

To Study the Anthropometric Measurements of the Neonates between 28 to 42 Weeks of Gestational Age at the Tertiary Health Care Center, Bhavnagar, Gujarat

Shreya A Patel^{1*}, Jayendra R Gohil¹, Vibhuti D Gamit¹ and Mamta K Suthar¹

¹Department of Pediatrics, Government Medical College and Hospital, Bhavnagar, Gujarat, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author JRG designed the study. Author SAP performed the measurements and statistical analysis, wrote the protocol and both authors wrote the first draft of the manuscript. Author SAP managed the analyses of the study. Authors VDG and MKS managed the literature searches. Authors SAP, VDG and MKS collected data. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJPR/2020/v3i230122

Editor(s):

(1) Dr. Emiliana Cristina Melo, Professor, Universidade Estadual do Norte do Paraná, Campus Luiz Meneghel, Bandeirantes, Brazil.

Reviewers:

(1) Dra Patrícia Haas, Centro de Ciências da Saúde, Brasil.

(2) Meer Ahmad Mydin Meera, Malaysia.

(3) Giuseppe Gregori, Italy.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/54078>

Original Research Article

Received 20 November 2019

Accepted 23 January 2020

Published 30 January 2020

ABSTRACT

Aims: To study the anthropometric measurements of the neonates between 28 to 42 weeks of gestational age. To express them as smoothed percentiles and obtain their correlation with the constant. Comparing the data trend with the Shah Study conducted twelve years ago in the same institute.

Study Design: Cross-sectional observational study of 500 (selected out of 1223 by convenience sampling) live new-borns, 28 to 42 weeks gestational age (confirmed by Ballard score) was conducted in NICU and post-natal ward, Sir-T hospital, Bhavnagar. Infantometer and non-stretchable measuring tape were used for measurements.

Results: Demographic data- female, male: [247 (49.4%), 253 (50.6%)]. The newborns weighing < 2.499 kg were n= 193(38.6%), 2.500- 3.00 kg n=247(49.4%) and > 3.00 kg n= 60(12%). 244

*Corresponding author: Email: patelahreya010392@gmail.com;

newborns were <37 weeks old (48.8%) and 256 were 37- 42 weeks old (51.2%), with 37 weeks old contributing n=167(33.4%). The *male* newborn had *higher* anthropometric variable than female: Weight, Crown Heel Length, Head Circumference, Chest Circumference, Ponderal Index, Thigh Circumference, Mid Arm Circumference, Foot Length were 2.500, 46.73, 31.65, 29.69, 2.38, 12.06, 8.4, 6.79 of female and 2.595, 47.43, 32.08, 29.95, 2.39, 12.19, 8.2, 7.13 of male respectively, except in MAC.

By comparing the mean of the parameters of 34 to 38 week newborns, the mean of TC and MAC of the present study was found to be increased than in Shah Study. Similarly, the mean of weight in 34, 36, 37 and 38, CHL in 36 and 38, the HC in 36, 37 and 38, the CC in 34, 35, 36 and 37, the FL in 35 and 37, and the Ponderal Index in 34, 35 and 38 week newborns, of present study was increased, as compared to Shah Study. By Pearson's correlation, the maximum association was found with TC (r 0.934), followed by PI (0.868) and HC (0.844) in the present study and with TC (0.966) in Shah Study. The intrauterine growth curves were constructed by plotting percentile values of each anthropometric parameter against gestational age in weeks.

Conclusion: The nutrition has improved in the near term and full-term neonates. The percentile charts constructed in accordance with current data trends thus can be utilised regionally.

Keywords: Antropometry; ponderal Index; gestational age; pearson's correlation.

ABBREVIATIONS

CHL	: Crown Heel Length;
HC	: Head Circumference;
CC	: Chest Circumference;
MAC	: Mid Arm Circumference;
TC	: Thigh Circumference;
PI	: Ponderal Index;
FL	: Foot Length;
LBW	: Low Birth Weight;
OFC	: Occipito-Frontal Circumference;

1. INTRODUCTION

Establishment of various physical parameters of a newborn helps in predicting the prognosis and managing the subnormal as well as normal newborns.

It is very important to know the status of the intrauterine growth because it affects further growth, complications that may occur in the neonatal period and their management [1]. Intrauterine growth curves were first constructed by Lubchenco et al. [2].

Birth weights of the newborns and patterns of intrauterine growth show considerable differences from population to population. Therefore, this study was conducted to construct intrauterine growth curves (anthropometric curve of the newborn) based on local data of Bhavnagar, Gujarat. And in addition, various physical parameter measurements of the present study were compared with the previous study conducted twelve years back, from the same institute to evaluate changes in the data trends.

The correlation of the various anthropometric parameters was made in comparison to weight as a constant. Hence the best predictor of the low birth weight can be made [3-5].

2. METHODOLOGY

2.1 Study Design

A cross-sectional observational study of 500 live newborns out of all 1223 newborns born and/ or admitted from January 2018 to April 2018 was conducted in NICU and postnatal ward, at the Department of Pediatrics, at Sir T G (teaching) Hospital, Bhavnagar. The newborns were selected by convenience sampling method. (Flow Chart Fig.1).

Inclusion criteria

All babies born between 28 – 42 weeks.

Exclusion criteria

Babies with major congenital malformations e.g. holoprocencephaly.

Severely ill babies e.g. babies on non- invasive/ invasive mode of ventilation, oxygen support, sepsis.

Stillborn babies' guardians did not give consent.

Measurements

Infantometer and non-stretchable measuring tape were used for anthropometric measurements. The gestational age was confirmed by applying new Ballard scoring. All the recordings

were made between 24 to 48 hours of birth as it is recommended that the head circumference measured before 24 hours of birth have some amount of moldings.

Measurements of anthropometric data were made as follows.

Birth Weight: It was recorded on an electronic weighing machine in a warm room with the baby in a naked state. The machine was sensitive up to 5000 gram of weight.

Head Circumference (HC): was measured with the help of measuring tape touching the external occipital protuberance and glabella, above the ears.

Chest Circumference (CC): was measured at the level of nipple with the help of measure tape.

Mid Arm Circumference (MAC): was measured at a point midway down the left arm between the tip of acromion and olecranon processes with the help of measure tape.

Crown Heel Length (CHL): was measured on the infantometer with the baby supine with both legs straightened and both feet including the heel resting against the footboard.

Maximum Thigh Circumference (TC): In the supine position, the maximum thigh circumference was measured at the level of the lowest furrow in the gluteal region, measure tape being placed perpendicular to the long axis of the lower limb.

Foot Length (FL): was measured by joining points made from the tip of the great toe to the heel after placing the foot against the vertical board with the help of plastic scale.

Ponderal Index (PI): Weight in grams /Length in cms³ x 100.

Gestational Age: The gestational age was calculated by clinical assessment using the New Ballard Score.

2.2 Statistical Analysis

Microsoft excel was used to plot smoothed percentile charts. SPSS was used for expressing anthropometric measurements in mean and SD, according to their gender. The unpaired t-test was applied to obtain their significant value. Linear regression equation applied for correlation of each parameter (HC, CC, MAC, CHL, TC and ponderal index) with weight, for gaining maximum association.

