Birthweight and gestational age centiles in South Indian newborns

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Abstract

Background: India has recently gone through a vast technological and economic revolution which has influenced all sections of society. The study was undertaken to determine any changes in the pattern of intrauterine growth in South Indian babies over three decades compared with national and international studies.

Objectives*:* To construct new 2015-2017 centile charts for birthweight in babies born from 28 to 42 gestational weeks in the metropolitan city of Bangalore, South India compared with an earlier South Indian centile chart constructed in 1983 at Christian Medical College and Hospital (CMCH), Vellore, India and other national and international studies.

Design, setting and method*:* This is a retrospective study of two cohorts. The first cohort consisted of 4,426 consecutive live births from January to December 1983, at CMCH, a tertiary referral hospital in South India. The second cohort consisted of 2,708 consecutive live births from January 2015 to May 2017 at Shifaa Hospital, a multispecialty centre, in the metropolitan city of Bangalore, South India, about 300 km from CMCH. The chief outcome measure was birthweight centiles according to gestational age. The two cohorts of singleton live births were analysed to determine the mean birth weights, gestation and centile growth patterns. Data were obtained from labour room records.

Results: Among a total of 4,426 live births during 1983, the mean birthweight was 2881g and among 2,708 live births during 2015-2017, the mean birth weight was 2873g, a difference of 8g. The mean gestation was 38.8 weeks in the former and 38.2 weeks in the latter study respectively. The centile growth curves among the two cohorts revealed almost similar percentile weight distribution except for preterm 31-36 weeks gestation, where birthweights in the 2015-2017 cohort were 200-300g higher compared to the 1983 cohort. However, the 90th centile curve, at term 38-40 weeks revealed an increase of 200-300g weight gain in 1983 cohort which thereafter plateaued, with 300g weight gain at 40-41 weeks in the 2015-2017 cohort. Comparison was also made with both national and international centile intrauterine growth curves.

Conclusions: The 2015-2017 centile charts for birthweight in babies born from 28 to 42 gestational weeks in the metropolitan city of Bangalore, South India had almost similar growth curves and mean birthweights compared to the 1983 South Indian centile chart indicating an inherent genetic predisposition for the small Indian baby. The updated centiles for births during 2015-2017 provide a more valid tool to assess South Indian fetal growth.

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(Key words: Asian birthweight, gestational age, centiles, SGA, LGA, AGA)

Introduction

Birth weight is an indicator of antenatal well-being, postnatal complications and survival[1,2]. Although birth weight is a standard, cut-offs like 1500g or 2500g do not differentiate the roles of growth and maturity unlike birth weight for gestational age[3,4]. Birthweight percentiles demonstrating birthweight distribution at each gestational age help clinicians to identify babies who require increased monitoring. Population specific updated growth charts are useful for the categorisation of babies as small for gestational age (SGA), large for gestational age (LGA) or appropriate for gestational age (AGA).

Objectives

This is a retrospective study. The study was carried out with the aim of:

- Estimation of birth weights and gestational ages in two cohorts of babies born in 1983 and 2015-2017 in South India.
- To obtain a standard birth weight and gestational age centiles reference range for South Indian babies.

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- Comparison of 10th, 25th, 50th, 75th, and 90th centile growth charts over three decades to determine inherent or genetic factors at play rather than environmental factors, as newborn birth weights are expected to increase due to technological advances and economic reforms over the decades.

- Comparison of the above mentioned statistics with available national and international studies.

Method

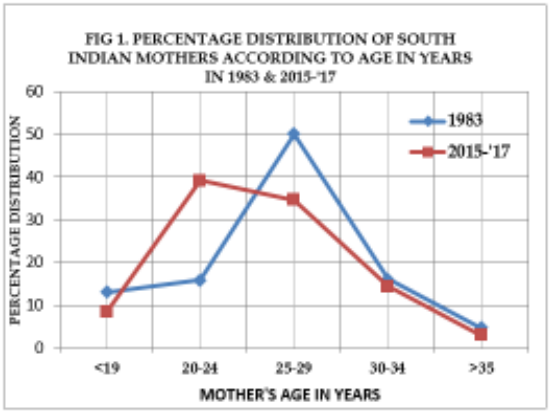
This is a retrospective study of two cohorts. The first cohort consisted of 4,426 consecutive live births from January to December 1983, at Christian Medical College and Hospital (CMCH) Vellore, a tertiary referral hospital in South India. The second cohort consisted of 2,708 consecutive live births from January 2015 to May 2017 at Shifaa Hospital, a multispecialty centre, in the metropolitan city of Bangalore, South India, about 300 km from CMCH, both centres catering to almost similar middle and lower socioeconomic populations.

