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Original Article

Is canscore a good indicator of fetal malnutrition in preterm newborn

B.N. Ezenwa *, V.C. Ezeaka

Department of Pediatrics, Lagos University Teaching Hospital, Lagos, Nigeria

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ABSTRACT

Background: Fetal malnutrition is a risk factor for increased neonatal morbidities and mortalities worldwide. BMI and CANScore had been used for determining fetal malnutrition in term newborns.
Objective: To assess the nutritional status of preterm newborns at birth using BMI, PI and CANscore and determine the better indicator for FM.
Methods: The study was carried out on consecutive, live-born babies between 28 completed weeks through 36 weeks gestation. Birth weights and lengths were recorded as per protocol. BMI was calculated and BMI <10th centile using Brock's chart is considered as FM and a PI <2.2 was considered as malnutrition. Using Metcoff's CANscore, score <25 is FM. Data was analyzed using the SPSS version 22.0.
Results: One hundred and forty preterm newborns were assessed and 108 (77%) were of LBW. BMI, CANscore and PI identified 40.0%, 34.3% and 30.0% of the preterm newborns as FM. Using BMI as standard for detecting FM, CANscore and PI identified 33.9% and 51.8% of the babies as FM. PI had a better sensitivity for detecting FM in preterm infants compared to CANScore and this was statistically significant, $p < 0.00$.
Conclusion: FM is common in preterm babies. BMI and PI are simple and easy tools to use in assessing FM in preterm babies. They are also better identifiers of FM in preterm newborns compared to CANScore.

1. Introduction

The nutritional status of a fetus has major influence on the overall health of the infant post-nataly.[1,2] The fetus can be undernourished, well-nourished or over-nourished in utero. Fetal malnutrition commonly refers to undernutrition in utero in which the fetus fails to acquire adequate quantum of subcutaneous tissues and muscle mass as it experienced deprivation of adequate calories, proteins and other nutrients necessary for proper growth and development.[2] At birth the affected baby may be under weight for gestational age, there is loss or poor accumulation of subcutaneous fat and the child may look thin and wasted.[3] This clinical state can occur at any birth weight[2] and has been described also in preterm infants.[4] It describes infants who show evidence of soft tissue wasting at birth irrespective of the specific aetiology.[5,6]

Worldwide, WHO has implicated undernutrition as the underlying cause of half of the under- five mortality. Meanwhile 37% of the under- five mortality are contributed by neonatal mortality with prematurity and its complications making up to 28% of the mortalities. Prematurity is prevalent in developing countries and fetal malnutrition (FM) is also prevalent.[3,7] Fetal malnutrition may lead to high risk delivery and perinatal problems.[8–10] FM has been implicated in both short and long term adverse outcome in affected newborns. Adebami et al. documented higher incidences of neonatal morbidity and mortality in infants with FM compared with those without malnutrition.[3,11] In Turkey Korkmaz documented similar finding in preterm infants with FM.[3] Small preterm neonates have difficulty maintaining normal blood glucose concentration and are at risk of recurrent hypoglycemia at birth.[12] The study by Greeves et al.[13] demonstrated that in utero sub-optimal nutrition may hamper the cognitive development and academic proficiency of children exposed to FM. Barker et al. in their epoch hypothesis "fetal origin of adult diseases" associated LBW with adult onset cardiovascular diseases. Babies who were thin at birth tend to be insulin resistant as children and adult and tend to develop insulin resistance syndrome later in life.[14]

Nutritional assessment in the newborn period reflects the average growth pattern from conception to birth.[15] Fetal growth and development are determined by gestational age, genetic and environmental factors.[16] The fetus grows most rapidly between 12 and 36 weeks of gestation both in length and in weight acquisition.[17]

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* Corresponding author.
E-mail address: beatriceezenwa@yahoo.com (B.N. Ezenwa).

