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Assessment of Fetal Malnutrition Based on the CANSCORE Index and Anthropometric Indices

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ABSTRACT

Introduction: To prevent the adverse effects of fetal malnutrition (FM), its management and early diagnosis by reliable tools are essential. The present study aimed to identify the rate of malnutrition in a referral maternity center in Iran using different systems for evaluating the nutritional status and determining a better index for FM.

Methods: This cross-sectional study was performed on the neonates born in the maternity ward of Hajar Hospital in Shahrekord, Iran in 2020. FM was evaluated based on different parameters, including the CANSCORE index, body mass index (BMI), Ponderal index, and mid-arm circumference/head circumference (MAC/HC) index. After recording the measurements, birth weight and height were plotted on the intrauterine growth chart, and the infants were classified into groups of appropriate for gestational age (AGA), small for gestational age (SGA), and large for gestational age (LGA).

Results: Based on the fetal growth status index, 14.7% of the neonates were in the AGA group, and 95.3% were in the LGA group. Malnourishment was detected in 40.5% of the neonates based on the CANSCORE index, 8.3% based on the MAC/HC index, 6.9% based on the BMI, and 5.2% based on the Ponderal index. In addition, the CANSCORE index had a significant positive correlation with all the growth indices (except the MAC/HC index), and the Ponderal index was also significantly correlated with all the growth indices except height.

Conclusion: According to the results, the CANSCORE index could show growth status and FM more accurately compared to other anthropometric parameters that may underestimate FM. Furthermore, BMI is a highly sensitive indicator, and infants malnourished in terms of BMI should be examined based on the CANSCORE index to accurately identify FM.

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Introduction

Fetal malnutrition (FM) is a term first proposed by Scott and Usher in 1966 to describe infants with evidence of soft tissue loss at birth regardless of specific etiology (1). FM is defined as the lack of sufficient quantum fat and muscle mass during intrauterine growth (2). The importance of addressing the hidden complications associated with FM is because studies have shown that the potentially severe complications of malnutrition in various body systems are irreversible (3).

Perinatal problems or long-term consequences of the central nervous system occur mainly in infants with FM despite being appropriate for gestational age (4). FM may also occur due to poor maternal diet, inability of the mother to metabolize and transfer sufficient nutrients, impaired nutritional supply (vascular and placental) to the fetus, and increased fetal demand due to faster growth (5). Changes in the structure and physiology of the fetus may occur due to the lack of the nutrients or components needed to build high-quality organs and tissues and adaptation to nutrient depletion through reduced fetal growth or prioritizing essential organs (6).

The regulation of the endocrine system (especially hormones that regulate fetal growth and maturation) and support of the tissues are different. It has been hypothesized that metabolic changes after birth remain to increase the risk of diabetes and cardiovascular diseases

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in the future, especially in the presence of additional stressors in later life stages (e.g., obesity and sedentary lifestyle) (7, 8). Overall, an infant who is not properly nourished during the intrauterine growth period is at the risk of short-term and long-term complications after birth, which adversely affect the growth, intelligence, and overall health of the neonate. To prevent these consequences and have healthier infants and future adults, it is crucial to diagnose the symptoms of infant malnutrition properly and provide treatment to high-risk infants immediately. The management of these neonates at birth may reduce complications and improve their survival.

Congenital malnutrition is assessed using various systems, including anthropometric indices, fitness indices (e.g., Ponderal index, head-to-toe ratio, chest circumference, mid-arm circumference, mid-arm-to-head circumference), body mass index (BMI), and the CANSCORE index, which is a scoring system based on nine 'superficial' and readily detectable signs of malnutrition in newborns (9). Several studies have used these criteria, and some have suggested the CANSCORE index to be a more accurate measure of the nutritional status for infants compared to the birth weight index for gestational age. The CANSCORE index could also identify the infants who are small for gestational age (SGA) but not malnourished (10, 11). Although this score is recognized as the primary standard of diagnosis, it is a time-consuming method and requires adequate staffing and appropriate skills to perform the required examinations on all infants and provide equal grading (12). Although the CANSCORE index appears to be a more appropriate tool for the assessment of infant nutrition, studies have shown that the Ponderal index (PI) and BMI are simple and common tools for the examination of FM in infants, as well as more reliable diagnostic markers of FM compared to the CANSCORE index (13).

