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Clinical assessment of nutrition status score and body mass index in newborns: A comparative study

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***Abstract*---**Background: Fetal growth restriction can occur at any gestational period and is affected by maternal, placental and environmental factors. These factors can cause neonatal mortality or morbidity and long term sequalae. Thereby it is important to assess the nutritional status at birth. Clinical assessment of nutrition status score (CAN) assessment based on birth centile became important. Objectives: Aim was to compare CAN score and BMI birth centiles using pre-designated cut offs for assessing fetal nutrition. Materials and Methods: 1000 newborns cross-Sectional descriptive study. Department of Paediatrics, K.S. Hegde Medical Academy, Mangalore. Nov-2015 to June-2017. Inclusion criteria included term neonates with gestational age >37 completed weeks of gestation by dates or ultra-sonogram. Neonates with major congenital malformation or syndromes were excluded. Results: Out of 1000 newborns, 259 newborns (25.9%) had BMI below 10th centile out of which 99(9.9%) had BMI less than 3rd centile suggesting severe malnutrition. Malnutrition as per CAN Score was seen in 319(31.9%) infants. When CAN score and BMI was compared, among the 353 babies who had CAN score less than 25 indicating FM, only 129(36.5%) had BMI less than 10th centile. In 130 of the 259 infants with BMI less than 10th

centile, CAN score was normal. This difference was statistically significant (Chi square: 51.59; p<0.001). Conclusion: CAN score does not identify disproportionate growth and relies on physical parameter which may not accurately assess the adiposity. BMI would be more reliable as an indicator of fetal nutritional status.

Keywords---newborns, CAN, BMI.

Introduction

About 19 million low birth weight (LBW) babies are born every year in the developing world weighing less than 2500 grams, out of which India alone has more than 7 million LBW babies annually.[1] Maternal risk factors for LBW include maternal malnutrition, anaemia, low socioeconomic status, extreme of age, having had in-vitro fertilisation treatment and previous history of LBW.[2] The incidence of LBW babies continue to be high in India at about 30%. About 60% of the LBW infants are born at term and are subjected to fetal growth restriction (FGR) while preterm account for 40%. India contributes to one-fifth of global live births and more than a quarter of neonatal deaths. According to National Family Health Survey (2015-16), the current infant mortality rate is 41 per 1000 live births and neonatal mortality rate 28 per 1000 live births.[3] Most common causes of neonatal mortality are prematurity (35%), birth asphyxia (20%) and other causes like pneumonia, sepsis and malformation. Neonatal morbidities are huge concern for our society. The most common morbidities are feeding issues with failure to thrive, hypothermia, umbilical sepsis, neonatal sepsis, pneumonia and developmental disability. A LBW newborn carries the highest morbidity and mortality.[4]

The term fetal malnutrition (FM) was coined by Scott and Usher.[5] Factors involved are placental insufficiency or dysfunction resulting in fetal growth restriction (FGR) in utero and a small full term infant.[6,7] The traditional classifications of newborns based on birthweight that is 2500 grams being the cut off for LBW was replaced by classification based on gestational age and percentile. Small for gestational age (SGA) based on birthweight less than 10th percentile for gestational age were considered malnourished.[8] An infant who is classified FGR may, or may not, also be classified SGA. Similarly, an infant who is FGR or SGA may, or may not, have FM. Fetal malnutrition affects body composition and impairs brain development and behaviour.[9,10] The perinatal and later developmental effects of FM often are serious. It is important to recognise fetally malnourished babies because of high incidence of neonatal morbidity and long term sequelae.[11]

Studies proved that birth weight alone is inadequate for identifying FM. Various other methods used to assess FM include Clinical Assessment of head circumference (HC), mid arm circumference (MAC), mid arm circumference/head circumference ratio (MAC/HC). Weight-height ratios are the most simple methods used to assess FM.[12] CAN score is clinical method of assessing FM which was developed exclusively for term babies and was observed to be remarkably good.[13] This is a simple, rapid and quantifiable examination consisting of nine

parameters out of which eight parameters clinically assess the amount of subcutaneous fat. Each parameter is scored from one to four where one is considered as severe FM and four is considered as well nourished. The highest achievable score for a neonate is thirty six and nine the lowest. CAN Score less than twenty five is considered as FM.[14]

