

## **Original Research Article**

To study the anthropometric measurements of the neonates between 28 to 42 weeks of gestational age at tertiary health care center, Bhavnagar, Gujarat.

### **Abstract:**

#### Objectives

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 and methodology

Cross sectional observational study of 500 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 was 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

newborns were <37 weeker (48.8%) and 256 were 37- 42 weeker (51.2%), with 37 weekers 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 weeker newborn, the mean of TC and MAC of 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 weeker 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 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 been improved in near term and full-term neonates. The percentile charts constructed in accordance to current data trends, thus can be utilised regionally.

## INTRODUCTION

Establishment of various physical parameters of 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 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 based on local data of Bhavnagar, Gujarat. And in addition, various physical parameter measurements of present study were compared with the previous study conducted twelve years back, from same institute to evaluate changes in the data trends.

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

## METHODOLOGY

### *Study design:*

A cross sectional observational study consisting of 500 live newborns was conducted in NICU and post – natal ward, at the department of Pediatrics, in a tertiary care hospital, Sir T G Hospital, Bhavnagar, from January 2018 to April 2018. (figure1)

### Inclusion criteria

All babies 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 not gave consent

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 after 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 baby in naked state. The machine was sensitive up to 500 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 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)*:  $\text{Weight in grams} / \text{Length in cms}^3 \times 100$

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

#### *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.

## *Result and Discussion*

In 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 weeker) were contributing maximum distribution 167 out of 500 (33.4%) and preterm neonates (28 and 29 weeker) contributing minimum distribution 1 and 2 (0.2% and 0.4%) (Table 1).

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

By comparing the mean of the parameters of 34 to 38 weeker newborn, the mean of TC and MAC of 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 weeker newborns, of present study was increased as compared to Shah Study (Table 3).

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

This suggests 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 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 parameters [7], [9].

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 [10]. 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 [10].

Another study by Bhat [11], 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 [11].

#### *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. (Figure 2) The percentile charts of previous study are mentioned as 3a to 3g (Figure 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 [8] could be created.

#### *Abbreviations*

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

#### *What is already known?*

Anthropometry of the neonate varies between different genders, regions and gestational age.

#### *What this study adds*

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



*Recommendations*

Assessment and charting of anthropometry of each local region including newborns delivered in private hospitals should be carried out.

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## References

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Table 1: Demographic distribution according to gestational age.

| Gestational Age (weeks) | Present Study n, (%) | Study1 <sup>7</sup> 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) |

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Table 2: Mean difference among gender

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

\*p= 0.017

CHL- 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 Study7

| Gestational Age (weeks) | 34                           |                              | 35                           |                              | 36                           |                             | 37                           |                      | 38                           |                              |
|-------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|-----------------------------|------------------------------|----------------------|------------------------------|------------------------------|
|                         | <i>Present study</i>         | Shah study                   | <i>Present study</i>         | Shah study                   | <i>Present study</i>         | Shah study                  | <i>Present study</i>         | Shah study           | <i>Present study</i>         | Shah study                   |
| Weight (kg)             | <b>2.12,</b><br><b>0.10</b>  | 1.93,<br>0.33                | 2.05,<br>0.29                | <i>2.06,</i><br><i>0.29</i>  | <b>2.23,</b><br><b>0.30</b>  | 2.10,<br>0.25               | <b>2.84,</b><br><b>0.21</b>  | 2.69,<br>0.31        | <b>2.99,</b><br><b>0.25</b>  | 2.82,<br>0.27                |
| CHL (cm)                | 45.47,<br>1.52               | <i>45.55,</i><br><i>0.55</i> | 47.04,<br>1.16               | <i>47.30,</i><br><i>1.42</i> | <b>47.60,</b><br><b>3.86</b> | 47.32,<br>0.94              | 48.47,<br>1.50               | 48.73,<br>0.70       | <b>49.85,</b><br><b>1.07</b> | 49.69,<br>0.69               |
| HC (cm)                 | 30.48,<br>1.80               | <i>30.83,</i><br><i>0.74</i> | 31.03,<br>1.42               | <i>31.05,</i><br><i>0.88</i> | <b>31.96,</b><br><b>1.72</b> | 31.91,<br>0.96              | <b>33.94,</b><br><b>1.11</b> | 33.40,<br>0.70       | <b>33.61,</b><br><b>1.11</b> | 33.56,<br>0.96               |
| CC (cm)                 | <b>28.73,</b><br><b>1.97</b> | 27.35,<br>0.85               | <b>28.76,</b><br><b>1.41</b> | 28.46,<br>0.98               | <b>28.99,</b><br><b>1.76</b> | 28.33,<br>1.06              | <b>30.68,</b><br><b>1.47</b> | 30.22,<br>0.85       | 31.90,<br>1.09               | <i>31.97,</i><br><i>1.81</i> |
| FL (cm)                 | 6.75,<br>0.56                | <i>6.94,</i><br><i>0.13</i>  | <b>6.52,</b><br><b>0.19</b>  | 6.25,<br>0.28                | 7.43,<br>0.61                | 7.55,<br><i>0.20</i>        | <b>7.54,</b><br><b>0.89</b>  | 7.53,<br>0.16        | 7.39,<br>0.42                | <i>7.51,</i><br><i>0.15</i>  |
| PI                      | <b>1.21,</b><br><b>0.71</b>  | 1.04,<br>0.29                | <b>1.95,</b><br><b>0.23</b>  | 1.94,<br>0.24                | 1.93,<br>0.24                | <i>1.98,</i><br><i>0.19</i> | 2.45,<br>0.20                | 2.88,<br><i>0.22</i> | <b>2.49,</b><br><b>0.19</b>  | 2.09,<br>0.16                |
| TC (cm)                 | <b>11.32,</b><br><b>0.32</b> | 11.10,<br>0.31               | <b>12.56,</b><br><b>0.58</b> | 12.27,<br>0.31               | <b>12.28,</b><br><b>0.63</b> | 12.26,<br>0.29              | <b>12.60,</b><br><b>0.52</b> | 12.52,<br>0.47       | <b>12.88,</b><br><b>0.45</b> | 12.86,<br>0.44               |
| MAC (cm)                | <b>7.53,</b><br><b>0.53</b>  | 7.40,<br>0.42                | <b>8.65,</b><br><b>0.68</b>  | 8.09,<br>0.58                | <b>8.63,</b><br><b>0.66</b>  | 8.26,<br>0.37               | <b>8.88,</b><br><b>0.63</b>  | 8.83,<br>0.67        | <b>8.89,</b><br><b>0.80</b>  | 8.78,<br>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<sup>7</sup>

| Gestational Age (weeks) | 34      |       |             | 35      |       |            | 36      |        |           | 37      |        |            |
|-------------------------|---------|-------|-------------|---------|-------|------------|---------|--------|-----------|---------|--------|------------|
|                         | 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  |
| 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  |
| 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  |
| 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  |
| 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  |
| 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  |
| 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  |
| 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 |

\*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

Table 5: Pearson correlation (r value) with Weight

| Measurement             | CHL   | HC    | CC    | FL    | PI    | <b>TC*</b>   | MAC   |
|-------------------------|-------|-------|-------|-------|-------|--------------|-------|
| Present study           | 0.796 | 0.844 | 0.588 | 0.800 | 0.868 | <b>0.934</b> | 0.640 |
|                         |       |       |       |       |       |              |       |
| Shah Study <sup>7</sup> | 0.845 | 0.860 | 0.596 | 0.813 | 0.882 | <b>0.966</b> | 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.

