

## Original Research Article

# Detection of fetal malnutrition and its associated maternal factors in a rural setting

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**Received:** 30 June 2020

**Accepted:** 31 July 2020

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### ABSTRACT

**Background:** The objectives of study were to analyse and compare the methods for detection of fetal malnutrition and to study the maternal factors associated with fetal malnutrition in babies born in rural hospitals.

**Methods:** Periodic prospective cross-sectional case-control questionnaire-based study. Nursing home and Hospital based in rural population from January 2017-March 2018. There were 350 term newborns born in Shrinivasa Nursing Home, and Crawford General Hospital, Sakleshpur, were selected consecutively. Inclusion criteria: live, singleton term neonates. Exclusion criteria: Preterms, post-terms, those with congenital malformation, multiple gestations, cephalhematoma, subgaleal bleed. Anthropometry, fetal malnutrition assessed using clinical assessment of nutrition (CAN) score, Ponderal and Kanawati indices between 24–48 hours of birth. Newborns with fetal malnutrition (cases), and well-nourished babies (controls) assessed for maternal risk factors using standardised questionnaire from mothers.

**Results:** CAN score identified 185 (52.9%) as malnourished and 165 (47.1%) as normal; Ponderal index classified 170(48.6%) as malnourished and 180 (51.4%) normal. Kanawati index grouped 151 (43.1%) as malnourished. Maternal factors: age (91.7% among <20 yr mothers-malnourished, 25% among >35 yrs), socioeconomic status (status 3, 4 had 57.2%, 66.7% malnourishment), improper antenatal care(80.7% irregulars; 38.5% among regulars), primiparity (60%;against 38.3% among multipara), pre-eclampsia (78.7%; 41.3% in normotensives), anemia (55.4%), weight gain (83.2% in <10 kg; 33.33% in >10 kg), stature (73.5% in <145 cm; 39.7% in >145 cm), medical illness (55.81%).

**Conclusions:** CAN score is simple, systematic, clinical method of identifying malnutrition; statistically superior as screening tool. Maternal factors: improper antenatal checkups, primiparity, pre-eclampsia, medical illness, inadequate weight gain, short stature had significant association with fetal malnutrition. Maternal age, socioeconomic status, anemia not statistically significant.

**Keywords:** CAN score, Fetal malnutrition, Kanawati index, Maternal factors, Ponderal index

### INTRODUCTION

Birth weight and gestational age are important indicators for survival, future growth and overall development of the child. Infants are classified into small for gestational age (SGA), appropriate for gestational age (AGA), and large for gestational age (LGA) as per the predetermined weight cut-off given in various intrauterine and post-natal growth charts derived for a study population.<sup>1,2</sup> This

classification does not indicate the overall nutritional status of the baby as fetal malnutrition (FM) can occur even in AGA infants and fetal malnutrition may not be present in SGA infants.<sup>3</sup>

Fetal malnutrition is defined as failure to acquire adequate quantum of fat and muscle mass during intrauterine growth.<sup>3</sup> It is a term coined by Scott and Usher<sup>4</sup> to describe infants who show evidence of soft

tissue wasting at birth irrespective of the specific etiology and is independent of birth weight and gestational age.<sup>1,3-5</sup>

Studies have found that perinatal problems and CNS sequel occurred primarily in those with malnutrition, whether AGA or SGA, but not in those who were simply SGA and well nourished.<sup>3-5</sup> Thus it is necessary to classify babies as with or without malnutrition in addition to their gestational age assessment. The measurements used to identify fetal malnutrition include Ponderal index, mid-arm circumference/Head circumference ratio, chest circumference and/or mid-arm circumference to head circumference ratio, Body mass Index and head circumference-to-length ratio.<sup>6</sup>

