Assessment of Foetal Malnutrition Using CAN Score and its Comparison With Various Anthropometric Parameters and Proportionality Indices

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ABSTRACT

Introduction: Nutritional status at birth is assessed by using various anthropometric parameters and proportionality indices. Present study aims to assess the utility of CAN score in identifying fetal malnutrition (FM) which would have been missed by using anthropometry alone. We also aim at re-evaluating the cut-off value of CAN score for our population.

Methods: Nutritional status of 411 neonates was assessed using anthropometric parameters, proportionality indices and CAN score. Effectiveness of each parameter in detecting FM was assessed and compared with CAN score cutoff < 25 as well as new found cut-off < 27 using appropriate statistical tools.

Result: Mean (SD) of all anthropometric parameters were significantly less in FM group ($p < 0.001$). CAN score identified FM in 18.5% (76 / 411) babies whereas weight for GA identified 8.8% (36 / 411) babies as SGA and 91.2% as AGA (375 / 411); 12.3% (46 / 375) babies identified as AGA, were found to be malnourished by CAN score. Similar trend is seen with other parameters too. ROC curves show that AUC for birth weight, mid arm circumference, body mass index, Ponderal index, length and MAC / HC for determining FM was 0.891, 0.855, 0.837, 0.761, 0.749 and 0.714 in decreasing order. Birth weight with cut-off 2300 grams in a term newborn has maximum AUC making it the best marker for predicting FM. Present study identifies more FM by using modified CAN score cut off < 27 instead of < 25, 32.11% (132 / 411) and 18.5% (76 / 411) respectively.

Conclusion: CAN score is a simple method to assess FM which does not require any sophisticated equipment or time-consuming calculations.

Keywords: Anthropometry; CAN Score; Foetal Malnutrition; Newborn; Nutrition Assessment

INTRODUCTION

Fetal malnutrition (FM), the term coined by Scott and Usher in 1963, is a clinical state, characterised by intrauterine loss or failure to acquire normal amount of fat and muscle mass.[1] All newborns should be assessed for FM regardless of the classification of their weight for gestational age (GA), as weight alone is a poor indicator of nutritional status at birth.[2,3]

Terminologies like small for gestational age (SGA) or intra uterine growth restriction (IUGR) are used to describe intrauterine malnutrition. Although, these terms are used synonymously with FM, both are quite different as they do not assess the accumulation of subcutaneous fat and muscle mass in fetus.[2] Also, they do not take account of genetic and ethnic variations amongst different populations.[4] It is important to recognize FM early as there is a high incidence of neonatal morbidity and mortality and long term neurological sequelae associated with it. They are more likely to have lower IQ scores, have neurologic and intellectual disabilities, learning disorders, as well as cardiovascular, endocrine and metabolic disorders in late childhood.[5-7]

Nutrition at birth can be assessed by various anthropometric parameters [weight, length, head circumference (HC), chest circumference (CC), mid arm circumference (MAC)], proportionality indices [(Body mass index (BMI), Ponderal index (PI), Kanawati index (MAC / HC)] and Clinical Assessment of Nutrition (CAN).[3,8,9] Weight for GA is most commonly used to identify newborn's nutritional status. FM is a clinical state which may be present at almost any birth weight and gestational age. FM, SGA and IUGR are not synonymous and one may occur without the presence of other.[2,9] CAN score, a scoring system, developed by J Metcoff (1994), is based on nine 'superficial' readily detectable signs of malnutrition in the newborn baby developed to differentiate malnourished from appropriately nourished babies.[2] Researchers have reported that many newborn babies identified as malnourished by CAN score had been missed by using other anthropometric parameters and indices.[3,6,10-12]

Therefore, present study is undertaken to assess the utility of CAN score in identifying the FM in neonates in central part of India which would have been missed by using various anthropometric parameters alone or in combination. Due to ethnic and geographical variations of population studied, we also tried to find out a modified cut-off of CAN score for identifying FM in our own population. As a secondary outcome, we studied various maternal risk factors contributing to fetal malnutrition.