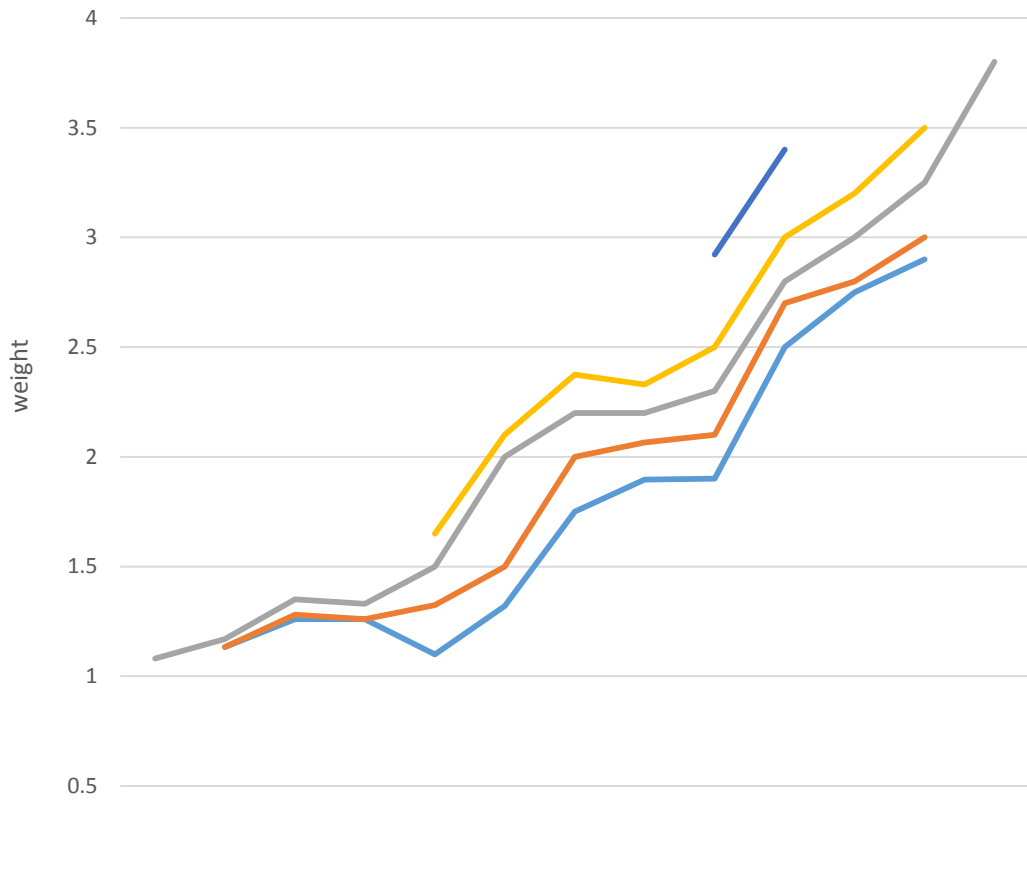
\*In both this study, the maximum association with weight is that of thigh circumference (TC) (r is near to 1), followed by ponderal index (PI), head circumference (HC) and foot length (FL).

Figure 1: percentile charts present study

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### 1.1)weight percentile chart

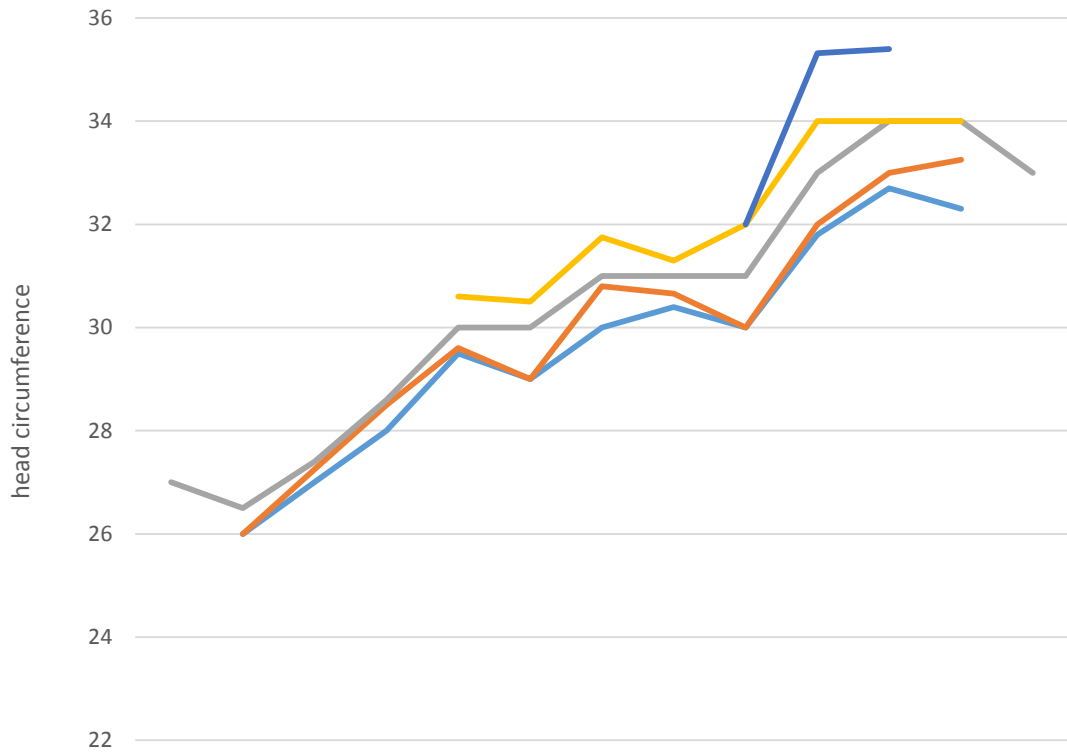


|               | 28   | 29     | 30   | 31   | 32    | 33   | 34    | 35     | 36    | 37  | 38   | 39   | 40  |
|---------------|------|--------|------|------|-------|------|-------|--------|-------|-----|------|------|-----|
| Tenth         |      | 1.133  | 1.26 | 1.26 | 1.1   | 1.32 | 1.75  | 1.8965 | 1.9   | 2.5 | 2.75 | 2.9  |     |
| Twenty fifth  |      | 1.133  | 1.28 | 1.26 | 1.325 | 1.5  | 2     | 2.065  | 2.1   | 2.7 | 2.8  | 3    |     |
| Fiftieth      | 1.08 | 1.1695 | 1.35 | 1.33 | 1.5   | 2    | 2.2   | 2.2    | 2.3   | 2.8 | 3    | 3.25 | 3.8 |
| Seventy fifth |      |        | 1.7  |      | 1.65  | 2.1  | 2.375 | 2.33   | 2.5   | 3   | 3.2  | 3.5  |     |
| Ninety ninth  |      |        |      |      |       |      |       |        | 2.922 | 3.4 |      |      |     |

gestational age (weeks)

— Tenth   
 — Twenty fifth   
 — Fiftieth   
 — Seventy fifth   
 — Ninety ninth

## 1.2) HC percentile chart

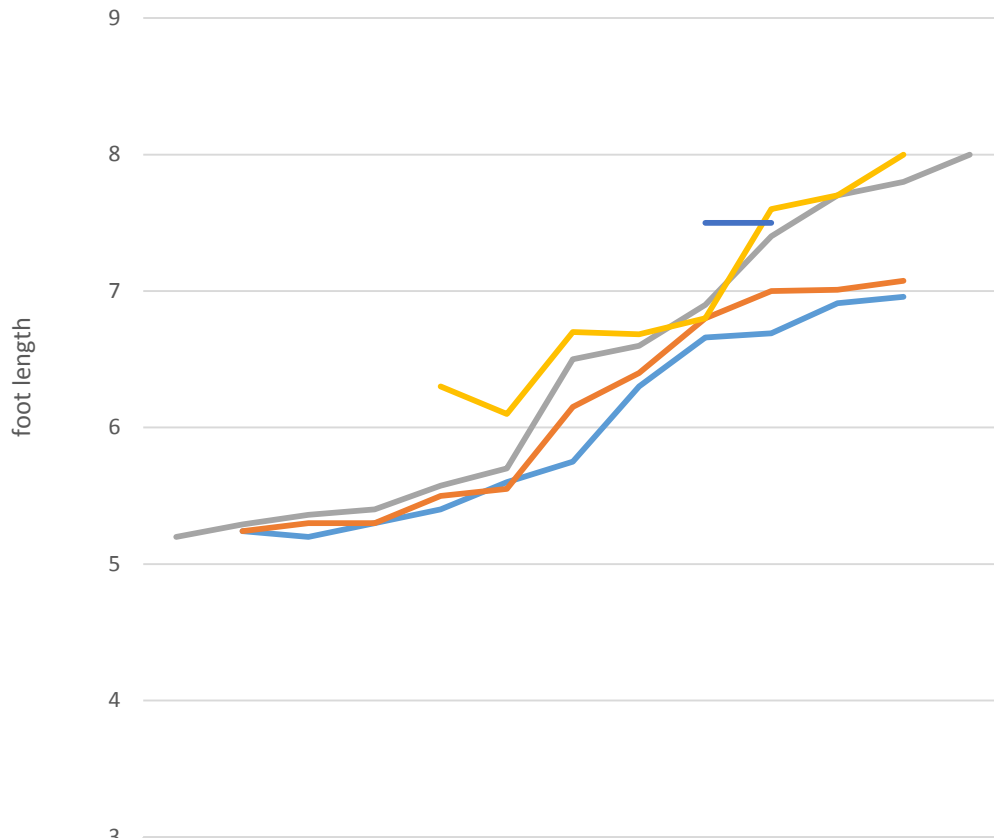


|               | 28 | 29   | 30    | 31   | 32   | 33   | 34    | 35    | 36 | 37    | 38   | 39    | 40 |
|---------------|----|------|-------|------|------|------|-------|-------|----|-------|------|-------|----|
| Tenth         |    | 26   | 27    | 28   | 29.5 | 29   | 30    | 30.4  | 30 | 31.8  | 32.7 | 32.3  |    |
| Twenty fifth  |    | 26   | 27.25 | 28.5 | 29.6 | 29   | 30.8  | 30.66 | 30 | 32    | 33   | 33.25 |    |
| Fiftieth      | 27 | 26.5 | 27.4  | 28.6 | 30   | 30   | 31    | 31    | 31 | 33    | 34   | 34    | 33 |
| Seventy fifth |    |      | 27.6  |      | 30.6 | 30.5 | 31.75 | 31.3  | 32 | 34    | 34   | 34    |    |
| Ninety ninth  |    |      |       |      |      |      |       |       | 32 | 35.32 | 35.4 |       |    |

gestational age (weeks)

