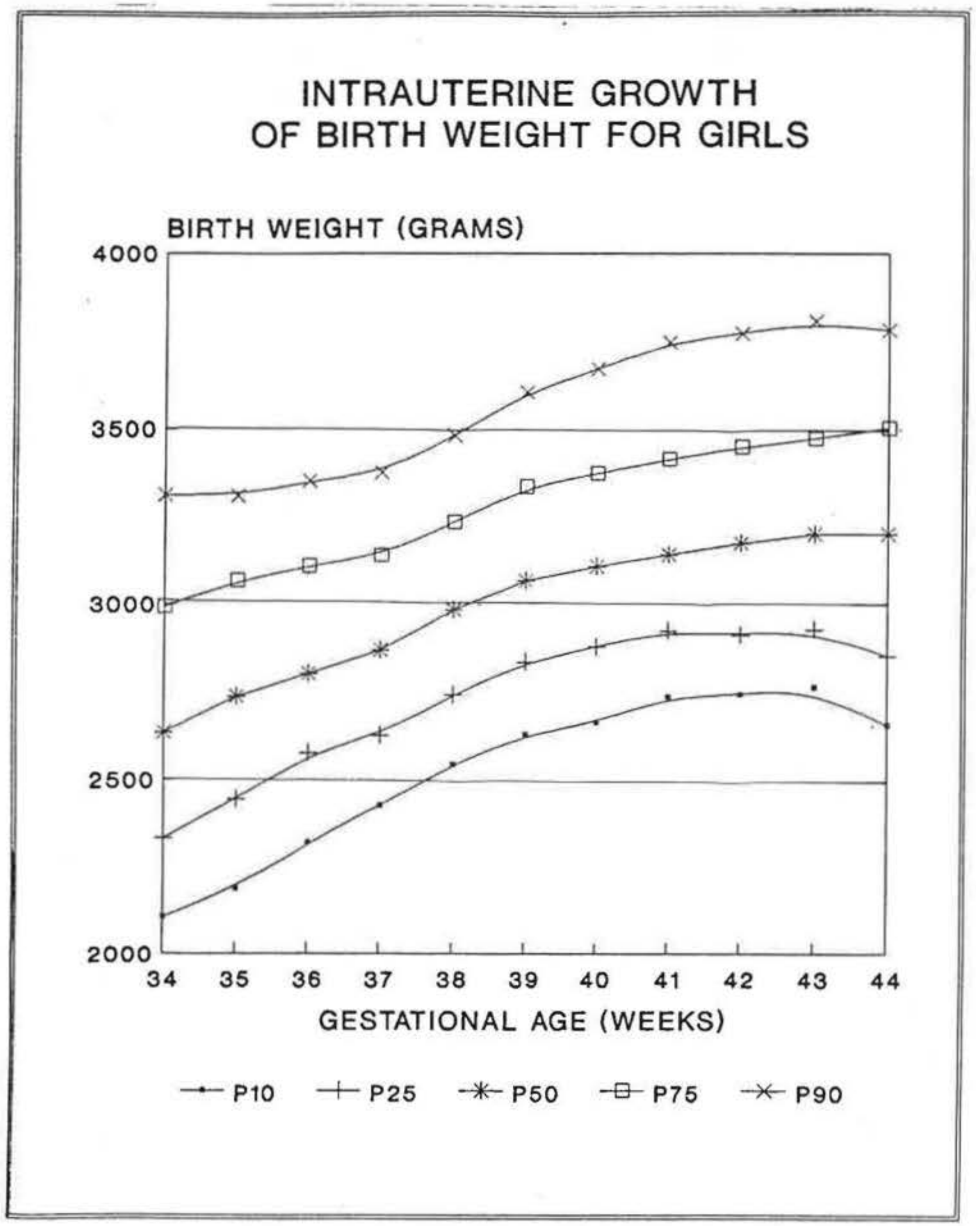

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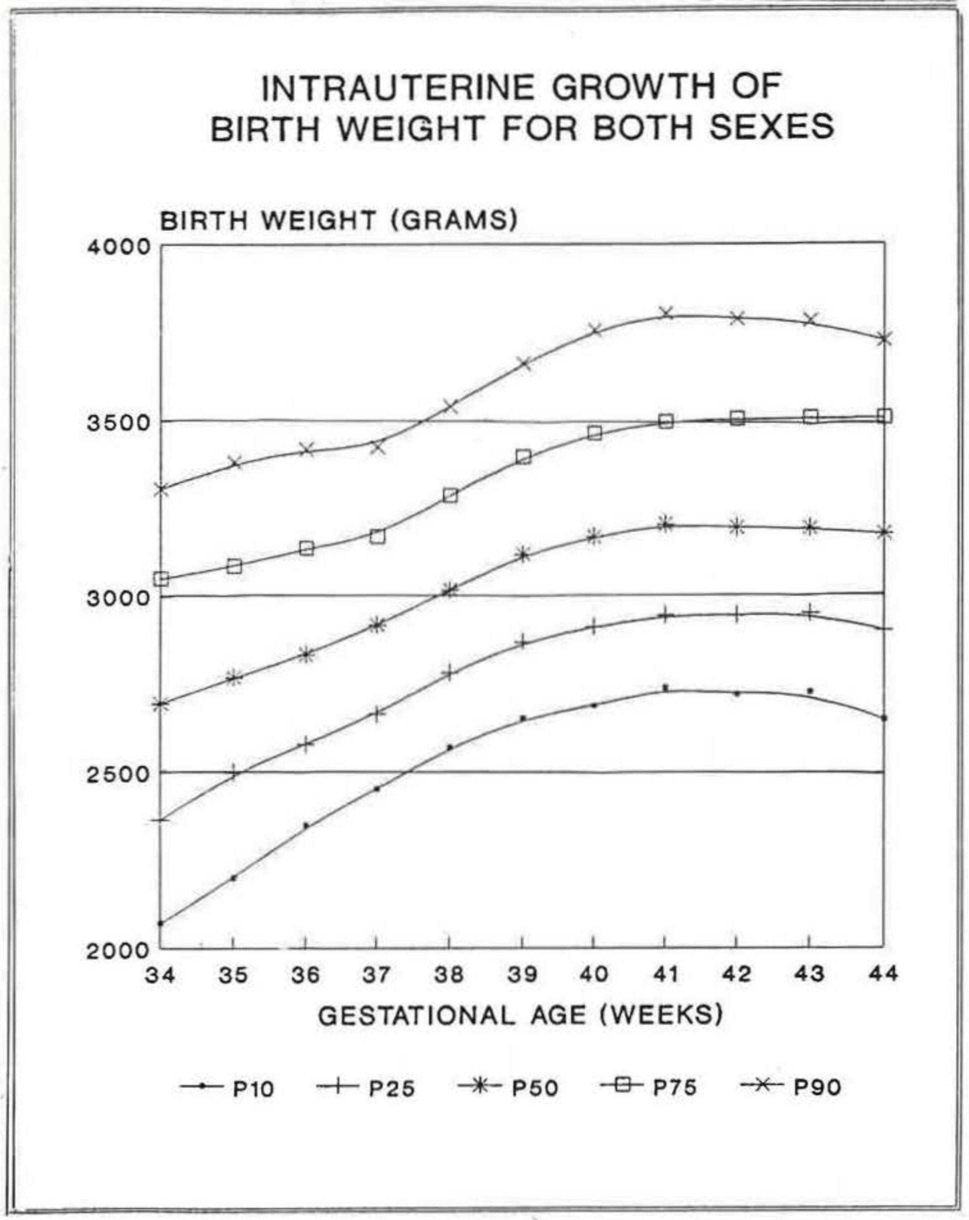