Intrauterine growth-retarded newborns can be classified into subgroups based on differences in their nutritional status. These differences can be distinguished at birth using the ratio of weight-for-length, which is summarized by Rohrer's Ponderal index.<sup>7</sup> Ponderal index values of < 2.0 between 29-37 weeks and <2.25 beyond 37 weeks are indicative of intrauterine fetal malnutrition. The mid-arm circumference/head circumference (MAC/HC) ratio (Kanawati index), independent of birth weight, readily discriminated the late gestation growth retarded baby.<sup>8,9</sup> An clinical assessment of nutritional status (CAN score) was developed to differentiate malnourished from appropriately nourished babies, to be assessed within 48 hours on the basis of the superficial readily detectable signs of malnutrition in the newborn as described by Metcalf. A score of <25 was used to define fetal malnutrition. This score offered the best breakpoint between growth retarded and normal infants as determined by weight for age. CAN SCORE scoring system helps to classify babies based on nutritional status, as malnourished or well-nourished babies, so that malnourished infants can be given special care.<sup>2</sup>

Considering, the various methods suggested by clinicians across the world, our aim of this study was to analyse and correlate the three most widely accepted methods of assessment of fetal malnutrition namely, CAN score, Ponderal index and Kanawati index, and suggest the ideal screening tool for fetal malnutrition.

Fetal malnutrition is multi-factorial, and the diverse patterns of fetal growth retardation depend on the timing, type and severity of fetal insult.<sup>2</sup> A major proportion of the causes attributed to fetal malnourishment has been linked to maternal factors. In developing countries, the major attributable causes of IUGR include low weight gain, low maternal nutrition, low BMI, short stature, malaria and pregnancy-induced hypertension although a substantial component is due to unknown causes.<sup>10</sup> The identification of maternal risk factors, in turn, the modifiable (preventive and treatable) risk factors can significantly improve the nutritional status and hence the overall health of infants and children. Epidemiological variations in the maternal factors need to be studied and

test of significance of the same must be assessed to obtain a clear perspective.

In our research, we have also elucidated the major prevalent association of maternal factors with fetal malnutrition in rural Indian setting, and the magnitude of impact these factors have on FM.

## METHODS

Present study is a hospital based cross sectional study consisting of singleton full term neonates born Shrinivasa Nursing Home, and Crawford General Hospital, Sakleshpur. Consecutively born neonates included in the study were evaluated between January 2017-March 2018. Sample size was calculated depending on the prevalence of fetal malnutrition and estimated as 350. Live born, singleton term neonates whose hospital stay exceeded 24 hours of age were included in the study. All preterm and post-term babies, babies born with major congenital malformation, twins & other multiple gestations, and babies with cephalhematoma, subgaleal bleed were excluded from the study.

Informed consent was taken from the mothers of infants who qualified for the study. A face-to-face interview with mothers using a standardized questionnaire was conducted by the same observer to prevent observer bias. Single blind technique was used while collecting details of questionnaire of babies of case and controls groups.

Gestational age assessment of newborn babies was done by modified Dubowitz method as described by Ballard JL et al.<sup>11</sup>

Anthropometric measurements: birth weight, crown heel length, weight for gestational age (AIIMS chart) were measured as per standard norms.<sup>12</sup> All measurements were carried out between 24-48 hours of newborn age. Kanawati Index: value <0.27 taken as FM and >0.27 as well-nourished. Ponderal index: <2.25 as FM and >2.25 well-nourished.<sup>13</sup> CAN Scoring done as per the standard norms described by Metcalf et al.<sup>3</sup> Scores <25 was considered FM, >25 as well-nourished. Maternal risk factor assessment was carried out by obtaining detailed history in the structured questionnaire.

## Statistical analysis

Data analyzed using SPSS 19<sup>th</sup> version. Analysis included mean, frequencies, percentage, Chi-square test and Pearson's correlation test.

## RESULTS

In the present study, out of 350 babies, 235 newborns were AGA (67.1%) and SGA newborns were 111 (31.7%). According to CAN score 185 (52.9%) were classified as fetal malnutrition and 165 (47.1%) as well nourished. The CAN score detected 35.7% of

malnourished in AGA and 91% of malnourished babies in SGA babies which was statistically significant. Based on Ponderal index, 170 (48.6%) babies were classified as malnourished babies and 180 (51.4%) babies were classified as well nourished. Based on Kanawati index, 151 (43.1%) babies were classified as malnourished and 199 (56.9%) babies were classified as well nourished.

Weight for gestational age chart classified 67.1% of the babies as well-nourished and 31.7% as malnourished. Of the above methods, CANSCORE identified more number of fetal malnutrition babies, i.e. 52.9% when compared to other methods, which is statistically significant ( $p=0.000$ ).