— Tenth   
 — Twenty fifth   
 — Fiftieth   
 — Seventy fifth   
 — Ninety ninth

### 1.3)FL percentile chart

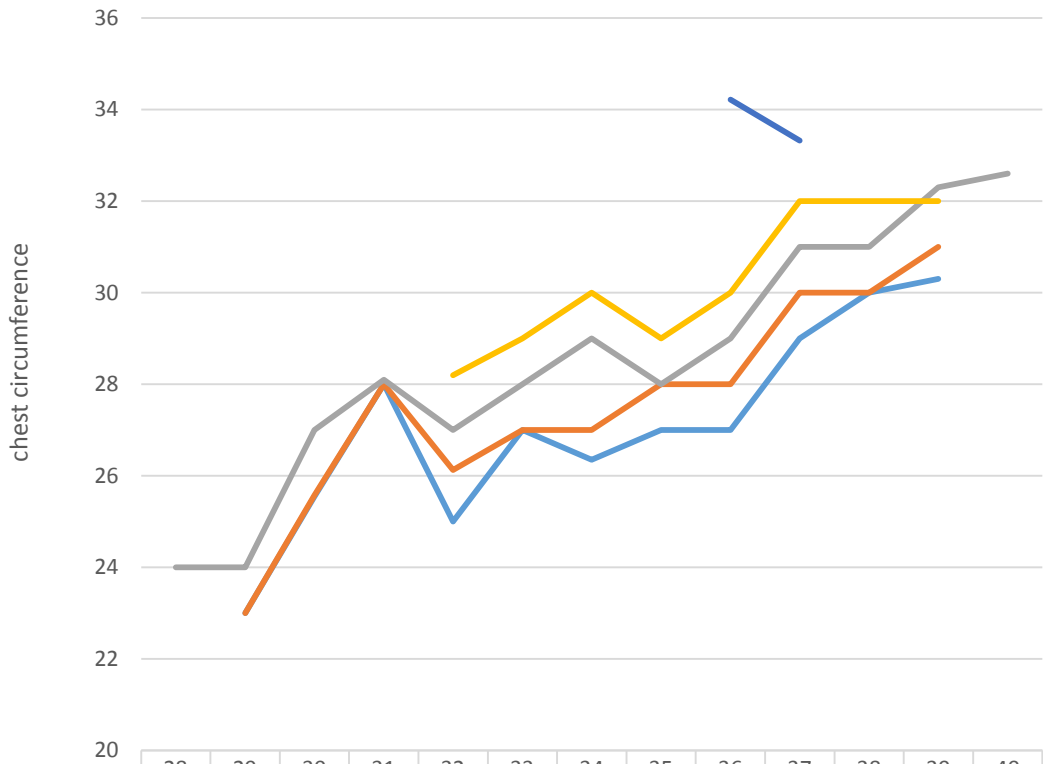


|               | 28  | 29   | 30    | 31  | 32    | 33   | 34   | 35     | 36   | 37   | 38   | 39    | 40 |
|---------------|-----|------|-------|-----|-------|------|------|--------|------|------|------|-------|----|
| Tenth         |     | 5.24 | 5.2   | 5.3 | 5.4   | 5.6  | 5.75 | 6.3    | 6.66 | 6.69 | 6.91 | 6.958 |    |
| Twenty fifth  |     | 5.24 | 5.3   | 5.3 | 5.5   | 5.55 | 6.15 | 6.4    | 6.8  | 7    | 7.01 | 7.075 |    |
| Fiftieth      | 5.2 | 5.29 | 5.36  | 5.4 | 5.575 | 5.7  | 6.5  | 6.6    | 6.9  | 7.4  | 7.7  | 7.8   | 8  |
| Seventy fifth |     |      | 5.765 |     | 6.3   | 6.1  | 6.7  | 6.6825 | 6.8  | 7.6  | 7.7  | 8     |    |
| Ninety ninth  |     |      |       |     |       |      |      |        | 7.5  | 7.5  |      |       |    |
|               |     |      |       |     |       |      |      |        |      |      |      |       |    |

gestational age (weeks)

— Tenth   
 — Twenty fifth   
 — Fiftieth   
 — Seventy fifth   
 — Ninety ninth   
 —

1.4)CC percentile chart



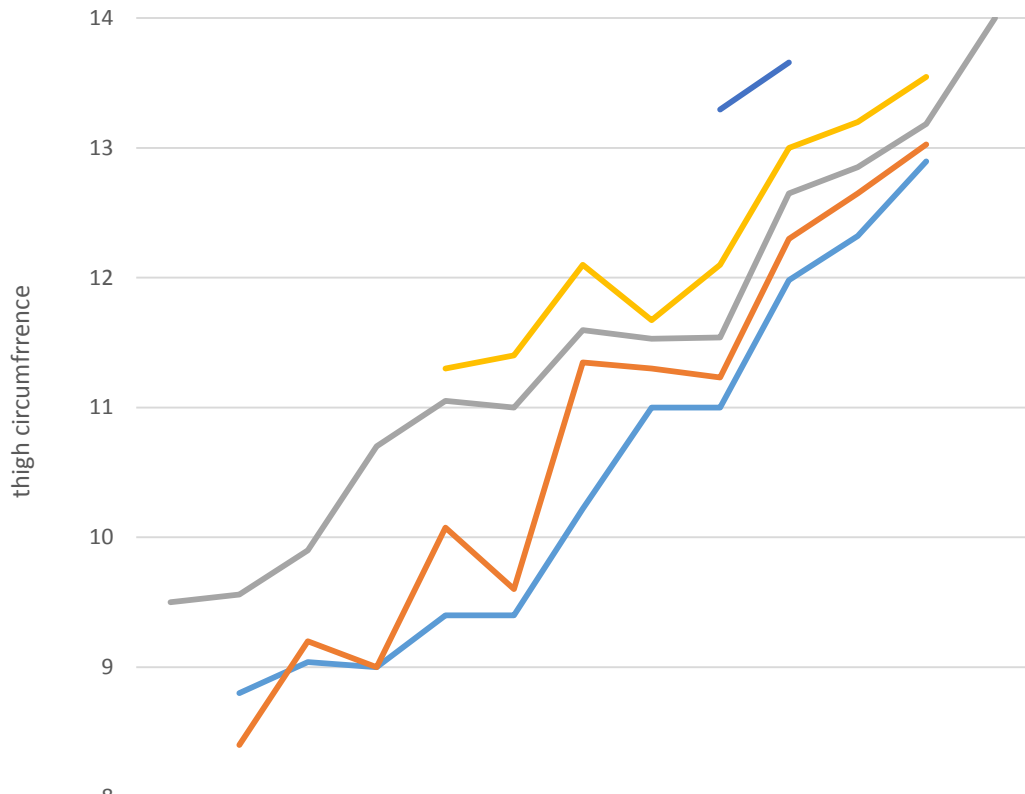
|               | 28 | 29 | 30     | 31   | 32     | 33 | 34    | 35 | 36    | 37    | 38 | 39   | 40   |
|---------------|----|----|--------|------|--------|----|-------|----|-------|-------|----|------|------|
| Tenth         |    | 23 | 25.55  | 28   | 25     | 27 | 26.35 | 27 | 27    | 29    | 30 | 30.3 |      |
| Twenty fifth  |    | 23 | 25.575 | 28   | 26.125 | 27 | 27    | 28 | 28    | 30    | 30 | 31   |      |
| Fiftieth      | 24 | 24 | 27     | 28.1 | 27     | 28 | 29    | 28 | 29    | 31    | 31 | 32.3 | 32.6 |
| Seventy fifth |    |    | 29     |      | 28.2   | 29 | 30    | 29 | 30    | 32    | 32 | 32   |      |
| Ninety ninth  |    |    |        |      |        |    |       |    | 34.22 | 33.32 |    |      |      |

gestational age (weeks)