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Increased rate of fat deposition commences around 28 weeks of gestation.[17]

Various instruments have been used to identify children with malnutrition. In older children and adults Body Mass Index (BMI) is used as the gold standard[18] in determining body proportions and adiposity or for screening for malnutrition. In neonates as in older children various criteria have been used to identify and classify FM. The most common criterion used being the birth weight. Researchers have argued that birth weight alone may not reflect the state of nutrition in utero.[19] Working on this premise Brock et al.[20] and Olsen et al.[21] separately validated the use of BMI for assessing the nutritional status of newborns at birth. De Cunto et al[22], Kamath et al.[23] and Carrera[16] in their different studies demonstrated that BMI has a direct correlation with percentage body fat mass in neonates. Ponderal Index (PI) is another commonly used proportionality index of adequacy of intrauterine growth[24,25] often used in preterm infants. Other researchers have also used clinical assessment of nutritional status score (CANScore) which assesses nine clinical signs on the newborn as an indicator of FM in term[3–7] and preterm infants.[4]

The aim of the present study was to assess the nutritional status of preterm newborns at birth using BMI, PI and CANscore and to determine the better indicator for FM in preterm newborns. The findings from this study would provide guidance into choosing the better method of determining FM in preterm newborns.

2. Methodology

The study was a cross-sectional study of all singletons, live born babies of ⩾28 completed weeks through 36 weeks gestation delivered in the labor ward of the Hospital.

Babies with major congenital abnormalities or severe perinatal illness were excluded. Ethical clearance was obtained from the Research and Ethics Committee of the Hospital. Informed parental consent was obtained for each new-born recruited.

Sample size of 140 was calculated using the formula for descriptive study. Each infant was examined by the investigator within 48 h of birth. All the anthropometric measurements, except birth weight, were carried out by the investigator with trained assistance where necessary. Neonates were weighed nude at birth by the delivery room staff using the infant weighing scale (Weighmaster model®, USA), which records the weight to the nearest 10 g. Using the Lubchenco intrauterine growth chart,[26] birth weights for gestational age below the 10th percentile and above the 90th percentile on the chart were taken as small for gestational age and large for gestational age respectively. The infant's length was measured using standard protocol.[27] BMI was calculated for each baby using the formula: [weight (kg)/ length (m)^2] and the value was plotted on the BMI curve designed by Brock et al.[20] for newborn babies. PI was computed from the formula: PI = weight (g)/length^3 (cm) X100. A PI <2.2 was considered as malnutrition.

CANScore was applied to each baby within 48 h of birth based on the nine clinical signs of malnutrition as described by Metcoff (Appendix A)[5] which consisted of inspection of hair and estimation of loss of subcutaneous tissues and muscles in the designated areas: cheeks, neck and chin, arms, back, buttocks, legs, chest and abdomen. The range of scores for each varied between 1 and 4. A maximum score of 4 was awarded to each parameter with no evidence of malnutrition, and the lowest score of 1 was awarded to parameter with the worst evidence of malnutrition. The total rating of the 9 signs was the CANScore for the subject. Fetal malnutrition was defined as CANScore less than 25.[5,11]

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) for windows, version 22.0 (IBM Corp. released 2013, Armonk New York). The variables were presented by frequency tables and cross-tabulations. Student's *t*-test was used to compare the mean anthropometry between males and females. Chi-squared analysis was used to assess association between categorical variables. Fisher's exact test was used for variables < 5 and Pearson's correlation was used to test for relationship between two quantitative variables. $P < 0.05$ was considered statistically significant at 95% confidence level.

3. Results

One hundred and forty preterm newborns participated in the study. There were 67 males and 73 females giving a male: female ratio of 1:1.08. Of these, 108 (77.1%) were of LBW, 7(5%) were SGA while 122 (87.1%) were AGA. The mean birth weight of the subjects was 2100 ± 600 g and the mean length was 43.2 ± 5.0 cm. There was no significant difference between mean birth weight and length centiles in male and female preterm babies.

BMI detected FM in 40% of the subjects while PI and CANScore detected 30.7% and 34.3% respectively as FM. This is shown in Fig. 1.

