Scientific
Research
Publishing

Draft of an Anthropometric Reference System for Full-Term Cameroonian Newborns: Prospective Study with Analytical Aim in the Maternity Wards of Douala

Henri Essome[1,2]*, Charlotte Epossè Ekoube[3], Fulbert Mangala Nkwele[1],
Rita Carole Mbono Betoko[1], Irène Cyrielle Edjoa Mboe[1], Michel Roger Ekono[1],
Alphonse Ngalame Nyong[4], Robert Tchounzou[4], Ingrid Doriane Ofakem Ilick[2],
Hassanatou Iyawa[3], Moustapha Bilkissou[1], Astrid Ndolo Kondo[1], Junie Ngaha Yaneu[1],
Marga Vanina Ngono Akam[1], Gervais Mounchikpou Ngouhouo[1], Grâce Tocki Toutou[5],
Nelly Noubi[6], Valère Mve Koh[6], Théophile Nana Njamen[4]

[1]Training, Teaching and Research Unit in Gynecology Obstetrics and Reproduction, Faculty of Medicine and Pharmaceutical Sciences, University of Douala, Douala, Cameroon
[2]Department of Obstetrics and Gynecology, Laquintinie Hospital, Douala, Cameroon
[3]Department of Pediatrics, Laquintinie Hospital, Douala, Cameroon
[4]Faculty of Health Sciences of Buea, University of Buea, Buea, Cameroon
[5]Pluridisciplinary Department, Laquintinie Hospital, Douala, Cameroon
[6]Faculty of Medicine and Biomedical Sciences, University of Yaounde 1, Yaounde, Cameroon
Email: *essometocky@yahoo.com

Abstract

Introduction: Anthropometry applied to newborns is a reliable indicator of the quality of fetal growth. The latter is influenced by genetic, racial and nutritional factors varying from one population to another, explaining why a standard cannot be applied to all populations. **Research question:** should the Caucasian frame of reference be dogmatically applied in our African context? Multicenter studies are therefore necessary; hence the interest of this work, the main objective of which was to describe the anthropometric profile of full-term newborns in the city of Douala. **Methodology:** We carried out a cross-sectional study with an analytical aim and prospective data collection in the maternity wards of the Douala General Hospital, Laquintinie Hospital, District hospitals of Deido, Nylon and Bonassama over a period of 4 months (January to April 2020). We were interested in any newborn, born alive, vaginally or by cesarean section, seen in the first 24 hours from a full-term single-fetal pregnancy whose mother had given consent. We excluded newborns whose term was unclear and those with congenital malformations or signs of

embryo-foetopathy. Data collection was done using structured and pre-tested survey sheets. The study variables were obstetric and anthropometric. Statistical analyzes were carried out with CS Pro 7.3 and SPSS version 25.0 software. The Student, Chi-square and Fischer tests were used to compare the means of the variables, the percentages with a significance threshold P value < 0.05. **Results:** During the study period, 305 full-term newborns were included, divided into 172 boys and 133 girls. The average anthropometric parameters of the full-term newborn in the city of Douala were: average weight: 3305 grams, average height: 49.8 centimeters, average head circumference: 34.6 centimeters, average upper arm circumference: 11.3 centimeters, circumference average thoracic: 32.8 centimeters. The percentile distribution showed a 10th percentile at 2656 grams and a 90th percentile at 3966 grams for weight defining the limits for small-for-gestational-age neonates and macrosomes. **Conclusion:** The anthropometric data of the full-term newborn in the city of Douala were: an average weight of 3305.4 grams, an average height of 49.8 centimeters, an average head circumference of 34.2 centimeters, an average upper arm circumference of 11.3 centimeters, and an average thoracic circumference of 32.8 centimeters with higher valuesin male newborns.

Keywords

1. Introduction

Anthropometry is the method for assessing the corpulence, proportions and composition of the human body [1]. It is of great interest in public health and in clinical decisions because body dimensions, whatever the age, reflect the overall state of health and well-being of individuals and populations. Thus, for newborns, the anthropometric study is an essential research tool for studying the determinants and early consequences of insufficient or excessive fetal growth [2] [3]. According to the World Health Organization (WHO), body size at birth reflects the duration of gestation and the speed of fetal growth [1]. The rate of fetal growth will be influenced by both maternal and paternal factors [2] [4]. However, it must be recognized that any population has its own characteristics, determined by racial, ethnic, geographic, nutritional and socio-economic factors [5] [6] [7] [8].