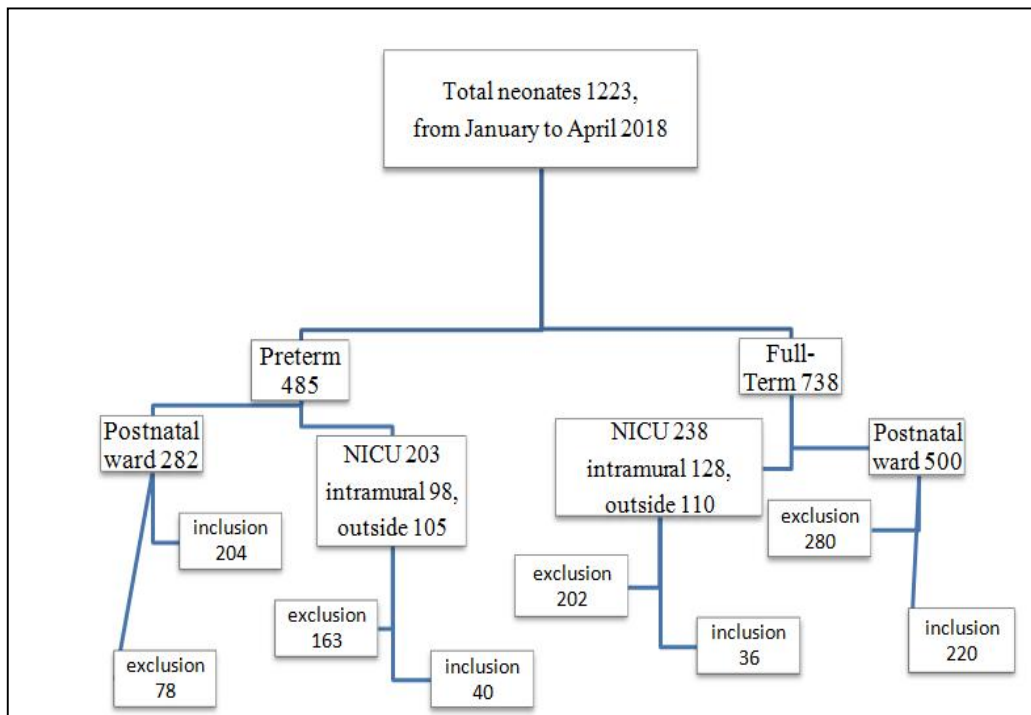


Fig. 1. Flowchart: Study design

3. RESULTS AND DISCUSSION

In the present study of 500 newborns, there were 247 female (49.4%) and 253 male (50.6%).

193 were weighing less than 2.499 kg (38.6%), 247 were between 2.500 – 3.00 kg (49.4%) and 60 were weighing >3.00 kg (12%). This is the first study to document the anthropometry of neonates from Bhavnagar, Gujarat.

Among these there were 244 newborns were of <37 week (48.8%) and 256 newborns were between 37 – 42 week of gestational age (51.2%). The near full-term neonates (37 week) were contributing maximum distribution 167 out of 500 (33.4%) and preterm neonates (28 and 29 week) contributing minimum distribution 1 and 2 (0.2% and 0.4%) (Table 1).

Table 1. Demographic distribution according to gestational age

Gestational Age (weeks)	Present Study n, (%)	Study 1 [7] n, (%)
28	1, (0.2)	14, (1.6)
29	2, (0.4)	14, (1.6)
30	5, (1.0)	19, (2.2)
31	2, (0.4)	26, (3.1)
32	6, (1.2)	22, (2.5)
33	7, (1.4)	28, (3.2)
34	24, (4.8)	16, (1.8)
35	72, (14.4)	17, (2.0)
36	125, (25.0)	30, (3.5)
37	167, (33.4)	82, (9.6)
38	76, (15.2)	121, (14.2)
39	12, (2.4)	145, (17.1)
40	1, (0.2)	244, (28.7)

The demographic distribution of newborns of present and Shah Study [6], according to gestational age and number were plotted. There were a maximum of 167 newborns of 37 weeks gestational age in present study. In Shah Study, there were maximum 244 newborns of 40 weeks of gestational age (Fig. 4).

The mean of every anthropometric measurements : CHL, HC, CC, PI, TC, MAC, FL among female and male were 2.500, 46.73, 31.65, 29.69, 2.38, 12.06, 8.4, 6.79 and 2.595, 47.43, 32.08, 29.95, 2.39, 12.19, 8.2, 7.13 respectively according to gender. Each mean had gender difference, in which male newborn

has higher mean as compared to female except that of, mid arm circumference which is more in female (Table 2). In the study by Sajjadian N of total 500 newborns correlating anthropometry parameters with gender, there were significant differences in birth weight and anthropometric measurements between male and female newborns ($p < 0.05$), the males had higher birth weight and all anthropometric variable except mid arm to head circumference ratio as there is more subcutaneous fat in female as compared to male [7].

By comparing the mean of the parameters of 34 to 38 week newborn, the mean of TC and MAC of the present study was increased than in Shah Study. Similarly, the mean of weight in 34, 36, 37 and 38, CHL in 36 and 38, the HC in 36, 37 and 38, the CC in 34, 35, 36 and 37, the FL in 35 and 37, and the Ponderal Index in 34, 35 and 38 week newborns, of present study was increased as compared to Shah Study (Table 3).

The association between the present study and Shah Study was made; in 34- 38 week gestational age with significant p values (Table 4).

This suggests an improvement in nutrition of near term and full-term neonates over a period of twelve years from 2006 to 2018.

By Pearson's correlation, the maximum association was found with TC (r 0.934), followed by PI (0.868) and HC (0.844) in chronological order in the present study and with TC (0.966) in Shah Study (Table 5). In study by P. Sampathkumar, foot length was the best surrogate to weight, to evaluate high risk (LBW) newborn, as compared to another physical anthropometric parameter [7,8].

In a study by Gohil, of foot length measurement in neonates from Ahmedabad, the correlation of foot length was made between length and occipital-frontal circumference [9]. The percent variation in CHL, occipito-frontal circumference (OFC) and FL measurements for preterm babies was 1.8, 1.5, and 1.2 respectively by the same observer and had inter-observer variation of 1.9, 1.55 and 1.23. The variations for TSGA (term small for gestational age) were: intra-observer-2.0, 1.8, 1.4 and inter-observer -2.2, 1.84, 1.46; and for TAGA (term appropriate for gestational age) babies intra-observer -2.7, 2.48, 1.56 and inter-observer -2.8, 2.52, 1.6 for CHL, OFC and FL in that order [9].

Table 2. Mean difference among gender

Gender (n)	Mean weight (kg)/ SD	Mean CHL (cm)/ SD	Mean HC (cm)/ SD	Mean CC (cm)/ SD	Mean PI/ SD	Mean TC (cm)/ SD	Mean MAC (cm)/ SD	Mean FL (cm)/ SD
Female (247)	2.500*/ 0.464	46.73/ 3.457	31.65/ 1.967	29.69/ 2.022	2.38/ 0.266	12.06/ 0.877	8.4/ 5.276	6.79/ 1.932
Male (253)	2.595*/ 0.489	47.43/ 2.355	32.08/ 1.991	29.95/ 1.786	2.39/ 0.260	12.19/ 0.877	8.2/0.997	7.13/ 1.952

*p= 0.017CHL- Crown Heel Length, HC- Head Circumference, CC- Chest Circumference, FL- Foot Length, PI- Ponderal Index, TC- Thigh Circumference, MAC- Mid Arm Circumference

Table 3. Mean, SD value of present study and Shah Study [7]