METHODS

Present study was a cross-sectional, analytical study, conducted in Paediatric Department of a tertiary care referral hospital getting patients from all socio-economic groups after obtaining Institutional Ethics Committee clearance. Data of 411 full term (assessed by Modified Ballard score system) neonates were included in the study.[13] Newborns with congenital anomalies and infants of diabetic mothers were excluded. Nude birth weight was measured to the nearest 10 grams using electronic weighing scale. Length was measured using an infantometer; HC, CC and MAC were measured to the nearest of 0.1cm using non-stretchable tape. Weight, length and HC were plotted on Lubchencho chart.[14] Written parental consent was taken for all the babies included in the study.

Kanawati Index (KI = MAC / HC) cut-off value of < 0.25 and Ponderal index [PI= Weight (gms) × 100 / Length (cms)^3] cut-off value of < 2.2 gm / cm^3 were considered as indicators of malnutrition.[4,15] Body mass index [BMI = Weight (Kg) / Length (m)^2] was plotted on BMI charts for different GA and gender; less than 10th centile was considered abnormal.[8] Maternal risk factors, age, parity, birth spacing, BMI, pregnancy induced hypertension (PIH), thyroid disorder, anaemia, infection, socio economic status by Modified Kuppuswamy Scale were recorded.[16] CAN score of each baby was determined within first 24 - 48 hours of life from nine superficially detectable signs of malnutrition; they are hair, cheeks, chin & neck, skin of forearm, skin of thigh and legs, scapular and interscapular region, buttocks, chest and abdomen. Each sign is rated from four (best, no evidence of malnutrition) to one (worst, definite evidence of

malnutrition). Total score ranges from nine to 36. CAN score less than 25 is classified as FM.[2] All data were compiled in Microsoft Excel and data analysis was performed using softwares IBM SPSS v.20 and MED CALC 19.5. Quantitative data is expressed as mean (SD) whereas categorical data is expressed as number and percentage. Means were compared using One Way ANOVA test. Percentage and numbers were compared using Chi square test and level of significance was considered at 5%.

RESULTS

Present study enrolled 411 full term neonates (M: F-1.12:1). Mean (SD) of anthropometric parameters were significantly less in FM group ($p < 0.001$) (table 1).

Table 2 shows the distribution of babies into well nourished and malnourished groups using pre-selected cutoff of anthropometric parameters, indices and CAN score.

The frequency distribution graph between CAN score and number of babies, shows that more babies were clustered between CAN score 27 to 29 (Graph 1). With the assumption that in a community large proportion of babies can't be abnormal, we also calculated association of anthropometric parameters with CAN score < 27 as cutoff for FM for our own population and compared it with CAN score cutoff < 25 (Table 3).

The utility of CAN score in classifying newborns with and without FM in comparison to other anthropometric parameters was analysed using Receiver Operating Characteristic curve (ROC curve) and Area Under Curve (AUC) analysis

Table 1. Comparison of mean (SD) of anthropometric parameters

Parameters	CAN score		P value
	With FM (< 25)	Without FM (≥ 25)	
Birth Weight (gm)	2325.53 ± 274.40	2870.90 ± 358.46	< 0.001
Length (cm)	46.29 ± 1.85	47.85 ± 1.46	< 0.001
Head circumference (cm)	32.04 ± 1.04	33.50 ± 0.98	< 0.001
Chest circumference (cm)	29.76 ± 1.47	31.24 ± 1.18	< 0.001
MAC (cm)	8.89 ± 0.56	9.67 ± 0.57	< 0.001

Table 2. Comparison of anthropometric parameters with CAN score < 25

		CAN score		Total	P value
		FM (< 25)	Without FM (≥ 25)		
Weight for GA	< 10 centile	30 (83.4%)	6 (16.6%)	36 (8.8%)	< 0.001
	≥ 10th centile	46 (12.3%)	329 (87.7%)	375 (91.2%)	
	Total	76 (18.5%)	335 (81.5%)	411 (100%)	
MAC/HC	< 0.25	21 (91.4%)	2 (8.6%)	23 (5.6%)	< 0.001
	≥ 0.25	55 (14.2%)	333 (85.8%)	388 (94.4%)	
	Total	76 (18.5%)	335 (81.5%)	411 (100%)	
PI	< 2.2	29 (51.7%)	27 (48.3%)	56 (13.6%)	< 0.001
	≥ 2.2	47 (13.2%)	308 (86.8%)	355 (86.4%)	
	Total	76 (18.5%)	335 (81.5%)	411 (100%)	
BMI	< 10th centile	68 (32.4%)	142 (67.4%)	210 (51.09%)	< 0.001
	≥ 10th centile	8 (3.9%)	193 (96.1%)	201 (48.91%)	
	Total	76 (18.5%)	335 (81.5%)	411 (100%)	
Length for GA	< 10th centile	12 (75%)	4 (25%)	16 (3.9%)	< 0.001
	≥ 10th centile	64 (16.2%)	331 (83.8%)	395 (96.1%)	
	Total	76 (18.5%)	335 (81.5%)	411 (100%)	

