ABSTRACT: CONTEXT: Fetal malnutrition is a major problem in developing countries like India. It is associated with increased mortality and long term sequel. There are various methods to determine nutritional status of newborns like weight for gestational age, Ponderal index, Body mass index, mid arm circumference/ head circumference ratio etc., but each have their own limitations. The terms fetal malnutrition and small for gestational age are not synonymous and one may occur without the other. Clinical assessment of nutritional status score (CAN Score) developed by Metcoff is a reliable test for identification of fetal malnutrition. This study was undertaken to identify incidence of fetal malnutrition by CAN Score and to compare it with other anthropometric indices. METHODS: It was a prospective study conducted in a tertiary care hospital. 256 neonates were assessed using CAN Score and anthropometry was recorded. Neonates were classified as per weight for age. Ponderal index, body mass index, mid arm circumference/ head circumference ratio, body mass index were calculated and compared with CAN Score for accuracy in identifying fetal malnutrition. RESULTS: Incidence of fetal malnutrition as per CAN Score was 26.17%, 6.4% of Appropriate for gestational age babies were malnourished. Weight for age parameter classified 28.52% of babies as malnourished; Ponderal index classified 23.44% as malnourished, body mass index and mid arm circumference/ head circumference ratio classified 39.45% and 34.38% neonates as malnourished respectively. Weight for age and body mass index had sensitivity of 83.58% and 80.6% respectively in identifying fetal malnutrition. CONCLUSION: CAN score is a simple clinical method for identification of fetal malnutrition without use of any sophisticated equipments and it can even detect malnourished babies who are missed by other anthropometric methods. KEYWORDS: CAN Score, Fetal malnutrition, Body mass index, Ponderal Index, SGA.

INTRODUCTION: Fetal malnutrition is a state of poor nutrition in–utero resulting from inadequate supply and or utilization of nutrients, this term was coined by Scott and Usher in 1966 to describe infants who showed evidence of soft tissue wasting at birth irrespective of the specific etiology.¹ Many factors affect fetal growth, including nutritional state and social habits of mother, state of placental function and genetic makeup of the fetus. The incidence of fetal malnutrition continues to be high India at around 30% in contrast to 5-7% in developed nations.² It is important to recognize fetal malnourished babies because of increased neonatal mortality and long term sequelae.³⁴ The existing terminologies for describing intrauterine malnutrition are small for gestational age (SGA), intrauterine growth restriction (IUGR) and placental insufficiency, but
none of these terms are synonymous with fetal malnutrition. The criteria used to define fetal malnutrition is very much variable. The most common criteria adapted are weight at birth, a value less than 2500gms is used as cut off. This will miss newborns with malnutrition in late third trimester as their birth weight may be above 2500gms. The Ponderal index, mid arm circumference/head circumference ratio are the other two parameters used to identify fetal malnutrition. But each has its own limitations.

Clinical assessment of nutritional status score or CAN Score is a simple scoring system developed to differentiate malnourished from appropriately nourished babies. Jack Metcoff described 9 superficial, easily detectable signs of malnutrition in the newborn which includes hair, buccal pad of fat, chin fat which usually obscures the neck in well-nourished babies; skin of arm and legs, intercostals spaces on chest and subcutaneous fat on back, abdomen and buttocks, a CAN score of < 25 is used to identify fetal malnutrition.

Objective of our study was to identify the incidence of fetal malnutrition by CAN score and to compare it with other anthropometric indices.

METHODODOLOGY: This prospective study was conducted in the Department of Pediatrics, Mandya Institute of Medical Sciences, Mandya. 256 singelton term newborns born during January 2015 to May 2015 were studied. Ethical clearance was obtained from Institutional ethical committee prior to start of study.

Inclusion Criteria: Live born singleton neonates of gestational age between 37 weeks and 42 weeks delivered at Mandya Institute of Medical Sciences, Mandya.