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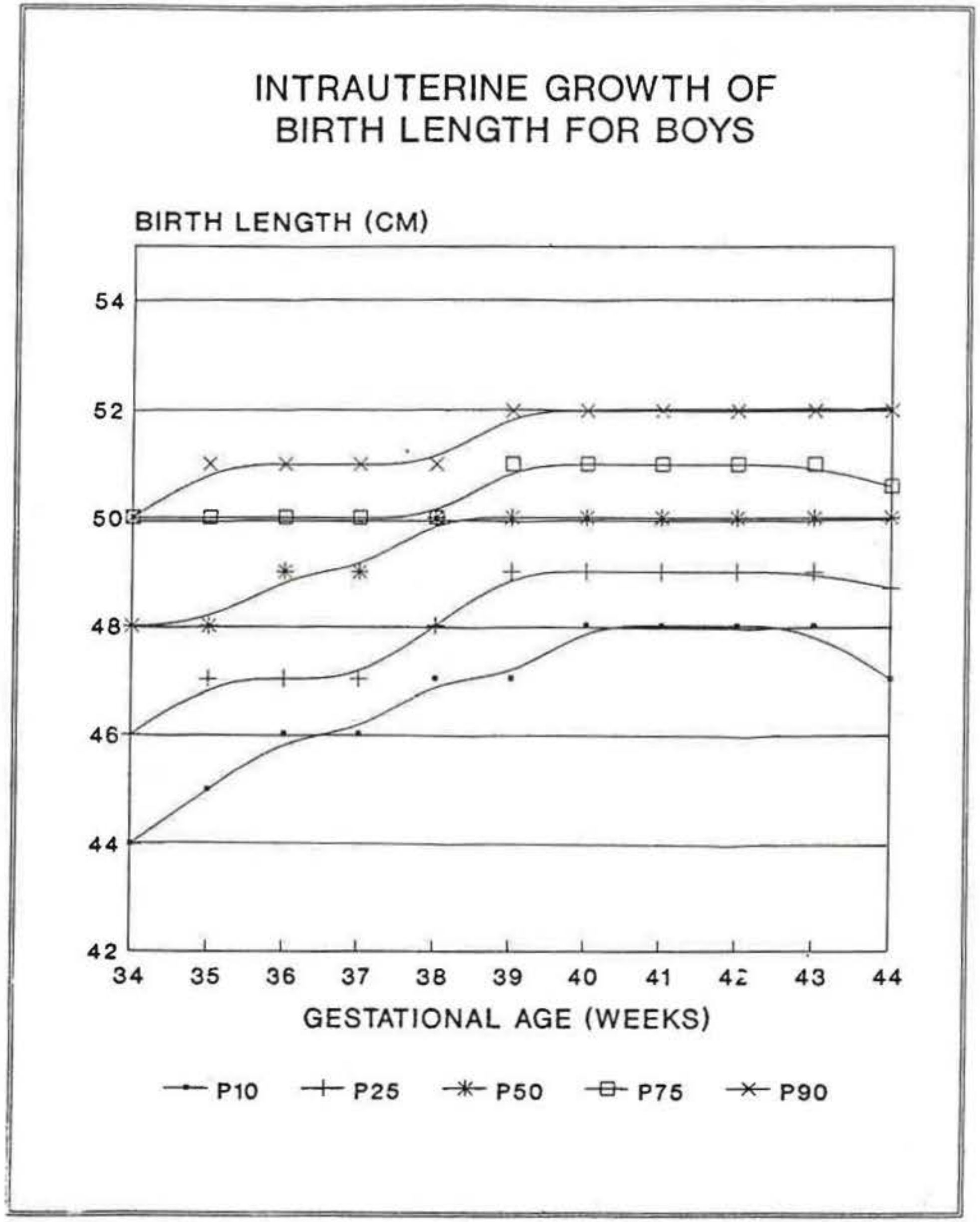

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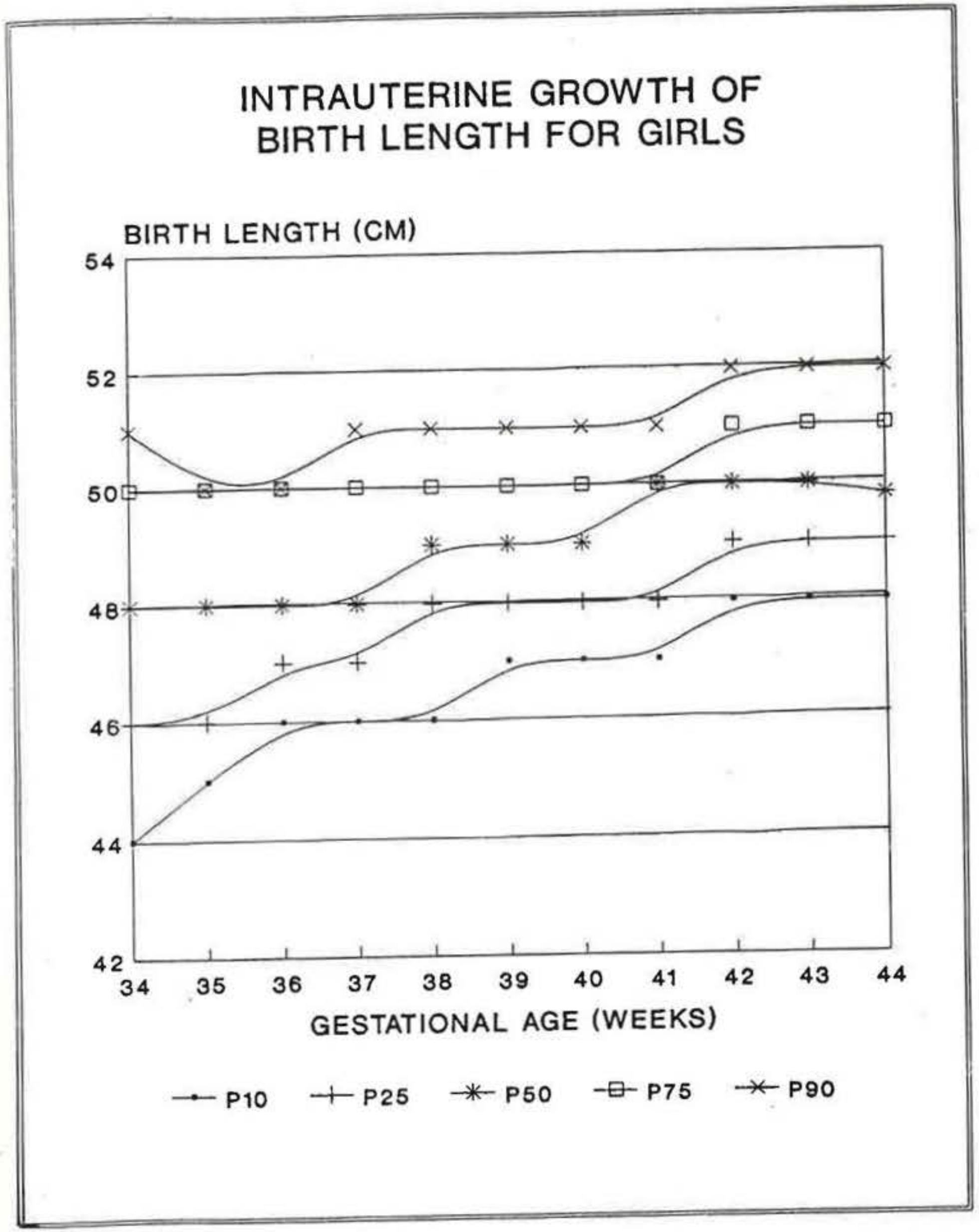