**Table 1: Maternal factors associated with fetal malnutrition; their frequencies in our study and the percentage prevalence given in brackets.**

Maternal factors	Sub-categories	CAN score > 25 well-nourished	CAN score <25 fetal malnourishment	P value
		N (%)	N (%)	
Socio economic status (SES)	2	80 (54.8)	66 (45.2)	0.785
	3	77 (42.8)	103 (57.2)	
	4	8 (33.3)	16 (66.7)	
Parity	Primipara	94 (40)	141 (60)	<0.001
	Multipara	71 (61.7)	44 (38.5)	
Antenatal check-ups	Regular	142 (61.2)	89 (38.5)	<0.001
	Irregular	23 (19.3)	96 (80.7)	
Hemoglobin (Hb) level of mother at delivery (g/dl)	<11	87 (44.6)	108 (55.4)	0.288
	>11	78 (50.3)	77 (49.7)	
Weight gain (kg)	<10	142 (66.6)	71 (33.33)	<0.001
	>10	23 (16.78)	114 (83.2)	
Maternal height (cm)	<145	129 (60.2)	85 (39.7)	<0.001
	>145	36 (26.4)	100 (73.5)	
Pre-eclampsia	Yes	23 (21.3)	85 (78.7)	<0.001
	No	142 (58.7)	100 (41.3)	
Concurrent medical illness	Yes	19 (44.18)	24 (55.81)	0.000
	No	146 (47.55)	161 (52.44)	

Taking CANSCORE as the gold standard in identifying fetal malnutrition, the sensitivity, specificity, PPV and NPV of other methods were calculated. The sensitivity of birth weight and gestation was 64%, ponderal index was 70.55%, and Kanawati index was 76.88%. The specificity of birth weight and gestation was 90%, ponderal index was 77.64% and Kanawati index was 92%. The positive predictive value was 91%, 71% and 92% respectively. The negative predictive value was 64.8%, 70.5% and 76.88% respectively.

Maternal factors were correlated with fetal malnutrition after identification of fetal malnutrition by CAN score, as shown in Table 1. primiparity, irregular antenatal checkups, poor maternal weight gain and short stature of mother showed significant association ( $p$  value <0.001). Pre-eclampsia and concurrent medical illness also showed statistical significance with  $p$  value <0.001 and 0.000 respectively.

## DISCUSSION

The clinical manifestation of fetal malnutrition depends in part, on when it began during gestation. Babies whose

length, head circumference and weight are significantly reduced probably were exposed to malnutrition beginning early in the second trimester. Those whose length and head circumference are less affected but are small and underweight with features of loss of subcutaneous tissues and muscle became malnourished in the third trimester, i.e. total tissue mass may be above the tenth percentile for gestational age; however, signs of malnutrition may be obvious. Such an infant's "expected weight" might have been at the 50<sup>th</sup> to 75<sup>th</sup> percentile in-utero, whereas observed birth weight is at the 10-15<sup>th</sup> percentile at birth.<sup>3</sup>

Our study estimated a net 52.9% occurrence of fetal malnutrition as identified by CAN scoring system and mean 41.3% by all other assessment systems, implying higher incidence of FM in our study population. The higher numbers of FM is explained by the rural background of our setup serving essentially the lower socio-economic strata. A study done on FM in urban Karnataka tertiary hospital showed an incidence of 24%.<sup>14</sup>

CAN score identified 52.9% newborns as malnourished, ponderal index showed 48.6% and MAC/HC recognized

43.1% FM, while intrauterine growth chart recognized 31.7% as SGA. FM cannot be reliably detected by the growth charts.<sup>3-6</sup> The analysis of CAN score, Ponderal index and Kanawati index showed higher sensitivity for FM in CAN score. Further, CAN score was taken as the gold standard for comparative study, (in concordance with other studies), and the sensitivity, specificity and predictive value of growth charts, Ponderal and Kanawati indices were calculated.

The sensitivity, specificity, positive predictive value and negative predictive value of growth charts were 64%, 90%, 91% and 64.8% respectively. Although specificity is high as per statistics, there was statistically significant occurrence of fetal malnutrition in the group considered as AGA as per the charts, hence it is unlikely to be consistent in identifying or describing infants with wasting or fetal malnutrition.