Gestational Age (weeks)	34		35		36		37		38	
	Present study	Shah study	Present study	Shah study	Present study	Shah study	Present study	Shah study	Present study	Shah study
Weight (kg)	2.12, 0.10	1.93, 0.33	2.05, 0.29	2.06, 0.29	2.23, 0.30	2.10, 0.25	2.84, 0.21	2.69, 0.31	2.99, 0.25	2.82, 0.27
CHL (cm)	45.47, 1.52	45.55, 0.55	47.04, 1.16	47.30, 1.42	47.60, 3.86	47.32, 0.94	48.47, 1.50	48.73, 0.70	49.85, 1.07	49.69, 0.69
HC (cm)	30.48, 1.80	30.83, 0.74	31.03, 1.42	31.05, 0.88	31.96, 1.72	31.91, 0.96	33.94, 1.11	33.40, 0.70	33.61, 1.11	33.56, 0.96
CC (cm)	28.73, 1.97	27.35, 0.85	28.76, 1.41	28.46, 0.98	28.99, 1.76	28.33, 1.06	30.68, 1.47	30.22, 0.85	31.90, 1.09	31.97, 1.81
FL (cm)	6.75, 0.56	6.94, 0.13	6.52, 0.19	6.25, 0.28	7.43, 0.61	7.55, 0.20	7.54, 0.89	7.53, 0.16	7.39, 0.42	7.51, 0.15
PI	1.21, 0.71	1.04, 0.29	1.95, 0.23	1.94, 0.24	1.93, 0.24	1.98, 0.19	2.45, 0.20	2.88, 0.22	2.49, 0.19	2.09, 0.16
TC (cm)	11.32, 0.32	11.10, 0.31	12.56, 0.58	12.27, 0.31	12.28, 0.63	12.26, 0.29	12.60, 0.52	12.52, 0.47	12.88, 0.45	12.86, 0.44
MAC (cm)	7.53, 0.53	7.40, 0.42	8.65, 0.68	8.09, 0.58	8.63, 0.66	8.26, 0.37	8.88, 0.63	8.83, 0.67	8.89, 0.80	8.78, 0.68

CHL- Crown Heel Length, HC- Head Circumference, CC- Chest Circumference, FL- Foot Length, PI- Ponderal Index, TC- Thigh Circumference, MAC- Mid Arm Circumference. Bold indicates higher value in present study. Italics indicate higher value in Shah Study

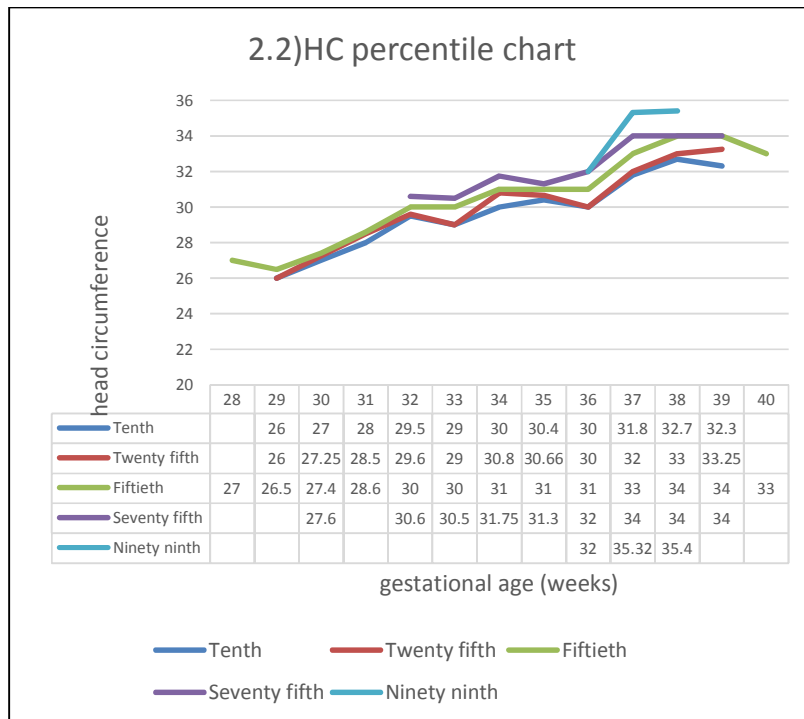
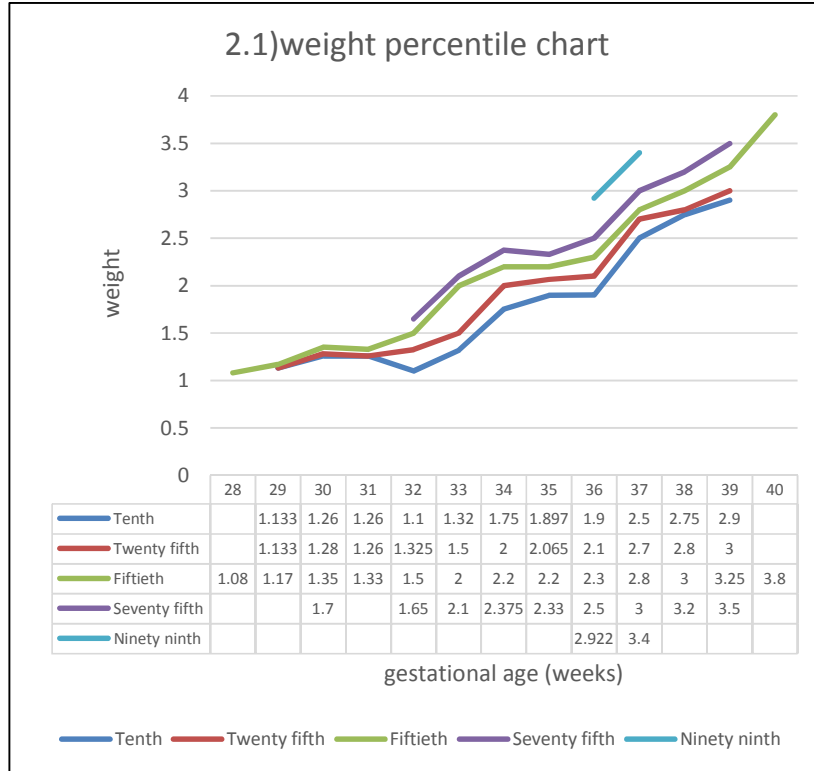
Table 4. Association of anthropometry between present study and Shah Study [7]

