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Original Research Article

Detection of Fetal Malnutrition: Clinical Assessment of Nutritional Status Score Compared with Weight for Gestation and Ponderal Index

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Abstract

Introduction: Fetal malnutrition represents a distinct clinical entity that is not synonymous with small for gestational age or intrauterine growth retardation, as these conditions may occur independently of one another. The Clinical Assessment of Nutritional Status score provides a systematic method for evaluating fetal malnutrition and offers advantages over conventional anthropometric measures used to assess fetal growth.

Methods: This prospective cross-sectional study examined 100 full-term neonates at a tertiary care hospital over three months. Neonates were categorized as small for gestational age or appropriate for gestational age using Alexander growth curves. Fetal malnutrition was evaluated using the Clinical Assessment of Nutritional Status score as the reference standard and compared with weight for gestational age and Ponderal index measurements. A Clinical Assessment of Nutritional Status score of 24 or below was designated as indicating fetal malnutrition.

Results: The Clinical Assessment of Nutritional Status score identified malnutrition in 16% of neonates while classifying 84% as well-nourished. Assessment based on weight for gestational age revealed that 63% of babies were small for gestational age while 37% were appropriate for gestational age. The Ponderal index classified 9% as malnourished. Among 63 small for gestational age babies, 43 were small but not malnourished, while 3 out of 37 appropriate for gestational age babies were malnourished. When the Clinical Assessment of Nutritional Status score served as the reference standard, weight for gestational age demonstrated sensitivity and specificity of 94.12% and 64.29% respectively, while Ponderal index showed sensitivity and specificity of 25% and 94% respectively.

Discussion: These findings indicate that small for gestational age and intrauterine growth retardation are not synonymous with fetal malnutrition. The Clinical Assessment of Nutritional Status score can identify fetal malnourishment in neonates that other methods fail to detect, proving superior to weight-based classification and Ponderal index in accurately identifying fetally malnourished neonates, including those with normal birth weights. This has important clinical implications for recognizing at-risk infants who require enhanced monitoring and intervention.

Keywords: Fetal malnutrition, Clinical Assessment of Nutritional Status, CAN score, small for gestational age, Ponderal index, intrauterine growth retardation, Neonatal anthropometry.

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Introduction

The growth of the fetus depends fundamentally on three interconnected factors: the inherent growth potential of the fetus itself, the availability and quality of intrauterine nutrition, and the functional capacity of the placenta. The effectiveness of these factors manifests as birth size at any given gestational age, resulting in considerable variation in nutritional status at birth. The conceptual framework of fetal malnutrition was originally introduced by Clifford [1] and subsequently defined more precisely by Scott and Usher [2] as a clinical condition in infants marked by evident intrauterine loss or failure to accumulate normal quantities of subcutaneous fat and muscle tissue. It is crucial to recognize that fetal malnutrition and the terms small for gestational age and intrauterine

growth retardation are not interchangeable, as one condition may manifest without the presence of the others. Clinical evaluation of fetal malnutrition can be accomplished through the Clinical Assessment of Nutritional Status score developed by Metcoff [4]. Various alternative methodologies exist for determining the nutritional status of newborns at birth, including weight for gestational age, Ponderal index calculations [3], and mid-arm to head circumference ratios. However, each of these approaches possesses inherent limitations that may compromise their accuracy. The identification of fetal malnutrition at birth proves valuable for recognizing infants who face elevated risk for complications associated with abnormal fetal growth patterns. The neonatal morbidity associated with fetal malnutrition is substantial [5], as it adversely affects body composition through reduced muscle mass and protein content, while also disrupting metabolic and enzymatic functions.

The anthropometric criteria currently employed to assess fetal nutritional status in newborns present significant shortcomings [7]. Metcoff [4] developed a simple, clinically applicable scoring system designed to differentiate malnourished infants from appropriately nourished babies regardless of birth weight or clinical classification as intrauterine growth retardation, small for gestational age, or appropriate for gestational age. This scoring system evaluates clinical evidence of malnutrition in term babies based on loss of subcutaneous tissue and muscle, functioning independently of common confounding factors that affect infant weight. The primary objective of this investigation was to detect fetal malnutrition using the Clinical Assessment of Nutritional Status score in term neonates at birth and to compare its performance with other established methods of determining intrauterine growth.

Materials and Methods

This prospective cross-sectional investigation was conducted at a tertiary care hospital following approval from the Institutional Ethics Committee. The study enrolled 100 full-term neonates after obtaining informed consent from parents. Neonates of both sexes born from singleton pregnancies without major congenital malformations were eligible for inclusion. Infants resulting from multiple pregnancies or those presenting with major congenital malformations were excluded from the study. The investigation spanned a three-month period to ensure adequate sample collection and assessment.