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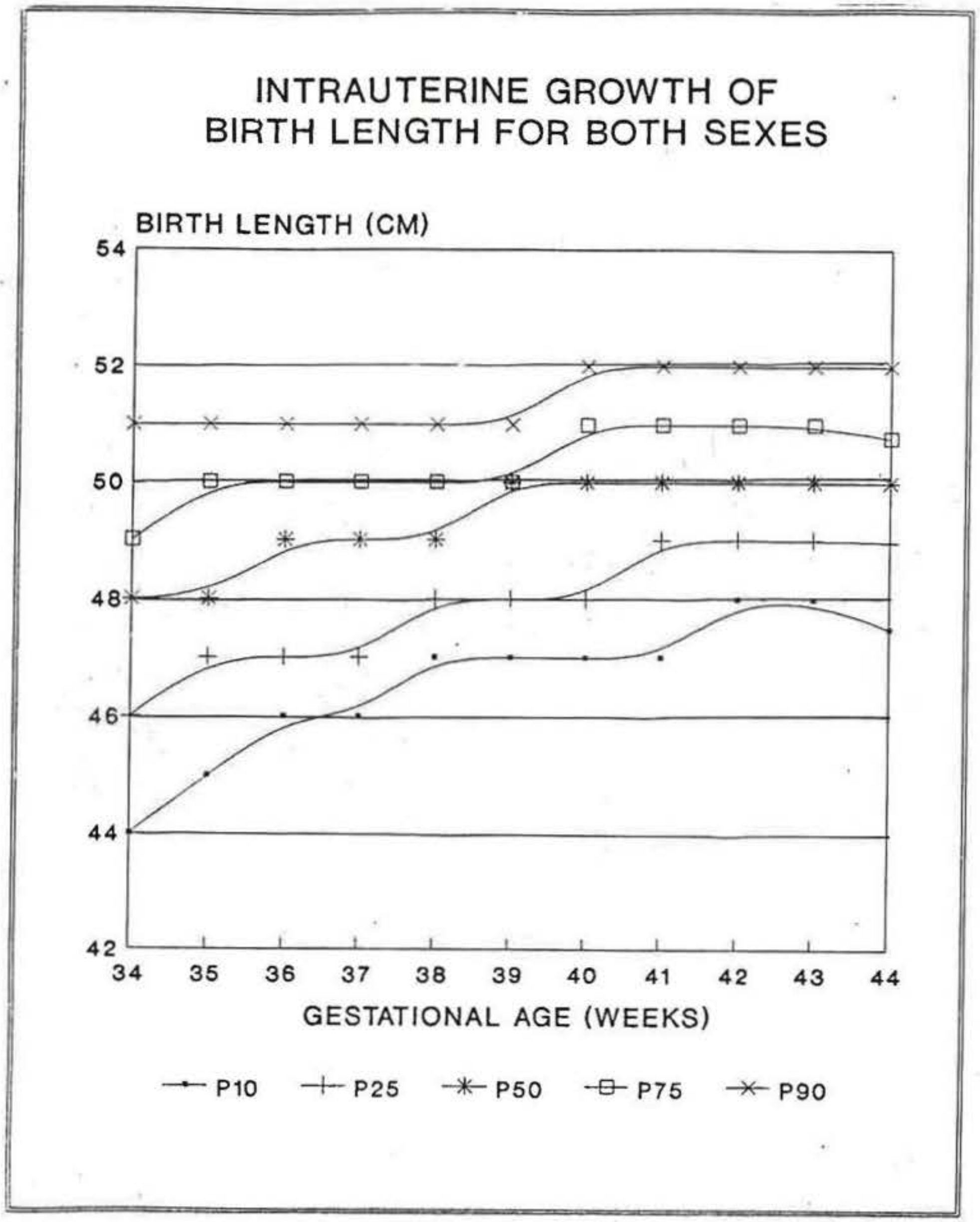

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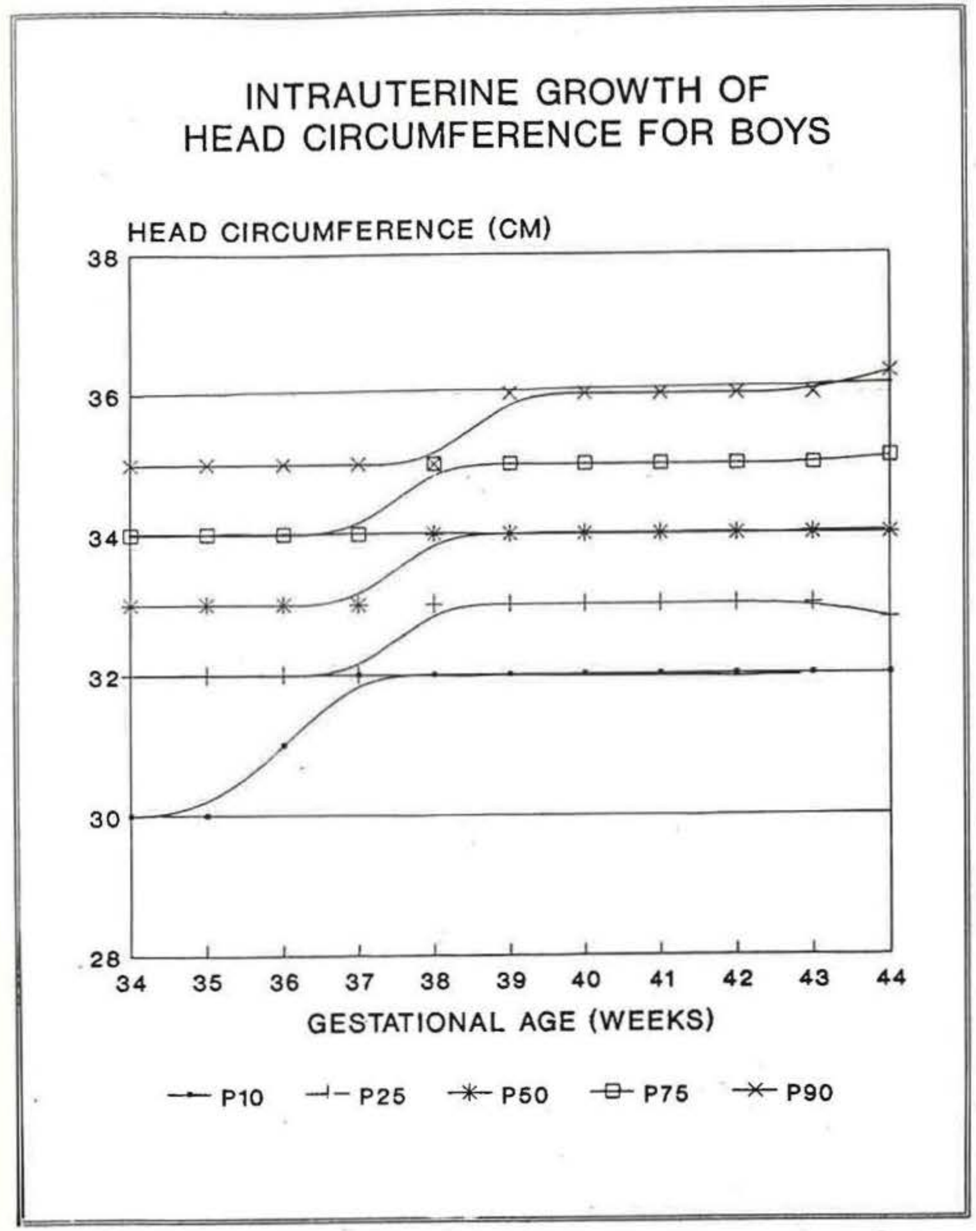