— Tenth — Twenty fifth — Fiftieth — Seventy fifth — Ninety ninth

UNDE

1.5)TC percentile chart

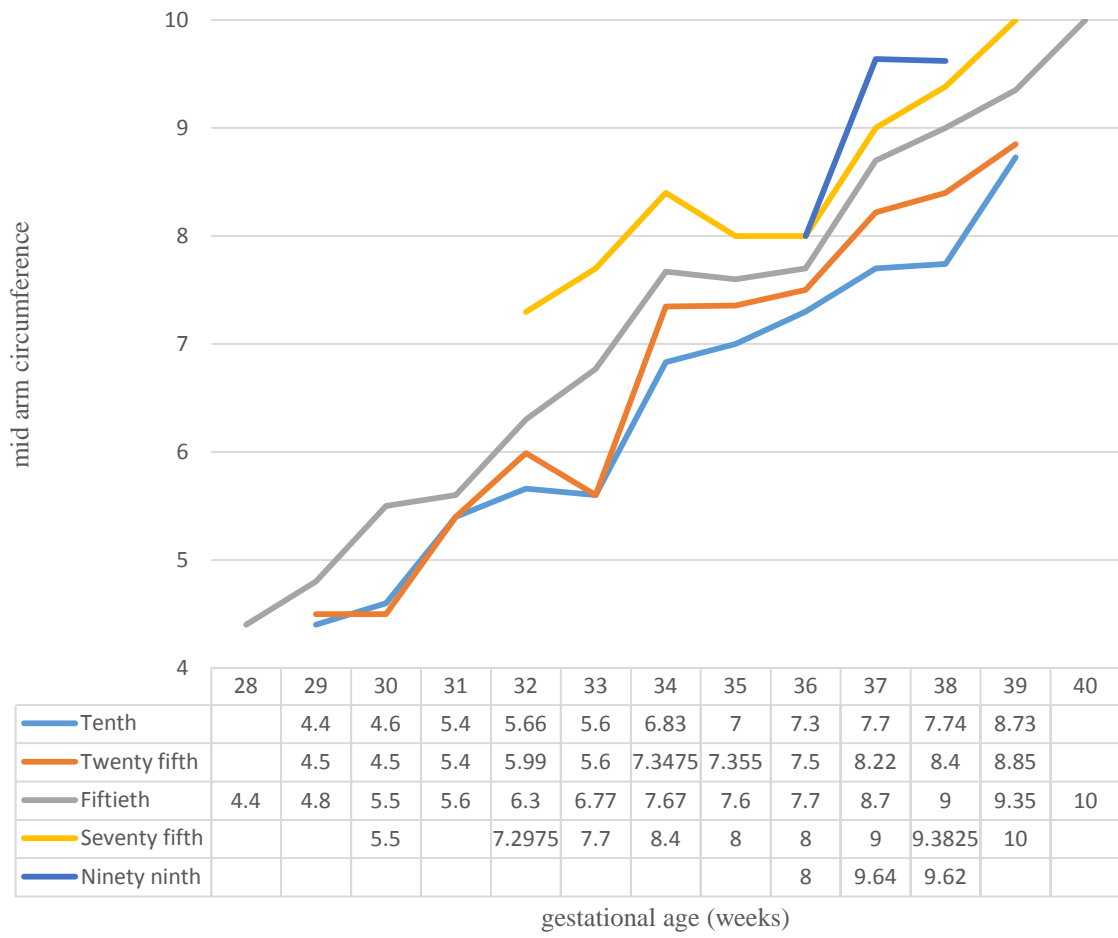


|               | 28  | 29   | 30   | 31   | 32     | 33   | 34     | 35     | 36     | 37     | 38     | 39     | 40 |
|---------------|-----|------|------|------|--------|------|--------|--------|--------|--------|--------|--------|----|
| Tenth         |     | 8.8  | 9.04 | 9    | 9.4    | 9.4  | 10.22  | 11     | 11     | 11.98  | 12.321 | 12.895 |    |
| Twenty fifth  |     | 8.4  | 9.2  | 9    | 10.075 | 9.6  | 11.348 | 11.3   | 11.23  | 12.3   | 12.65  | 13.025 |    |
| Fiftieth      | 9.5 | 9.56 | 9.9  | 10.7 | 11.05  | 11   | 11.595 | 11.53  | 11.54  | 12.65  | 12.85  | 13.185 | 14 |
| Seventy fifth |     |      | 10.5 |      | 11.3   | 11.4 | 12.1   | 11.673 | 12.1   | 13     | 13.2   | 13.548 |    |
| Ninety ninth  |     |      |      |      |        |      |        |        | 13.296 | 13.656 |        |        |    |

gestational age (weeks)

— Tenth   
 — Twenty fifth   
 — Fiftieth   
 — Seventy fifth   
 — Ninety ninth

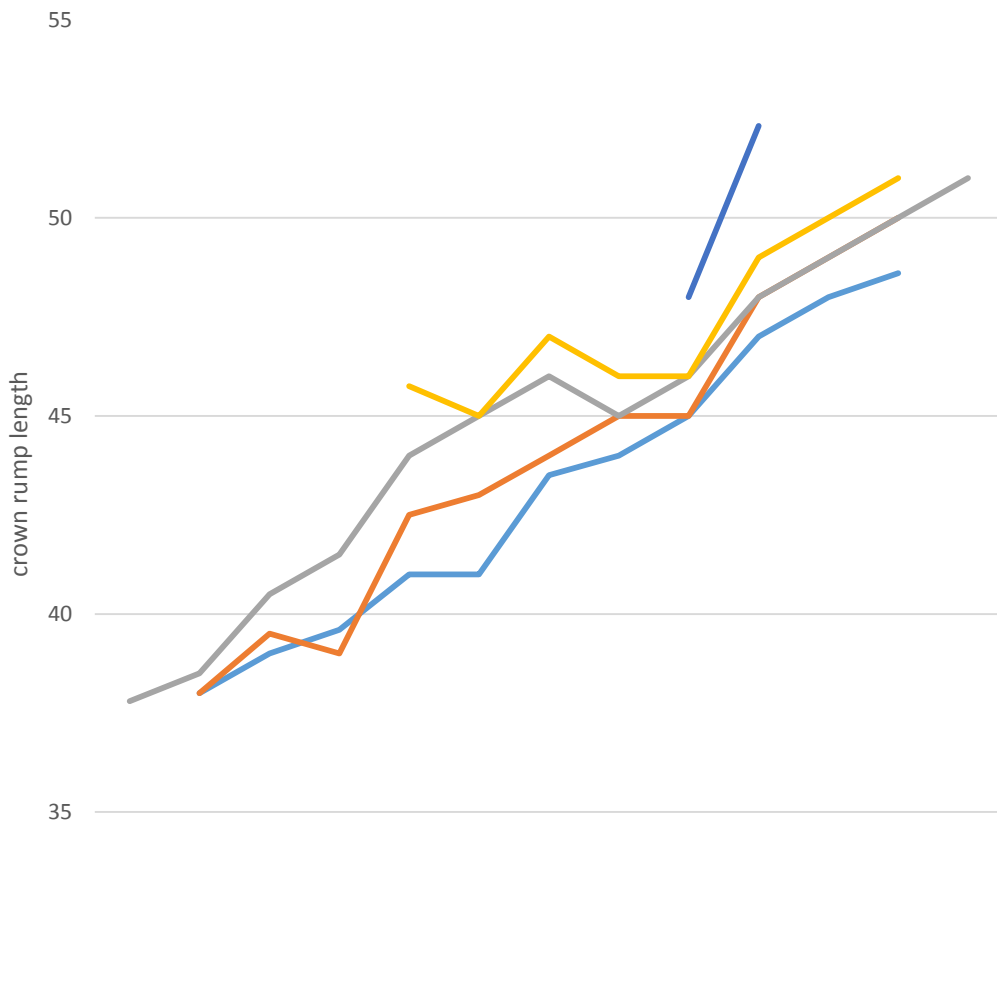
1.6)MAC percentile chart



— Tenth — Twenty fifth — Fiftieth — Seventy fifth — Ninety ninth

UNDER

1.7)CHL percentile chart



|               | 28   | 29   | 30   | 31   | 32    | 33 | 34   | 35 | 36 | 37    | 38 | 39   | 40 |
|---------------|------|------|------|------|-------|----|------|----|----|-------|----|------|----|
| Tenth         |      | 38   | 39   | 39.6 | 41    | 41 | 43.5 | 44 | 45 | 47    | 48 | 48.6 |    |
| Twenty fifth  |      | 38   | 39.5 | 39   | 42.5  | 43 | 44   | 45 | 45 | 48    | 49 | 50   |    |
| Fiftieth      | 37.8 | 38.5 | 40.5 | 41.5 | 44    | 45 | 46   | 45 | 46 | 48    | 49 | 50   | 51 |
| Seventy fifth |      |      | 40.6 |      | 45.75 | 45 | 47   | 46 | 46 | 49    | 50 | 51   |    |
| Ninety ninth  |      |      |      |      |       |    |      |    | 48 | 52.32 |    |      |    |

— Tenth   
 — Twenty fifth   
 — Fiftieth   
 — Seventy fifth   
 — Ninety ninth  
 gestational age (weeks)