In this study, we intended to identify the prevalence rate of FM in newborns in a maternity ward using various systems for evaluating the nutritional status and determining a better index for FM. Our findings could contribute to the identification of an appropriate screening method to detect primary malnutrition in infants and prevent the complications of FM. The best screening method found in this study can be proposed to the governing health authorities to be implemented in national guidelines and routine maternity checklists.

The present study aimed to compare the nutritional status of the neonates born in a referral maternity ward based on the CANSCORE index and anthropometric indices.

Materials and Methods

This cross-sectional study was performed on 363 neonates born in the maternity ward of Hajar Hospital in Shahrekord, Iran in 2020. The inclusion criteria were term infants (gestational age>37 weeks based on modified Ballard date and score), age of <48 hours, and no medical complications or congenital anomalies. The exclusion criteria of the study were as follows: 1) multiple births; 2) requiring NICU care; 3) neonates of mothers with gestational diabetes and 4) neonates of mothers with unreliable estimates of gestational age.

Based on similar studies, assuming that the prevalence of malnutrition in infants is equal to 40%, and considering 95% confidence interval and 5% accuracy, the sample size of the study was determined to be 368 using the following formula (14):

$P = (40\%\ d=5\%)\quad N = Z^2p(1-p)/d^2 = 368$

The study protocol was approved by the Ethics Committee of Shahrekord University of Medical Sciences (ethics code: IR.SKUMS.REC.1398.144). After obtaining written consent from the legal guardians, the infants were weighed at birth by an experienced nurse using a Misaki scale (made in Japan) with an accuracy of 50 grams. Neonatal height and head circumference (HC) were also measured using a standard tape, and arm circumference was measured using a non-stretch tape at the midpoint of the arm. After recording the mentioned measurements, birth weight and height was plotted on the intrauterine growth chart, and the infants were classified into groups of appropriate for gestational age (AGA), SGA, and large for gestational age (LGA).

According to the Alexander nomogram, infants weighing less than 10 percentile are SGA, and infants weighing 10-90 percentile are AGA. Based on the study by Soundarya et al., mid-arm circumference/head circumference (MAC/HC) index with the cutoff point of 27 was used to determine malnutrition (13). In addition, BMI was calculated by dividing the weight (kg) by squared height (m), and the cutoff point of <11.2

kg/m^2 was considered the malnutrition index. The PI was also determined by calculating the ratio of weight to the cubic length, and the score of <2.2 g/cm^3 was considered the malnutrition index (15).

To assess the status of clinical nutrition, the CANSCORE scoring system was employed.

In the CANSCORE system, the physical factors of nine infants were assessed during the examination, and four states (worst to best) were defined for each factor. In this regard, the worst state was scored one, and the best state was scored four. Therefore, the lowest and highest possible scores for each infant were nine and 36, respectively. An infant with the CANSCORE index of less than 25 was diagnosed with FM (16).

Nine signs for the clinical assessment of nutritional status in newborns (CANSCORE index) include hair (large amount, straight, and soft hair that is easily styled [4], less hair [some straight 'staring' hair] [3], still thinner [more straight, 'staring' hair that does not brush] [2]), cheeks (progression from full buccal pads and round face [4] to significantly reduced buccal fat, with a narrow, flat face [1]), neck and chin (double/triple chin fat fold, neck not evident [4] to thin chin, no fat fold, neck with loose wrinkled skin [very evident] [1]), arms (fullness, cannot lift the skin [4], slightly thin arms, check on the pressure of hands, accordion-like folds may form [3], thinner arm with more accordion-like folds [2], very limited fat, significant accordion-like folds [1]), legs (like arms), back (different to grasp and left skin in the interscapular area [4] to loose skin easily lifted in a thin-fold from the interscapular area [1]), buttocks (full, round gluteal fat pads [4], slightly reduced fat [3], significantly reduced fat with wrinkles [2], fat disappears, loose skin over the upper posterior thigh as well [1]), chest (full found ribs not seen (4); to progressively prominence of the ribs with an obvious loss of the intercostal tissue [1]), and abdomen (fullness, thick subcutaneous fat [4], slightly reduced fat [3], abdominal wall thinning, may form accordion-like folds [2], boat-shaped abdomen, loose skin, may form accordion-like folds [1]) (10, 17).