As a result, numerous studies have been able to demonstrate that the anthropometric parameters of the newborn at birth vary from one region to another, from one population to another. In the United States of America, Neggers *et al.* in 1995 in Alabama through an anthropometric study of 1205 full-term births at the University Hospital of Alabama found an average weight of 3272 grams (g), an average head circumference (BW) of 34.1 centimeters (cm), a thoracic perimeter (PT) of 33 centimeters (cm), an upper arm circumference (MUAC) of 10.8 centimeters (cm) [9]. On the European continent, in 2018 in Turkey the results of Betul *et al.* following an anthropometric study on 476 newborns of gestational age between 37 and 38 weeks were: average weight: 3238 g, average head circumference:

34.9 cm, average thoracic perimeter: 33 cm [10]. In Asia Chao *et al*. in 2018 during a study carried out on 51 full-term births at the neonatology department of the Xian Jiaoton university center found an average weight of 3260 g, average head circumference of 34 cm [11]. Within the African continent, disparities have also been observed. In Sub-Saharan Africa, Ndiaye *et al*., in Senegal in 2003 reported an average weight of 3120 g +/− 405 g, an average height of 49.2 cm +/− 2 cm, an average head circumference of 34.3 cm +/− 1.2 cm, the average thoracic circumference of 32.4 cm +/− 1.8 cm after a study carried out on a population of 300 newborns of gestational age between 37 weeks and 42 weeks of amenorrhea [12]. In Ouagadougou in 2005, after a study of 2162 full-term newborns, Ye *et al*. revealed an average weight of 2888.7 g, an average height of 49.1 cm, and the average head circumference was 33.9 cm, the average thoracic circumference of 32.0 cm, and an average upper arm circumference of 10.7 cm [13]. In Cameroon, Tietche *et al*. in 1994 on a population of 902 full-term Cameroonian newborns in an urban environment found an average weight of 3229 g, an average height of 49.0cm, an average head circumference of 34.7 cm, an average upper arm circumference of 10.6 cm, an average thoracic circumference of 33.0 cm [14].

Given the variability of said parameters and the age of the data in our environment, multicenter studies were therefore necessary; hence the interest of our research.

2. Material and Methods

2.1. Type, Location and Period of Study

We conducted a multicenter prospective cross-sectional study with analytical aims in certain hospitals in the city of Douala, notably the Laquintinie Hospital of Douala, the General Hospital of Douala, the Deido District Hospital, the Nylon District Hospital, Bonassama District Hospital over a period of 04 months from January 13, 2020 to April 18, 2020.

2.2. Study Population

Our target population consisted of all newborns from the hospitals in our study, born alive, at term during the recruitment period (January 2020-April 2020), with a single-fetal pregnancy.

2.3. Inclusion Criteria

Any newborn born alive during the recruitment period in the above-mentioned hospitals, vaginally or by cesarean section, seen in the first 24 hours of life from a single-fetal pregnancy of gestational age was included. Between 37 completed weeks and 41 weeks of amenorrhea + 6 days of which the mother had given her consent. A total of 1146 newborn were sreened and 305 finally included.

2.4. Non-Inclusion Criteria

Newly eligible people whose mothers did not consent to the study.

2.5. Exclusion Criteria

Excluded were:

- Newborns whose term was unclear.
- Newborns with congenital malformations or signs of embryo-foetopathy.

2.6. Sampling

We carried out non-exhaustive consecutive sampling.

2.7. Procedure

Administrative process

We obtained authorization (Ethical Clearance No. 2144) from the institutional ethics committee of the University of Douala as well as research authorizations in the various hospitals.

Data collection procedure

In order to determine the fetal anthropometric profile, a questionnaire was developed for this purpose. Mothers were interviewed upon admission to the maternity ward or within 48 hours of giving birth.

It included the variables.

- *Obstetric monitoring*
  - The date of the last period
  - The term of the pregnancy which was calculated in weeks of amenorrhea from the date of the last period (by questioning the mother/pregnancy logbook) with the Naegle formula (gestational age = date of the last period + 7 days − 3 months) or from the ultrasound in the first trimester (before the 14th week). In the event of discrepancy between the two estimates, the gestational age calculated from the date of the first trimester ultrasound was used.
- *Progress of childbirth*
  - Delivery routes
  - Indications if cesarean section
- *Anthropometric profile of the newborn*
  - Sex
  - Apgar
  - Caput succedaneum
  - Anthropometric parameters: the parameters studied were: weight in grams, height in centimeters, upper arm, thoracic and cranial perimeters in centimeters.

The anthropometric measurements of the newborn were taken at birth in the delivery room or within 24 hours after birth in hospital (except weight):

- Weight was measured in grams using baby scales from different hospitals. Newborns were weighed naked directly at birth. We delicately placed the newborn in supine position on the tared scale covered with a fine wipe. The value obtained once the newborn was stable on the scale was noted.

- The height of the newborn was measured with a horizontal measuring rod graduated in centimeters, the newborn being naked lying on his back, along the measuring rod. She was taken with the help of the mother. It was placed behind the fixed part of the measuring board against which the baby's head was positioned. We stood on the side of the movable part of the measuring board on which the feet were resting. The child's legs were extended thanks to light pressure on the knees without hurting the child, then the movable base of the height chart was slid against the flat soles of the feet, the toes turned upwards and we noted the size value.

- The cranial, thoracic and brachial perimeters were measured to the nearest centimeter, using a non-extensible tape measure: For the cranial perimeter, we carefully placed the tape measure around the head, choosing the point where the circumference is largest corresponding to the greatest occipito-frontal diameter, that is to say a width of one or two fingers above the eyebrow on the forehead and the most prominent point at the back of the head. The chest circumference was measured by applying the measuring tape around the newborn's thorax through an imaginary line passing through the most prominent point of the chest, in most cases at the level of the nipples. Finally, the upper arm circumference was measured at the level of the newborn's left arm midway between the acromion and the olecranon.