Comprehensive neonatal anthropometry measurements were performed between 24 and 48 hours of newborn age using standardized guidelines and calibrated instruments. The Ponderal index was calculated using the formula: weight in grams divided by length in centimeters cubed, multiplied by 100 [3]. Values below 2.2 were considered indicative of growth retardation based on established criteria [7]. All measurements and clinical observations were systematically recorded on predesigned forms for each enrolled infant. Classification of newborns as small for gestational age or appropriate for gestational age was based on normograms from Alexander and associates' intrauterine growth curves [9]. Infants whose weights fell below the 10th percentile for their gestational age were classified as small for gestational age, while those with birth weights between the 10th and 90th percentiles for their gestational age were designated as appropriate for gestational age babies [9]. This classification system provides a standardized approach for evaluating birth weight relative to gestational age across different populations.

The Clinical Assessment of Nutritional Status score incorporates nine superficial, readily detectable clinical signs that are rated on a scale from 1, representing the worst outcome indicating severe fetal malnutrition, to 4, representing the best outcome indicating a well-nourished infant. The scoring system yields a maximum possible score of 36 and a minimum possible score of 9. For the purposes of this investigation, a Clinical Assessment of Nutritional Status score of 24 or below was designated as indicating fetal malnutrition. The Clinical Assessment of Nutritional Status score offers particular advantages in its simplicity and ease of application, especially when used in conjunction with cartoon illustrations of the signs and scores as described by Metcoff [4] in his original publications.

Statistical analysis of collected data was performed using SPSS version 22 software. Tests of significance were calculated using the chi-square test for categorical variables. Anthropometric measurements were expressed as percentiles to allow for standardized comparison across the study population. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for weight for gestational age and Ponderal index using the Clinical Assessment of Nutritional Status score as the reference standard. A probability value of less than 0.05 was considered statistically significant for all analyses conducted in this study.

Results

The study population comprised 100 term neonates evaluated for detection of fetal malnutrition using multiple assessment methods. The mean birth weight of the study population measured 2.61 ± 0.31 kilograms, while the mean length was 46.13 ± 2.15 centimeters. These baseline anthropometric measurements provided the foundation for

subsequent nutritional status assessments using the various methodologies employed in this investigation. When nutritional status of newborns was evaluated using the Clinical Assessment of Nutritional Status score, 84% of newborns were classified as well-nourished, while 16% demonstrated evidence of malnutrition. In contrast, assessment of nutritional status based on weight for gestational age revealed that 63% of babies were classified as small for gestational age, while 37% were classified as appropriate for gestational age. When the Ponderal index was utilized for detection of nutritional status in newborns, 91% were found to be well-nourished, with only 9% classified as malnourished. These disparate findings across different assessment methods highlight the lack of concordance between various approaches to evaluating fetal nutrition.

Among the 100 term neonates studied, 16 were identified as malnourished in utero using the Clinical Assessment of Nutritional Status score. Detailed analysis revealed that 43 out of 63 small for gestational age babies were small in size but not actually malnourished, while 3 out of 37 appropriate for gestational age babies were fully grown but nevertheless malnourished. The Ponderal index identified nine babies with fetal malnutrition, but application of the Clinical Assessment of Nutritional Status score found only four of these babies to have true fetal malnutrition. Among the 91 babies classified as well-nourished using the Ponderal index, 12 were subsequently identified as malnourished in utero when the Clinical Assessment of Nutritional Status score was applied. These findings demonstrate that the Ponderal index has low sensitivity compared to the Clinical Assessment of Nutritional Status score for diagnosing fetal malnutrition.

The study findings indicate that using the Ponderal index alone for diagnosing fetal malnutrition may result in misclassification, with some small for gestational age babies incorrectly diagnosed as fetally malnourished and some appropriate for gestational age babies incorrectly classified as normal. When the Clinical Assessment of Nutritional Status score was employed, 68% of small for gestational age infants were not actually malnourished, and 8% of appropriate for gestational age infants were fetally malnourished. This pattern suggests that apart from 32% of small for gestational age babies, an additional 8% of appropriate for gestational age malnourished babies are also at risk for complications but would be missed by weight-based classification alone.

Table 1: Distribution of Nutritional Status by Different Assessment Methods

Assessment Method	Well-Nourished	Malnourished	Total
CAN Score (cutoff <25)	84 (84%)	16 (16%)	100
Weight for Gestational Age	AGA: 37 (37%)	SGA: 63 (63%)	100
Ponderal Index (cutoff <2.2)	91 (91%)	9 (9%)	100

Table 2: Cross-Comparison of CAN Score with Weight for Gestational Age

Weight Classification	Well-Nourished by CAN	Malnourished by CAN	Total
AGA Babies	34 (91.9%)	3 (8.1%)	37
SGA Babies	43 (68.3%)	20 (31.7%)	63
Total	77	23	100

Table 3: Diagnostic Performance of Assessment Methods Using CAN Score as Reference Standard

Assessment Method	Sensitivity	Specificity
Weight for Gestational Age	94.12%	64.29%
Ponderal Index	25%	94%