PI in neonatal period and BMI in older children and adults are extensively used to assess body composition.[15] BMI is a good measure of adiposity index because its connection with body fat percentage is high.[16] Head growth is the fastest, weight growth is slower but gain in length is slowest and weight for length ratio provides a simple objective and accurate method of identifying, quantifying and tracking disproportionate growth by comparing weight relative to length in one parameter.[17,18] In comparison to BMI, PI is not strongly dependent on weight. BMI is strongly connected to both weight and to fat body mass and satisfactory for determining the disproportionate growth.[19] BMI values for newborns according to gestational age based on retrospective study of 2,406 neonates was available in 2008.[20]

Aims and Objectives

Aims

- To assess fetal nutrition in newborns by using clinical assessment of nutrition status score and body mass index.
- To compare clinical assessment of nutrition status score (CAN score) and body mass index with standard intrauterine growth charts for assessing fetal nutritional status.

Objectives

- In a term neonate to address birth anthropometry, CAN score and calculate BMI.
- Ascertain birth and BMI centiles in standard intrauterine growth chart.
- To compare both CAN score and BMI birth centiles using pre-designated cut offs for assessing fetal nutrition.

Material and Methods

This study was a cross-sectional descriptive study of 1000 babies born with gestational age between 37 and 42 weeks, in birthing unit of pediatric department of KS Hegde Medical Academy, Mangalore during the period from Nov-2015 to June-2017. The patients were included following Inclusion and Exclusion criteria.

Inclusion Criteria

Singleton neonates born in our hospital with gestational age between 37 and 42 weeks.

Exclusion criteria

- Congenital anomalies or other birth defect that suggest intrauterine infections/teratogen exposure.
- History of significant perinatal insult requiring NICU care.
- Gender not specified.

Methodology

All newborns had their anthropometric evaluation and CAN score done soon after birth. All observations were made by a single observer in a warm well lighted room. Gestational age of the neonate in week was taken from the case record calculated from the last menstrual period and also assessing by new Ballards score. Length was measured with an infantometer with head at the fixed end and infant' knee which was brought together straightened out, the movable foot piece then applied to the sole of the feet with the slide touching the heel. Length was recorded in cm to the nearest mm. HC recorded to the nearest mm before using a non-stretchable measuring tape over the occiput prominence posteriorly and just above the supra orbital ridges anteriorly. Head circumference was recorded in cm. These parameters were plotted on the gender specific Olsen growth charts.[21] Newborns were classified as SGA, AGA and large for gestational age (LGA). Neonates whose birth weights were between 10th and 90th percentile were classified as AGA, whose birth weight was less than 10th percentile were classified as SGA, when the birth parameters were less than 3rd centile it was categorised into severe malnourishment and LGA defined as birth weight above the 90th percentile for gestational age.[21] BMI was derived with the formula: [weight (grams)/length (cm^2)]*10, and was plotted on gender specific BMI growth charts (Olsen et al).[22]

Statistical analysis

All data were entered in excel and analysis of data was done using SPSS version 15 and epi info. Descriptive statistics of individual anthropometric measure of all newborns were done. Proportion and percentage of newborn with FM or disproportionate growth were calculated for weight for age less than 10th centile (SGA), CAN score and BMI and compared using chi square. A p-value of <0.05 was considered significant.

Results

Age

Mean gestational age of the study population was 38.86±0.9 weeks with median at 39 weeks.

Gender

Gender distribution was almost equal with males consisting 50.1% (n=501) and female 49.9% (n=499).