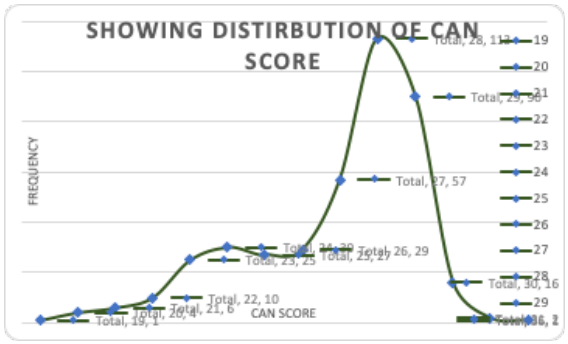

Figure 1. Frequency distribution curve between CAN score and number of babies for each score

Table 3. Identification of FM by using CAN score cut off of < 25 and < 27

	CAN score (< 25)	CAN score (< 27)
Total no of AGA babies	375 (91.2%)	375 (91.2%)
Total no of SGA babies	36 (8.8%)	36 (8.8%)
Total no of FM babies	76 (18.5 %)	132 (32.11%)
Total no of FM among AGA	46 (12.26%)	100 (26.66%)
Total no of FM among SGA	30 (83.33%)	32 (88.88 %)

(table 4 and Figure 2). Since birth weight with cut-off 2300 grams has maximum AUC, it is a good marker for predicting FM.

Among the maternal risk factors, significant association of FM was seen with PIH (p = < 0.001), anemia (p = 0.001), infection (p = < 0.001) and poor socioeconomic status of mother (p = 0.003). Birth spacing (year), BMI of mother and hypothyroidism was not found to be associated with FM.

DISCUSSION

Present study assesses nutritional status of new born using CAN score and compares it with selected anthropometric indices. CAN score identified FM in 18.5% (76 / 411) babies whereas weight for GA criteria identified 8.8% (36 / 411) babies as SGA and 91.2% as AGA (375 / 411); 12.3% (46 / 375) babies who were identified as AGA, were found to be malnourished by CAN score. This is similar to previous studies, where CAN score identified FM in 12.9% and 8.3% babies respectively who were classified as AGA using weight for GA assessment criteria.[17,18]

Present study identifies more FM by using modified CAN score cut off < 27 instead of < 25 and it went up from 18.5% (76 / 411) to 32.11% (132 / 411). On the contrary, a study done by Ajay Mohan et al, used a modified CAN score cut off < 21, as more babies were clustered between 21 and 24 in their cohort.[19]

To classify nutritional status of new born, PI has been used by various investigators.[15,20] PI relies on the principle that length is spared at the expense of weight during acute conditions; whereas, weight and length both are proportionately impaired in chronic insults. Therefore, using PI alone as a

Table 4. ROC-AUC curve of various anthropometric variables in comparison to CAN score cut off < 25 (n = 411)

Variable	Optimal criteria cut off	sensitivity	specificity	+ LR	- LR	+ PV	- PV	AUC	95% confidence interval (CI)	p-value
Birth weight	> 2300	95.52	61.84	2.5	0.077	91.7	75.8	0.891	0.853 - 0.930	< 0.001
MAC	> 8.5	97.31	47.37	1.85	0.057	89.1	80.0	0.855	0.805 - 0.905	< 0.001
BMI	> 10.57	95.5	44.74	1.73	0.10	88.3	69.4	0.837	0.785 - 0.880	< 0.001
PI	> 2.02	99.7	11.84	1.13	0.025	83.3	90.0	0.761	0.701 - 0.822	< 0.001
Length	> 45.5	97.31	28.95	1.37	0.093	85.8	71.0	0.749	0.684 - 0.814	< 0.001
MAC / HC	> 0.258	99.4	10.53	1.11	0.057	83.0	80.0	0.714	0.702 - 0.831	< 0.001