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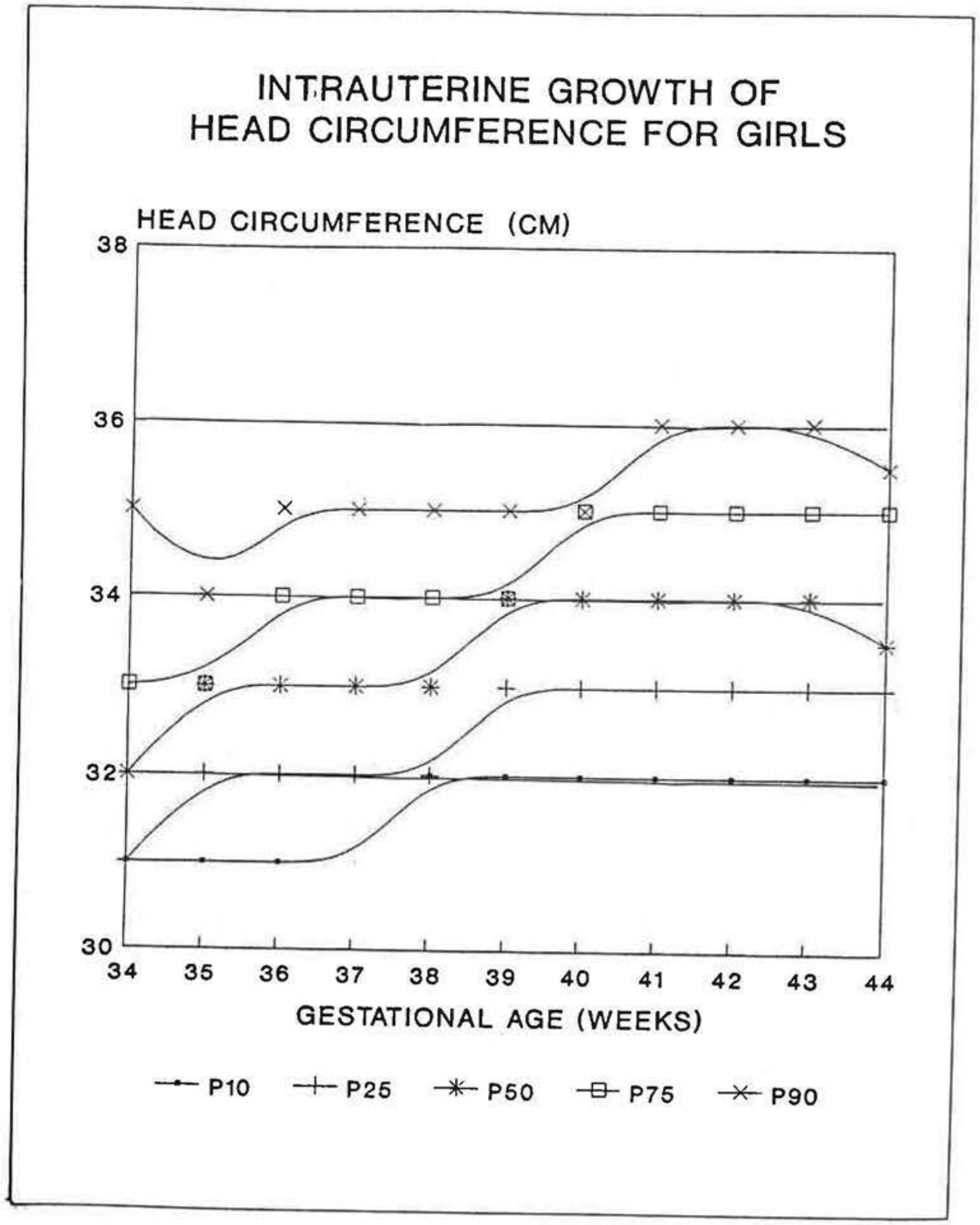

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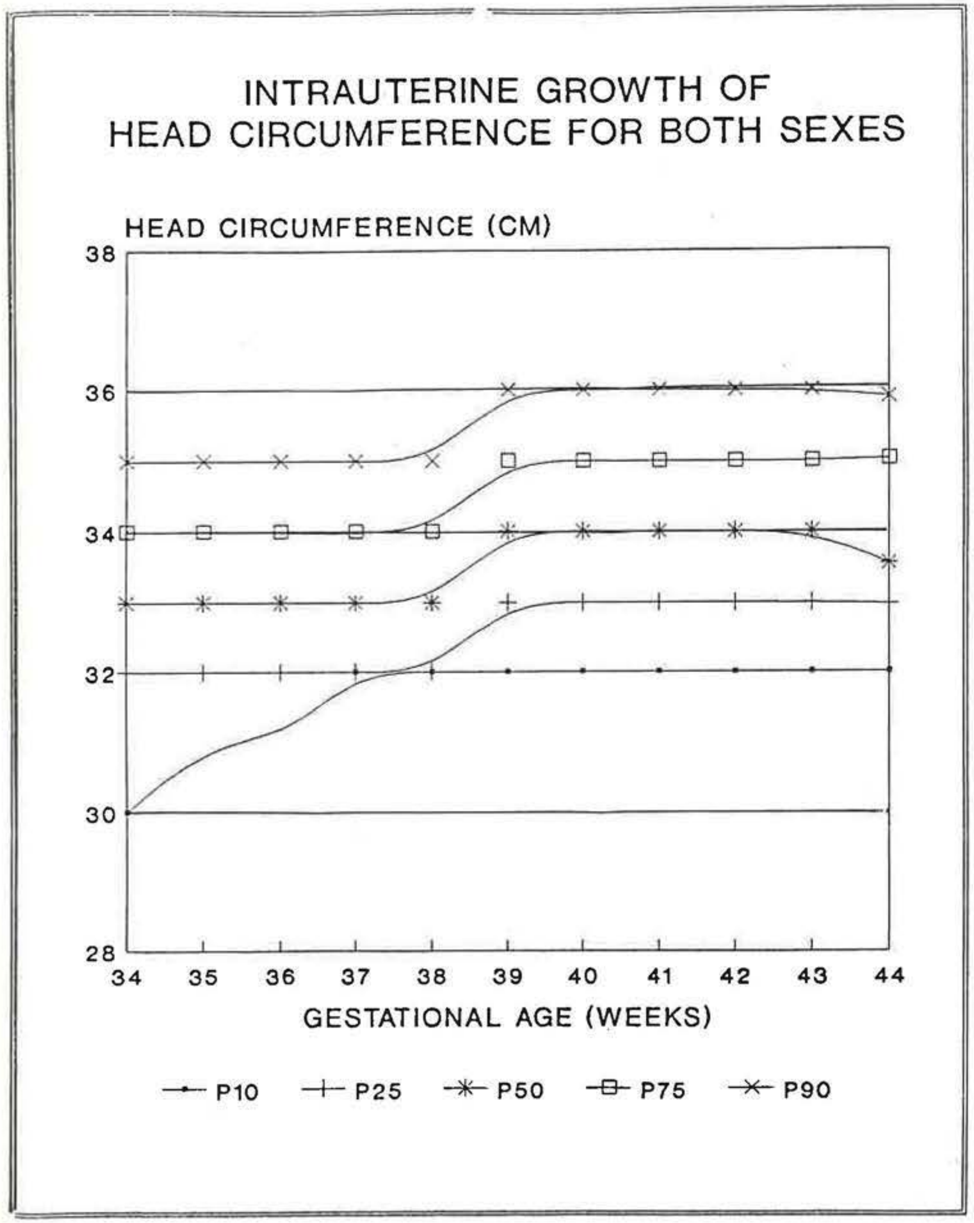