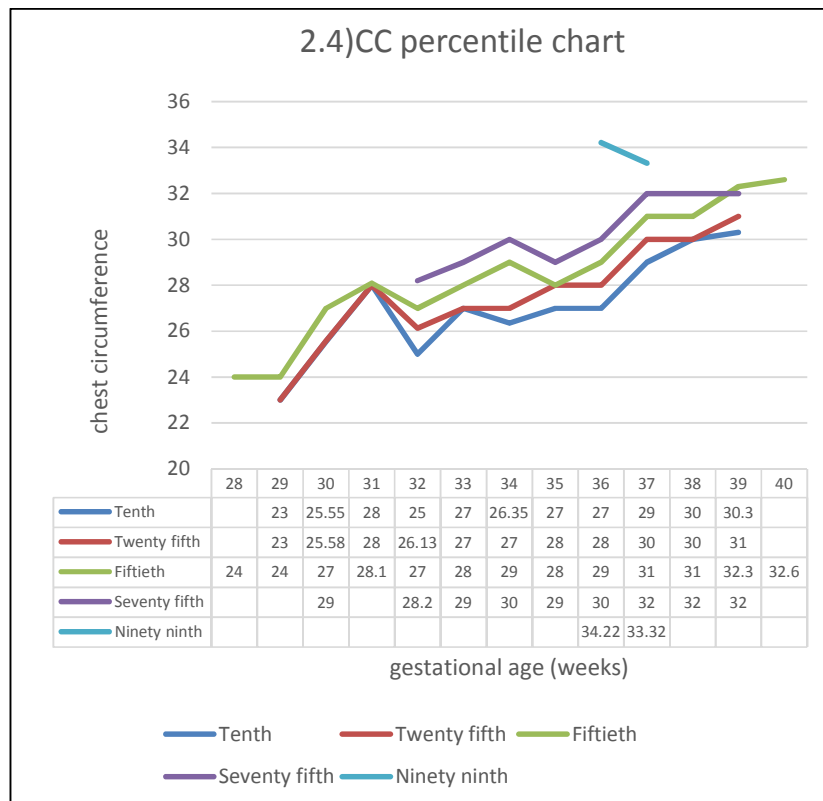
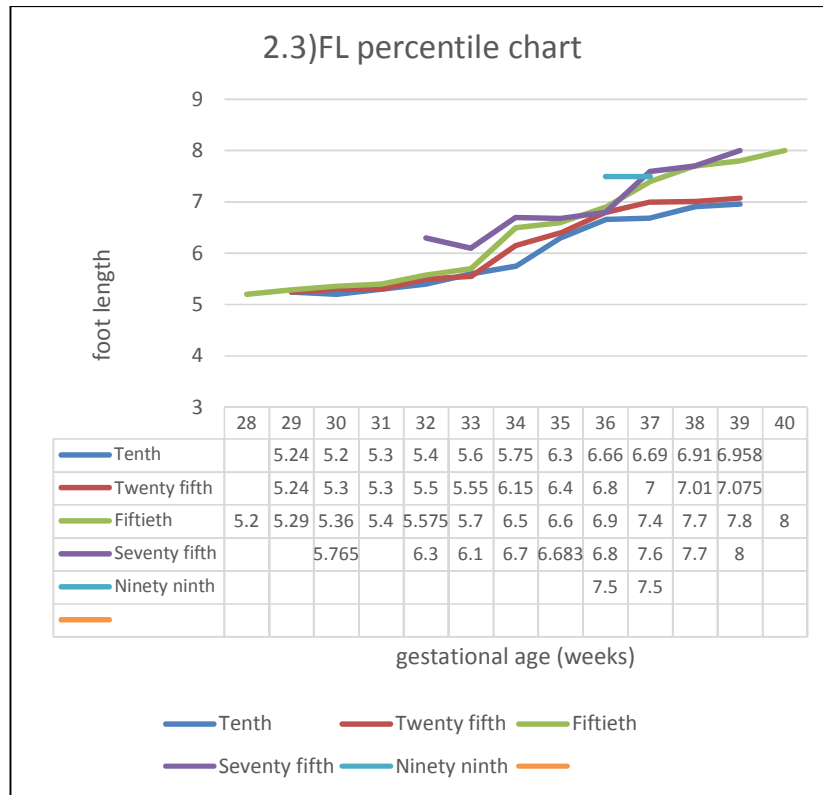
Gestational Age (weeks)	34			35			36			37			38		
	p-value	df	95% CI	p-value	df	95% CI	p-value	df	95% CI	p-value	df	95% CI	p-value	df	95% CI
Weight (kg)	0.12	36.10	0.437- 0.054	0.27	22.61	2.57- 0.07	0.03*	51.57	1.29- 0.05	0.002*	121.24	0.72- 0.58	0.00*	170.18	0.64-0.49
CHL (cm)	0.86	31.18	0.739- 0.880	0.05	20.05	1.21- 2.754	0.017*	152.90	1.17- 0.71	0.139	247.27	0.08- 0.61	0.00*	114.07	0.80- 0.30
HC (cm)	0.17	32.99	1.162- 0.311	0.02*	33.30	0.26- 1.42	0.88	79.30	0.05- 0.23	0.002*	223.90	1.80- 1.26	0.00*	142.09	1.34- 0.75
CC (cm)	0.012*	33.75	2.451- 0.322	0.47	29.75	0.89- 0.34	0.05	72.92	0.66- 0.25	0.00*	241.99	2.20- 1.51	0.00*	195.77	1.70- 0.79
FL (cm)	0.028*	25.28	1.237- 0.500	0.002*	57.15	0.60- 0.16	0.001*	145.11	0.37- 0.06	0.026*	166.46	2.91- 0.18	0.00*	78.35	1.51- 1.23
PI	0.11	34.36	0.489- 0.080	0.00*	21.09	0.54- 0.25	0.00*	54.91	0.34- 0.04	0.00*	152.26	0.62- 0.58	0.00*	138.35	0.14- 0.11
TC (cm)	0.05	36.97	0.039- 0.667	0.00*	41.20	0.51- 0.93	0.001*	98.04	0.68- 0.07	0.207	176.59	0.22- 0.14	0.00*	158.45	0.14- 0.11
MAC (cm)	0.21	36.63	0.544- 1.192	0.002*	44.87	1.16- 1.99	0.03*	72.85	1.82- 0.08	0.189	166.11	13.88- 8.14	0.00*	195.97	1.21- 1.55

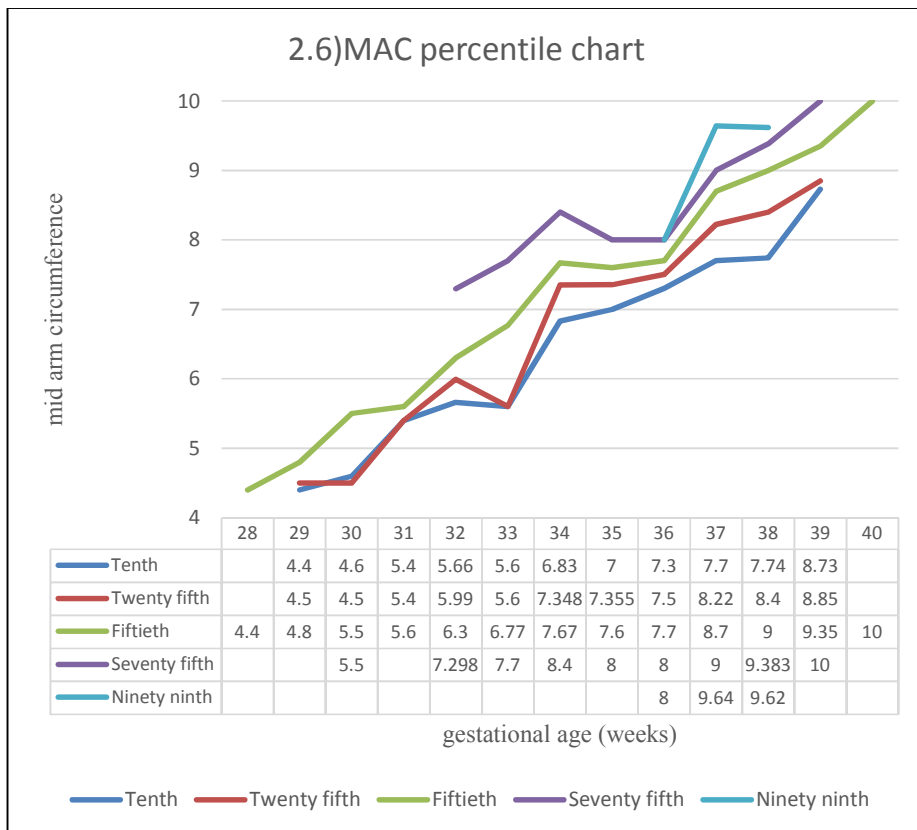
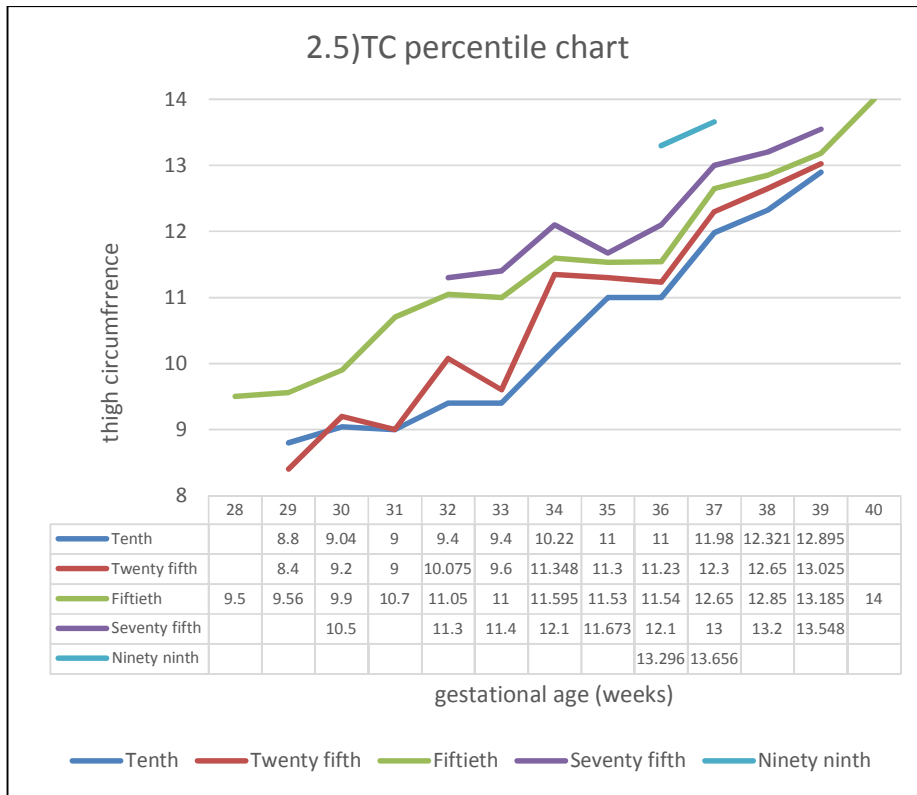
*p significant CHL- Crown Heel Length, HC- Head Circumference, CC- Chest Circumference, FL- Foot Length, PI- Ponderal Index, TC- Thigh Circumference, MAC- Mid Arm Circumference, df- degree of freedom

