

Assessment of fetal nutrition status at birth using the clinical assessment of nutritional status score

Lakshmi Lakkappa¹, Suguna Somasundara²

From ¹Senior Resident, ²Associate Professor, Department of Paediatrics, Chamarajanagar Institute of Medical Sciences, Chamarajanagar, Yadapura, Karnataka, India

Correspondence to: Dr. Suguna Somasundara, Department of Paediatrics, Chamarajanagar Institute of Medical Sciences, Chamarajanagar, Yadapura, Karnataka, India. E-mail: Statisticsaclinic2018@gmail.com

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ABSTRACT

Introduction: Assessment of fetal malnutrition (FM) among neonates has been a major concern to health personnel due to the potentially serious sequelae of malnutrition on multiple organ systems. There is a dearth of research in the use of a clinical assessment of nutritional (CAN) status score as a method of assessing FM in term newborns regarding the Indian context. **Objective:** This study was conducted to assess the FM by CAN score and to verify the validity of CAN score in relation to other anthropometric variables.

Materials and Methods: A hospital-based observational study was carried out at a tertiary care hospital, Chamarajanagar, for a period of 3 months from March 2018 to May 2018. All liveborn, singleton term infants >37 weeks of gestation were included in the study. All measurements were carried out between 24 and 48 h of newborn age and data were collected using a structured questionnaire. **Results:** In this study, out of 250 neonates included, 52.8% of newborns were female and 47.2% were males. Total 8% of the study population was low birth weight, and 92% had normal birth weight. The CAN score of <25 was found in 21.2% while the rest of 78.8% of cases had CAN score of >25. CAN score had a sensitivity of 90%, specificity of 84.78%, and diagnostic accuracy of 85.2%. **Conclusion:** CAN score, a simple clinical index for identifying FM, is a good indicator than other anthropometric methods of determining intrauterine growth restriction like ponderal index.

Key words: Clinical assessment of nutritional status score, Fetal malnutrition, Term neonates

Early fetal growth is a biophysical process where the most rapid period of normal fetal growth is between 12 and 36 weeks of gestation. The rate of fetal growth peaks to 220–225 g/week at 32–36 weeks of gestation and declines thereafter [1] fetal growth is a complex, dynamic process controlled by a wide range of factors of maternal, placental, and fetal origin. In early fetal life, the fetal genome is the crucial determinant of growth; however, later in pregnancy, environmental, nutritional, and hormonal influences become increasingly important [2]. The morbidity and mortality rates in newborn infants due to fetal malnutrition (FM) are high; this predominantly needs optimal care for improved survival. Hence, assessment of neonates for early detection of problems, FM, and initiation of prompt management becomes important [3].

Various methods have been used to identify malnourished fetuses as early as possible. There is no consensus among experts with regard or concern with the adopted terminologies; and the reliability, reproducibility, sensitivity, specificity, and the ease of performing an assessment of the nutritional status of the babies at birth. There is a need for prompt identification of babies with FM as the anticipatory management of such infants at birth may decrease morbidity and improve the survival of such infants [4]. Various methods have been used to identify babies that suffered

suboptimal fetal growth such as birth weight for gestational age [5,6] ponderal index (PI) [5–7], mid-arm circumference/head circumference (MAC/HC) ratio [6], and clinical assessment of nutritional (CAN) status score.

CAN score - contains nine clinical signs, namely hair, cheeks, neck, arms, chest, abdomen, back, buttocks, and legs - which was developed by Metcalf to differentiate between the malnourished and appropriately nourished babies [8]. The anthropometric indices which are being routinely used might have failed to answer all the questions about FM. CAN score has been used widely by researchers to determine FM in term babies which was even compared with other methods [9]. However, there is a dearth of research on CAN score as a means of assessing FM in term newborns in the Indian context. Hence, this study was conducted to assess the FM by CAN score and to verify the validity of CAN score in relation to other anthropometric variables.

MATERIALS AND METHODS

This hospital-based observational study was carried out at a tertiary care hospital in Chamarajanagar, for a period of 3 months from March 2018 to May 2018. After getting ethical clearance, all liveborn, singleton term infants >37 weeks of gestation

were included in the study. All preterm neonates, neonates with congenital anomalies and multiple gestations were excluded from the study.

The sample size was estimated using the incidence of malnutrition of 17.5% in neonates, 5% absolute error, and 95% confidence level; a sample size of 222 was obtained. Considering 10% attrition rate, sample size of $222 + 22.2 \approx 245$, rounded off to 250 neonates was taken in this study. Formula used for estimation of sample size was $n = Z\alpha/2^2 p(1-p)/d^2$ [10].

In all neonates, weight was recorded on an electronic weighing scale at birth; length was measured by infantometer while the MAC and HC were measured using standard nonstretchable measuring tape. All measurements were taken as per standard guidelines. All measurements were carried out between 24 and 48 h after birth. Infant's age was assessed using the new Ballard score and was further correlated with last menstrual period, and ultrasonic measurement was taken antenatally in available cases.