Data were obtained from the labour room register at CMCH, Vellore for 4426 live births in 1983, and from the labour room register at Shifaa Hospital, Bangalore for 2078 live births in 2015-2017. All consecutive live births delivered between 28 to 42 weeks of gestation were considered. In the 1983 study, gestation was estimated based on a reliable menstrual history, early antenatal clinical examination, and in around 60%, using sonographic fetal biometry. In the 2015-2017 study, crown-rump length (CRL) measurement by ultrasound examination was undertaken in all women within 18-20 weeks to establish fetal age when menstrual dates were unknown or in pregnancy with discrepancy greater than ±7 days. If CRL and menstrual dates agreed to within the normal range of error (±7 days), then the last menstrual period was used to establish fetal age. Gestational age is recorded as completed gestational weeks.

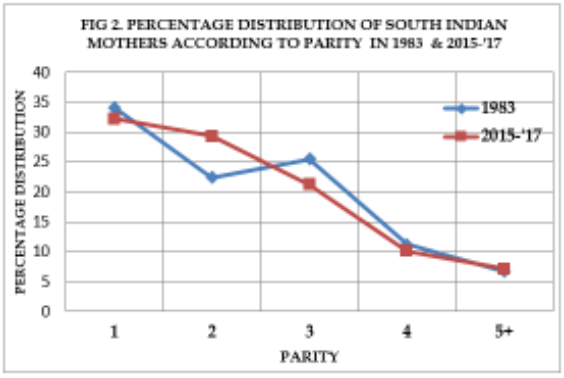
Birth weights were measured within an hour of birth on a Braun electronic weighing scale to the closest 50g in the 1983 study and on a digital weighing machine accurate up to ±10g in the 2015-2017 study. The data were entered using EPIINFO software in the 1983 study. In the 2015-2017 study, data were entered into EPIDATA entry software, 3.1.2701.2008 and data analysis was done using STATA version 13.1. The actual birth weight centiles were used to construct the charts rather than smoothed centiles. The extremely low birthweights below 28 weeks gestation were excluded being few in number and outliers. Centile charts were constructed for birthweight in infants 28 to 42 weeks' gestation.

Results

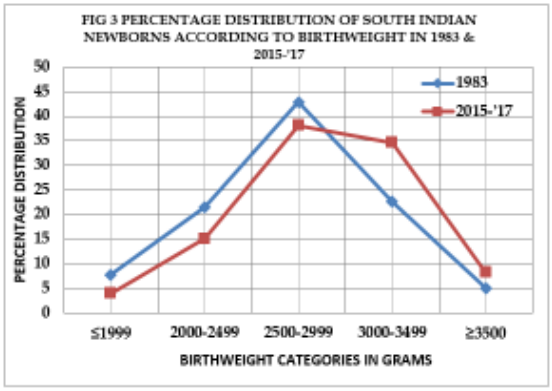
There were 4,426 consecutive live births during the twelve months from January to December 1983 at CMCH, Vellore and 2,708 consecutive live births during twenty nine months from January 2015 to May 2017 at Shifaa Hospital, Bangalore. The mean birthweights were 2881g during the 1983 study and 2873g during the 2015-2017 study, a difference of 8g. The centile growth charts were constructed using actual birthweights. However similar mean birthweights were noted with a difference of only -8g in the 2015-2017 study, with changes in maternal factors over past three decades, with 16% (n=553) aged 20-24 years a difference of 24%. Thus 70.9% (n=2471) among 3481 mothers with known maternal age in the 1983 cohort were older than 24 years compared to 52.2% (n=1351) among 2583 mothers with known maternal age in 2015-2017 cohort. The distribution of mothers according to age in years is seen in Figure 1.



Although 34.1% (n=1519) were primigravidae among a total 4426 births in the 1983 cohort, this reduced to 22.4% (n=992) for second gravida mothers but increased to 25.5% (n=1134) for third gravida mothers. In contrast, 32.7% (n=876) were primigravida mothers among a total 2673 mothers with known parity in the 2015-2017 cohort with a progressive decline in numbers by 5-10% for subsequent pregnancies. Thus 71% of mothers were aged 25 years and above, with 43.3% having three or more pregnancies, in the earlier 1983 cohort compared to 52.3% (n=1351) mothers aged 25 years and above with 37.3% (n=999) mothers with three or more pregnancies in the 2015-2017 cohort. The majority (62.6%) has had one or two pregnancies. In contrast only 56.5% (n=2523) had one to two pregnancies in the 1983 cohort. Hence in the new millennium, a shift towards a small family norm was noted with younger mothers. The distribution of mothers according to parity is seen in Figure 2.