Exclusion Criteria: Preterm neonates, neonates with congenital anomaly, neonates requiring admission to neonatal intensive care unit (NICU), multiple gestation and neonates born to gestational Diabetes Mellitus mother were excluded from the study.

The following parameters were recorded in all babies (Weight was recorded at birth, clinical assessment of nutrition score, length, mid arm circumference and head circumference were recorded between 24-48hrs of life). Nude birth weight was recorded using electronic weighing scale. Length was measured using infantometer. Mid arm circumference (MAC) was measured in the left arm at a point midway between tip of the acromion and the olecranon process. Head circumference (HC) was taken at the largest circumference of skull using a non-stretchable tape. Weight and length obtained were plotted on intrauterine growth charts to classify the newborns as appropriate for gestational age (AGA), small for gestational age (SGA) and large for gestational age (LGA).  

Ponderal index (PI) was calculated using the formula: weight (gms)X 100/ length (cm), value less than 2.2 was considered as an index of malnutrition. MAC/HC ratio was calculated, value less than 0.27 was considered as an index of malnutrition. Body mass index (BMI) was calculated using the formula: weight (Kg)/ length (m), a value less than 11.20Kg/m² was considered as an index for malnutrition.

Clinical assessment of nutritional status score (CAN Score) was determined on the basis of the readily detectable signs of malnutrition in the newborns as described by Metcoff (Table 1), a
CAN score of <25 was used to define fetal malnutrition. Each attribute was scored based on specific described criteria from 1 to 4; 1 being the maximum evidence of malnutrition and 4 being the evidence of good nutrition. The CAN score ranges between 9 as lowest score and 36 as highest score.

In this study CAN score was the parameter used as the gold standard for identification of fetal malnutrition. Correlation of anthropometric indices was done in comparison to CAN score. Gestational age was calculated from the date of last menstrual period, in concordance with New Ballard Score.

Statistics: The data collected was compiled and entered in MS Excel spread sheet. Observations were statistically analyzed using Epi Info statistics software version 3.5.1. Chi square test was performed, mean and standard deviation were calculated; sensitivity, specificity positive and negative predictive values were calculated.

| Parameter          | Points |
|--------------------|--------|
|                    | 4      | 3      | 2      | 1                   |
| Hair               | Thick, dense, smooth, satin-like, easy to comb | Thick, scarce, there is little hair straight | Thin, straight and put up with more hairs | Sparse, straight and erect, hair bundle associated with reduced pigmentation |
| Cheek              | Plump, round face | Slightly reduced fat | Significantly reduced | Fat is almost gone, narrow face |
| Neck chin          | Fat overlap into double or triple chin, neck covered | Slightly reduced fat chin, the neck can be seen | Fat pad thin chin, neck revealed | Chin fat disappears, the neck is clear, loose skin, wrinkle |
| Arm                | Fullness, cannot lift the skin | Little thin, check on pressure of hands, the accordion-like folds can be formed | Small arm, to form accordion-like folds | Very little fat, loose skin, significant accordion-like folds |
| Back               | Inter-scapular area of skin cannot be picked | Little to lift the skin | Easy to lift the skin | Loose skin, easy to lift wrinkles can form |
| Buttock            | Fat pad thick | Slightly reduced fat | Significantly reduced fat, hips tip wrinkle | Fat disappears, wrinkles, loose skin and a very thin pipe like hip |
| Leg                | Described with the same arm | Described with the same arm | Described with the same arm | Described with the same arm |
| Chest              | Ribs not visible, Intercostal space full | Intercostal space slightly visible | Prominent ribs, intercostals space slightly visible | Prominent ribs, obvious loss of intercostals tissue |
Abdomen | Fullness, thick subcutaneous fat | Slightly reduced fat | Wall thinning, can form accordion-like folds | Abdominal bulging/boat shaped abdomen, looses skin, can form accordion-like folds

Table 1: Parameters of Clinical assessment of nutrition status (CAN Score)