The team in charge of the anthropometric measurements consisted of 5 peoplefrom a Gynecologist and university professor, two pediatric hospital practitioners and lecturers and a 7th year medical student tutored in this task.

The data recorded on the forms were entered consecutively into a digital database created for this purpose and the entered forms stored in a binder.

This thus prevented a risk of duplication or confusion.

3. Definitions of Operational Terms

3rd percentile: Value of a parameter in relation to which 3% of measurements are lower and 97% are higher.

10th percentile: Value of a parameter relative to which 10% of measurements are lower and 90% are higher.

90th percentile: Value of a parameter relative to which 90% of measurements are lower and 10% are higher.

97th percentile: Value of a parameter relative to which 97% of measurements are lower and 3% are higher.

Small for gestational age newborn: A newborn whose birth weight is less than the 10th percentile for gestational age.

Macrosome: Newborn whose birth weight is greater than or equal to the 90th percentile for gestational age.

4. Statistical Analysis

The data collected were recorded and analyzed by the Census Survey Processing

System CS Pro version 7.3 and Statistical Package for Social Science SPSS 25 software.

The results were expressed in terms of average (average weight, average height, average head circumference, average arm circumference, average chest circumference) in the form of tables and graphs using Microsoft Office Excel 2016 and Word 2013 software. To study trophicity, we also brought out the distribution of anthropometric measurements in percentiles using SPSS software.

The Student, Chi-square and Fischer tests were used to compare the means of the variables, the percentages with a significance threshold P value < 0.05. Analysis of variance (ANOVA) made it possible to compare the parameters of newborns according to gestational age groups.

5. Ethical Considerations

Our study was previously submitted for approval to the institutional ethics committee of the University of Douala, and obtained ethical clearance allowing us to conduct our study. Study authorization was also obtained from the administrative services of the hospitals in our study.

Parents of eligible newborns were clearly informed by the information sheet.

We carried out our study in strict compliance with the fundamental principles of medical research: the principle of the interest and benefit of research, the principle of the safety of research, confidentiality, and justice.

During our study period, 305 full-term newborns were included, divided into 172 boys and 133 girls (Figure 1) with a sex ratio of 1.3.

In our sample, 3 out of ten women gave birth had a gestational age of between 38 and 39 weeks of amenorrhea. The average gestational age was 39.2 weeks ± 1.21 with a median of 39.2 weeks (Figure 2) and the greatest number of births was recorded between 38 - 39 weeks of amenorrhea for all sexes combined (Table 1).
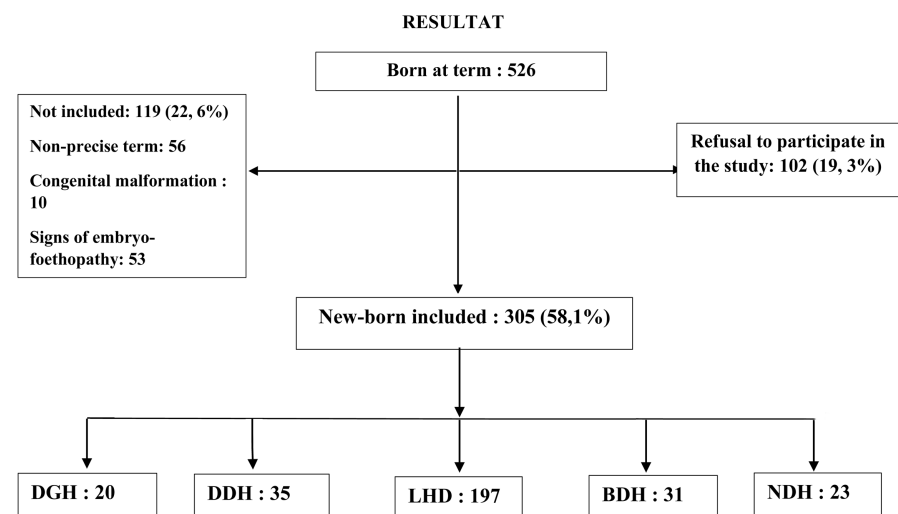