Data analysis was performed in SPSS version 22 (IBM Corp. Released 2013, Armonk, New York) using descriptive statistics to describe the data, including mean and standard deviation (SD) for the quantitative variables and frequency and percentages for the categorical variables. To assess the correlations between the studied parameters, the Pearson's or Spearman's correlation-coefficients were used. In all the statistical analyses, the P-value of less than 0.05 was considered significant.

Table 1. Neonatal growth indices in Hajar Hospital, Shahrekord (2020)

Index	Minimum	Maximum	Mean±SD
Weight (gr)	2000	4400	3126±426
Height (cm)	43	56.0	49.2±1.81
Head circumference (cm)	31	38.5	34.6±1.20
Chest circumference (cm)	28	37.0	32.7±1.60
Arm circumference (cm)	8	14.0	10.7±1.13
Arm to head circumference (cm)	0.24	0.38	0.31±0.029
Body mass index (kg/m^2)	9.05	16.4	12.86±1.24
Head circumference to height (cm)	0.65	0.78	0.703±0.024
Ponderal index	1.93	3.37	2.61±0.24
CANSCORE index	15	38.0	26.02±4.23

Table 2. Frequency of malnutrition based on neonatal growth indices in Hajar Hospital, Shahrekord (2020)

Index	Cutoff value	Frequency (%)
Birth weight (gr)	AGA	17 (4.7)
	LGA	342 (95.3)
CANSCORE index	<25	147 (40.5)
	≥25	216 (59.5)
Arm to head circumference	<0.27	30 (8.3)
	≥0.27	333 (91.7)
Body mass index (kg/m^2)	≤11.2	25 (6.9)
	>11.2	338 (93.1)
Ponderal index	≤2.2	19 (5.2)
	>2.2	344 (94.8)

Table 3. Spearman correlation coefficient of CANSCORE and Ponderal indices with other neonatal growth indices

Growth index	CANSCORE index		Ponderal Index	
Weight	0.728	<0.001	0.580	<0.001
Height	0.546	<0.001	-0.056	0.289
Head circumference	0.487	<0.001	0.266	<0.001
Chest circumference	0.661	<0.001	0.461	<0.001
Arm circumference	0.627	<0.001	0.431	<0.001
Arm to head circumference	0.525	<0.001	0.381	<0.001
Body mass index	0.623	<0.001	0.910	<0.001
Head circumference to height	-0.059	0.265	0.354	<0.001

Results

In total, 363 infants were studied, including 188 boys (51.8%), and the remaining were girls. Based on the fetal growth status index, 17 neonates (4.7%) were in the AGA group, 342 (95.3%) were in the LGA group. Malnourishment was detected in 40.5% of the neonates based on the CANSCORE index, 8.3% based on the MAC/HC index, 6.9% on the BMI, and 5.2% based on the PI (tables 1 & 2). Table 3 shows the correlation-coefficients of the CANSCORE index and PI with the other growth indices. Accordingly, the CANSCORE score had a significant positive correlation with all the growth indices, except the head-to-toe ratio (P<0.001). In addition, the PI had a significant positive association with all the growth indices, except height (P<0.001).

Discussion

The present study aimed to assess and compare the nutritional status of infants born in Hajar Hospital maternity ward based on the CANSCORE index and anthropometric indices in 2020. In total, 363 infants were studied, and the rate of FM was estimated at 40.5%, 8.3%, 6.9%, and 5.2% based on the CANSCORE scoring system, arm-to-head circumference ratio, BMI, and PI, respectively. Furthermore, the CANSCORE index was considered a more reliable and accurate measure of FM comparatively. In line with our findings, the study by Singh evaluated FM and its ratio between AGA and SGA infants using the CANSCORE index, reporting that the CANSCORE index may be a simple clinical indicator for the detection of FM and prediction of the associated neonatal complications without the need for advanced equipment (14).