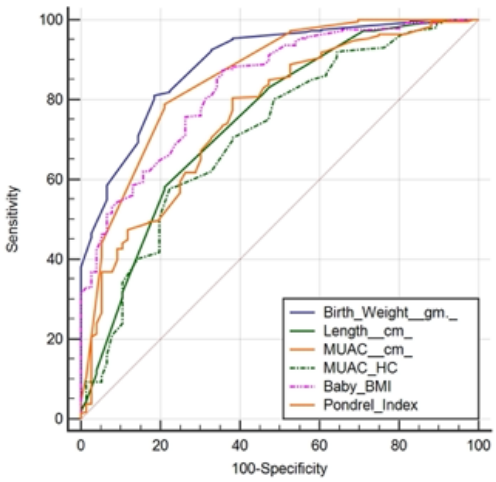

Figure 2. AUC for various parameters for determining FM with CAN score < 25

method of nutritional assessment can misclassify the babies.[15,20] Present study identified 13.2% (47 / 355) babies to be malnourished by CAN score who were classified as well nourished by PI (≥ 2.2 grams / cm^3). Similar results were obtained by many investigators.[3,10-12,19] A study done by Soundarya M et al, concluded that FM is best identified by CAN score and BMI is best screening tool for FM and when coupled with PI will identify most normally nourished newborns.[21]

Application of weight standard alone may be inappropriate in studying nutritional status in many diverse and multi-ethnic population groups. To overcome this, investigators studied MAC / HC ratio and found no intra-ethnic variation and concluded that it can be used as screening test for identifying growth retarded babies even when their weight does not fall below 10th centile. However, in chronic in-utero insult, HC is also reduced; therefore, such babies are missed by MAC / HC ratio; even these FM babies can be detected by CAN score.[4,15] In accordance to our study, Georgieff MK et al also found that MAC / HC ratio is more accurate than PI for evaluation of potentially symptomatic newborn who suffered abnormal fetal growth.[9] We calculated AUC using ROC curve to find out best cut-off values of various parameters taking CAN score as gold standard for detecting FM. It showed that AUC for birth weight, MAC, BMI, PI, length and MAC / HC for determining FM was 0.891, 0.855, 0.837, 0.761, 0.749 and 0.714 in decreasing order. Similar results are seen by Sen J et al with maximum AUC for birth weight (0.796, 95% CI 0.741 - 0.850) followed by MAC (AUC 0.776, 95% CI 0.721 - 0.831); however, they have not used CAN score as a measure of FM in their study. This highlights that birth weight and BMI are strongly associated with FM, however if coupled with CAN score, they can provide better assessment for FM.[22]

We found maternal infections to be significantly associated with FM. Other investigators have also observed HIV, malaria, periapical infection, urinary tract infection, vaginal trichomoniasis, placental malaria and severe chorion-amnionitis affecting the fetal growth.[23-26] Maternal infection leads to loss of appetite, nausea and vomiting decreasing their dietary intake. It elicits a systemic inflammatory response that restricts foetal growth by reducing placental vascularisation and diminished nutrient and oxygen transfer to fetus.[27] PIH leading to vasospasm and decreased intravascular volume may play an important role in intra uterine growth restriction.[28] Poor socio-economic status affects maternal as well as fetal nutrition and pregnancy at younger age which leads to FM.[29] Being a single centre study and assessment of CAN score by single observer are major limitations of the study

CONCLUSIONS

FM is a major underlying cause of neonatal mortality and morbidity. CAN score is a simple method to assess FM which does not require any sophisticated equipment or time-consuming calculations. Birth weight with cut-off 2300 gram in a term newborn has maximum AUC; therefore, is best marker for predicting FM. Apart from the globally accepted CAN score cut-off value of < 25 for predicting FM, we found the cut off < 27 as appropriate for our community and it detected more FM babies who would have been missed with cut-off < 25. Studies on a larger sample size would further appropriate these findings.

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