**RESULTS:** A total of 256 newborns were assessed which included 141 males and 115 females. The overall incidence of fetal malnutrition was 26.17% as identified by CAN Score (Table 2). There was equal sex predisposition in the incidence of fetal malnutrition between male and female newborn babies.

| Parameter                      | Male (%)  | Female (%) | Total (%) |
|--------------------------------|-----------|------------|-----------|
| Malnourished (CAN Score < 25) | 38(26.95) | 29(25.21)  | 67(26.17) |
| Well Nourished (CAN Score > 25)| 103(73.05)| 86(74.79)  | 189(73.83)|
| Total                          | 141       | 115        | 256(100)  |

Table 2: Relation between Sex and Fetal malnutrition

All the babies (n=256) in the study were term neonates. Mean birth weight of study population was 2801.38±476.97gms, mean length was 48.91±2.11, mean HC was 33.45±1.25, mean MAC was 10.27±1.16, mean Ponderal index was 2.25±0.31, mean MAC/HC ratio was 0.32±0.052 and mean BMI was 11.35±1.53 (Table 3).

| Parameter                     | Mean±SD    | Range     |
|-------------------------------|------------|-----------|
| Birth weight (gms)            | 2801.38±476.97 | 1720-4110 |
| Length (cm)                   | 48.91±2.11 | 42-54.1   |
| Head circumference(cm)        | 33.45±1.25 | 29.8-36.1 |
| Mid arm circumference (cm)    | 10.27±1.16 | 7.8-12    |
| Ponderal index                | 2.25±0.31  | 1.62-3.2  |
| MAC/ HC ratio                 | 0.32±0.052 | 0.23-0.37 |
| Body mass index               | 11.35±1.53 | 7.98-14.66|

Table 3: Anthropometric characteristics of neonates in the study

MAC/ HC: Mid arm circumference/Head circumference.

Distribution of study population as well-nourished and malnourished according to various anthropometric indices in comparison to CAN Score is depicted in Table 4. As mentioned earlier CAN Score classified 26.17% as malnourished and 73.83% as well nourished. Birth weight classified 28.52% as malnourished and 71.48% as well nourished. Ponderal index classified 23.44% as malnourished and 76.66% as well nourished. BMI classified 39.45% as malnourished and 60.55% as well nourished. MAC/HC ratio classified 34.38% as malnourished and 65.62% as well nourished.
### Table 4: Comparison between Body Indices and CAN Score

| Parameter                  | CAN Score |         |         |
|---------------------------|-----------|---------|---------|
|                           | Malnourished | Normal  |         |
| PI<2.2 ≥ 2.2              | 39        | 21      |         |
|                           | 28        | 168     |         |
| BMI<11.2 >11.2            | 54        | 47      |         |
|                           | 13        | 141     |         |
| MAC/HC<0.27 >0.27         | 37        | 51      |         |
|                           | 30        | 138     |         |
| SGA                       | 56        | 17      |         |
| AGA+LGA                   | 11        | 172     |         |

PI: Ponderal index, BMI: Body mass index, MAC/ HC: Mid arm circumference/ Head circumference, SGA: Small for gestational age, AGA: Appropriate for gestational age, LGA: Large for gestational age.

Comparison of validity measurements of CAN Score with various anthropometric parameters for detection of fetal malnutrition is given in Table 5. Ponderal index had low sensitivity of 58.2% with 88.8% specificity, BMI had a sensitivity of 80.6% with specificity of 74.6%, MAC/ HC ratio had low sensitivity of 55.22% and specificity of 73.02%, Weight category had high specificity of 91.01% with sensitivity of 83.58%.

### Table 5: Comparison of validity measures of different parameters with CAN Score

| Value                          | Birth weight | Ponderal Index | Body mass index | MAC/ HC ratio |
|--------------------------------|--------------|----------------|-----------------|---------------|
| Sensitivity (%)                | 83.58        | 58.2           | 80.6            | 55.22         |
| Specificity (%)                | 91.01        | 88.8           | 74.6            | 73.02         |
| Positive predictive value (%)  | 76.71        | 65             | 53.47           | 42.05         |
| Negative predictive value (%)  | 93.99        | 85.71          | 91.55           | 82.14         |

MAC/ HC: Mid arm circumference/Head circumference.