Newborns were classified as small for gestational age (SGA), appropriate for gestational age (AGA) on the basis of growth chart centile weight (in kg), length (in cm), HC (in cm) as per the guidelines of US-NCHS reference standards, and recommended by the WHO. PI was calculated using the formula $\{\text{Weight (g)} \times 100/\text{Length (cm)}^3\}$ and the babies with PI <2 were considered as malnourished. The CAN scoring was done within 48 h of the birth and a score of <25 was considered as malnourished.

CAN score estimation was done using the following parameters: (1) Hair: Large amount, smooth, silky, easily groomed thinner, some straight, "staring" hair still thinner, more straight, and "staring" hair which does not respond to brushing. Straight "staring" hair with depigmented stripe (flag sign). (2) Cheeks: Progression from full buccal pads and round face, to significantly reduced buccal fat with narrow, flat face. (3) Neck and chin: Double or triple chin fat fold, neck not evident; to thin chin. No fat fold, neck with loose, wrinkled skin, very evident. (4) Arms: Full, round, cannot elicit "accordion" folds or lift folds of skin from elbow or triceps area; to a striking "accordion" folding of lower arm, elicited when examiner's thumb and fingers of the left-hand grasp the arm just below the elbow of the baby. Furthermore, thumb and fingers of the examiner's right hand circling the wrist of the baby are moved toward each other; skin is loose and easily grasped and pulled away from the elbow. (5) Legs: Like arms. (6) Back: Difficult to grasp and lift skin in the interscapular area; loose skin, easily lifted in a thin fold from the interscapular area. (7) Buttocks: Full round gluteal fat pads; to virtually no evident gluteal fat and skin of the buttocks and upper posterior high loose and deeply wrinkled. (8) Chest: Full, round, ribs barely visible; to progressively prominence of the ribs with obvious loss of intercostal tissues. (9) Abdomen: Full, round, with no loose skin; to distended or scaphoid, but with very loose skin, which is easily lifted, wrinkled, and "accordion" folds demonstrable.

Data were entered into Microsoft Excel data sheet and were analyzed using SPSS 22 version software. Categorical data were represented in the form of frequencies and proportions. Chi-square test was used as a test of significance for qualitative

data. Continuous data were represented as mean and standard deviation, and the validity of CAN score was assessed by measuring sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy. Kappa Statistics: Agreement between measurements and birth weight was assessed using Kappa statistics; p value was statistically significant ($p < 0.05$).

RESULTS

Total 250 newborns were included in this study; out of which, 52.8% were female and 47.2% were male newborns. The demographic profile of the study population is presented in Table 1. The CAN score <25 was found in 21.2% neonates and the rest 78.8% neonates had a CAN score >25. Out of 20 subjects with low birth weight (LBW), 90% had CAN score of <25, and 10% had CAN score of >25 (false negative). Out of 230 subjects with normal birth weight, 84.8% had CAN score >25 and 15.2% had CAN score <25 (false positive). The association between CAN score and birth weight was found to be statistically significant.

Out of 20 subjects with LBW, 15% had PI of <2.2 and 85% had PI of >2.2. Furthermore, 15% had MAC/HC ratio of <0.27 and 85% had MAC/HC ratio of >0.27. Out of 230 subjects with normal birth weight, 97% had PI >2.2 and 3% had PI <2.2. The MAC/HC ratio in 95.2% was >0.27 and 4.8% had MAC/HC ratio <2.2. There was a significant association between PI and birth weight while there was no significant association between MAC/HC ratio and birth weight (Table 2).

Table 1: Profile of Newborn in the study

Variable	Number (%)
Sex	
Female	132 (52.8)
Male	118 (47.2)
Mode of delivery	
Normal	104 (41.6)
Elective LSCS	80 (32.0)
Emergency LSCS	46 (18.4)
Forceps	14 (5.6)
Vacuum-assisted	6 (2.4)
Birth weight (Kg)	
<2.5	20 (8.0)
>2.5	230 (92.0)
PI	
<2.2	10 (4.0)
>2.2	240 (96.0)
MAC/HC ratio	
<0.27	14 (5.6)
>0.27	236 (94.4)
CAN score	
<25	53 (21.2)
>25	197 (78.8)

LSCS: Lower (uterine) segment cesarean section, PI: Ponderal index, MAC: Mid-arm circumference, HC: Head circumference, CAN: Clinical assessment of nutritional

In comparison to birth weight, CAN score had a sensitivity of 90%, specificity of 84.78%, positive predictive value of 33.96%, and negative predictive value of 98.98%, and diagnostic accuracy of 85.2%. Kappa agreement for CAN score was 0.4265 (fair agreement) and that of PI was 0.1549 (poor agreement) and MAC/HC ratio was 0.1184 (poor agreement) as shown in Table 3.