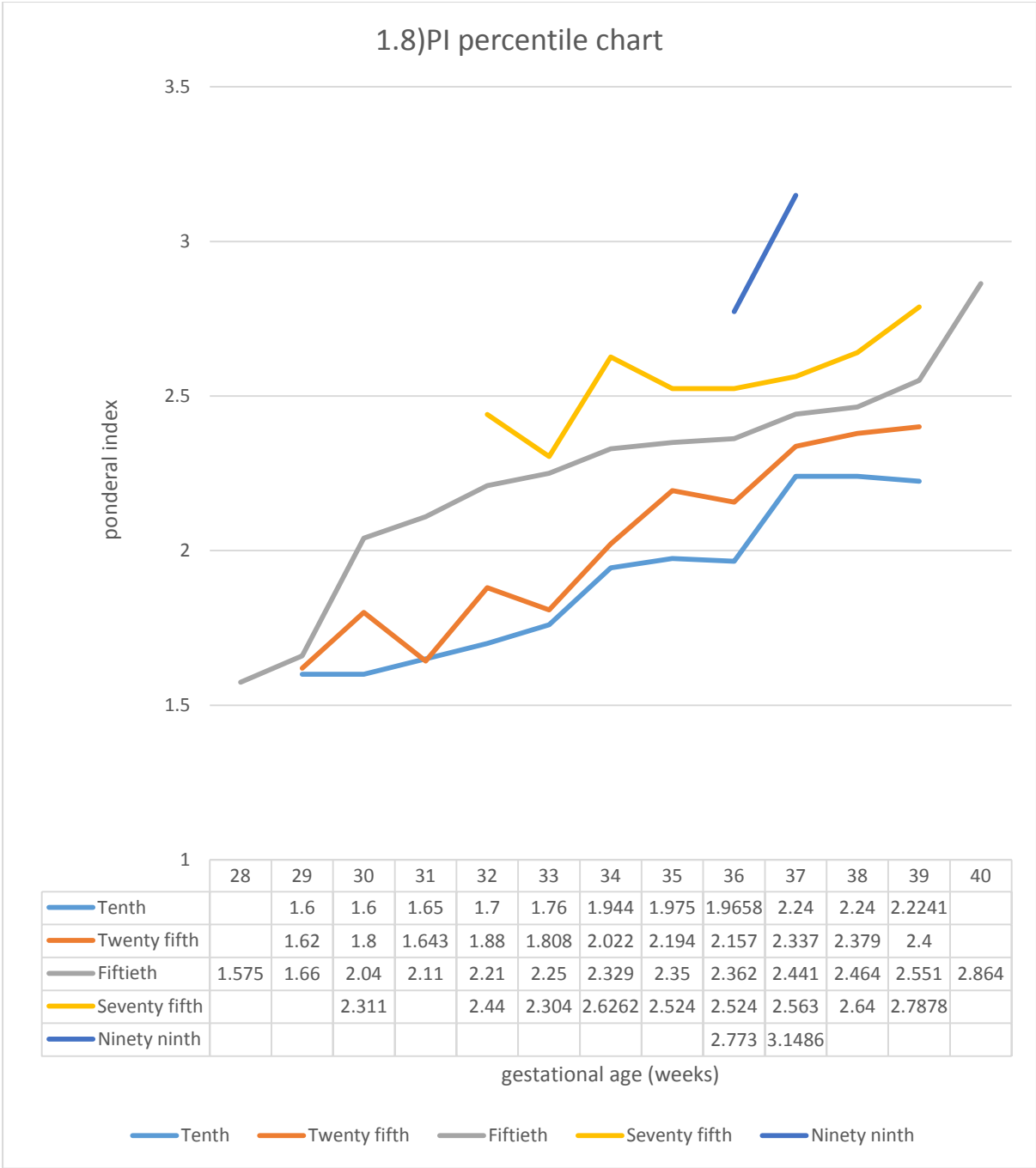
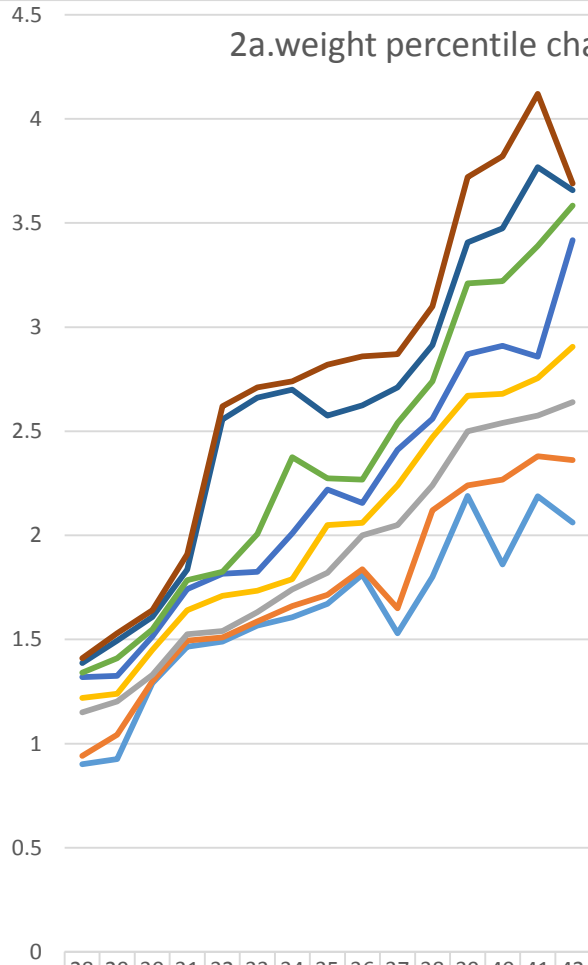


Figure 2: percentile charts Shah Study<sup>7</sup>



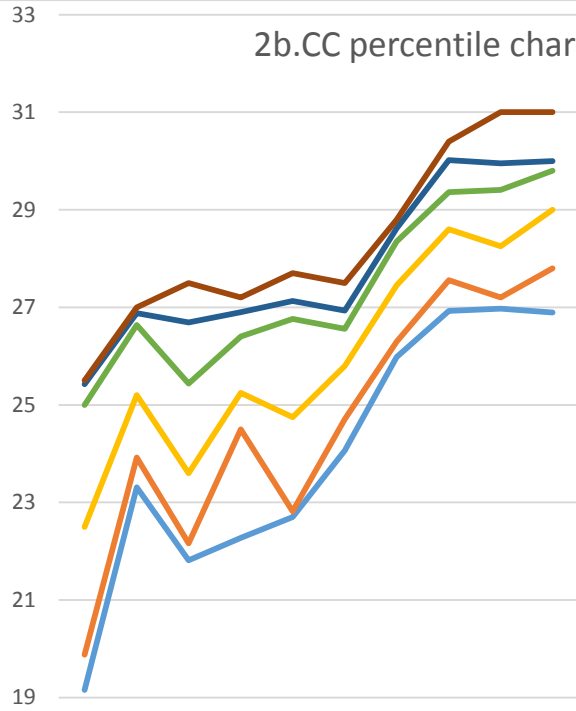
2a.weight percentile chart



- Third
- Tenth
- Twenty fifth
- Fifteth
- Seventy fifth
- Nintieth
- Ninty seventh
- Hundredth

|               | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  | 36  | 37  | 38  | 39  | 40  | 41  | 42  |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Third         | 0.9 | 0.9 | 1.3 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.8 | 1.5 | 1.8 | 2.2 | 1.9 | 2.2 | 2.1 |
| Tenth         | 0.9 | 1   | 1.3 | 1.5 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.7 | 2.1 | 2.2 | 2.3 | 2.4 | 2.4 |
| Twenty fifth  | 1.2 | 1.2 | 1.3 | 1.5 | 1.5 | 1.6 | 1.7 | 1.8 | 2   | 2.1 | 2.2 | 2.5 | 2.5 | 2.6 | 2.6 |
| Fifteth       | 1.2 | 1.2 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 2.1 | 2.1 | 2.2 | 2.5 | 2.7 | 2.7 | 2.8 | 2.9 |
| Seventy fifth | 1.3 | 1.3 | 1.5 | 1.7 | 1.8 | 1.8 | 2   | 2.2 | 2.2 | 2.4 | 2.6 | 2.9 | 2.9 | 2.9 | 3.4 |
| Nintieth      | 1.3 | 1.4 | 1.5 | 1.8 | 1.8 | 2   | 2.4 | 2.3 | 2.3 | 2.5 | 2.7 | 3.2 | 3.2 | 3.4 | 3.6 |
| Ninty seventh | 1.4 | 1.5 | 1.6 | 1.8 | 2.6 | 2.7 | 2.7 | 2.6 | 2.6 | 2.7 | 2.9 | 3.4 | 3.5 | 3.8 | 3.7 |
| Hundredth     | 1.4 | 1.5 | 1.6 | 1.9 | 2.6 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 3.1 | 3.7 | 3.8 | 4.1 | 3.7 |