Another study by Bhat [10], for efficacy of various anthropometric measurements in determining low birth weight babies; had a significant correlation of birth weight with calf circumference

($r = 0.87$), thigh circumference ($r = 0.7$), mid-arm circumference ($r = 0.7$), and chest circumference ($r = 0.40$). Calf circumference accounted for 75.69% of the total variance [10].







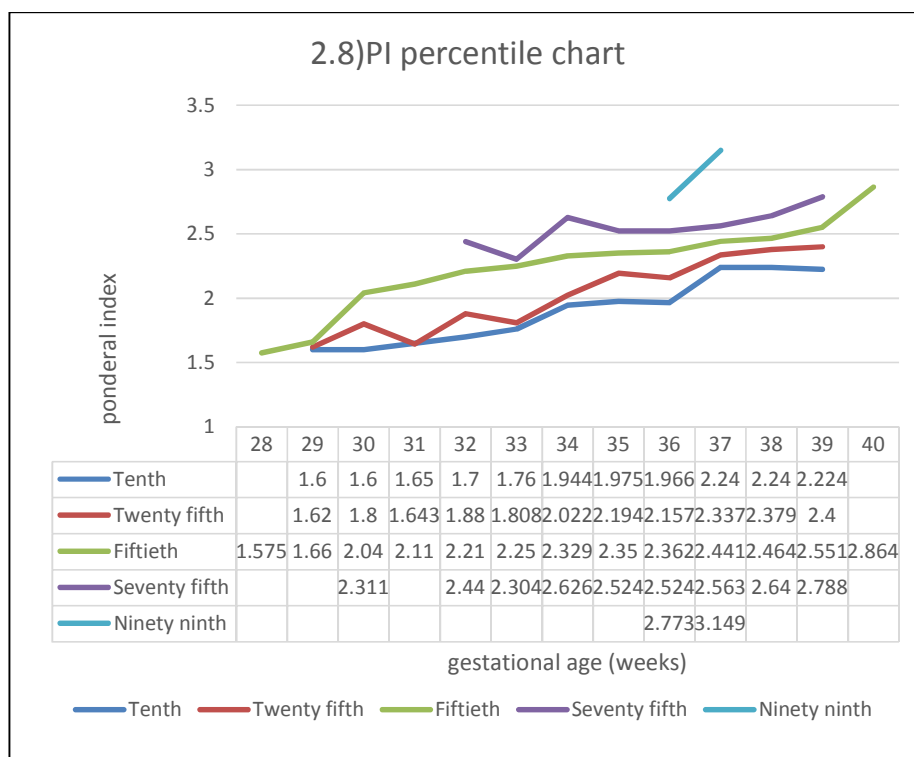
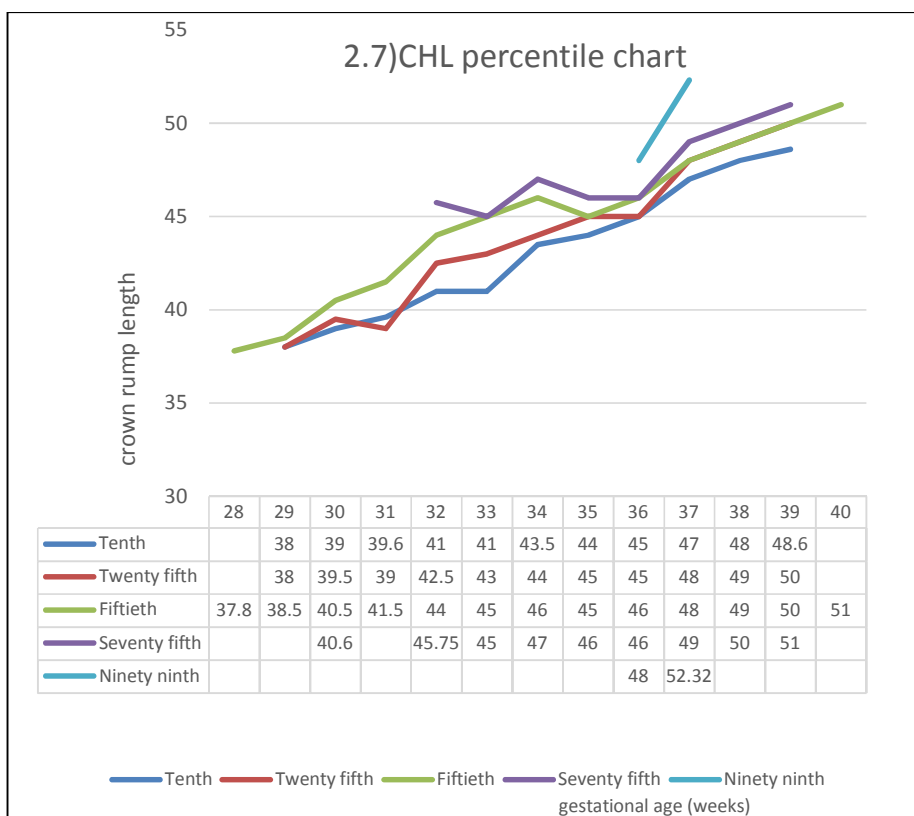
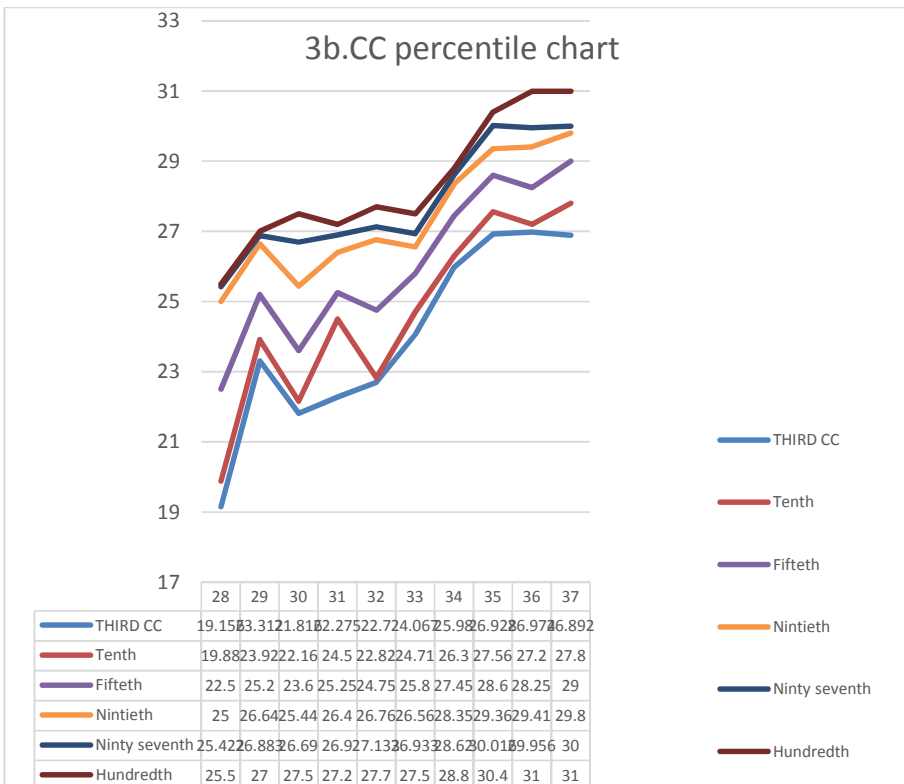
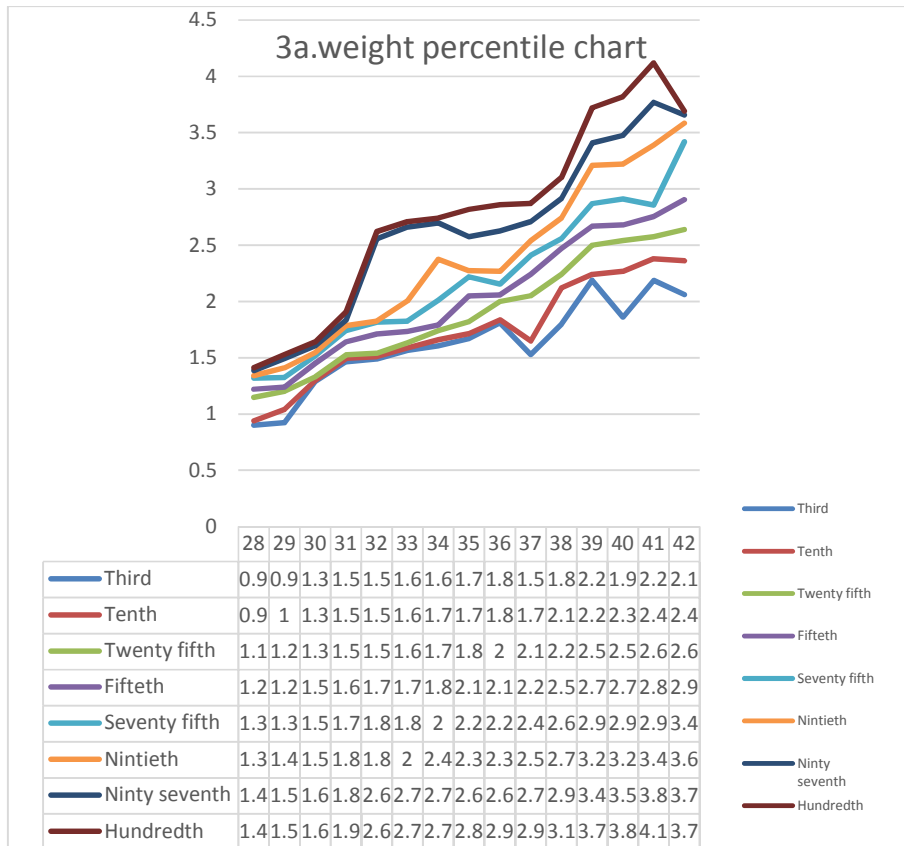
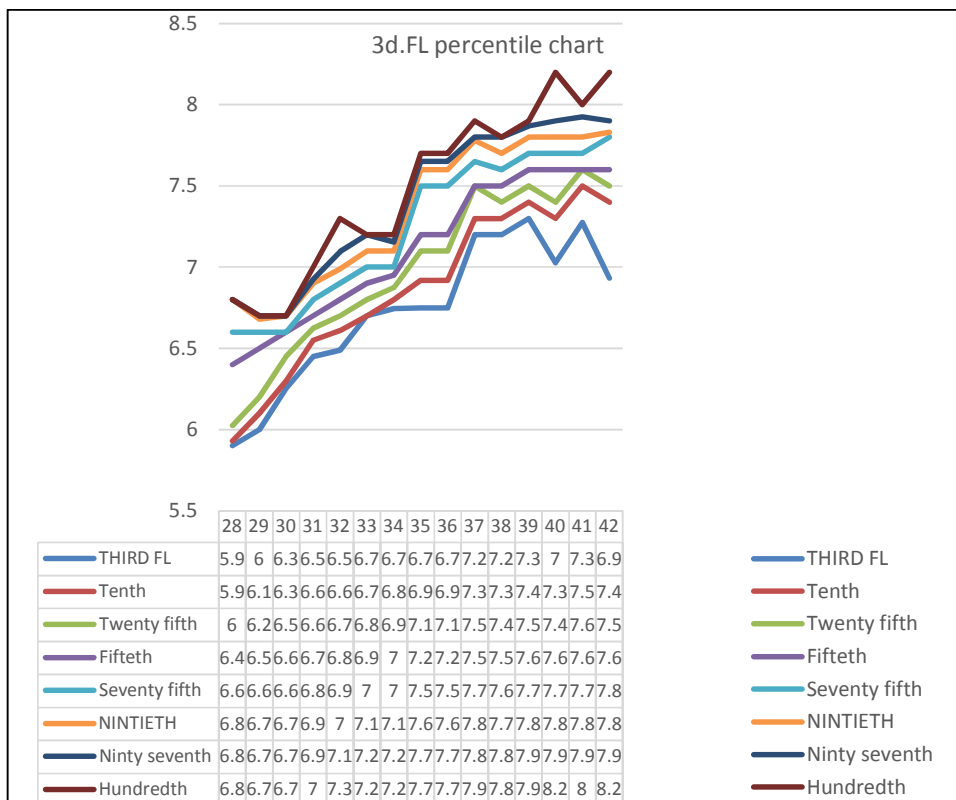
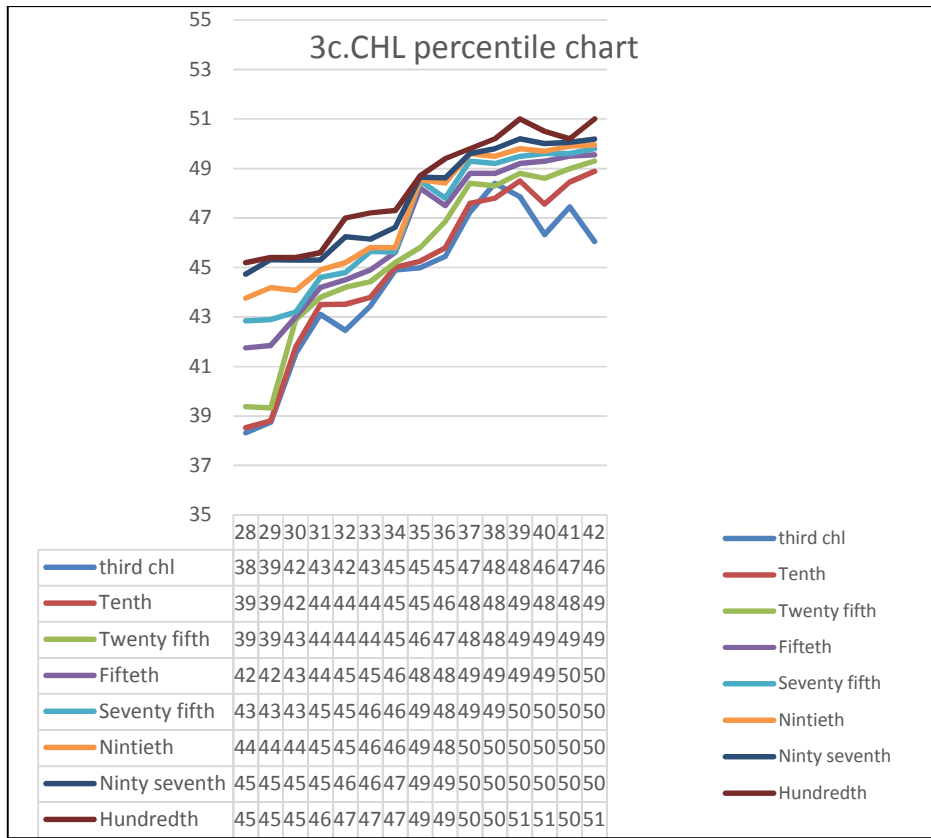
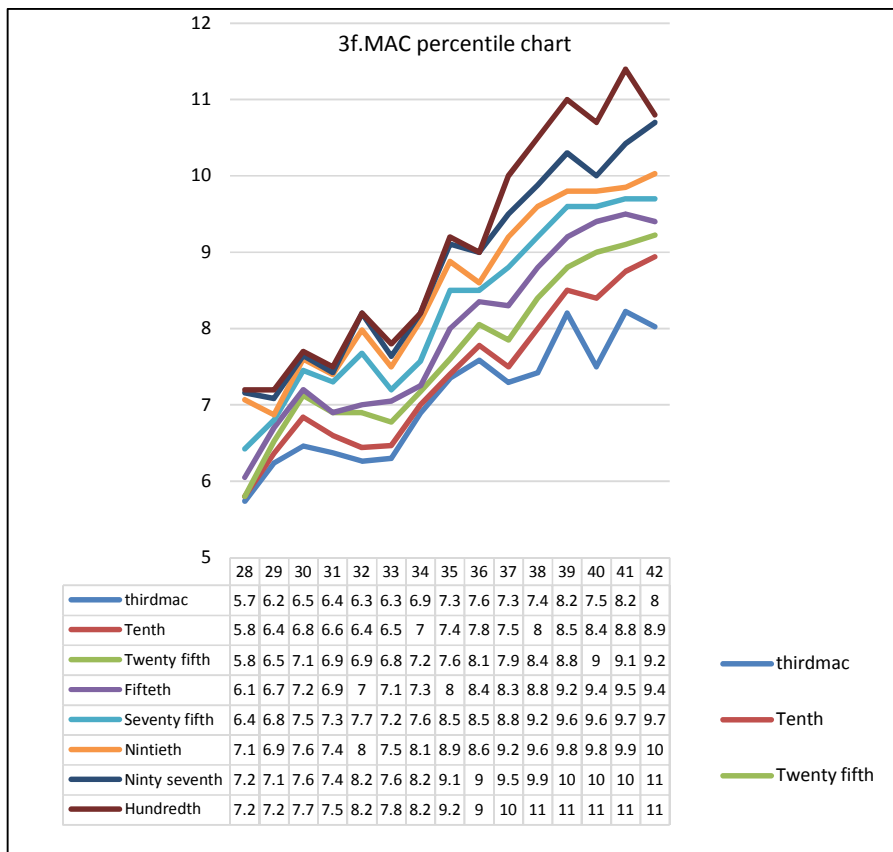
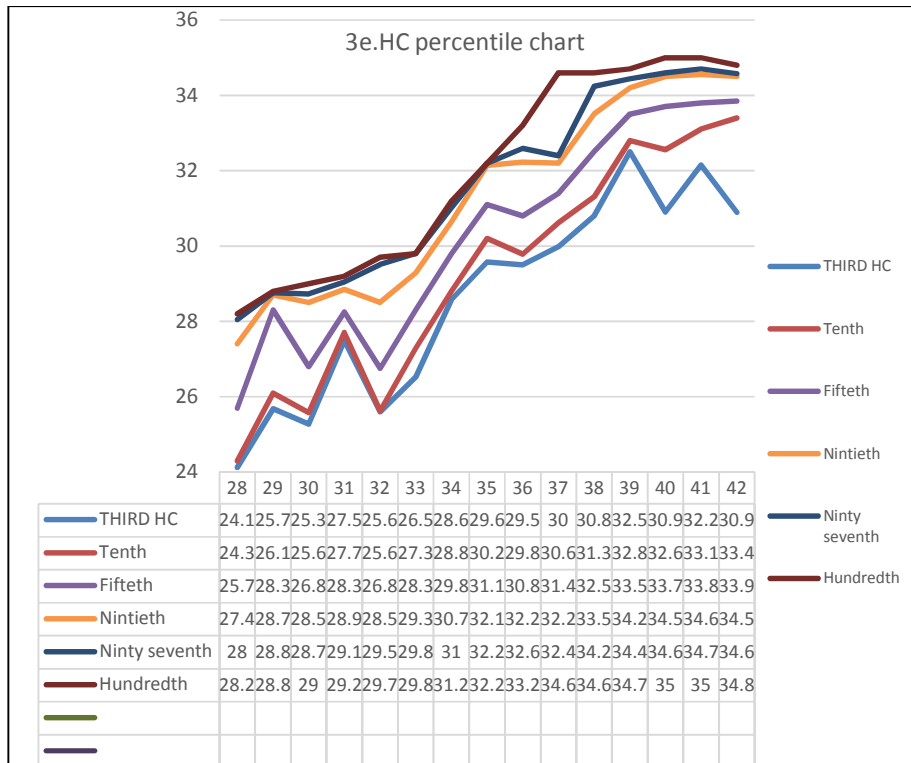