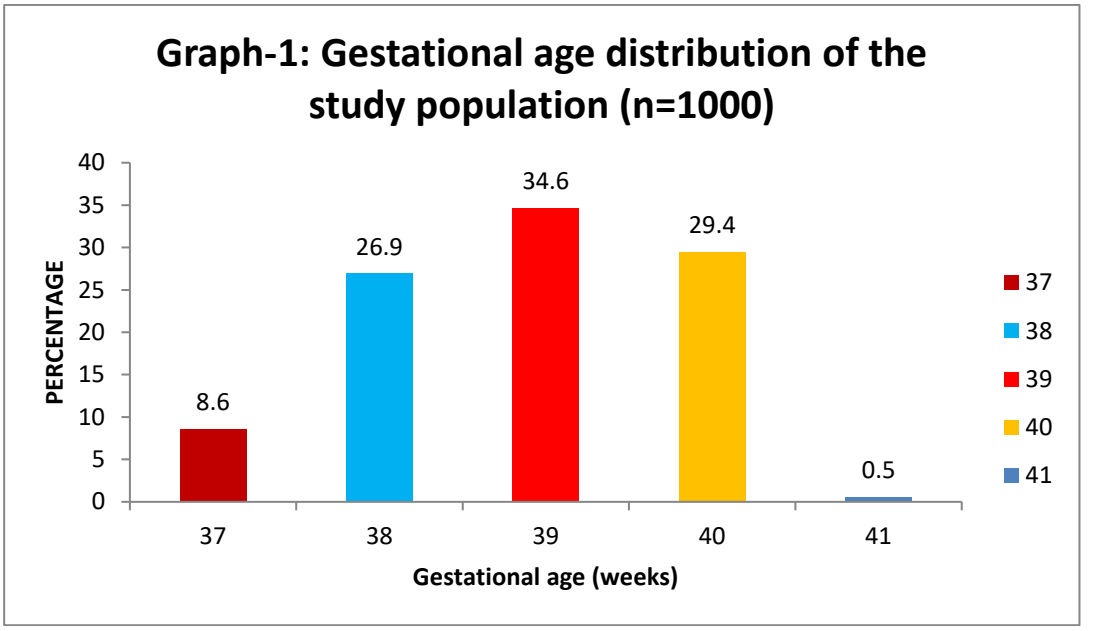


Table 1
Anthropometric distribution of study group

Anthropometry	Mean	Std. deviation	95% confidence interval of mean	Median
Weight(gm)	3005.76	424.39	2979.42–3032.09	300
Length(cm)	49.03	1.4	48.94–49.12	49
HC(cm)	33.52	1.0	233.46–33.59	34
BMI(kg/m^2)	12.49	1.64	12.39–12.59	12.4

Mean birth weight of the study population was 3005.76 grams and ranged between 1500 and 4680 grams with median at 3000 grams. The length of the newborns in this study ranged from 44cm to 52.5cm with 49.03 cm and 49 cm being the mean and the median respectively. The mean head circumference of newborns were 33.52 cm with median of 34. The mean and median body mass index of the subjects were 12.49 kg/m^2 and 12.41 kg/m^2 respectively, the values ranging from 6.38 kg/m^2 and 18.74 kg/m^2.

Table 2
Birth descriptive and percentile in comparison with Olsen *et al*[21,22] for female newborns

Gestational age (weeks)	Present study (percentile)					Olsen et al[21,22] (Percentile)				
	5	10	50	90	95	3	10	50	90	95
Weight(gm)										
37	1956	2202	2855	3406	3440	1958	2260	2937	3651	3997
38	2285	2400	2955	3500	3740	2235	2526	3173	3847	4172
39	2360	2500	3002.5	3566.5	3759.5	2445	2724	3338	3973	4276
40	2472.5	2605	3100	3600	3740	2581	2855	3454	3070	4363