2b.CC percentile chart

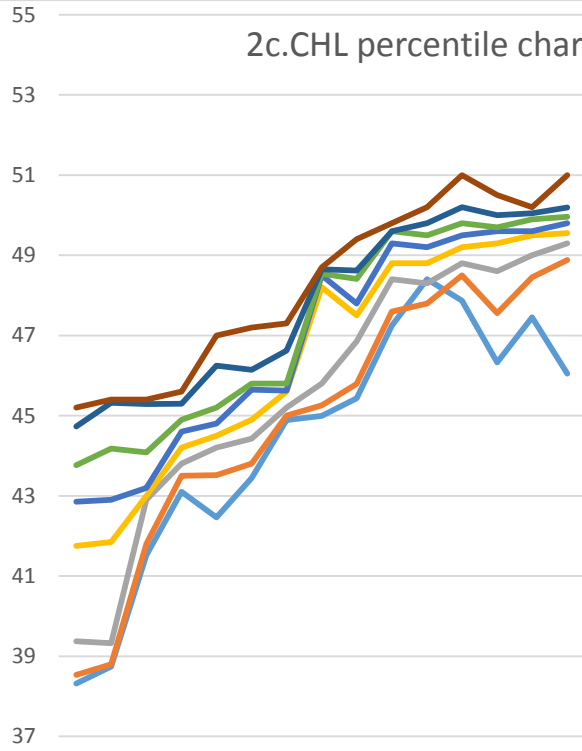


- THIRD CC
- Tenth
- Fifteth
- Nintieth
- Ninty seventh
- Hundredth

|               | 28    | 29    | 30    | 31    | 32    | 33    | 34    | 35    | 36    | 37    |
|---------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| THIRD CC      | 19.16 | 23.31 | 21.82 | 22.28 | 22.7  | 24.07 | 25.98 | 26.93 | 26.97 | 26.89 |
| Tenth         | 19.88 | 23.92 | 22.16 | 24.5  | 22.82 | 24.71 | 26.3  | 27.56 | 27.2  | 27.8  |
| Fifteth       | 22.5  | 25.2  | 23.6  | 25.25 | 24.75 | 25.8  | 27.45 | 28.6  | 28.25 | 29    |
| Nintieth      | 25    | 26.64 | 25.44 | 26.4  | 26.76 | 26.56 | 28.35 | 29.36 | 29.41 | 29.8  |
| Ninty seventh | 25.42 | 26.88 | 26.69 | 26.9  | 27.13 | 26.93 | 28.62 | 30.02 | 29.96 | 30    |
| Hundredth     | 25.5  | 27    | 27.5  | 27.2  | 27.7  | 27.5  | 28.8  | 30.4  | 31    | 31    |

UNDER

2c.CHL percentile chart

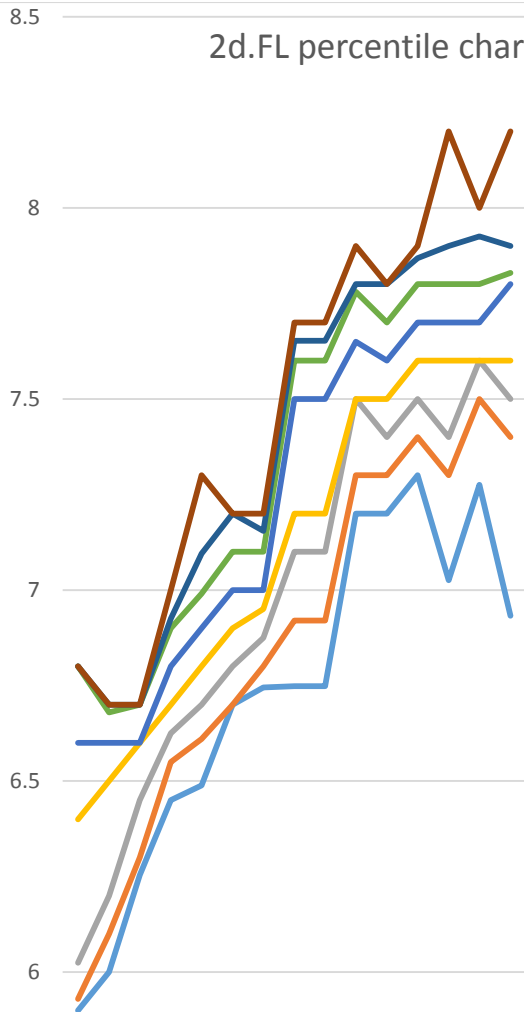


- third chl
- Tenth
- Twenty fifth
- Fifteth
- Seventy fifth
- Nintieth
- Ninty seventh
- Hundredth

|               | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| third chl     | 38 | 39 | 42 | 43 | 42 | 43 | 45 | 45 | 45 | 47 | 48 | 48 | 46 | 47 | 46 |
| Tenth         | 39 | 39 | 42 | 44 | 44 | 44 | 45 | 45 | 46 | 48 | 48 | 49 | 48 | 48 | 49 |
| Twenty fifth  | 39 | 39 | 43 | 44 | 44 | 44 | 45 | 46 | 47 | 48 | 48 | 49 | 49 | 49 | 49 |
| Fifteth       | 42 | 42 | 43 | 44 | 45 | 45 | 46 | 48 | 48 | 49 | 49 | 49 | 49 | 50 | 50 |
| Seventy fifth | 43 | 43 | 43 | 45 | 45 | 46 | 46 | 49 | 48 | 49 | 49 | 50 | 50 | 50 | 50 |
| Nintieth      | 44 | 44 | 44 | 45 | 45 | 46 | 46 | 49 | 48 | 50 | 50 | 50 | 50 | 50 | 50 |
| Ninty seventh | 45 | 45 | 45 | 45 | 46 | 46 | 47 | 49 | 49 | 50 | 50 | 50 | 50 | 50 | 50 |
| Hundredth     | 45 | 45 | 45 | 46 | 47 | 47 | 47 | 49 | 49 | 50 | 50 | 51 | 51 | 50 | 51 |

UNDETECT

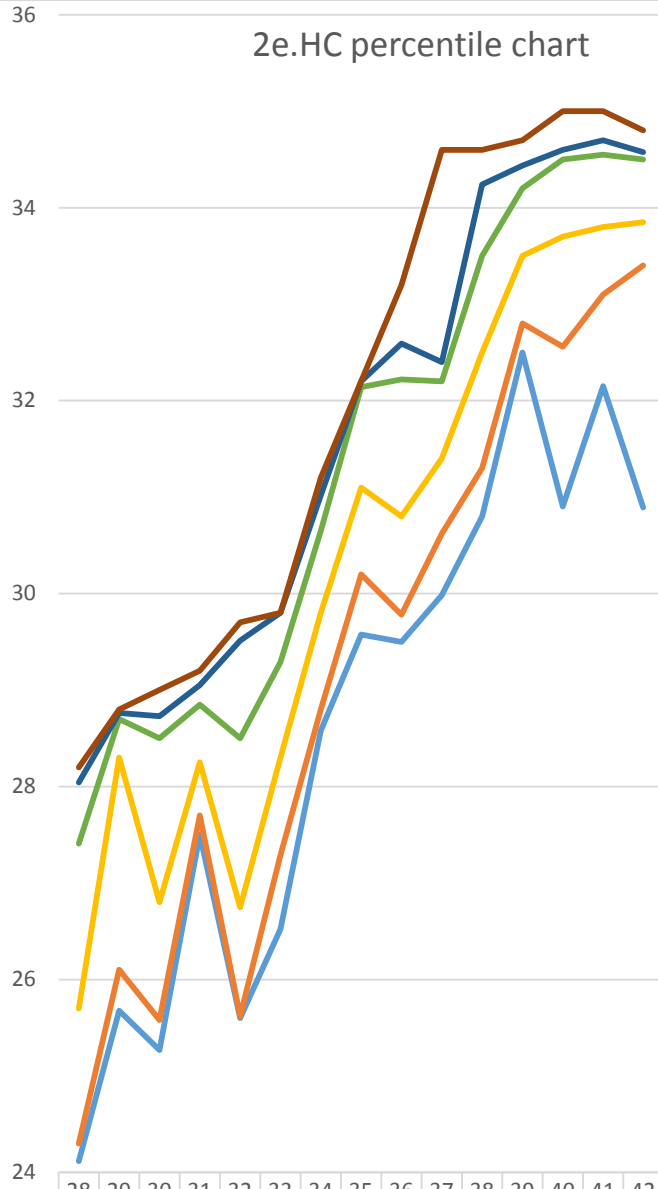
2d.FL percentile chart



- THIRD FL
- Tenth
- Twenty fifth
- Fifteth
- Seventy fifth
- NINTIETH
- Ninty seventh
- Hundredth