Fig. 2. Percentile charts present study







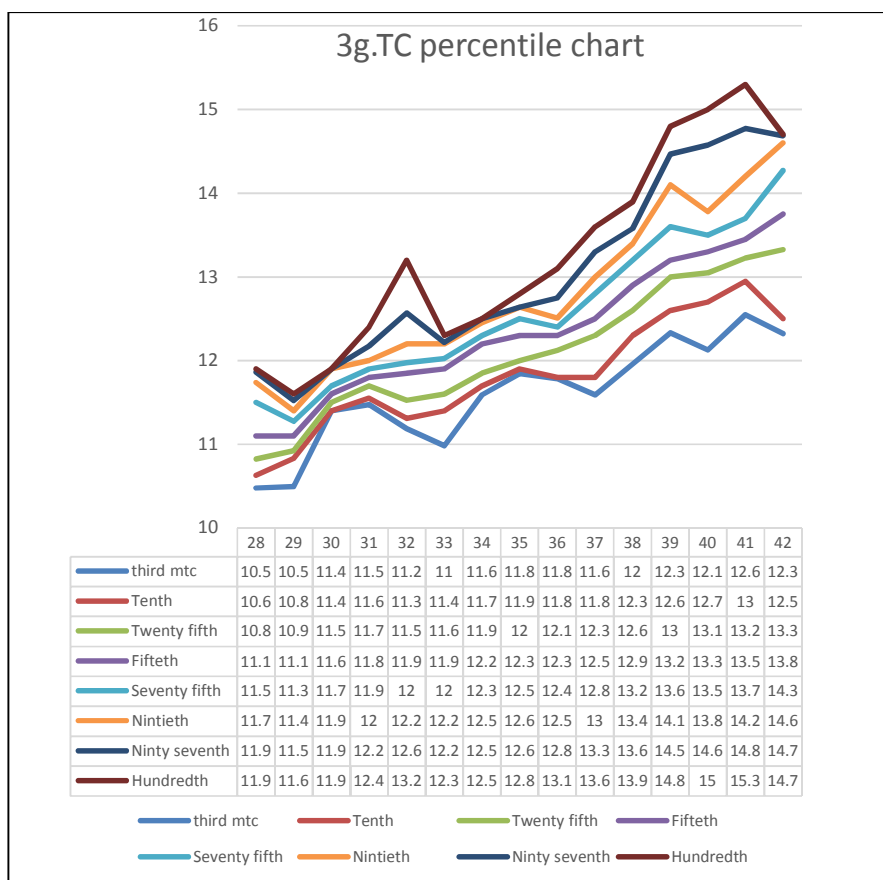


Fig. 3. Percentile charts Shah Study [7]