Length(cm)										
37	46.2	47	49	505	51	43.2	44.9	48.5	51.9	53.4
38	46.7	47.5	49	50.5	51	44.4	46.1	49.5	52.7	54.2
39	47	47	49	51	51	45.3	46.9	50.2	53.3	54.7
40	46.4	47	49	51	51.6	46.1	47.6	50.8	53.8	55.1
HC(cm)										
37	31.7	32	33.5	35	35	30.1	33.1	33.3	35.4	36.3
38	31.5	32	33.5	35	35	30.7	31.7	33.7	35.7	36.7
39	31.5	32	34	35	35	31.1	32	34	36	36.9
40	32	32.5	34	35	35	31.4	32.3	34.3	36.1	37
BMI(kg/m^2)										
37	8.08	9.46	11.67	13.79	14.68	9.54	10.43	12.4	14.63	15.86
38	9.64	10.2	12.33	14.31	15.42	10.10	10.96	12.86	15.02	16.2
39	10.05	10.55	12.31	14.54	15.35	10.54	11.36	13.19	15.25	16.38
40	10.58	11.26	12.77	14.72	15.53	10.78	11.59	13.36	15.34	16.41

Fetal Malnutrition
Birth weight

The study population (n=1000) results showed that 270 (27%) were SGA, 712 (71.2%) were AGA, and 18 (1.8%) were LGA as classified by birth weight according to Olsen chart.[21]

Table 3
Birth weight distribution in the study population (n=1000)

Weight(centile)	N(%)	Mean birth weight	Std. deviation	Std. error of mean
> 10th	730(73%)	3179.70	334.57	12.38
< 10th	270(27%)	2535.47	247.86	15.08
< 3rd	94(9.4%)	2345.63	245.54	25.33

Out of 270 neonates with SGA, 94 neonates (34.8%) had weight less than 3rd centile. Hence showing severe malnutrition. The number of SGA among 501 male neonates were 147(29.3%) and 499 females were 123(24.6%). There was no statistically significant difference (Chi square: 2.092; p-value 0.095) in the number of SGA among the males and female babies. When neonates with weight less than 3rd centile were studied it was noted that the number of males who were severely malnourished were significantly more than females (OR=1.6, 95% CI 1.04-2.47).This difference was statistically significant (Chi square: 4.609; p-value: 0.03).

Length

Table 4
Length distribution in the study population (n=1000)

Length(centile)	N(%)	Mean	Std. deviation	Std. error of mean
>10th	894(89.4%)	49.30	1.20	0.04
<10th	106(10.6%)	46.78	1.08	0.1
<3rd	103(10.3%)	46.81	1.08	0.11

Out of 1000 neonates, 106(10.6%) newborns had length less than 10th centile out of which 103(97.1%) had length less than 3rd centile. On comparison of newborns with length less than 10th centile across gender, 68 neonates (13.6%) were males and 38(7.6%) were females. This difference was statistically significant (Chi square: 8.9; p-value: 0.002). Hence males were stunted when compared to females. Similar difference in length across gender was noted in neonates with length less than 3rd centile (Chi square: 9.36; p-value: 0.003).