|               | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| THIRD FL      | 5.9  | 6    | 6.36 | 6.56 | 6.56 | 6.76 | 6.76 | 6.76 | 6.77 | 6.77 | 6.77 | 6.77 | 6.77 | 6.77 | 6.77 |
| Tenth         | 5.96 | 6.16 | 6.36 | 6.66 | 6.66 | 6.76 | 6.86 | 6.96 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 |
| Twenty fifth  | 6    | 6.26 | 6.56 | 6.66 | 6.76 | 6.86 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 |
| Fifteth       | 6.46 | 6.56 | 6.66 | 6.76 | 6.86 | 6.9  | 7    | 7.27 | 7.27 | 7.57 | 7.57 | 7.67 | 7.67 | 7.67 | 7.67 |
| Seventy fifth | 6.66 | 6.66 | 6.66 | 6.86 | 6.9  | 7    | 7    | 7.57 | 7.57 | 7.77 | 7.67 | 7.77 | 7.77 | 7.77 | 7.77 |
| NINTIETH      | 6.86 | 6.76 | 6.76 | 6.9  | 7    | 7.17 | 7.17 | 6.76 | 6.76 | 6.87 | 6.77 | 6.87 | 6.87 | 6.87 | 6.87 |
| Ninty seventh | 6.86 | 6.76 | 6.76 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 | 6.97 |
| Hundredth     | 6.86 | 6.76 | 6.77 | 7    | 7.37 | 6.27 | 6.27 | 6.77 | 6.77 | 6.97 | 6.87 | 6.98 | 6.2  | 6.8  | 6.82 |

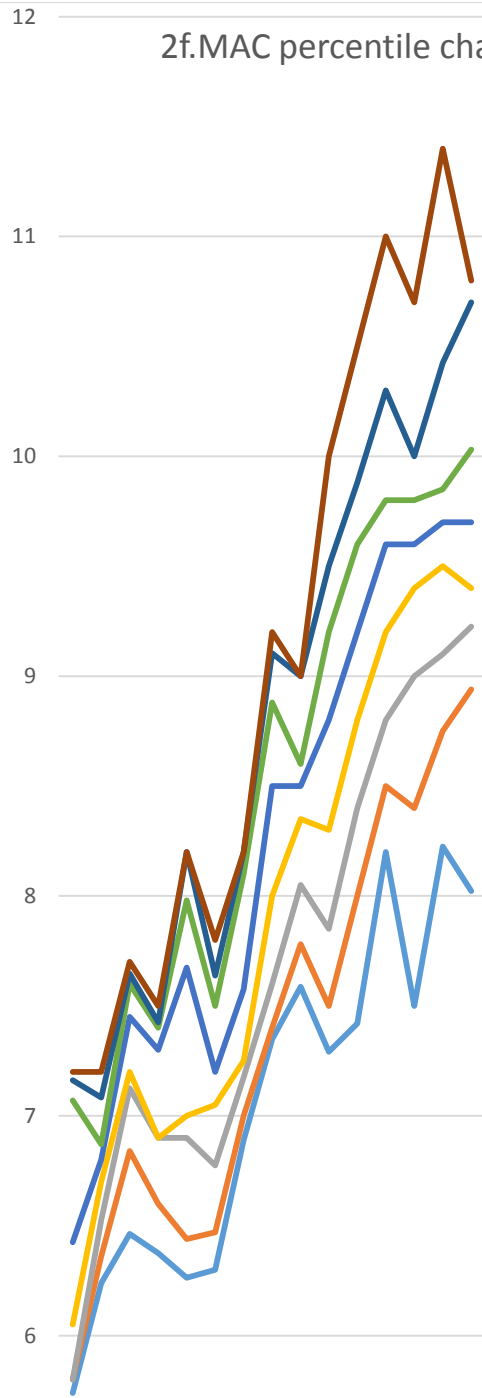
2e.HC percentile chart



|               | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| THIRD HC      | 24.1 | 25.7 | 25.3 | 27.5 | 25.6 | 26.5 | 28.6 | 29.6 | 29.5 | 30.8 | 32.5 | 30.9 | 32.3 | 30.9 |      |
| Tenth         | 24.3 | 26.1 | 25.6 | 27.7 | 25.6 | 27.3 | 28.8 | 30.2 | 29.8 | 30.6 | 31.3 | 32.8 | 32.6 | 33.1 | 33.4 |
| Fifteth       | 25.7 | 28.3 | 26.8 | 28.3 | 26.8 | 28.3 | 29.8 | 31.1 | 30.8 | 31.4 | 32.5 | 33.5 | 33.7 | 33.8 | 33.9 |
| Nintieth      | 27.4 | 28.7 | 28.5 | 28.9 | 28.5 | 29.3 | 30.7 | 32.1 | 32.2 | 32.3 | 33.4 | 34.2 | 34.5 | 34.6 | 34.5 |
| Ninty seventh | 28.2 | 28.8 | 28.7 | 29.1 | 29.5 | 29.8 | 31.2 | 32.6 | 32.6 | 32.4 | 34.2 | 34.4 | 34.6 | 34.7 | 34.6 |
| Hundredth     | 28.2 | 28.8 | 29.2 | 29.7 | 29.7 | 29.8 | 31.2 | 32.6 | 33.2 | 34.6 | 34.6 | 34.7 | 35.0 | 35.0 | 34.8 |
|               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|               |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |

- THIRD HC
- Tenth
- Fifteth
- Nintieth
- Ninty seventh
- Hundredth

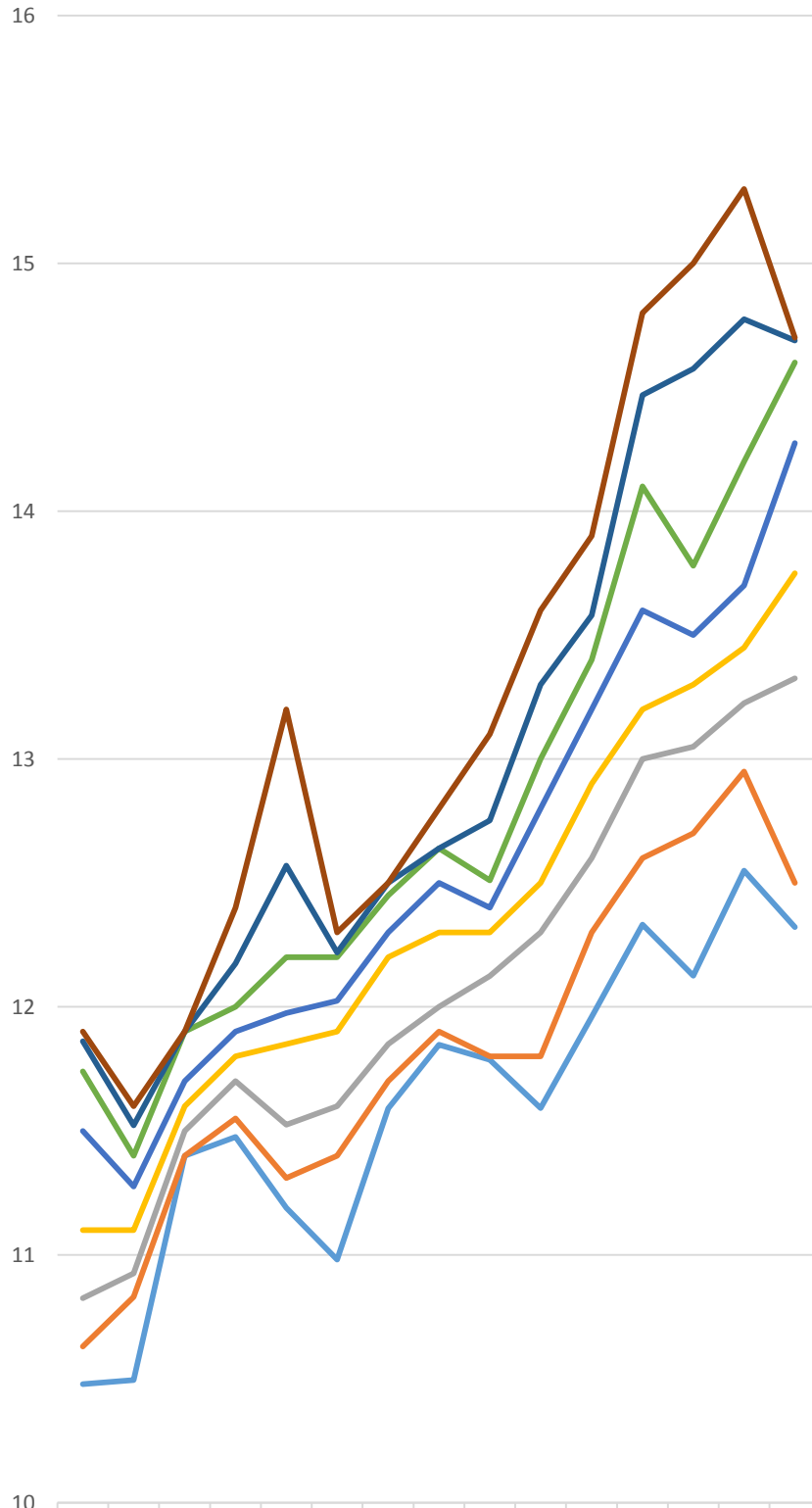
2f.MAC percentile chart



|               | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38    | 39   | 40   | 41    | 42 |
|---------------|------|------|------|------|------|------|------|------|------|------|-------|------|------|-------|----|
| thirdmac      | 5.76 | 6.26 | 6.56 | 6.46 | 6.36 | 6.97 | 7.37 | 7.67 | 7.37 | 7.48 | 7.27  | 7.58 | 7.28 | 8     |    |
| Tenth         | 5.86 | 6.46 | 6.86 | 6.66 | 6.46 | 6.57 | 7.47 | 7.87 | 7.58 | 8.58 | 8.48  | 8.88 | 8.9  |       |    |
| Twenty fifth  | 5.86 | 6.57 | 6.16 | 6.96 | 6.96 | 6.87 | 7.68 | 8.17 | 8.98 | 8.48 | 8.89  | 9.19 | 9.2  |       |    |
| Fifteth       | 6.16 | 6.77 | 6.26 | 6.97 | 7.17 | 7.38 | 8.48 | 8.38 | 8.89 | 9.29 | 9.49  | 9.59 | 9.4  |       |    |
| Seventy fifth | 6.46 | 6.87 | 6.57 | 6.37 | 6.77 | 6.27 | 6.68 | 6.58 | 6.58 | 6.89 | 6.29  | 6.69 | 6.69 | 6.79  | 7  |
| Nintieth      | 7.16 | 6.97 | 6.67 | 6.48 | 6.88 | 7.58 | 7.18 | 7.98 | 6.99 | 6.29 | 6.69  | 6.89 | 6.89 | 6.910 |    |
| Ninty seventh | 7.27 | 6.17 | 6.67 | 6.48 | 6.27 | 6.68 | 6.29 | 6.19 | 6.99 | 6.59 | 6.910 | 6.10 | 6.10 | 6.11  |    |
| Hundredth     | 7.27 | 6.27 | 6.77 | 6.58 | 6.27 | 6.88 | 6.29 | 6.29 | 6.10 | 6.11 | 6.11  | 6.11 | 6.11 | 6.11  |    |

- thirdmac
- Tenth
- Twenty fifth
- Fifteth
- Seventy fifth
- Nintieth
- Ninty seventh

2g.TC percentile chart

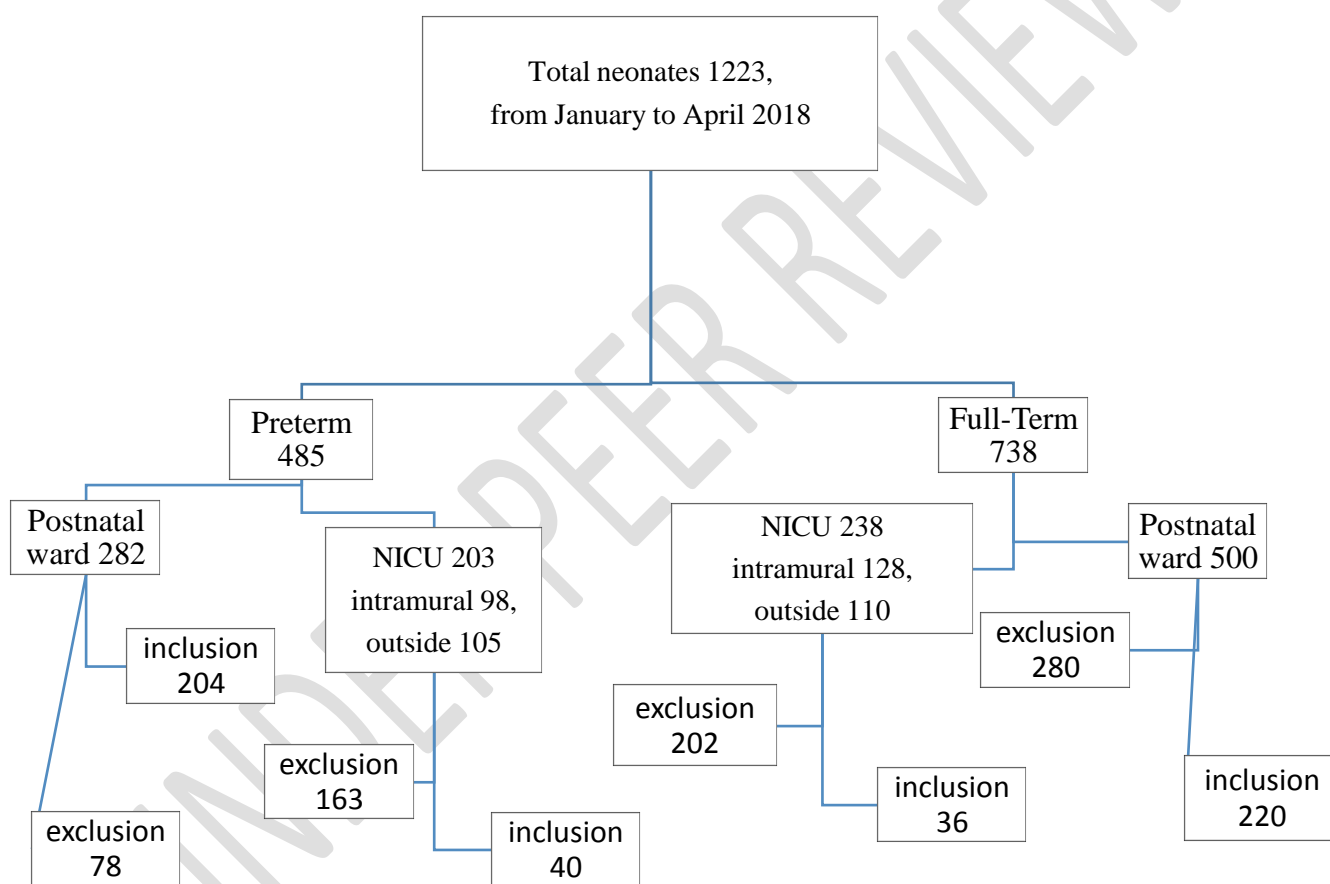


|               | 28   | 29   | 30   | 31   | 32   | 33   | 34   | 35   | 36   | 37   | 38   | 39   | 40   | 41   | 42   |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| third mtc     | 10.5 | 10.5 | 11.4 | 11.5 | 11.2 | 11   | 11.6 | 11.8 | 11.8 | 11.6 | 12   | 12.3 | 12.1 | 12.6 | 12.3 |
| Tenth         | 10.6 | 10.8 | 11.4 | 11.6 | 11.3 | 11.4 | 11.7 | 11.9 | 11.8 | 11.8 | 12.3 | 12.6 | 12.7 | 13   | 12.5 |
| Twenty fifth  | 10.8 | 10.9 | 11.5 | 11.7 | 11.5 | 11.6 | 11.9 | 12   | 12.1 | 12.3 | 12.6 | 13   | 13.1 | 13.2 | 13.3 |
| Fifteth       | 11.1 | 11.1 | 11.6 | 11.8 | 11.9 | 11.9 | 12.2 | 12.3 | 12.3 | 12.5 | 12.9 | 13.2 | 13.3 | 13.5 | 13.8 |
| Seventy fifth | 11.5 | 11.3 | 11.7 | 11.9 | 12   | 12   | 12.3 | 12.5 | 12.4 | 12.8 | 13.2 | 13.6 | 13.5 | 13.7 | 14.3 |
| Nintieth      | 11.7 | 11.4 | 11.9 | 12   | 12.2 | 12.2 | 12.5 | 12.6 | 12.5 | 13   | 13.4 | 14.1 | 13.8 | 14.2 | 14.6 |
| Ninty seventh | 11.9 | 11.5 | 11.9 | 12.2 | 12.6 | 12.2 | 12.5 | 12.6 | 12.8 | 13.3 | 13.6 | 14.5 | 14.6 | 14.8 | 14.7 |
| Hundredth     | 11.9 | 11.6 | 11.9 | 12.4 | 13.2 | 12.3 | 12.5 | 12.8 | 13.1 | 13.6 | 13.9 | 14.8 | 15   | 15.3 | 14.7 |

third mtc      Tenth      Twenty fifth      Fifteth

Figure 3

Flowchart: study design





UNDER PEER REVIEW

Figure 4 Distribution of newborns according to gestational age