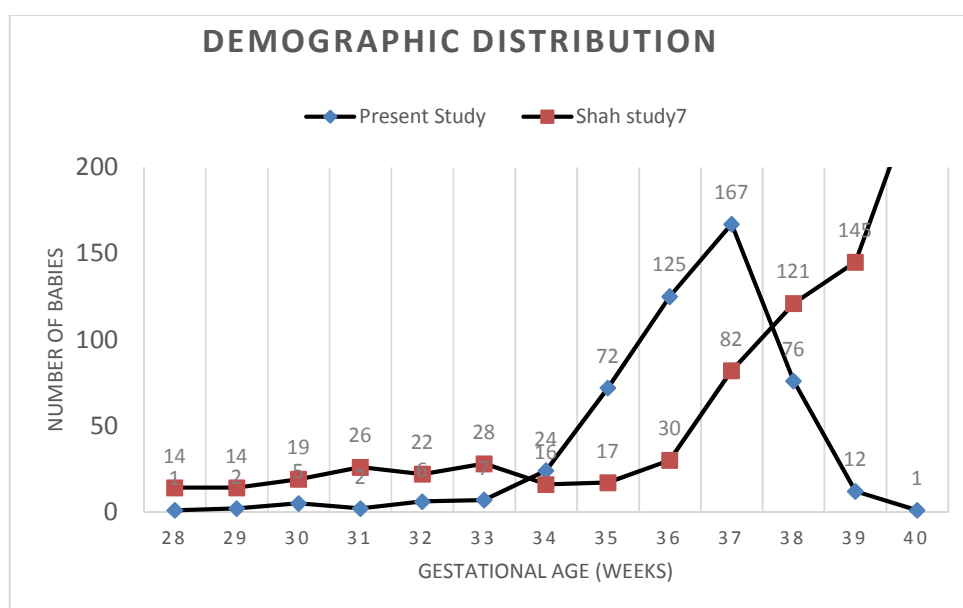


Fig. 4. Distribution of newborns according to gestational age

Table 5. Pearson correlation (r value) with Weight

Measurement	CHL	HC	CC	FL	PI	TC*	MAC
Present study	0.796	0.844	0.588	0.800	0.868	0.934	0.640
Shah Study ⁷	0.845	0.860	0.596	0.813	0.882	0.966	0.714

CHL- Crown Heel Length, HC- Head Circumference, CC- Chest Circumference, FL- Foot Length, PI- Ponderal Index, TC- Thigh Circumference, MAC- Mid Arm Circumference.

*In both this study, the maximum association with weight is that of thigh circumference (TC) (r is near to 1), followed by ponderal index (PI), head circumference (HC) and foot length (FL).

4. TABLES OF SMOOTHED PERCENTILE VALUES AND PERCENTILE CHARTS

Smoothed percentiles (10th, 25th, 50th, 75th and 99th) were obtained of each anthropometric value along with gestational age of present study and are mentioned as chart number. 2.1- 2.8 (Fig. 2) The percentile charts of previous study are mentioned as 3a- 3g (Fig. 3).

Both of them observed were different. These percentile values, plotted against gestational age in weeks gave the intrauterine growth curves for each anthropometric parameter. Thus percentile charts of particular regions similar to Lubchenco [2] and Oslen [11] could be created.

5. FACTORS AFFECTING BIRTH WEIGHT

- Genetics** - The mother's weight impacts the weight of the baby at birth - and the father's weight have an impact too. Some babies are small because it runs in the family.
- Age of the Parent** - Evidence shows that women aged 35+ have larger babies, and teenage pregnancies are more likely to result in babies that are underweight.
- Twins** - Babies who are twins are born relatively smaller than those without because the twins share a uterus.
- Diet During Pregnancy** - If the mother under-eats, the required nutrients won't be passed to the child and they are more likely to be born underweight.
- Early Births** - If the baby is born early, they will not have developed fully in the womb. Babies put on their weight during the latter stages of pregnancy, so this stage is missed.
- Gender** - Slight differences between boys and girls can be observed. Generally, boys are slightly heavier.

- Parent's Birth Weight** - The parents' birth weights also play a part in the baby's weight - the mother's weight has more of an influence than the father's.
- Smoking and Drinking** - If the mother has smoking and drinking habits, the baby's birth weight can be reduced.
- Mother's Medical Issues** - Any medical issue during pregnancy can affect the weight of the infant. Conditions like anaemia and diabetes also puts the baby at risk of being born underweight.
- Remaining Inherited Medical Conditions** - A baby can also inherit hereditary diseases within the womb which can cause a low birth weight.

6. CONCLUSION AND RECOMMENDATIONS

This is the first study to publish the anthropometry of neonates from Bhavnagar, Gujarat.

There is an improvement in nutrition of near term and full-term neonates in sir T hospital, Bhavnagar Gujarat over a period of twelve years from 2006 to 2018.

Assessment and charting of anthropometry of each local region including newborns delivered in private hospitals should be carried out. Anthropometry of the neonate varies between different genders, regions and gestational age.

CONSENT

It is not applicable.

ETHICAL APPROVAL

After receiving Ethical approval from the Inst Review Board the study was registered at clinicaltrials.gov.in [CTRI/2018/02/011834].

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Leitner Y, Fattal-Valevski A, Geva R, et al. Six-year follow-up of children with intrauterine growth retardation: long-term, prospective study. *J Child Neurol.* 2000; 15(12):781-786.
2. Lubchenco LO, Hansman C, Dressler M, Boyd E. Intrauterine growth as estimated from liveborn birth-weight data at 24 to 42 weeks of gestation. *Pediatrics.* 1963; 32(5):793-800.
3. Ramji S, Marwah J, Satyanarayana L, et al. Neonatal thigh circumference as an alternative indicator of low birth weight. *Indian J Med Res.* 1986;83:653-4.
4. Gupta V, Hatwal SK, Mathur S, et al. Calf circumference as a predictor of low birth weight babies. *Indian Pediatr* 1996;33: 119-21.
5. Magzoub MM, Ali TE, Ali AB. A low-cost tool for traditional birth attendants to identify low-birth-weight infants. *Food and Nutrition Bulletin.* 1994;15(3):1-5.
6. Shah AR, Jhala DR. A clinical study of neonatal anthropometry. *Dissertation MD Pediatrics.* Maharaja Krishnakumarsihji Bhavnagar University; Bhavnagar, Gujarat, India; 2006.
7. Sajjadian N, Shajari H, Rahimi F, Jahadi R, Barakat MG. Anthropometric measurements at birth as predictor of low birth weight. *Health.* 2011;3(12):752.
8. Sampathkumar P, Devi SA. A study on new-born foot length measurement to identify high risk neonate. *Int J Contemp Pediatr.* 2018;5:1078-82.
9. Gohil JR, Sosi M, Vani SN, Desai AB. Footlength measurement in the neonate. *Indian J Pediatr.* 1991;58(5):675-7. DOI:10.1007/BF02820189
10. Bhat IA, Dhar GM, Shah GN, Shehzada A. Efficiency of various anthropometric measurements in determining low birth weight babies. *Indian Journal of Maternal and Child Health,* 1995;6(2):40-2.
11. Oslen I, Groveman S, Lawson M, Clark R, Zemel B. New Intrauterine Growth Curves on United States Data. *Pediatrics.* 2010;125(2):e214-e224.

© 2020 Patel et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/54078>