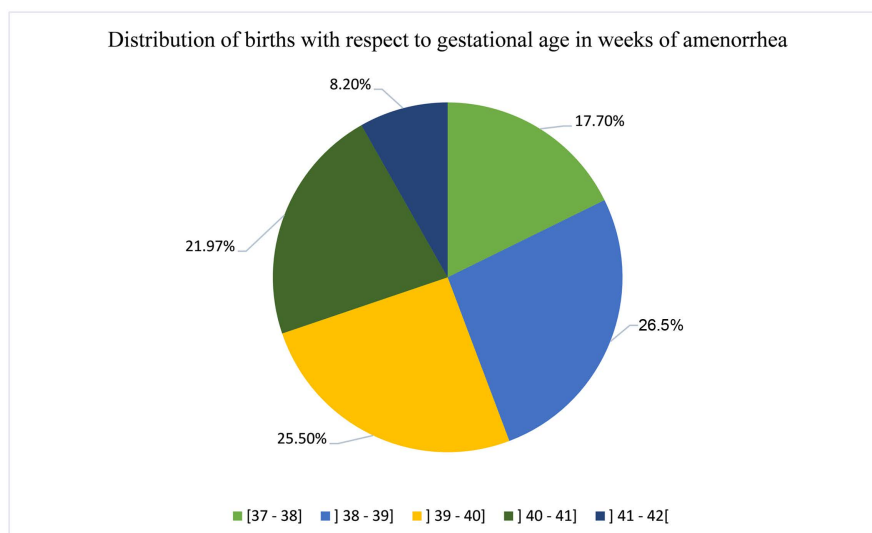**Figure 1.** Full-term newborn inclusion flowchart.

Figure 2. Distribution of births according to the term of pregnancy.

Table 1. Distribution of newborns according to sex and gestational age.

Gestational age (WA)	Male(%)	Female(%)	All (%)
[37 - 38]	25 (14.5)	29 (21.8)	54 (17.7)
[38 - 39]	48 (27.9)	34 (25.6)	82 (26.8)
[39 - 40]	47 (27.3)	31 (23.3)	78 (25.6)
[40 - 41]	40 (23.2)	27 (20. 3)	67 (22.0)
[41 - 42]	12 (7.0)	12 (9.0)	24 (7.9)
Total	172 (56.3)	133 (43.6)	305 (100.0)

6. Basic Information about Newborns

6.1. The Weight of Newborns

The overall average weight in our series was 3305.4 grams with extremes of 1840 grams and 5220 grams. The average weight was higher in newborn males (3368.8 grams vs 3222.3 grams) and it increased with gestational age. The weight of boys was higher regardless of gestational age.

A statistically significant difference was found between the weight of boys and girls between the 40th and 41st weeks of amenorrhea (p = 0.039) (Table 2).

We found a statistically significant difference between the means of weight, height, head circumference, upper arm circumference and thoracic circumference between girls and boys (Table 3).

6.2. The Size of the Newborns

The average height in our series was 49.8 centimeters with extremes of 41 and 56 centimeters. The average height was higher among newborn males (50.0 centimeters vs. 49.6 centimeters). Depending on the gestational age, the average size

increased between the 37th and the 41st week then decreased after the 41st week. A statistically significant difference was found between the height of girls and boys between the 40th and 41st weeks (p = 0.006) (Table 4).

6.3. The Head Circumference of Newborns

The overall average head circumference in our sample was 34.6 centimeters with extremes of 30 and 38 centimeters and a median value of 35 centimeters. It was higher in newborn males (34.8 centimeters vs 34.2 centimeters), remained higher regardless of gestational age.

We found a statistically significant difference between the head circumference of boys and girls between the 40th and 41st weeks (p = 0.039) (Table 5).

6.4. Upper Arm Circumference of Newborns

The overall mean upper arm circumference in our sample was 11.3 centimeters with extremes of 8 and 14 centimeters and a median value of 11 centimeters. The average upper arm circumference was higher in male newborns (11.4 centimeters vs. 11.2 centimeters).

Depending on gestational age, the mean upper arm circumference increased with gestational age and was higher in male newborns regardless of gestational age.

At all these different gestational ages, there was no significant difference between the upper arm circumference of boys and girls (Table 6).

6.5. The Chest Circumference of Newborns

The overall mean chest circumference in our sample was 32.8 centimeters with extremes of 27 and 38 centimeters and a median value of 33 centimeters.

Depending on gestational age, the mean chest circumference increased with gestational age and was higher in male newborns regardless of gestational age (Table 7).

At all these different gestational ages, there was no significant difference between the chest circumference of boys and girls.

We also studied the distribution in percentiles of these parameters within the study population in order to identify the threshold values defining small for gestational age (< 10th percentile) and normal for gestational age (between the 10th and 90th percentile) and large for gestational age (> 90th percentile).

In our study population we reported a 3rd percentile at 2380 grams, a 10th percentile at 2656 grams, a 90th percentile at 3966 grams and a 97th percentile at 4351 grams (Table 8).

By sex, the percentile distribution of weight was higher among male newborns (Table 9).

- Regarding the size of newborns, in our sample, we found a 3rd percentile at 45 centimeters, a 10th percentile at 48 centimeters, a 90th percentile at 52 centimeters, a 97th percentile at 54 centimeters.

- Depending on sex, the distribution in percentiles of height was higher in male newborns for the 3rd and 97th percentiles but the 10th and 90th percentiles had the same values for all sexes combined (Table 10).

- *The head circumference of newborns*:

Overall, we had a 3rd percentile at 32 centimeters, a 10th percentile at 33 centimeters, a 90th percentile at 36 centimeters, a 97th percentile at 38 centimeters.

Depending on sex, the distribution in percentiles of head circumference was higher in female newborns for the 3rd percentile. For the 10th, 90th and 97th percentile the distribution was higher among newborn males (Table 11).

