Study On Skin Fold Thickness in Newborns as an Index of Foetal Nutritional Assessment

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ABSTRACT

Introduction: Skin fold thickness is a measure of adiposity and is a validated method of assessing malnutrition in older children. The present study was undertaken to see the role of skin fold thickness measurement in neonates as an index of foetal nutritional assessment and to compare between CAN (Clinical Assessment of Nutrition) score and other anthropometric indicators in foetal malnutrition (FM).

Methods: A prospective observational study was conducted in postnatal ward of Universal College of Medical Sciences-Teaching Hospital for a duration of six months. Three hundred seventy term newborns were assessed by CAN score and anthropometry recorded. The CAN score was determined and those with scores < 25 was classified as having foetal malnutrition. Skin fold thickness using the Slim Guide skin fold caliper was taken at the triceps, biceps, sub scapular, supra iliac and quadriceps locations for each neonate. Two readings were taken at every site and the mean was recorded. All the skin fold thickness measurements were correlated with the CAN score and statistical comparisons were made.

Results: Incidence of FM was 18.38%. The mean (SD) for sum of all skin-fold thickness at all sites for males and females were 4.3 ± 1.61 and 4.18 ± 0.72 mm respectively. All the skin-fold thickness measurements correlated significantly with the CAN score, but the sum of the five had the best correlation. The mean (SD) of anthropometric data of babies and sum of all comparing foetal malnutrition versus without foetal malnutrition using nutritional status CAN score was statistically significant (p-value < 0.001).

Conclusions: The sum of all five skin-fold measurements might be a useful screening tool for FM in view of its objectivity, convenience and simplicity, but it is not sufficiently sensitive or specific to replace the CAN score in the identification of FM in neonates.

Key Words: CAN score; Foetal malnutrition; Skin fold thickness

INTRODUCTION

Skin fold thickness (SFT) measurement is a reliable, cheap, simple as well as noninvasive method of body fat estimation at all ages including the newborn period.[1] Foetal malnutrition (FM) is defined as a clinical entity in which there is failure to achieve sufficient weight or there is loss of subcutaneous fat and / or muscle mass in utero.[2] A commonly used method of assessment of the nutritional status of the babies at birth is based on intrauterine growth chart in which a baby whose birth weight is below the 10^{th} percentile is said to be small for gestational age (SGA) or to have FM.[3]

However, a SGA baby may or may not have suffered from intrauterine growth restriction (IUGR) and not all SGA babies have foetal malnutrition.[4] On the other hand, babies classified as appropriate for gestational age may have features of FM. Attempts were made to establish FM by anthropometric criteria but were not successful. The nutritional status of a newborn was first assessed by using CAN (Clinical Assessment of Nutrition) score by Metcoff.[5] It consists of examination for nine clinical signs, and has reasonable sensitivity and specificity. CAN score is able to detect evidence of FM even in neonates whose weights are appropriate for gestational age, and it has been proposed for use in low-income countries.[6] However, it has its own limitations in that it entails examination for nine clinical parameters which takes time with some measure of subjectivity and therefore might not be aptly suitable in developing countries where fertility rates are high and manpower limited.[7]

Since the deliveries of SGA babies are common in developing countries like ours, FM is expected to be common because it is known to be commoner in SGA babies than other babies.[5] There has been very less studies done so far regarding FM. Static skin fold measurement which is a validated method of assessing malnutrition in children generally serves as estimates of body fat. This study was set out to evaluate the reliability of static skin fold thickness, which is a cheap, non-invasive and rapid means, for the assessment of FM. The study has been planned with a view to recommend it as an objective tool for early identification of FM among neonates in settings with limited resources.

METHODS

A hospital based prospective observational study was undertaken at Universal College of Medical Sciences, Rupandehi, Nepal from July 2018 to November 2018. Ethical approval was obtained as per the advice of Ethical Committee of the Institute. All babies born consecutively as singleton newborns with GA of 37 to 42 weeks, with less than 48 hours of life were included in the study. Each neonate's gestational age was assessed using new Ballard score described by Ballard JL et al.[8] Newborns with congenital anomalies, born < 37 weeks completed gestation age, requiring NICU care, born to mothers with gestational diabetes mellitus and unreliable estimation of gestational age were excluded from the study. With the absolute error / precision of 5% at a confidence interval of 95%, the sample size was calculated from the prevalence of 35% from the previous study and this size came out to be 348.[5] Hence, we recruited 370 subjects in the study.