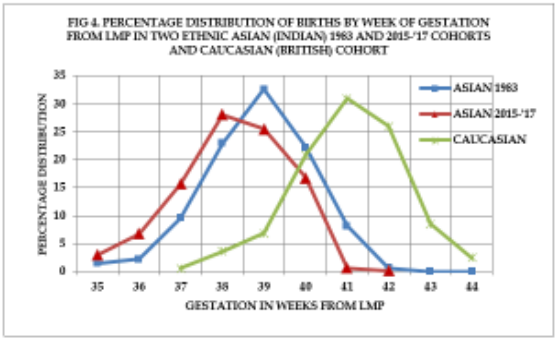
Newborns in the birthweight 2500-2999g category peaked to 43.7% (n=1918) among 4381 births with known birthweight in the 1983 cohort compared to 38.1% (n=1032) among 2708 births with known birthweight in the 2015-2017 cohort, but with 80.9% (n=2191) babies weighing 2500g and above in the recent 2015-2017 cohort compared to 71.6% (n=3141) in the earlier 1983 cohort. Low birthweight below 2500g in the 1983 cohort comprised 29.2% (n=1309) compared to 19.1% (n= 517) in the 2015-2017 cohort. Distribution of newborns by birthweight is seen in Figure 3.



First birth infants comprised 32.7% (n=876) in the 2015-2017 cohort, while second and later births comprised 67.2% (n=1797), though 37.7% (n=1797) of later births weighed 3000-3499g, compared to 41.6% (n=876) first birth infants who weighed 2500-2999g. The mean birth weight for first and later birth infants were 2817±484g and 2899±503g respectively, a difference of 82g (p=0.0001). Thus, younger primigravida mothers tended to have smaller babies. However in the 2015-2017 cohort a minimal increase by 10.4% of birthweight >2500g was noted when compared to the 1983 cohort with older mothers having three or more pregnancies and heavier babies.

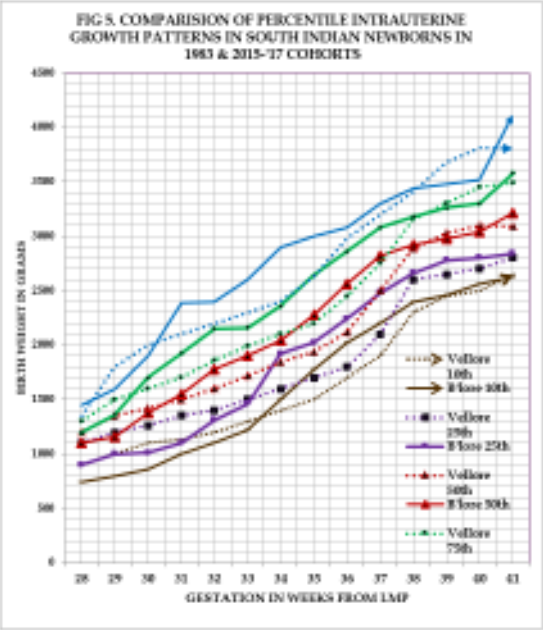
The mean gestation was 38.8 weeks in the 1983 cohort and 38.2 weeks in the 2015-2017 cohort. Term newborns >37 weeks comprised 92.9% (n=4149) in the 1983 cohort and 88.3% (n=2243) in the 2015-2017 cohort. Prematurity (<37 weeks) was 7% (n=315) in the 1983 cohort and 11.6% (n=295) in the 2015-2017 cohort. There were no post term births beyond 42 weeks. Most (45.6%, n=1893) term infants in 1983 cohort compared to 39% (n=875) in 2015-2017 cohort weighed 2500-2999g while preterm 34.2% (n=108) in 1983 cohort weighed 1500-1999g, and 36.6% (n=108) preterm in 2015-2017 cohort weighed 2000-2499g.