In a study conducted by Lakkappa et al. (2018) on single-term infants born in a reference hospital, 8% of the infants were SGA, and 92% were AGA. In the mentioned study, the prevalence of malnutrition based on the CANSCORE index was estimated at 21%, while it was 4% based on the PI, and 5.6% based on the MAC/HC index (18). In another study performed by Soundarya et al. (2012) (15) on 300 full-term and single twins, 23% of the infants were SGA, and 77% were AGA or LGA. When these SGA neonates were assessed based on the care assessment need (CAN) score, 23% (n=16) were observed to be well-nourished, while 8.2% of the AGA newborns (n=19) presented with clinical signs of malnutrition, which was considered statistically significant. In the mentioned research, 26% of the malnourished neonates (n=78) based on the PI were clinically well-nourished after evaluation based on the CANSCORE index, and 39.7% (n=31) were also clinically well-nourished. The remaining infants with a normal PI (11.2%; n=25) were reported to have severe malnutrition. According to Soundarya, FM is optimally detected by the CAN Score, and BMI could also be a reliable screening tool to diagnose malnutrition when used in conjunction with the PI.

In another study conducted by Adebami et al. (2008) (19), 442 full-term infants were examined, and 44 cases (10.8%) were SGA, 381 cases (86.2%) were AGA, and 13 cases (3%) were LGA. Based on the PI index, 36 infants (8.1%) were malnourished, while based on the CANSCORE index, 83 infants (18.8%) were considered malnourished. In most of the studies in this regard, the prevalence of malnutrition has been reported to be higher based on the CANSCORE index compared to other growth indices, such as the PI, BMI, and MAC/HC. Therefore, it could be inferred that compared to other growth indices, the CANSCORE index could detect FM in a larger number of infants, especially those who have not been identified by other methods. Moreover, the CANSCORE index could identify the infants who are SGA but not malnourished. In this regard, Singhal reported that based on the CANSCORE index, 8% of AGA infants and 23.2% of SGA infants were malnourished. In the mentioned study, the CANSCORE index also detected malnutrition in 65% of the neonates with the PI of less than 2.2 (17).

Our findings are inconsistent with the study by Ezenwa, which aimed to determine the incidence of FM based on the CAN score and compare nutritional assessment with anthropometry. According to the results of the mentioned study, FM was highly prevalent in premature infants, and the BMI and PI were considered simple and easy tools for the assessment of FM in premature infants. These indices were also reported to be a better benchmark for the detection of FM in premature infants compared to the CANSCORE index (13).

In the present study, the CANSCORE index was most significantly correlated with birth weight, chest circumference, arm circumference, and BMI. In a study by Adebami et al. (19), the mean weight, MAC, and PI of CANSCORE-malnourished infants were significantly lower compared to those without malnutrition. Although the mean head circumference and height of the malnourished infants were lower in the mentioned study, the differences were not considered statistically significant.

In the current research, the PI had the most significant correlation with BMI, which is not unexpected considering that the weight-to-height ratio is measured in both scales. On the other hand, the correlation of the PI with the other growth indices was less significant compared to the CANSCORE index, which implied that the CANSCORE index could indicated the growth status and malnutrition of the fetus more accurately.

In general, FM is highly prevalent at birth (especially in developing countries) and could be detected regardless of natural anthropometric indices. The CANSCORE index could be used as an alternative method to identify and manage FM in low-resource areas, especially in developing countries. The CANSCORE index is a simple and easy approach to assessing malnutrition compared to other complex methods. Moreover, it is easy to understand and perform by using Figural rating scales for measurement. (16). Since the rate of FM at birth is high and regardless of the natural anthropometric indices of neonates, the accuracy of the CANSCORE index could be enhanced with time and by using specialized techniques to diagnose the nutritional complications of infants and recommend the necessary treatment.

Limitations of the Study

The most important limitation of this study was a lack of cooperation on behalf of some of the parents despite the tact of the research team and their specialized opinions. Consequently, the implementation of the plan in all the phases was minimized.

Conclusion

According to the results, the CANSCORE index was significantly correlated with growth indices and could identify a larger number of malnourished infants. Furthermore, it is considered more accurate in showing the growth status and malnutrition of the fetus compared to other anthropometric indices, which may underestimate FM. The CANSCORE index is also a simple and appropriate clinical indicator for the detection of FM and preventing its complications. It may also have the potential to predict the complications caused by FM without the need for complex equipment. Therefore, it is recommended that such an advantageous technique be employed in developing counties such as Iran.

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