- *The upper arm circumference of newborns*:

We had a 3rd percentile at 09 centimeters, a 10th percentile at 10 centimeters, a 90th percentile at 13 centimeters, a 97th percentile at 13 centimeters.

Depending on sex, the distribution in percentiles of mid-upper arm circumference is higher in male newborns for the 3rd and 90th percentiles but the 10th and 97th percentiles had the same values for all sexes combined (Table 12).

- *The chest circumference of newborns*:

In our series, we found a 3rd percentile at 29 centimeters, a 10th percentile at 30 centimeters, a 90th percentile at 35 centimeters and a 97th percentile at 36 centimeters.

Depending on sex, the distribution in percentiles of chest circumference is higher in male newborns for the 10th, 90th percentile and 97th percentile but the 3rd percentile had the same value for all sexes combined (Table 13).

Table 2. Distribution of average weights according to gestational age and sex.

Gestational age	All	Male	Female	P-value
[37 - 38]	3077.0 ± 539.1	3132.4 ± 564.3	3029.3 ± 521.6	0.488
[38 - 39]	3177.0 ± 466.9	3201.8 ± 459.2	3142.0 ± 482.3	0.570
[39 - 40]	3416.3 ± 467.6	3476.3 ± 462.8	3322.1 ± 465.8	0.117
[40 - 41]	3471.1 ± 483.1	3595.8 ± 462.6	3326.0 ± 474.4	**0.039**
[41 - 42]	3474.5 ± 468.7	3453.8 ± 573.7	3512.8 ± 186.2	0.796

Table 3. Average anthropometric parameters at birth.

Gestational age	All	Male	Female	P-value
Weight (g)	3305.4	3368.8 ± 509.8	3222.3 ± 488.4	**0.011**
Height (cm)	49.8	50.0 ± 2.0	49.6 ±1.9	**0.029**
HC (cm)	34.6	34.8 ± 1.9	34.2 ± 1.3	**0.002**
UAC (cm)	11.3	11.4 ± 1.0	11.2 ± 0.9	**0.034**

Table 4. Distribution of average height according to gestational age and sex.

Gestational age	All	Male	Female	P-value
[37 - 38]	49.1 ± 2.3	49.5 ± 2.1	48.8 ± 2.5	0.341
[38 - 39]	49.6 ± 2.0	49.8 ± 1.9	49.3 ± 2.1	0.269
[39 - 40]	50.2 ± 1.5	50.3 ± 1.6	50.1 ± 1.4	0.533
[40 - 41]	50.2 ± 1.3	50.7 ± 1.3	49.7 ± 1.2	**0.006**
[41 - 42]	49.9 ± 3.0	49.6 ± 2.9	50.4 ± 0.9	0.603

Table 5. Distribution of average head circumference according to gestational age and sex.

Gestational age	All	Male	Female	P-value
[37 - 38]	33.8 ± 1.6	34.3 ± 1.6	33.5 ± 1.5	0.073
[38 - 39]	34.4 ± 1.5	34.4 ± 1.6	34.4 ± 1.3	0.941
[39 - 40]	34.7 ± 1.2	34.8 ± 1.2	34.5 ± 1.3	0.254
[40 - 41]	35.1 ± 1.5	35.4 ± 1.7	34.6 ± 1.7	**0.039**
[41 - 42]	35.5 ± 3.6	36.4 ± 1.2	34.0 ± 0.8	0.159

Table 6. Distribution of average upper arm circumference according to gestational age and sex.

Gestational age	All	Male	Female	P-value
[37 - 38]	10.9 ± 1.0	11.0 ± 1.1	10.8 ± 1.0	0.541
[38 - 39]	11.2 ± 0.9	11.2 ± 0.8	11.2 ± 1.0	0.976
[39 - 40]	11.4 ± 1.0	11.6 ± 1.0	11.2 ± 0.8	0.071
[40 - 41]	11.7 ± 1.0	11.8 ± 1.0	11.5 ± 1.0	0.222
[41 - 42]	11.7 ± 0.5	11.7 ± 0.6	11.7 ± 0.5	0.955

Table 7. Distribution of average chest circumference according to gestational age and sex.

Gestational age	All	Male	Female	P-value
[37 - 38]	32.1 ± 1.7	32.6 ± 1.8	31.6 ± 1.6	0.050
[38 - 39]	32.6 ± 1.7	32.9 ± 1.6	32.4 ± 1.7	0.209
[39 - 40]	33.0 ± 1.6	33.3 ± 1.7	32.6 ± 1.4	0.052
[40 - 41]	33.3 ± 1.5	33.5 ± 1.6	33.1 ± 1.6	0.269
[41 - 42]	33.4 ± 1.2	33.7 ± 1.0	33.7 ± 1.2	0.056

Table 8. Percentile distribution of anthropometric parameters.