Peak births in the two South Indian cohorts, 1983 (32.6%) and 2015-2017 (28.1%) occurred at 39th and 38th weeks of gestation respectively. In contrast, most ethnic Caucasian- British women went into spontaneous labour during the 41st and 42nd week of gestation[5]. The mean gestation 38.86±1.29 (SD) and 38.2±2 (SD) weeks in 1983 and 2015-2017 cohorts respectively, contrasted with peak births 31 percent at 41 weeks among 2100 Caucasian women with mean gestation of 41.03±1.32(SD) weeks, this difference being statistically significant (p<0.001). In fact, less than 9% of Asian women gave birth at 40 completed weeks or 280 days gestation at the expected date of delivery (EDD). In fact more than 90% Asian–Indian women gave birth before EDD. Thus a significant shortened gestation at birth was noted among the South Indian (Asian) population, differing by up to four weeks compared to Caucasian births. This shortened gestation at birth in ethnic Asians results in lower birthweight in the small Asian newborns. The percentage distribution of births by week of gestation from last menstrual period (LMP) in two ethnic Asian (Indian) 1983 and 2015-2017 cohorts and Caucasian (British) cohort is seen in Figure 4.

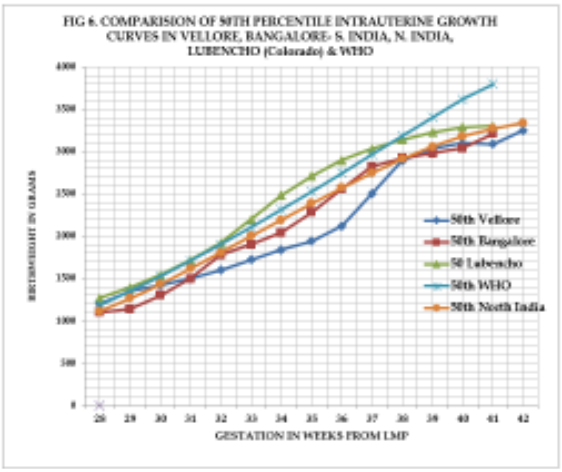


Comparison of birthweight and gestational age centiles in the 1983 cohort and 2015-2017 cohort revealed almost similar intrauterine growth curves, but between gestational ages of 32-37 weeks, birthweight centiles were higher by 100-300g birthweight in the 2015-2017 cohort compared to 1983 cohort. Weight gains thereafter were almost similar in both cohorts between 38 to 39 weeks except that the 90th percentile curve revealed 300 to 500g higher birthweight in 1983 cohort at 40 weeks compared to 2015-2017 cohort which later peaked by 300g at 41 weeks. Superimposition of the 1983 and 2015-2017 intrauterine growth charts for

10th, 25th, 50th, 75th, and 90th percentile curves is seen in Figure 5.



Superimposition with national and international 50th percentile growth curves from North Indian[6], Lubencho (Colorado)[7] computed in 1960s and WHO reported in 2017[8], revealed that both North and South Indian centiles were lower for all gestational ages compared to Lubchenco 50th centile curve with up to 300-500g for preterm 32-37 weeks gestation. Thereafter, Indian babies registered a 'catch up' growth but still lower by 100-300g for term gestation >38 weeks. WHO 50th centile curve corresponded closely to Lubchenco curve for preterm gestation <37 weeks but increased by 500g at 40 weeks[8]. Superimposition of the 50th percentile intrauterine growth curves for South Indian 1983 and 2015-2017 cohorts, study from North India, Colorado (Lubchenco) and multinational WHO percentile curve is seen in Figure 6.



Discussion

Birthweight percentiles represent cross-sectional measurement of birthweight at birth. An increase in birthweights is to be expected in more recent studies due to technological advances and economic reforms over the decades. However, the mean birthweight in the 1983 cohort from Vellore (2881g) was similar three decades later 8g less at 2873g, in 2015-2017 cohort from Bangalore, South India, both centres situated about 300 km apart, catering to almost similar middle and lower socioeconomic populations. Low birth weight (LBW) was 29.2% in the 1983 cohort and decreased to 19.1% in the 2015-2017 cohort. In the 2015-2017 cohort, very low birth weight (VLBW <1500g) babies, comprising 1.6%, had a mean gestation of 33.7±4.2 weeks compared to LBW (1500-2499g) infants with a mean gestation of 37.3±1.8 weeks, this being statistically significant (p<0.001)[9-11].

Similarly, a study from North India reported a mean birth weight of 2725.40±424.64g, mean gestation of 38.1±1.9 (SD) weeks and LBW of 19.8 % in 2010[12]. Another study from South India reported a mean birthweight of 2846g in the year 1996 and 2907g in 2010 (15 years later) a difference of 61 grams in the mean birthweights over one and a half decades[13]. In contrast, western populations report a high mean birth weight of 3446g in U.S. born white women, a difference of 573g compared to the 2015-2017 study[14]. Thus, most Asian births occurred at 38-39 weeks or four weeks before peak Caucasian births at 41-42 weeks[5]. This shortened gestation at birth among Asian–Indian babies result in small babies with lower birthweight compared to Caucasian newborn with longer gestation up to 41-42 weeks who continue to gain weight.