Head circumference distribution in study population

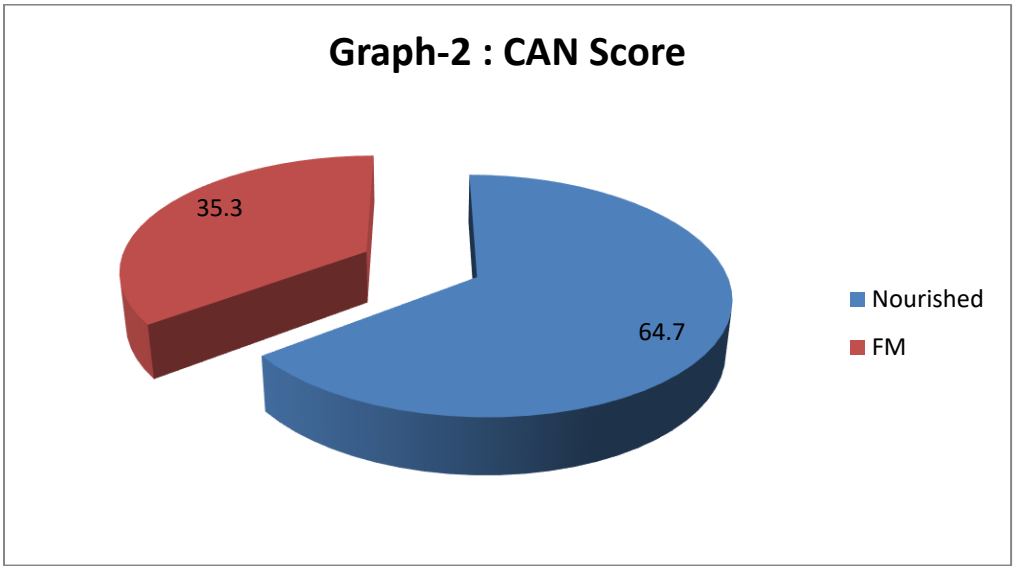
Out of 1000 newborn, 73 neonates (7.3%) had head circumference less than 10th centile of these 13(17.8%) had head circumference less than 3rd centile. Among the neonates with head circumference less than 10th centile 44(8.8%) and 29(5.8%) were males and females and this difference had no statistical significance (Chi square: 3.261; p-value: 0.071).

Body mass index

Out of 1000 newborns, 259 newborns (25.9%) had BMI below 10th centile out of which 99(9.9%) had BMI less than 3rd centile suggesting severe malnutrition. When difference in BMI was compared among the gender, 49.4% of the males and 50.6% of females had BMI less than 10th centile with no statistical significance (Chi square: 0.064; p-value: 0.8).

CAN Score

Among 1000 newborns malnutrition as per CAN Score was seen in 319(31.9%) newborns.



When CAN score was analysed across gender, there was 173(34.5%) males and 180(36.1%) females with malnutrition. There was no statistical difference across gender (Chi square: 0.260; p-value <0.610).

Comparison of composite markers for fetal malnutrition

Comparison between CAN score and BMI (n=1000)

- Among the 353 babies who had CAN score less than 25 indicating FM, only 129(36.5%) had BMI less than 10th centile. In 130 of the 259 infants with BMI less than 10th centile, CAN score was normal. The difference was statistically significant (Chi square: 51.59; p<0.001).
- CAN score has a sensitivity of 49.8% and specificity of 69.7% in comparison to BMI. CAN score assess fetal malnutrition based on visuals whereas BMI measures adiposity for the given length of the neonate. These two parameters look into two different group of babies hence cannot be used for comparison.

Comparison between BMI and weight (n=1000)

- Among the 270 babies who had weight less than 10th centile, 212(96.3%) neonates also had BMI less than 10th centile. In 47(18.14%) of the 259 children with BMI less than 10th centile had normal weight. The difference was not statistically significant (Chi square=51.59; p<0.001).
- Birth weight has sensitivity of 81.8% and specificity of 92.7% when compared to BMI.

Comparison between length and BMI (n=1000)

- Among the 106 babies who had length less than 10th centile, 14(13.2%) neonates also had BMI less than 10th centile. In 85(85.8%) of the 99 children with BMI less than 10th centile had normal length.
- Hence these anthropometric parameters that is BMI and length gave a comparable outcome to detect fetal malnutrition (p=0.228).

Discussion

The study group consisted of 1000 term neonates (37 to 41 weeks) with equal distribution in gender. Their birth parameters and CAN score were studied to assess the nutritional status. Olsen charts were used to plot the birth centile in this study, as BMI charts are available only recently, and considering the secular trend of growth.[21] Anthropometric values which were disproportionate for only one parameter were excluded from analysis. Birth weight and BMI values showed a normal distribution while length and HC were skewed to the right with kurtosis. This suggested that birth weight and BMI were representative of the nutritional status in newborn. The difference in mean birth weight when compared with intrauterine growth charts by Olsen *et al* progressively widened with increasing gestational age ranging between 186 grams to 360 grams at 37 weeks and 40 weeks respectively.[21] Similar trend was also seen with length and head circumference. On the contrary, BMI difference showed a declining trend ranging between 0.89 and 0.53 at 37 and 40 weeks respectively.[22] This suggested that the velocity of growth in the study population plateaued by 38 weeks of gestation.