	Weight (g)	Height (cm)	HC (cm)	UAC (cm)	CC (cm)
Percentiles					
3rd	2380.0	45.0	32.0	9.0	29.0
5th	2500.0	46.3	32.0	10.0	30.0
10th	2656.0	48.0	33.0	10.0	31.0
50th	3300.0	50.0	35.0	11.0	33.0
90th	3966.0	52.0	36.0	13.0	35.0
97th	4351.0	54.0	38.0	13.0	36.0

Table 9. Percentile distribution of weight by sex.

	Weight (g)	
Percentiles	Male	Female
3rd	2422.0	2329.7
5th	2564.0	2380.0
10th	2774.0	2513.0
50th	3310.0	3220.0
90th	4024.0	3780.0
97th	4391.2	4300.0

Table 10. Percentile distribution of height by sex.

	Height (cm)	
Percentiles	Male	Female
3rd	45.0	44.0
5th	47.0	46.0
10th	48.0	48.0
50th	50.0	50.0
90th	52.0	52.0
97th	54.0	53.0

Table 11. Percentile distribution of head circumference by sex.

	Head circumference (cm)	
Percentiles	Male	Female
3rd	31.0	32.0
5th	32.0	32.0

Continued

10th	33.0	32.3
50th	35.0	34.0
90th	37.0	36.0
97th	38.0	37.0

Table 12. Percentile distribution of upper arm circumference by sex.

	Upper arm circumference (cm)	
Percentiles	Male	Female
3rd	9.2	9.0
5th	10.0	10.0
10th	10.0	10.0
50th	11.0	11.0
90th	13.0	12.7
97th	13.0	13.0

Table 13. Percentile distribution of height by sex.

	Chest circumference (cm)	
Percentiles	Male	Female
3rd	29.0	29.0
5th	30.0	29.6
10th	30.4	31.0
50th	33.0	33.0
90th	35.0	34.0
97th	36.0	35.0

6.6. Anthropometric Profile of the Newborn

Our investigation focused on 172 boys (56.3%) and 133 girls (43.6%), i.e. a sex ratio of 1.3, far from the findings in the literature, such as Fengqing *et al*, whose sex ratio was 1.06 with, however, like us, a male predominance. More specifically, depending on the continent, a sex ratio of 1.04 in America, 1.075 in Central Asia, 1.054 in Europe and 1.03 in sub-Saharan Africa was reported, thus matching our results [15].

6.7. Weight of Newborns

The overall average weight in our series was 3305 grams.

Considering the findings of other authors both from the same geographical area and elsewhere, our weight reference was dichotomous; this data is complex and integrates the individual genetic constitution of the parents and hence the fusion product of their procreation including racial, ethnic, geographical, nutritional and socio-economic factors; hence this disparity compared to the findings of other authors on this theme [16].

If similarity or superposition there is with Yihua *et al*. in China (3374 grams) [17], Jerbi *et al*. in Tunisia (3278.2 grams) [18] Neggers *et al*. (3272 grams) [9], our finding was however higher than those of Tieche *et al*. (3229 grams) in Yaoundé [14] Ashraf *et al*. in Qatar (3185 grams) Adimora *et al*. in Nigeria (3170 grams) [15], Ndiaye *et al*. in Senegal (3120 grams) [12].

Like the findings of Djadou *et al*. in Togo, Yestea *et al*. in Spain, Huque *et al*. in Bangladesh, the average weight values were higher in newborn males (3368.8 grams vs 3222.3 grams) with a statistically significant difference [8] [19] [20]. Aly *et al*. cited a high level of serum type I C-terminal collagen propeptide (marker of fetal bone formation) in boys compared to girls to explain variations in weight according to sex [21].

The cutoff values defining the 10th percentile and the 90th percentile in our study were 2656 grams and 3966 grams. Which differed from the data of Yé *et al*. [13] who found 2400 grams and 3350 grams or those of Ndiaye *et al*. which had 2600 grams and 3648 grams [12]. Once again these differences reflect the genetic potential and nutritional variations of populations.

6.8. Size of Newborns

The average size of newborns was 49.8 centimeters, close to that reported by Tietche *et al*. (49 cm) [14] whose study took place in the same human mix because it was national, but higher than that of Djadou *et al*. in Togo (48.4 cm) [19].

Apart from parental anthropometric characteristics which could be incriminated here, the measurement of height in newborns is subject to variations in posture and tone which, if left uncontrolled, could create measurement biases.

According to sex, in agreement with data from Senegal, Togo and Burkina Faso, male newborns had a higher average height: 50.0 centimeters vs. 49.6 centimeters. But the mechanisms by which sex influences height are poorly understood [12] [13] [19].

Unlike Yestea *et al*. [22] who reported an increase in size with gestational age, in our series, the size of newborns decreased beyond the 41st week. The variations in size according to gestational age are still little studied today. Beyond the 41st week of amenorrhea, the occurrence of placental calcifications necessarily reduces maternal-fetal nutritional exchanges and therefore probably impacts growth; which, in our opinion, justifies our finding.

The threshold values for the 10th percentile and the 90th percentile in our study (48 centimeters and 52 centimeters) were higher than the thresholds reported in other African series [12] [13].