Another interesting demographic trend in the new millennium is a shift towards a small family norm with changes in maternal factors of age and parity with young primigravida. In the 2015-2017 study cohort 32.7% (n=876) primigravida mothers showed a progressive decline by 5-10% for subsequent pregnancies compared to 34.1% primigravida mothers, 22.4% second gravida mothers, increasing to 25.5% (n=1134) third gravida mothers in 1983 cohort. Thus, two thirds (62.6%) of women had one to two pregnancies in the 2015-2017 cohort compared to half 56.5% in the 1983 cohort.

Younger mothers aged 20-24 years peaked at 40% (n=1012) in 2015-2017 cohort compared to 16% (n=553) in the 1983 cohort, a difference of 24%. Thus 70.9% in 1983 cohort were older, above 25 years compared to 52.2% in 2015-2017 cohort. Also 32.7% primigravida mothers delivered babies with mean birth weight of 2817±484g compared to 67.2% second and more births with mean birth weight of 2899±503g, which is a significant (p=0.0001)

difference of 82g. Thus, younger primigravida mothers tended to have smaller babies in the 2015-2017 cohort.

Comparison of Asian-Indian intrauterine growth curves constructed in 1983 and 2015-2017 cohorts demonstrates an inherent genetic predisposition rather than influence of environmental factors of improved obstetric care, technological advances with economic reforms, in that growth patterns for 10th, 25th, 50th, 75th, and 90th centiles in 1983 and 2015-2017 cohorts was similar up to 32 weeks, diverging by 100-300g increase in 2015-2017 cohort to 37 weeks, following which there was catch–up increase weight in 1983 cohort till 40-42 weeks; however, 90th centile in 2015-2017 cohort revealed 500g increased weight at 40-41weeks.

National and international comparison of mean, 50th percentile growth curve for present study in 1983 and 2015-2017 cohort from South India and North India among 2875 consecutive live born babies' percentile curves which were not significantly different in comparison to past growth curves made 2 decades back from the same centre[6,15] being lower up to 600g for preterm gestation compared to Lubecheno's[5] computed in 1960s but with catch up at term. Multinational WHO charts show a rapid weight gain of 500g in term gestation after 38 weeks, and though recommended for international use, are not appropriate and ethnic specific. Asian charts are needed for local use to increase diagnostic and predictive performance[8]. Normal fetal growth occurs most rapidly from 12-36 gestational weeks. Fetal growth rate peaks to 220-225g/week at 32-36 gestational weeks and declines subsequently[16]. This study demonstrated relatively high rates of preterm births in the 2 South Indian cohorts and shortened gestation resulted in high rates of LBW. Thus, different guidelines are required for Asian-Indian newborns due to inherent factors of poor fetal growth as well as significantly shorter pregnancy duration[17].

SGA rates are determined using the 10th percentile cut-off on the fetal growth standard. Most units in India use Lubchenco charts to classify newborns as SGA and LGA. However, birthweights for South Indian babies were lower across all gestations in comparison with that of Lubchenco, 50th percentile, though a North Indian study reported higher birthweights only for term gestation above 38 weeks. Thus, if population specific updated growth charts are not used for categorisation of infants as SGA, LGA or AGA, there will be an overestimation of the frequency of SGA babies and an underestimation of the frequency of LGA babies.

The importance of these centile growth curves in a South Indian cohort of singleton live births brings to the forefront, unique ethnic differences in intrauterine growth patterns when compared to the Caucasian counterparts where notable differences are observed. Regional ethnic specific intrauterine growth charts have potential implications for use in clinical practice, as implementation of these new charts offers more accurate identification of the cohort of SGA babies with intrauterine growth retardation who require increased monitoring and observation, special care, additional feeding and who are at risk of a poor outcome. Asian-Indian babies require different guidelines for their wellbeing as opposed to Caucasian newborns with guidelines stated in all text books well adapted to the West or even multinational WHO intrauterine growth curves.

Conclusions

The 2015-2017 centile charts for birthweight in babies born from 28 to 42 gestational weeks in the metropolitan city of Bangalore, South India had almost similar growth curves and mean birthweights compared to the 1983 South Indian centile chart indicating an inherent genetic predisposition for the small Indian baby. The updated centiles for births during 2015-2017 provide a more valid tool to assess South Indian fetal growth.