The present study using Olsen chart observed that 27% had birth weight less than 10th centile indicating SGA.[21] Corresponding values noted in other studies include: 35.5% by Salihoglu *et al*, 45.4% by Sankhyan *et al*, 62.5% by Singhal *et al* and 23% by Soundarya *et al*.[23,24,25,26] When compared to weight centiles the percentage of babies with length less than 10th centile were 10.6% and in majority it was less than 3rd centile. This again suggested that BMI would be more reliable as an indicator of fetal nutritional status than birth weight alone. Only 7.3 % of the babies HC was less than 10th centile suggesting brain sparing in our study. By BMI, 25.9% of the study population were less than 10th centile. Kamath *et al*[27] identified 26.59% of the newborns had BMI less than 10th centile which was comparable to the present study. The incidence of disproportionate growth was less in the present study than values observed by Thammanna *et al* and Soundarya *et al* which accounted for 39.45% and 40.3% respectively.[28,26]

By CAN score, 31.9% of the study population were malnourished. Similar results were established by various authors. Dhanokar *et al* identified 32.29% as malnourished which was comparable to our study.[29] Similarly Jasim *et al*, Thamanna *et al*, Sankyan *et al*, Ahamed *et al* and Faheem *et al* identified 31%, 26.17%, 27.97%, 40% and 24.5% respectively.[30,28,24,31,32] However a lower incidence of malnourishment was observed by CAN score reported by Singhal *et al* accounting for 17.5%.[25] CAN score help to identify nourished and malnourished infants among the SGA and AGA infants respectively. Singhal *et al* in his study observed that 76.8% of the SGA were nourished according to CAN score and 18%

of the AGA infants were malnourished.[25] Corresponding values noted in others studies include: 40.1% SGA were nourished and 8.3% of AGA were malnourished according to Kashyap *et al*, 42.9% of SGA were nourished and 3.8% of AGA were malnourished by Sankyan *et al* and 12.5% of SGA were nourished and 10.8% of AGA were malnourished by Adebami *et al.*[14,24,33]

Thus the estimated malnutrition in this study by weight less than 10th centile, BMI less than 10th centile and CAN were 27%, 25.9% and 31.9% respectively. When CAN score was compared with BMI 224(63.5%) of the babies diagnosed as FM had BMI more than 10th centile. Soundarya *et al* when compared CAN score and BMI found that 11(15.2%) who were malnourished by CAN score had BMI more than 10th centile.[26] CAN score does not identify disproportionate growth and relies on physical parameters which may not accurately assess the adiposity in comparison with length. When BMI and weight were compared in the present study it was observed that 58 neonates (21.5%) who were SGA had BMI more than 10th centile. A similar result was obtained by Kamath *et al* in which 64(28.8%) neonates who are SGA had BMI more than 10th centile.[27] When length was compared with BMI 92(86.8%) neonates who were stunted had normal BMI.

Limitation of the study

The study setting was a tertiary referral hospital with no analysis of maternal risk factors and hence the data may not be representative of the entire community and this could be a limitation of the study.

Conclusion

- Assessment of fetal nutrition, clinical assessment of nutritional score and BMI were not comparable.
- While CAN score is based on visuals, BMI actually identify disproportionate growth and hence a better marker.
- The birth centiles in the study population were comparable to the international centiles until 38 weeks when plateauing was noted.
- Assessing fetal nutritional status, sensitivity and specificity of weight less than 10th centile was better than CAN score when calculated against BMI.
- There is scope of expanding the study with increased sample size and equal number of infants in all gestation including late preterm. Social, maternal and fetal factors will help in understanding the factors influencing newborn growth.

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