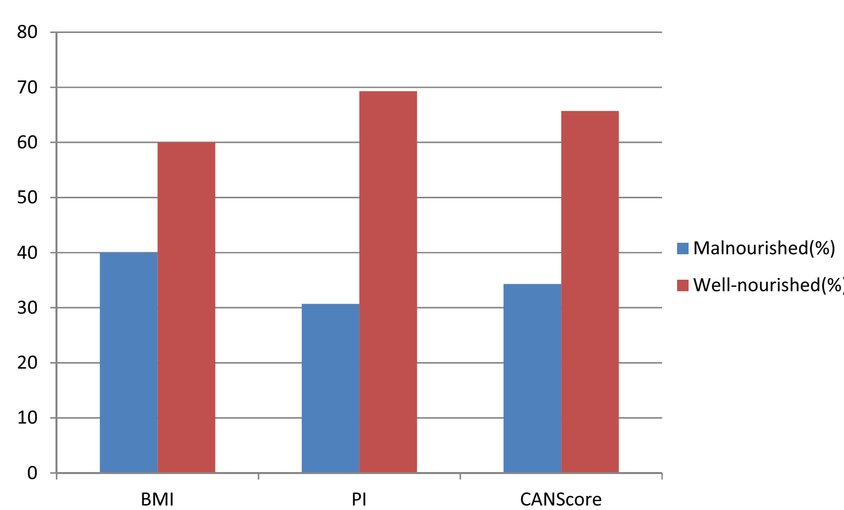

Fig. 1. Distribution of FM by BMI, PI and CANScore.

Table 1
Comparison of the validity measures of PI and CANScore with BMI.

Value	PI	CANScore
Sensitivity	69.8%	39.6%
Specificity	73.2%	59.8%
Positive predictive value (%)	54%	33.9%
Negative predictive value (%)	85%	59.8%

Table 2
Correlation of BMI with PI and CANScore.

Parameter	r	p value
PI	0.405	0.000*
CANScore	−0.006	0.94

* p value ⩽ 0.01 is significant. **N = 140.**

Further analysis showed that using BMI as a standard for detecting FM, PI detected 69.8% of those babies detected by BMI as FM as FM also while CANScore detected 40.2% of them. Comparison of validity measures of PI and CANScore with BMI in detection of FM showed that PI had the highest sensitivity and specificity for FM in preterm newborns as shown in Table 1.

A Pearson's correlation coefficient was computed to assess the relationship between BMI and the other two parameters for detecting FM (Table 2). Mean values for PI was 1.69 ± 0.46 and mean for CANscore was 1.66 ± 0.48. There was significant correlation between BMI and PI in detection of FM (p = 0.000) whereas BMI had no significant correlation with CANScore in preterm newborns.

4. Discussion

The present study has shown that FM is common in preterm newborns. Though there are no universally agreed indicators for FM in preterm babies, the existing indicator widely used has been the birth weight.[19,20] In term newborns, in addition to the birth weight, CANScore has been applied by many researchers and found to accurately assess the subcutaneous fat deposit in utero at term.[3–7,24,25] Many studies have demonstrated FM as a major public health problem in developing countries.[3,4,23] The present study documented prevalence of FM to be 40% using BMI which is similar to the 48.9% documented by Almarzoki et al[28] in Iraq. It is however, higher than the 26.59% documented in India by Kamath et al.[23] Both assessed the nutritional status with BMI. The use of combination of two parameters – weight and length – in BMI to assess the body proportions and nutritional status of an infant confers superiority to it over single parameters like weight alone. As a proportionality index, BMI accommodates the expected increase in size and weight as the gestational age increases, making it the ideal choice in nutritional screening of the preterm newborn.

In the present study PI identified 30.7% of the study subjects as FM but when BMI was applied to these FM babies, 13 of them were found to be well nourished. However, when PI was applied to the malnourished babies detected by BMI, 69.8% of them were also identified as FM. In the present study PI has a high sensitivity and specificity for FM with significant correlation with BMI, making it a good screening tool for FM. PI is also a proportionality index hence may not be affected by gestational age and it relies on the fact that length is spared in acute malnutrition.[29] It is one of the most widely used proportionality indices in neonatology, as it is more sensitive than birth weight for the identification of neonatal risk of morbidity associated with intrauterine growth abnormalities and is not affected by sex or ethnicity.[30] As length is cubed in PI a slight mistake or miscalculation in the length will give a marked disparity in PI.