6.9. The Head Circumference of Newborns

The average head circumference of newborns (34.6 cm) was comparable to those of other authors, notably Tietche in Cameroon (34.7 cm) [14] Djadou *et al.* (34.2 cm) [19] Ashraf *et al.* (34.5 centimeters) [23].

Depending on gender, most studies also reported a higher average head circumference in boys [12] [13].

Like Yestea *et al*, we found that head circumference increased with gestational age in accordance with optimal brain growth [22].

The threshold values for the 10th percentile and the 90th percentile in our study were (33 cm and 36 cm) superimposable to the thresholds reported by Ndiaye *et al* (32.8 cm and 35.9 cm) [12].

6.10. Upper Arm Circumference of Newborns

The average upper arm circumference of newborns was 11.3 centimeters. Long-term anthropometric studies involving mid-upper arm circumference are not numerous, but our data were close to the majority of studies identified; notably 10.6 cm for Tietche *et al*; 10.8 cm for Neggers *et al.* 10.7 cm for Yé *et al.* The slight disparities observed could be attributable to the measurement conditions [9] [13] [14].

Depending on gender, similar to the results from Yé in Ouagadougou, the average upper arm circumference was higher in boys [13].

The cutoff values for the 10th percentile and 90th percentile in our study were 10 cm and 13 cm. The 10th percentile had almost the same value in other African series that we consulted [12] [13] [19].

6.11. Chest Circumference of Newborns

The average chest circumference of newborns was 32.8 centimeters; it was superimposable to the average thoracic perimeter found in other studies (33 cm) [9] [10] [14] [19].

Depending on gestational age and sex, we agree with the findings of Yestea *et al.* with an increase in thoracic circumference with gestational age and a higher value in boys [22]. This variation according to sex would be in agreement with corpulence in adulthood.

The cutoff values for the 10th percentile and 90th percentile in our study were 30 centimeters and 35 centimeters. Like the upper arm circumference, the 10th percentile tended to keep the same value in other African studies [12] [13].

7. Conclusions

The anthropometric data of the full-term newborn in the city of Douala were: an average weight of 3305.4 grams, an average height of 49.8 centimeters, an average head circumference of 34.2 centimeters, an average upper arm circumference of 11 .3 centimeters, an average thoracic circumference of 32.8 centimeters with ever higher values in male newborns.

The percentile distribution showed a 10th percentile at 2656 grams and a 90th

percentile at 3966 grams for weight defining the limits for small-for-gestational-age newborns and macrosomes.

Acknowledgements

Conflicts of Interest

The authors declare that they have no conflict of interest; research concernswere essentially scientific.

References

[1] Comité d' Experts OMS (1995) Utilisation et interpretation de l'anthropometrie. Benteli, Genève, No. 854, 508 p.

[2] Nikiema, L., Martin-Prevel, Y., Testot-Ferry, A., Diarra, A., Tapsoba, S. and Sondo, B. (2015) Facteurs de risque associés au Retard de Croissance Intra Utérin: Étude cas-témoins dans la ville de Ouagadougou (Burkina Faso). *Congrès Francoph d' Epidémiologie en milieu Tropicales*, Montpellier, 20-22 May 2015.

[3] Mukuku, O., Shongo, M., Kakudji, P. and Luboya, O. (2017) Poids des nouveau-nés à la naissance à Lubumbashi, République Démocratique du Congo. *Médecine et Santé Tropicales*, **1**, 35-42.

[4] Gaudineau, A. (2013) Prévalence, facteurs de risque et morbi-mortalité materno-fœtale des troubles de la croissance fœtale. *Journal de Gynécologie Obstétrique et Biologie de la Reproduction*, **42**, 895-910.
https://doi.org/10.1016/j.jgyn.2013.09.013

[5] Harir, N., Belkacem, A., Dahmani, N. and Hadef, F. (2014) Wilaya d'El Bayadh (Sud-ouest Algérien): Étude des facteurs de risque de faible poids de naissance au cours du dernier trimestre de la grossesse. *Anthropos*, **32**, 79-87.

[6] Ilunga, P., Mukuku, O., Mawaw, P., Mutombo, A., Lubala, T., Shongo, Y., *et al.* (2016) Risk Factors for Low Birth Weight in Lubumbashi, Democratic Republic of the Congo. *Médecine et Santé Tropicales*, **26**, 386-390.
https://doi.org/10.1684/mst.2016.0607

[7] Mafina-Mienandi, M.-C., Ganga-Zandzou, P.-S., Makoumbou, P., Malonga, H., Ekoundzola, J.-R. and Mayanda, H.-F. (2002) Travail Original Facteurs de risque de retard de croissance intra-utérin au Congo. *Journal of Obstetrics & Gynecology and Reproductive Biology*, **31**, 500-505.