The sensitivity, specificity, positive predictive value and negative predictive value of Ponderal index were 70.55%, 77.64%, 71%, and 70.5% respectively. Ponderal index, which relies on the principle that length is spared at the expense of weight during period of acute malnutrition, is a more reliable negative predictor for FM rather than a screening tool.

Kanawati index estimated FM with a sensitivity of 76.88%, specificity of 91%, positive predictive value of 92% and negative predictive value of 76.88%. Although MAC/HC ratio is a reliable indicator of FM, those babies whose head circumference is reduced because of proportionate growth retardation might not be identified. Thus, CAN score have emerged as a single sensitive tool for assessment FM.

Maternal risk factors vary with epidemiology; the nature of impact depends on the severity, duration and characteristics of the risk factor. Many of these are preventable, few are treatable which if addressed can improve the fetal nourishment and hence the quality of life of the progeny. The various risk factors found to be attributable to FM in our rural population are as further discussed.

Maternal age is considered to be a non-modifiable risk factor associated with FM as a common notion. In the present study most of the mothers belonged to the age group of 20-34 years (330 mothers). Low number of cases in the present study in risk age group might be implicated in the statistical insignificance (p value being >0.07) of maternal age. Low SES showed higher prevalence of FM, though statistically this factor was not found to be significant (though p=0.785). Low maternal Hb (<11 mg/dl) had no statistical significance in causing fetal malnutrition.

FM was more common with primigravidae when compared to multigravidae. 80.7% of the babies who were born to mothers with irregular or no ANC had fetal

malnutrition which constitutes to 27.4% of the whole study population of 350 subjects and is statistically significant indicating inadequate antenatal care delivery system catering for the mothers or the effect of low socioeconomic status on the health of mothers.

Poor maternal weight gain <10 kgs and Short stature in mother <145 cm showed a significant association with fetal malnutrition with p value of <0.001. There was an increased prevalence of FM in mothers with pre-eclampsia, and with other maternal medical illnesses which included urinary tract infections, heart diseases, malformations and vascular diseases. Gender as a confounding neonatal factor for anthropometric variables was analysed and showed no statistical significance (p value ranged between 0.226–0.996).

Limitations of our study: Nutritional assessment based on CAN score is a subjective assessment of FM and is time-consuming procedure. The risk factors associated with FM were all analyzed together, hence the confounding effect of one by the other cannot be interpreted thus, only associations could be estimated.

Other studies done in similar lines show comparable results with our study regarding the superiority of CAN scoring over ponderal and Kanawati indices for identification of FM.<sup>3,14-16</sup> The negative predictive value of ponderal index was higher in Mehta et al (83.2%) and Liladhar et al (88%), which is in accordance with our conclusions.<sup>14,16</sup> Maternal anemia was found not to be statistically significant in Sachdeva et al.<sup>17</sup> Many studies have shown that the most favorable pregnancy outcomes occur when the mother's hemoglobin level is below the recommended cut-off value for anemia between 9.5±1.1 g/l.<sup>18-21</sup> Primiparity and poor weight gain in pregnancy as risk factors have shown similar associations in Kramer (Meta analysis) and the NFHS-4 in India; and by Srikrishna SR and WHO collaborative study respectively.<sup>22-24</sup>

## CONCLUSION

From our study, comparison between CANSORE system and other commonly used methods has shown that CANSORE is statistically superior to other methods, for screening of FM. Our study noted higher significant association of improper antenatal checkups, primiparity, pre-eclampsia, medical illness, inadequate weight gain and short stature while maternal age, socioeconomic status, anemia were not. The implicated maternal risk factors for FM, are not necessarily those causing preterm or low birth weight babies, hence need to be evaluated catering to the epidemiological perspective.

## ACKNOWLEDGEMENTS

Authors would like to thank all the babies and their mothers for participating in the study. We thank the

nursing home and hospital staff and the administration for providing us with the necessary support.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: Not required*

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**Cite this article as:** Janardhan AM, Alok S, Janardhan L. Detection of fetal malnutrition and its associated maternal factors in a rural setting. *Int J Contemp Pediatr* 2020;7:1880-4.