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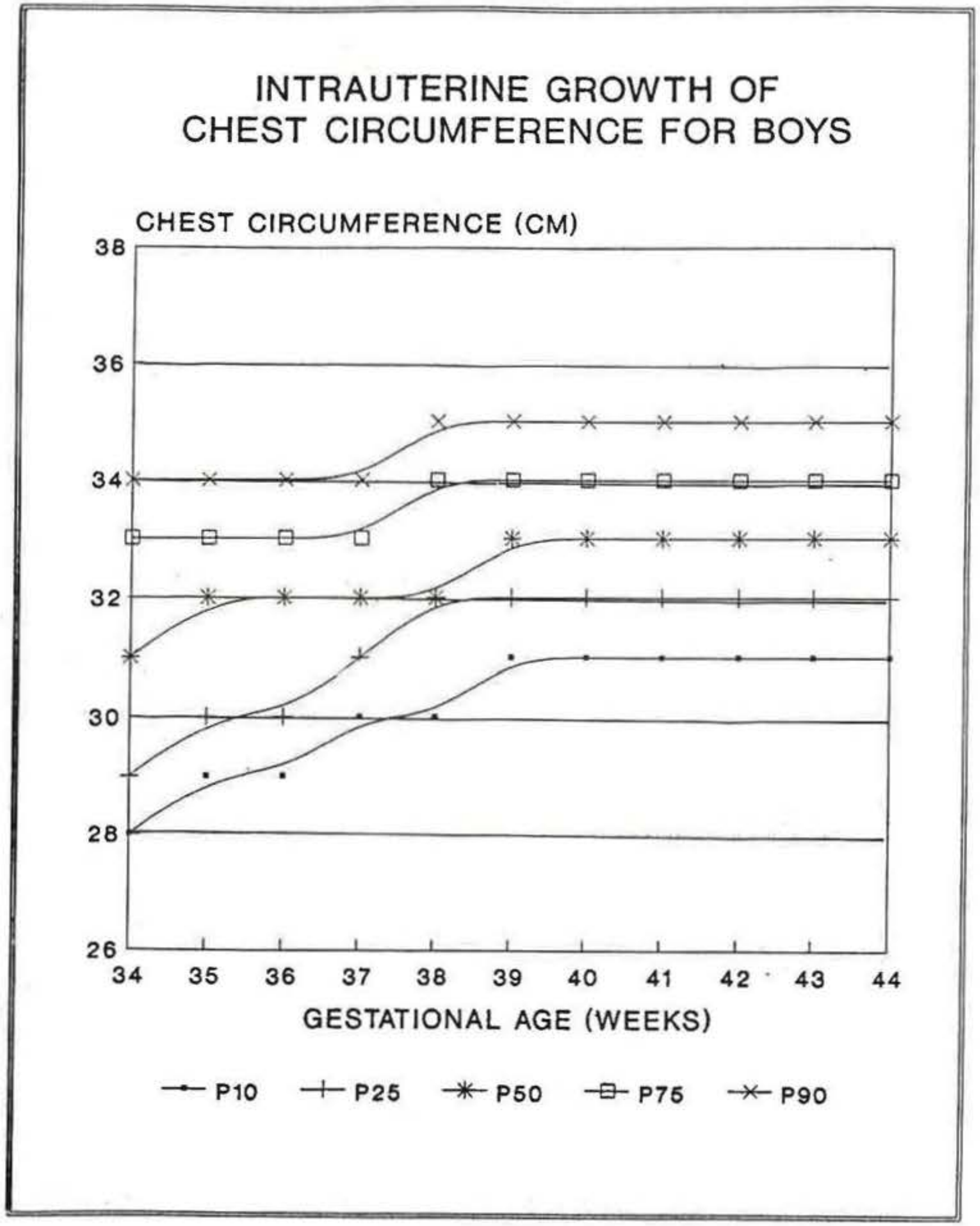

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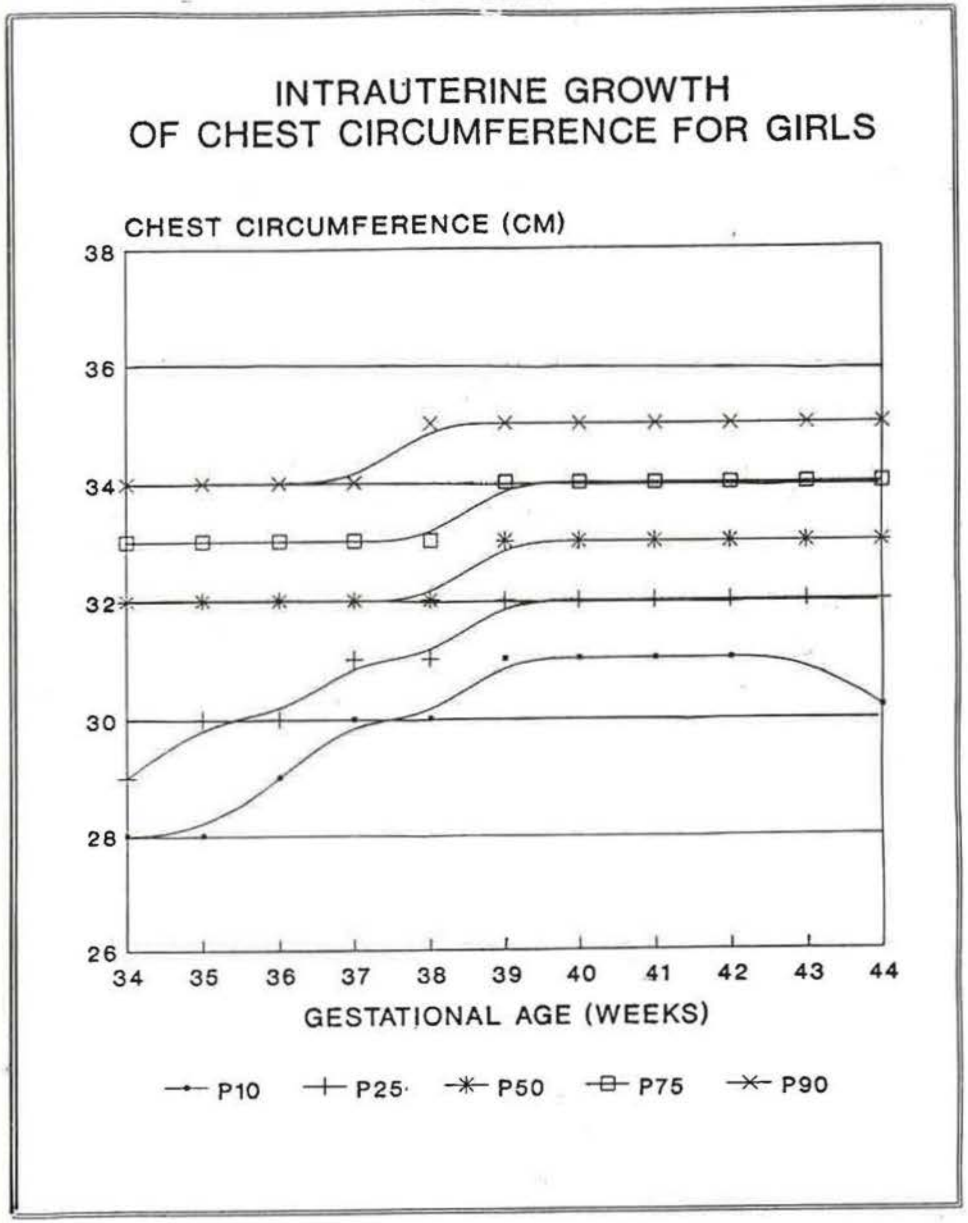
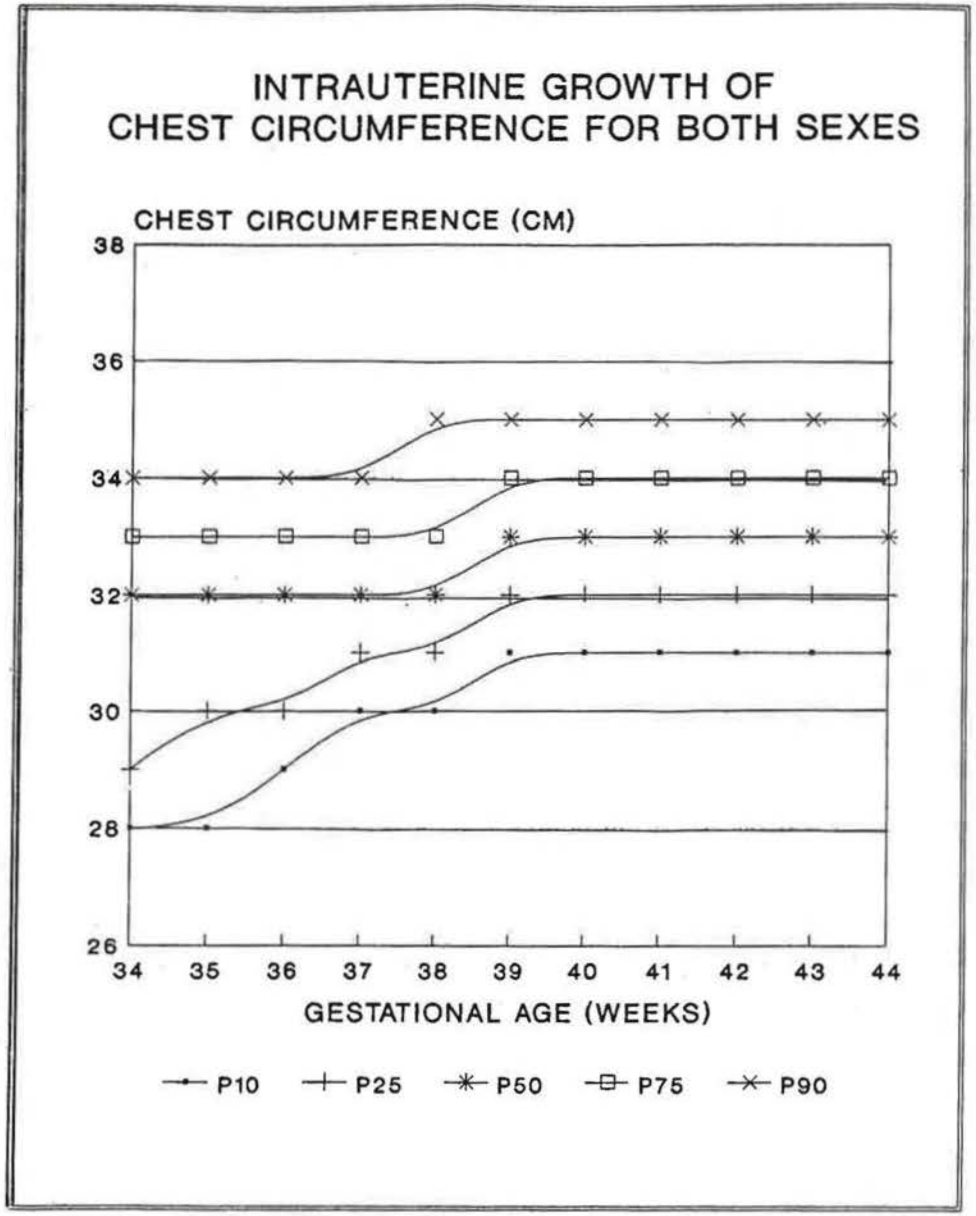