DISCUSSION

It is important to recognize babies with fetal malnutrition due to high incidence of neonatal morbidity and long-term sequelae-like metabolic syndrome [2,7,8] FM adversely affects body composition, including reduced muscle mass and protein content, organ structure and composition, bone, chemical composition and metabolic, and enzyme functions [11,12]. The perinatal problems and/or central nervous system sequelae, occurred primarily in malnourished babies in the fetus itself, whether AGA or SGA. According to Hill *et al.* [13], on the contrary, the same problem is not encountered by those who were simply SGA but not malnourished.

In utero, growth restriction is not a uniform condition with respect to its severity and duration, the underlying pathogenesis and the developmental stage of the fetus at the time of its occurrence. If malnutrition happens early in the second trimester, length, HC, and weight all are significantly reduced. On the other hand, if malnutrition occurs at the beginning of the third trimester,

length and HC are less affected, but baby is mostly underweight. If nutrient supply hampers in the late third trimester, length and HC are usually within the normal range, and weight is significantly less for the GA [12-15].

A simple, clinically applicable scoring system was developed by Metcalf [8] to differentiate the malnourished from appropriately nourished babies, irrespective of birth weight or clinical classification as intrauterine growth restriction (IUGR), SGA, or AGA. This scoring system rated clinical evidence of malnutrition in term babies determined by inspection and hands-on estimates of a loss of subcutaneous tissue and muscle and is independent of common confounding factors which affect the weight of the baby [12]. Similar studies were conducted to assess the validity of CAN score in predicting FM.

In the present study, CAN score validity was much better in the detection of FM than the previous studies [9,16,17]. The sensitivity and specificity of the CAN score were 90% and 84.78% in our study while it was much less in other studies done by Singhal *et al.* [9] (82.8% sensitivity and 41.8% specificity), Ahamed *et al.* [16] (73.8% sensitivity and 2.6% specificity) and Sankhyan *et al.* (52.7% sensitivity and 96.3% specificity). The positive and negative predictive value in our study was found to be lesser than the findings of studies by Singhal *et al.* [9] and Ahamed *et al.* [16].

In this study, PI validity was also comparable with other studies, and it had a sensitivity of 15% and specificity of 96.9%. These results are comparable to the findings of studies done by Singhal *et al.* [9] (28.5% and 96.3%), Ahamed *et al.* [16] (25.3% and 95.2%), and Sankhyan *et al.* [17] (20.9% and 96%). The positive and negative predictive value was 30% and 92.9% in our study whereas it was 62.5% and 86.4% in a study by Singhal *et al.* [9] and 78.04% and 65.6% in the study by Ahamed *et al.* [16], respectively.

The study recommends that CAN score can be used as an alternative method in low resource settings, especially in developing countries like India to detect and prevent the FM. The CAN score is much simpler to learn and easy to do as compared to sophisticated methods, particularly with the aid of cartoon illustrations of the signs and scores as described by Metcalf [8]. Its major drawback is its subjective nature, like all other scoring methods used in the evaluation of neonates. The method could be used as a screening or confirmatory test. Majority of the studies have compared CAN score with birth weight or PI separately. In this study, we compared CAN score with birth weight, PI and MAC together and also compared PI and MAC/HC ratio with birth weight to find the validity of these indices.

CONCLUSION

Our study concluded that CAN score, which is a simple clinical index for identifying FM, is a good indicator than other methods of determining IUGR such as PI and MAC/HC. CAN score identified fetal malnourishment in those neonates, which are missed by other methods.

Table 2: CAN score, PI, and MAC/HC ratio versus birth weight in detection of FM

Indicies	Birth weight		χ^2	df	p value
	<2.5 Kg	>2.5 Kg			
	Count (%)	Count (%)			
CAN score					
<25	18 (90.0)	35 (15.2)	61.59	1	<0.001*
>25	2 (10.0)	195 (84.8)			
PI					
<2.2	3 (15.0)	7 (3.0)	6.850	1	0.009*
>2.2	17 (85.0)	223 (97.0)			
MAC/HC ratio					
<0.27	3 (15.0)	11 (4.8)	3.634	1	0.057
>0.27	17 (85.0)	219 (95.2)			

PI: Ponderal index, MAC: Mid-arm circumference, HC: Head circumference, CAN: Clinical assessment of nutritional

Table 3: Validity of CAN Score, PI, and MAC/HC ratio in detecting Fetal malnutrition in comparison with birth weight

Parameter	CAN score (%)	PI (%)	MAC/HC ratio (%)
Sensitivity	90	15	15
Specificity	84.78	96.96	95.22
Positive Predictive Value	33.96	30	21.43
Negative Predictive Value	98.98	92.92	92.8
Diagnostic Accuracy	85.2	90.4	88.8
Kappa agreement	0.4265	0.1549	0.1184

PI: Ponderal index, MAC: Mid-arm circumference, HC: Head circumference, CAN: Clinical assessment of nutritional

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