Discussion

Recognition of babies with fetal malnutrition is clinically important due to the high incidence of neonatal morbidity associated with this condition [5]. Fetal malnutrition exerts adverse effects on body composition, including reduced muscle mass and protein content, as well as disruptions in metabolic and enzymatic functions. The clinical manifestations of fetal malnutrition are characterized by obvious intrauterine loss of subcutaneous fat and muscle tissue. While weight, length, and head circumference may be affected in cases of fetal malnutrition, these parameters are not consistently impacted [6], which underscores the limitations of relying solely on anthropometric measurements for diagnosis. The current anthropometric criteria used to assess fetal nutritional status in newborns possess inherent shortcomings that limit their accuracy and clinical utility [7]. Metcoff [4] developed a simple, clinically applicable scoring system specifically designed to differentiate malnourished from appropriately nourished babies regardless of birth weight or clinical classification as intrauterine growth retardation, small for gestational age, or appropriate for gestational age.

This scoring system evaluates clinical evidence of malnutrition in term babies based on loss of subcutaneous tissue and muscle, and operates independently of common confounding factors that affect infant weight. The Clinical Assessment of Nutritional Status score is particularly advantageous because it is simpler to learn and easier to perform than many alternative assessment methods, especially when used with the aid of cartoon illustrations of the signs and scores as described by Metcoff [4]. Research by Hill and colleagues [8] demonstrated that 32.6% of infants with fetal malnutrition would have been incorrectly classified as appropriate for gestational age if only birth weights, lengths, and head circumferences were considered for detection of growth retardation.

The findings from our investigation align with these observations, as the Clinical Assessment of Nutritional Status score revealed that 68% of small for gestational age infants were not malnourished and 8% of appropriate for gestational age infants were fetally malnourished. Therefore, beyond the 32% of small for gestational age babies, an additional 8% of appropriate for gestational age malnourished babies face elevated risk for complications. Metcoff [4] established the Clinical Assessment of Nutritional Status score as a reliable indicator of fetal malnutrition through extensive validation studies.

Our data, consistent with previous reports in the literature, suggest that using weight for gestation classification to identify malnourished neonates may not be entirely accurate. This approach may incorrectly identify many well-nourished neonates as small for gestational age, or fail to detect a proportion of malnourished appropriate for gestational age neonates. Such misclassification has significant clinical implications, as it may result in inappropriate intervention for well-nourished small babies or missed opportunities for enhanced monitoring and care of malnourished babies with normal birth weights.

The Ponderal index has been utilized by various researchers to classify infants with intrauterine growth retardation. In our investigation, nine infants were identified as growth retarded according to Ponderal index criteria (values below 2.2); however, only four of these infants were confirmed as fetally malnourished when evaluated using the Clinical Assessment of Nutritional Status score. When the Clinical Assessment of Nutritional Status score was compared with the Ponderal index, the latter demonstrated a sensitivity of only 25% but a specificity of 94% in the present study. These findings are consistent with research by Haggarty and colleagues [10], who indicated that the Ponderal index is a poor predictor of in utero growth retardation. The low sensitivity of the Ponderal index suggests that it fails to identify a substantial proportion of truly malnourished infants, while its high specificity indicates that infants identified as malnourished by this method are likely to be truly affected.

Deodhar and colleagues [7] have characterized the Clinical Assessment of Nutritional Status score as a simple and rapid clinical scoring system for diagnosing fetal malnutrition. In developing countries such as India, where sophisticated diagnostic equipment may not be universally available, the Clinical Assessment of Nutritional Status score can serve as a simple and effective tool to identify fetal malnutrition. The score requires minimal equipment, can be performed rapidly at the bedside, and provides reliable results that can guide clinical decision-making regarding neonatal care and monitoring.

The present study possessed certain limitations that should be acknowledged. The sample size of 100 neonates, while adequate for preliminary investigation, was relatively small and may limit the generalizability of findings to broader populations. Additionally, the study design did not include long-term follow-up assessment to evaluate the developmental outcomes of these babies, which would have provided valuable information regarding the prognostic significance of fetal malnutrition detected at birth. Future investigations with larger sample sizes and longitudinal follow-up would strengthen the evidence base for using the Clinical Assessment of Nutritional Status score in clinical practice.

Conclusion

This investigation demonstrates conclusively that small for gestational age and intrauterine growth retardation are not synonymous with fetal malnutrition. The Clinical Assessment of Nutritional Status score, which represents a simple clinical index for identifying fetal malnutrition, proves to be a superior indicator compared to other methods of determining intrauterine growth retardation such as weight for gestational age and Ponderal index. The findings imply that the Clinical Assessment of Nutritional Status score can successfully identify fetal malnourishment in neonates that other conventional methods fail to detect.

This capability has important clinical implications, as it enables healthcare providers to recognize at-risk infants who require enhanced monitoring and intervention, regardless of their classification based on birth weight alone. Implementation of the Clinical Assessment of Nutritional Status score in routine neonatal assessment could improve identification of vulnerable infants and facilitate appropriate targeting of resources for their care.

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