Figure 11



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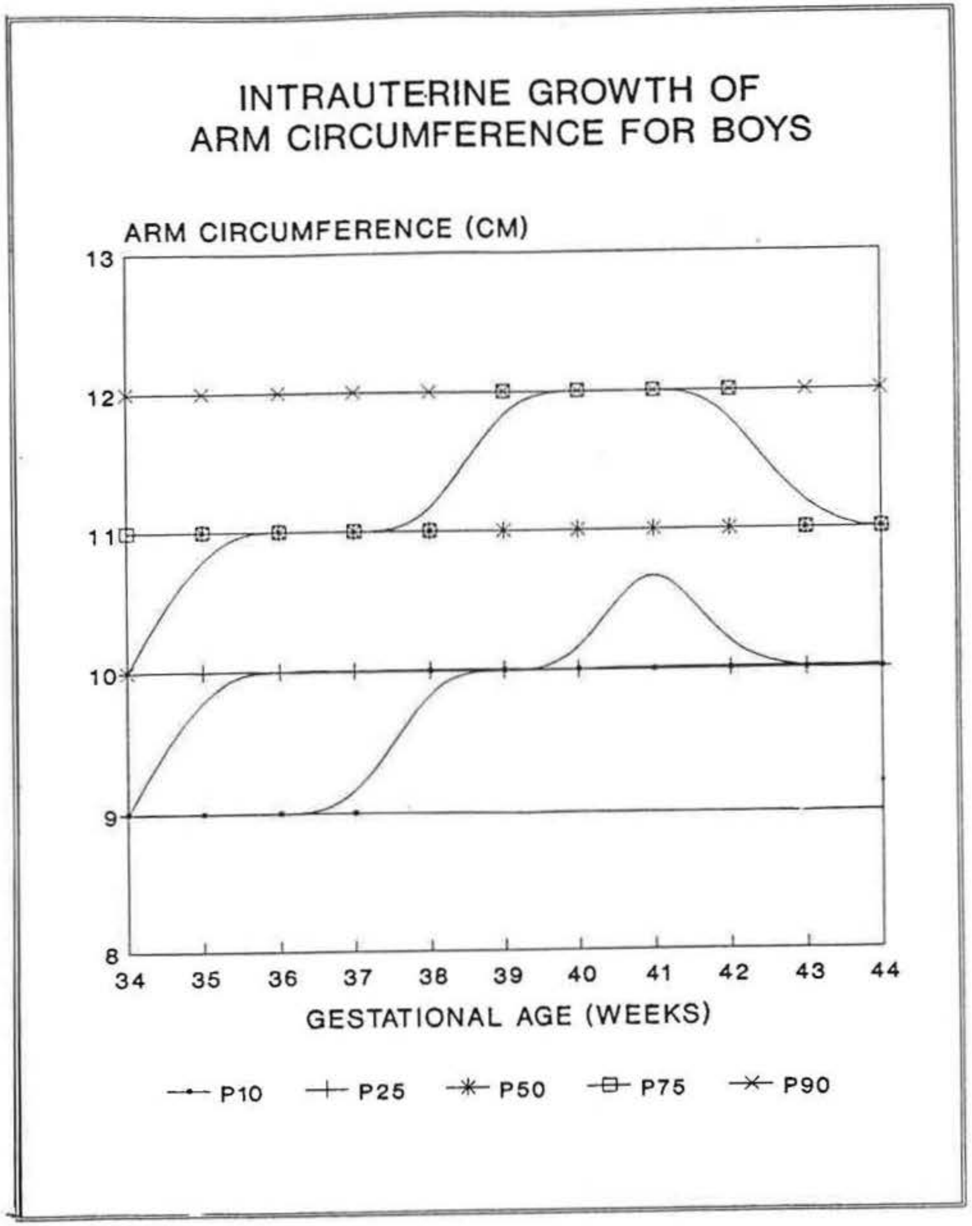