Most studies that had documented FM in term babies used CANScore to assess it. There has been paucity of studies on preterm newborns using CANScore. In this study we documented FM in 34.3% of the preterm newborns using CANScore. This is lower than the 40% documented with BMI in this study and also lower than the 54.8% documented in preterm babies in Turkey using CANScore.[4] This disparity may be due to the fact that CANScore assesses for subcutaneous fat deposition whereas it is a known fact that significant fat accretion starts in late gestation[17] hence CANScore may not be a good indicator of FM in preterm newborns especially in early preterm when fat deposition is minimal or non-existent. Most of the earlier studies that documented FM in preterm babies using CANscore have been in late preterm neonates. The present study assessed FM even in early preterm babies, gestational age at which adiposity is just starting. Hence CANscore which assesses evidence of subcutaneous fat accumulation and muscle wasting[5,31] may not be the ideal tool. Also the cutoff point for FM using CANscore is static at 25. Again this did not put into consideration the different rate of fat accumulation at different gestational ages. Sifianou[32] in his study of a cohort of late preterm and term babies disagreed with this cut-off and used a cut-off point of <27 for FM. Other studies had documented that in term babies when gestational age is in doubt CANscore may be a better assessment tool to use as it is not dependent on gestational age.[24] This may not be extrapolated in preterms.

In the present study, analysis of the relationship of CANScore with BMI, gave a very poor sensitivity and specificity for CANscore with a low positive predictive value. CANScore had no significant correlation with BMI in preterm babies (r = −0.006, n = 140, p = 0.94). All these support its poor suitability as a tool for assessing FM in preterm newborns.

As fat accumulation and mean anthropometry increase as gestational age increases, the parameters that take this into cognizance, like BMI and PI, will be a better choice in assessing nutritional status in preterm babies. Also the use of combination of parameters or criteria will ensure that all malnourished babies will be identified. It is obvious from this study and other similar studies that preterm infants also suffer FM. A newborn infant with FM is a high risk newborn who is prone to short and long term complications of FM. A newborn should be properly assessed at birth as identifying FM will greatly impact on the proactive management of anticipated complications. The combination of BMI and PI in assessing the preterm baby at birth is advocated as part of the essential newborn care as it will ensure that those babies with FM are identified and closely monitored or followed up.

5. Conclusion

FM is also common in preterm babies. BMI and PI are simple and easy tools to use in assessing FM in preterm babies. They are also better identifiers of FM in preterm newborns compared to CANScore. The combination of BMI and PI in assessing the newborn at birth will ensure that no malnourished baby is missed.

Appendix A. The nine signs for CAN status in the Newborn[4]

	CAN score			
Parameter	4	3	2	1
Hair	Thick, dense, smooth, easy to comb	Thick, less dense, with little hair straight	Less abundant, coarse, straight, and does not respond to brushing	Less abundant or thin, flag sign
Cheek	Round, large, fat pad	Slightly reduced fat pad	Significantly reduced	Reduced buccal fat with narrow flat face
Chin and Neck	Double or triple neck fat rolls, neck not visible	Full, submandibular fat, moderate neck fat with no rolls	No double chin, some submandibular fat, minimal neck fat	No submandibular fat, thin chin, neck with loose, wrinkled skin very evident
Arm	Upper and lower skin thick, subcutaneous tissue taught, cannot pick up over elbow or triceps area	Moderate subcutaneous tissue present on upper and lower arms, slight pleating of skin, cannot pick up over elbow and back of hand	Some subcutaneous tissue present on upper and lower arms, skin loose, pleats easily, can pick up over elbow but not on back of the hand and forearm	Very little fat, loose skin, accordion-like folds significantly
Back	Upper and lower back subcutaneous tissue thick. Inter-scapular area of skin cannot be picked	Moderate subcutaneous tissue, skin loose over scapular	Some subcutaneous tissue present, skin loose over scapular and lower back	Subcutaneous tissue minimal, skin very loose in appearance, easily tents over scapular, spine, and lower back
Buttock	Fat pad thickness Round, full and firm	Round, less full, less firm	Flat but definite fat present	Flat, appear wasted, little or no fat
Leg	Thick subcutaneous tissue that cannot be picked up	Some subcutaneous tissue, can pick up easily but good turgor	Skin upper medial thigh loose, easily picked up over anterior thigh but not over tibia	Thighs appear wasted, obvious loose skin, easily picked and pleats, very poor turgor.
Chest	Round, ribs not seen	Intercostal spaces less prominent, ribs less obvious	Intercostal space revealed	Intercostal space very clear, obvious loss of subcutaneous tissue
Abdomen	Full, round, no loose skin	Round with loose skin, not easily lifted, with no wrinkle	Scaphoid but not very loose, skin easily lifted and with some wrinkles	Distended or scaphoid; but with very loose skin, easily lifted and wrinkled

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