[8] Huque, F. and Hussain, Z. (1991) Detection of Low Birth-Weight New Born Babies by Anthropometric Measurements in Bangladesh. *The Indian Journal of Pediatrics*, **58**, 223-231. https://doi.org/10.1007/BF02751125

[9] Neggers, Y., Goldenberg, R., Cliver, S., Hoffman, H. and Cutter, G. (1995) The Relationship between Maternal and Neonatal Anthropometric Measurements in Term Newborns. *Obstetrics & Gynecology*, **85**, 192-196.
https://doi.org/10.1016/0029-7844(94)00364-J

[10] BSï, B., Uygur, Ö., Terek, D., Köroğlu, Ö.A., *et al.* (2018) Reference Values of Anthropometric Measurements in Healthy Late Preterm and Term Infants. *Turkish Journal of Medical Sciences*, **48**, 862-872. https://doi.org/10.3906/sag-1712-44

[11] Jin, C., Li, Y., Li, X., Liu, C., Wang, M., Cheng, Y., *et al.* (2019) Associations of Gestational Age and Birth Anthropometric Indicators with Brain White Matter Matu-

ration in Full-Term Neonates. *Human Brain Mapping*, **40**, 3620-3630. https://doi.org/10.1002/hbm.24620

[12] Ndiaye, O., Sylla, A., Diouf, S., Guèye, Mo., Guèye, Ma., Guélaye, M., *et al.* (2004) Paramètres anthropométriques du nouveau-né à terme au Sénégal. Résultats préliminaires. *Archives de Pédiatrie*, **11**, 259-260. https://doi.org/10.1016/j.arcped.2003.12.013

[13] Ye, D., Kam, K.L., Ouattara, Y. and Sawadogo, A. (2005) Paramètres anthropométriques du nouveau-né burkinabé à terme dans une maternité de la ville de Ouagadougou (Burkina Faso). *Archives de Pédiatrie*, **12**, 1277-1279. https://doi.org/10.1016/j.arcped.2005.04.079

[14] Tietche, F., Gwanvalla, J.F., Koki, P., Kago, I., Monebenimp, F., Mbede, J., *et al.* (1994) Paramètres anthropométriques du nouveau-né camerounais à terme en milieu urbain. *Medecine d'Afrique noire*, **41**, 147-149.

[15] Adimora, G., Chukwudi, N. and Ejke, O. (2004) Birth Weights of Full Term Newborn Babies among the Igbos of Eastern Nigeria. *Nigerian Journal of Clinical Practice*, **7**, 33-36.

[16] Gultekin, T., Hauspie, R., Susanne, C. and Gulec, E. (2006) Growth of Children Living in the Outskirts of Ankara: Impact of Low Socio-Economic Status. *Annals of Human Biology*, **33**, 43-54. https://doi.org/10.1080/03014460500424050

[17] Yihua, B., Zhan, Z., Liu, Q., Wu, D. and Wang, S. (2013) Maternal Risk Factors for Low Birth Weight in a Developed Region in China: A Hospital-Based Study of 55, 633 Pregnancies. *The Journal of Biomedical Research*, **27**, 14-22. https://doi.org/10.7555/JBR.27.20120046

[18] Jerbi, M., Hidar, S., Hannachi, N., Moueddeb, S., Djebarri, H. and Boukadida, J. (2007) Facteurs de risque du portage du streptocoque du groupe B chez la femme enceinte à terme: Étude prospective à propos de 294 cas. *Gynécologie Obstétrique Fertilité & Sénologie*, **35**, 312-316. https://doi.org/10.1016/j.gyobfe.2007.01.027

[19] Djadou, K., Sadzo-Hetsu, K., Tatagan, K., Assimadzi, K., Sodzi, K. and Lapillonne, A. (2005) Paramètres anthropométriques, fréquence et facteurs de risque du retard de croissance intra-utérin chez le nouveau-né à terme dans la région du Nord-Togo. *Archives of Pediatrics*, **12**, 1320-1326. https://doi.org/10.1016/j.arcped.2005.03.051

[20] Chao, F.Q., Gerland, P., Cook, A.R. and Alkema, L. (2019) Systematic Assessment of the Sex Ratio at Birth for All Countries and Estimation of National Imbalances and Regional Reference Levels. *Proceedings of the National Academy of Sciences*, **116**, 9303-9311. https://doi.org/10.1073/pnas.1812593116

[21] Aly, H., Moustafa, M.F., Amer, H.A., Hassanein, S., Keeves, C. and Patel, K. (2005) Gestational Age, Sex and Maternal Parity Correlate with Bone Turnover in Premature Infants. *Pediatric Research*, **57**, 708-711. https://doi.org/10.1203/01.PDR.0000160591.70409.C8

[22] Yestea, D., Carrascosaa, A., Copila, A., Almarb, J., Salcedob, S. and Gussinyé, M. (2004) Paramètres anthropométriques des nouveau-nés prématurés et à terme (24-42 semaines d'age gestationnel) à l'Hopital Materno-Infantil Vall d'Hebron (Barcelone) (1997-2002). *Anales de Pediatría*, **60**, 406-416.

[23] Soliman, A.T., Eldabbagh, M., Saleem, W., Zahredin, K., Shatla, E. and Adel, A. (2013) Placental Weight: Relation to Maternal Weight and Growth Parameters of Full Term Babies at Birth and during Chilhood. *Journal of Tropical Pediatrics*, **59**, 358-364. https://doi.org/10.1093/tropej/fmt030