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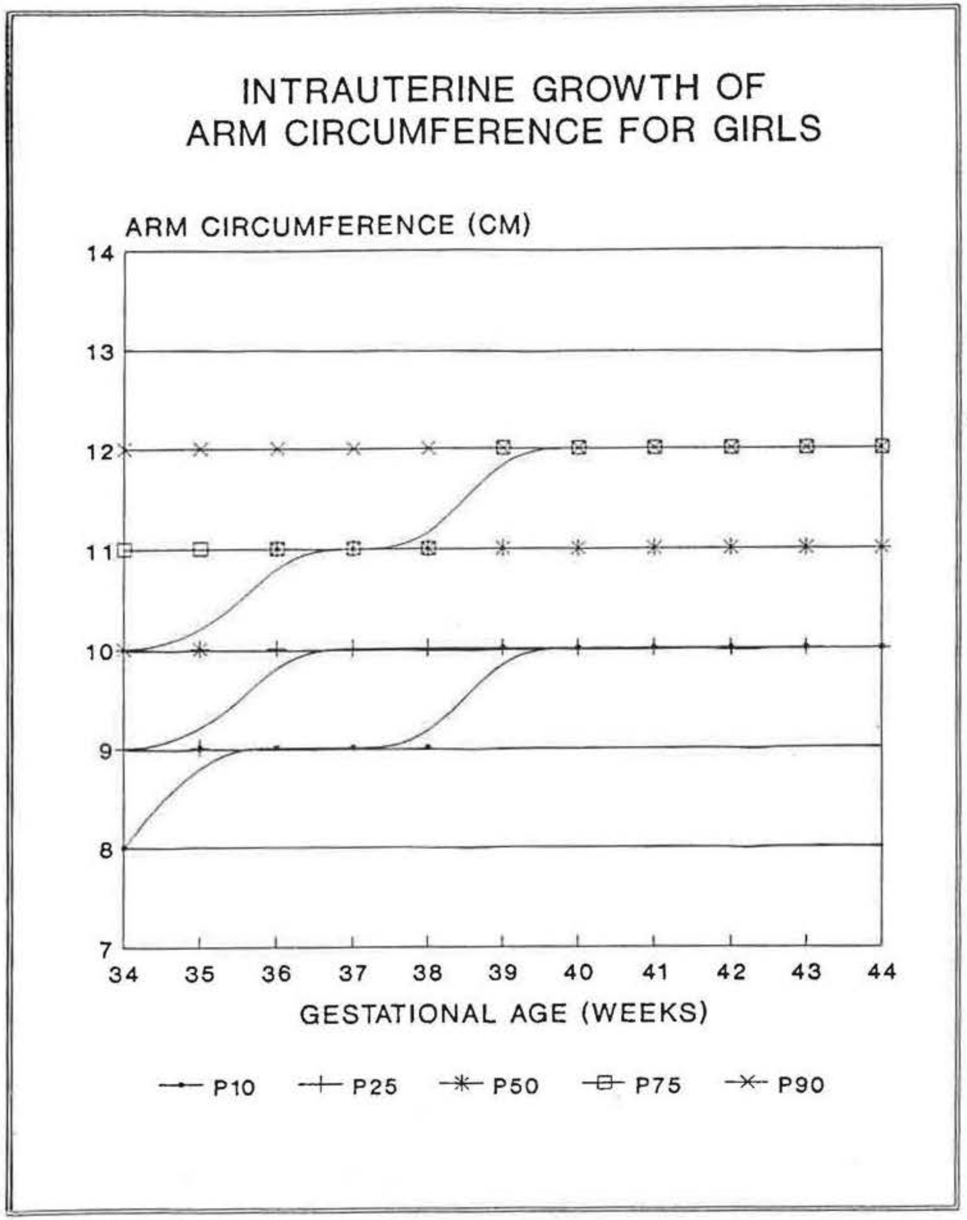

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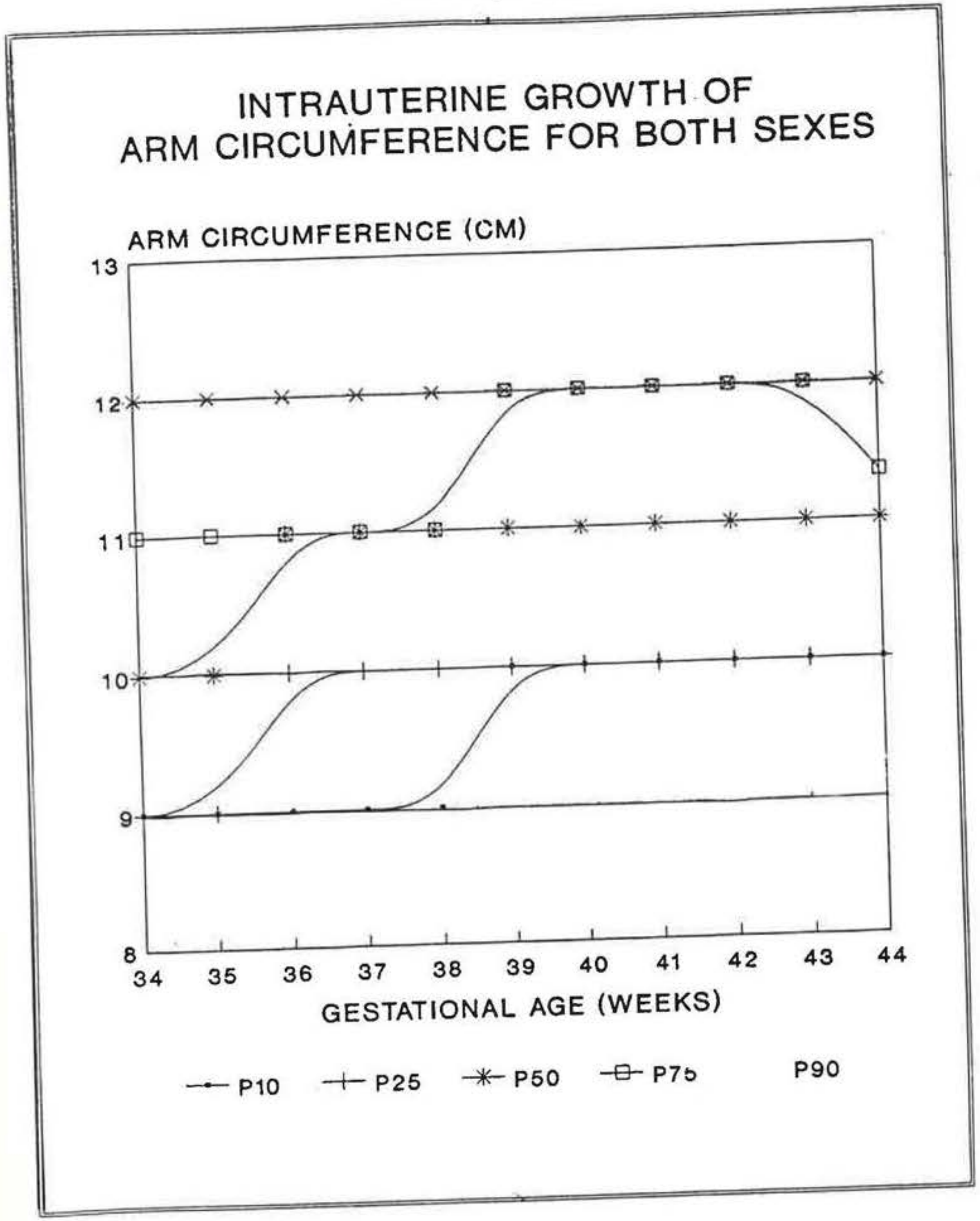