References

1. Wilcox A, Skjaeven R, Buekens P, Kiely J. Birthweight and perinatal mortality. A comparison of the United States and Norway. *Journal of the American Medical Association* 1995; **273**: 709-11. https://doi.org/10.1001/jama.1995.03520330039034 PMid: 7853628

2. Stein ZA, Susser M. Intrauterine growth retardation: epidemiological issues and public health significance. *Seminars in Perinatology* 1984; **8**: 5-14. PMid: 6710174

3. Berkowitz GS, Papiernik E. Epidemiology of preterm birth. *Epidemiologic Reviews* 1993; **15**: 414-3. https://doi.org/10.1093/oxfordjournals.epirev.a036128

4. Arnold CC, Kramer MS, Hobbs CA, *et al.* Very low birthweight: a problematic cohort for epidemiological studies of very small or immature neonates. *American Journal of Epidemiology* 1991; **134**: 604-13. https://doi.org/10.1093/oxfordjournals.aje.a116133 PMid: 1951265

5. Park GL: The duration of pregnancy. *Lancet* 1968; **ii:** 1388. https://doi.org/10.1016/S0140-6736(68)92685-8

6. Mohan M, Chellani H, Prasad SR, Kapani V. Intrauterine growth curves in north Indian babies: weight, length, head circumference and ponderal index. *Indian Pediatrics* 1990: **27**(1); 43-51. PMid: 2361742

7. Lubchenco LO, Hansman C, Dressler M, Boyd E. Intrauterine growth as estimated from live born birthweight data at 24 to 42 weeks of gestation. *Pediatrics* 1963:**32**; 793-800. PMid: 14075621

8. Kiserud T, Piaggio G, Carroli G, Widmer M, Carvalho J, Jensen LN, *et al.* The World Health Organization Fetal Growth Charts: A multinational longitudinal study of ultrasound biometric measurements and estimated fetal weight. PLOS Medicine. Published: January 24, 2017 https://doi.org/10.1371/journal.pmed.1002220

9. Jadhav M, Christopher GL. Perinatal mortality rates in Vellore, Part I. A study of 21,585 infants. *Indian Journal of Pediatrics* 1986: **53**; 351-3. https://doi.org/10.1007/BF02760413

10. Christopher GL, Jadhav M. Perinatal mortality in Vellore Part II. Lethal malformations. *Indian Journal of Pediatrics* 1986: **53**; 353-7. https://doi.org/10.1007/BF02760414 PMid: 3759212

11. Christopher GL. The effect of biological factors on birthweight and gestation in South Indian newborns. *Journal of Pediatric Neurology and Medicine* 2018; **3**(1): 97-103. https://doi.org/10.4172/2472100X.1000130

12. Kumar A, Chaudhary K, Prasad S. Maternal indicators and obstetric outcome in North India. A hospital-based study. *Journal of Postgraduate Medicine* 2010: **56**(3); 192-5. https://doi.org/10.4103/0022-3859.68647 PMid: 20739764

13. Kumar VS, Jeyaseelan L, Sebastian T, Regi A, Mathew J, Jose R. New birth weight reference standards customized to birth order and sex of babies from South India. *BMC Pregnancy Childbirth* 2013; **13**:38. https://doi.org/10.1186/1471-2393-13-38 PMid: 23409828 PMCid: PMC3583685

14. David RJ, Collins JW Jr. Differing birth weight among infants of U.S.-born blacks, African-born blacks and U.S.-born whites. *New England Journal of Medicine* 1997; **337**(17): 1209-17. https://doi.org/10.1056/NEJM199710233371706 PMid: 9337381

15. Ghosh S, Bhargava SK, Madhavan S, Taskar AD, Bhargava V, Nigam SK. Intra-uterine growth of North Indian babies. *Pediatrics* 1971; **47**(5): 826-30. PMid: 5573867

16. Metcoff J. Maternal fetal nutritional relationships. In Arneil GC, Metcoff J, editors: Pediatric Nutrition. London: Butterworth; 1985. pp 56-106 PMid: 3993611

17. Christopher GL. Low birth weight criteria in ethnic Asian, Eurasian and Caucasian newborns. Recent advances in perinatology with specific reference to ethnicity. 2nd Edition, Published by Dr. Grace Lalana Publications: 2018, Chapter 29; 253-257. https://www.newgenparenting.com

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