**DISCUSSION:** Low birth weight is a common clinical problem in India and other countries as compared to developed countries. Nearly two third of these low birth weight babies are with fetal malnutrition, fetal malnutrition is associated with increased mortality and long term neuro-developmental sequlæ. The present existing system indicators of nutrition status do not accurately assess malnutrition which is best identified by assessing the amount of subcutaneous fat accumulated in the in-utero period. The incidence of fetal malnutrition in our study was 26.17%, much higher than values observed by Metcoff, Study done by Soundarya M et al. reported values of 24%, Sankhyan N et al. reported values of 27.97%. Higher incidence of fetal
malnutrition is probably due to low socio economic condition and poor nutrition status of pregnant mother. The clinical manifestations of fetal malnutrition depends on the part of which time it began during gestation, it is characterized by obvious loss or decrease in intrauterine accumulation of normal amount of subcutaneous fat. Weight, length, head circumference and mid arm circumference may or may not be affected.

Birth weight alone does not reflect the state of nutrition. Among AGA/ LGA babies 93.98% had CAN Score greater than 25, rest had values less than 25 indicating that these babies are suffering from malnutrition.

Ponderal index depends on the pact that length is spared at the expense of weight during the acute malnutrition, in chronic malnutrition both weight and length may be equally affected and hence neonates with chronic insult in-utero may be misclassified by Ponderal index. In our study sensitivity of Ponderal index was 55.2% and specificity was 88.8%. Study done by Cole TJ et al.14 concluded that Ponderal index is not an appropriate index for measuring intrauterine malnutrition as it fails to adjust for length at all gestational ages.

In our study sensitivity of MAC/HC ratio was 55.22 and specificity was 73.02, study done by Soundarya M et al.12 reported sensitivity of the ratio as 41.6% with specificity of 77.6%. Sharma JN et al.15 in their study concluded that MAC, HC and MAC/HC ratio had a high correlation with birth weight.

In our study BMI had a sensitivity of 80.6% but with low specificity of 74.6%, similar finding are reported by study conducted by Soundarya M et al.12

Metcoff J in his study made observations that babies whose length, HC, weight are significantly reduced were probably exposed to malnutrition early in second trimester. Babies whose length and HC are less affected but are small, underweight with loss of subcutaneous tissue probably became malnourished early in third trimester. Our study reemphasizes the observations of Metcoff that fetal malnutrition is a clinical diagnosis, independent of birth weight. The advantages of CAN Score are that it is a simple, easy to perform without the aid of any sophisticated equipment’s.

CONCLUSION: Fetal malnutrition is a major problem in developing countries as compared to developed countries. The present use of classifying babies on basis of weight as SGA, AGA and LGA may miss to diagnose some of the cases who are affected very late in third trimester. CAN Score is a simple systematic method to identify fetal malnutrition. It does not require any sophisticated equipment’s or time consuming calculations. Hence it is the method preferred for/ideal for screening malnourished babies. The main area of application of this tool is in periphery where availability of qualified personnel is less, using this will help the health workers to identify fetal malnutrition easily in developing nations where the incidence of fetal malnutrition is high.

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ORIGINAL ARTICLE

AUTHORS:
1. Thammanna P. S.
2. Sandeep M.
3. Sridhar P. V.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Pediatrics, Mandya Institute of Medical Sciences, Mandya.
2. Senior Resident, Department of Pediatrics, Mandya Institute of Medical Sciences, Mandya.
3. Assistant Professor, Department of Pediatrics, Mandya Institute of Medical Sciences, Mandya.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Thammanna P. S,
Associate Professor,
Department of Pediatrics,
Mandya Institute of Medical Sciences,
Mandya-571401.
E-mail: drthammannaps@gmail.com

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