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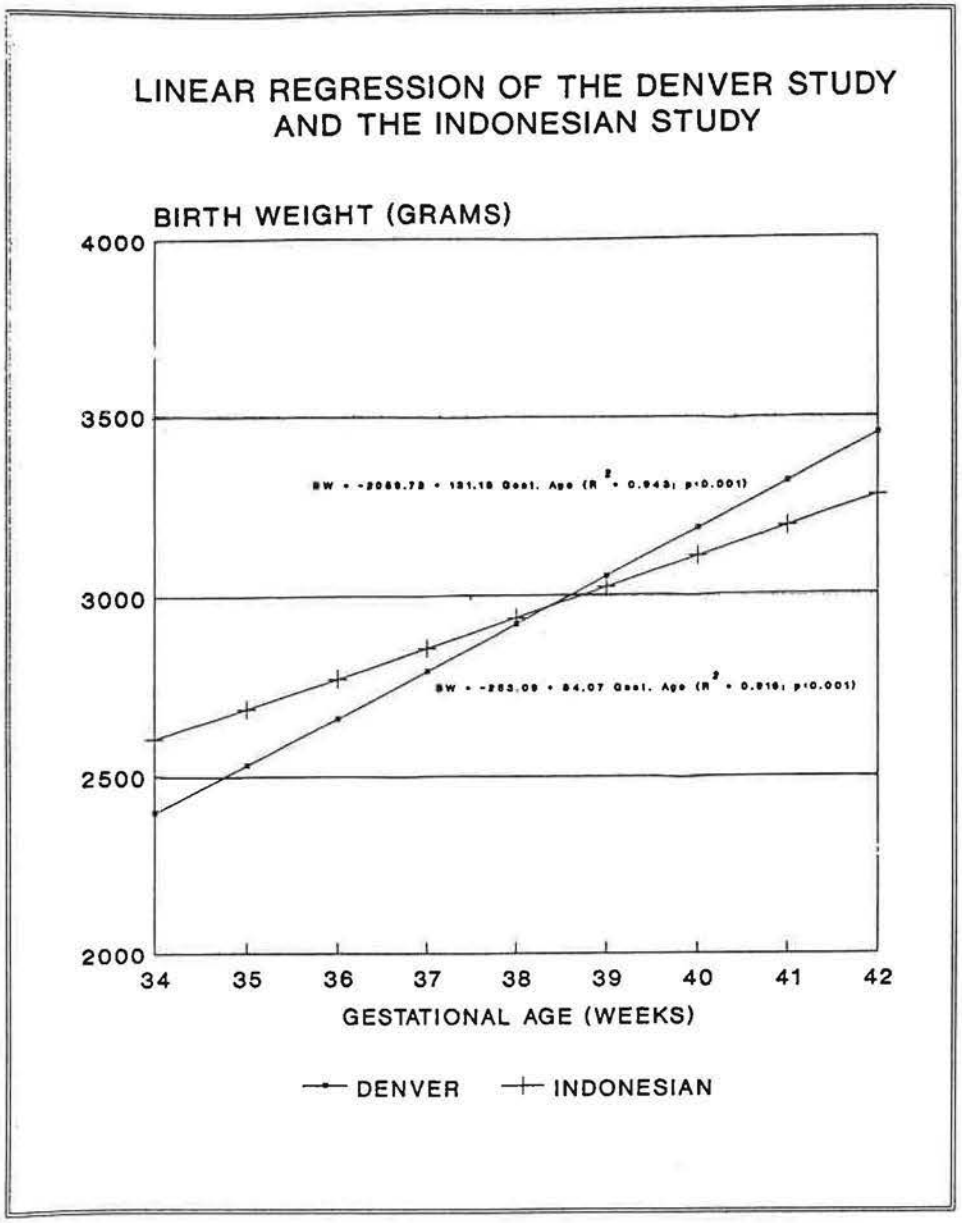

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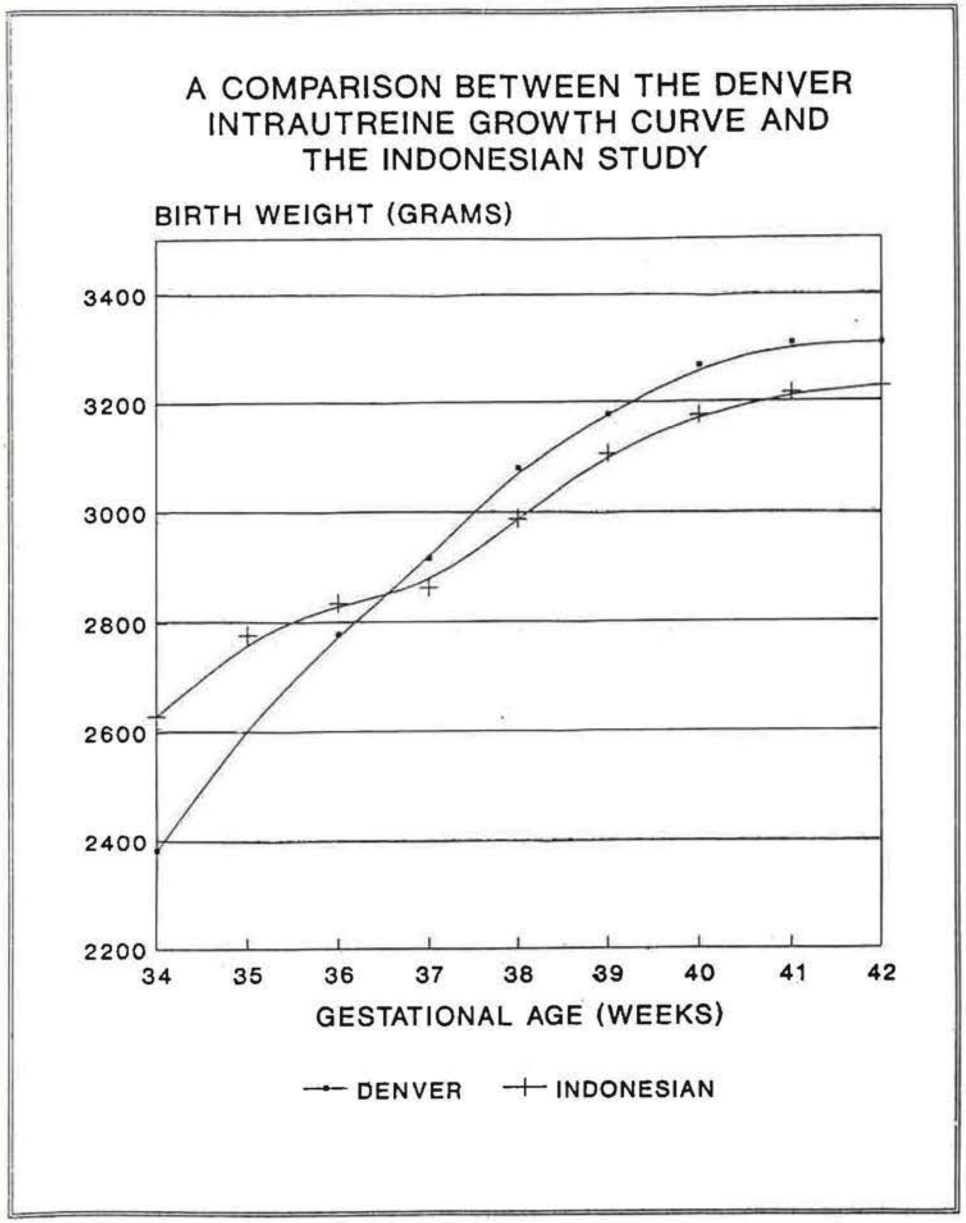

Figure 17