Following parameters were recorded in all babies (weight was recorded at birth, length, mid arm circumference and head circumference was recorded between 24 to 48 hrs of life): (i) Birth weight: Nude birth weight, measured to the nearest 10 grams using electronic weighing scale (ii) Crown to heel length: Length was measured to the nearest 0.1 cm using an infantometer (iii) Occipito-frontal circumference: was taken as the largest circumference of the skull using a flexible non stretchable tape to the nearest 0.1 cm (iv) Mid Arm Circumference: Measured in the left arm, at a point midway between tip of the acromion and the olecranon process using a flexible non stretchable tape to the nearest 0.1 cm. These measurements (birth weight and length) were then plotted on intrauterine growth charts for Indian babies to classify the newborns into AGA, SGA and LGA[9], and the following proportionality ratios were calculated and compared with clinical assessment using CAN score to assess their effectiveness in identifying malnutrition. The Ponderal index[10] was calculated and classified as well-nourished and malnourished babies. Ponderal index of less than

Figure 1. Measurement of quadriceps skin fold thickness by skin fold caliper

2.2 gm/cm^3 was considered as an index of malnutrition.[9]

Several maternal factors were recorded during collecting the sample. Age, religion, maternal education, maternal smoking, maternal history of eclampsia and pre-eclampsia and hypertension were recorded. The association of these maternal factors with FM was correlated. Skin fold thickness using the slim guide skin fold calliper was used, and measured at the triceps, biceps, sub scapular, supra iliac and quadriceps. All the readings were taken on the right side of the body. Two measurements were taken at each site at least 15 seconds apart and the mean of the two readings was recorded. The procedure of recording skin fold thickness by slim guide calliper (figure 1) was followed as explained by A Whitelaw.[11]

We used CAN score as standard in identifying FM which was determined with range from nine (lowest) and 36 (highest). The CAN score with scores less than 25 was classified as having FM and scores more than 25 was marked as well-nourished babies.[5] All the skin fold thickness measurements were correlated with the CAN score and statistical comparison was made. For studying the relationship of anthropometrical attributes with CAN score, the observations were statistically analysed using EPI INFO version 6 statistical package and Chi square and "t" test was performed.

Table 1. Mean (SD) values of measured and derived anthropometry in neonates (N = 370)

Anthropometry	Male	Female	p-value *
Birth weight (kg)	2.78 ± 0.613	2.69 ± 0.449	0.679
Length (cm)	49.47 ± 3.13	49.35 ± 2.51	0.149
MUAC (cm)	11.15 ± 1.13	10.92 ± 1.19	0.83
CC (cm)	31.07 ± 1.82	31.43 ± 30.83	0.194
OFC (cm)	35.07 ± 1.29	34.59 ± 1.35	0.06
PI (g/cm3)	1.86 ± 2.21	1.74 ± 2.12	0.164

*OFC (Occipital frontal circumference), CC (Chest circumference), MUAC (Mid-upper-arm circumference), PI (Ponderal Index), * t-test.*

RESULTS

A total of 370 [196 (53%) males] neonates were enrolled. Among all, babies < 39 weeks and > 39 weeks of gestation comprised of 50.5 % and 49.5 % respectively and again out of these, 240 (64.9%) were AGA, five (1.4%) were LGA and 125 (33.8%) were SGA. Age of mother was < 20 years and > 20 years in 15.4 % and 84.6% cases respectively.

The mean (SD) values of different anthropometric measurements in neonates are shown in Table 1. Though the anthropometric parameters were higher in male babies compared to females in all aspects, it was not statistically significant (P > 0.05).

FM was documented in 18.38% of the neonates using the CAN score whereas by using PI 62.5% were malnourished and 37.5% were well nourished. The mean (SD) of anthropometric data of babies including sum of all were significantly lower in the FM infants (p - value < 0.001). (Table 2).

Table 3 shows the distribution of babies with FM in relation to weight for gestation. Babies with FM were found among SGA and AGA babies. There was no baby with FM among the LGA babies. The proportion of babies with FM was significantly higher among the SGA babies.

All the skinfold thickness measurements correlated significantly with the CAN score, but the sum of the five had the best correlation. (Table 4)

Table 2. Mean (SD) value of neonates' anthropometry by nutritional status (CAN score) N = 370

Anthropo-metric measure	Malnourished	Well nourished	P-value*
Birth weight (kg)	2.14 ± 0.283	2.87 ± 0.49	< 0.001
Length (cm)	47.13 ± 2.51	49.94 ± 2.67	< 0.001
OFC (cm)	31.24 ± 1.39	33.49 ± 1.41	< 0.001
CC (cm)	28.97 ± 1.161	31.40 ± 1.40	< 0.001
MUAC (cm)	9.55 ± 0.93	11.38 ± 1.05	< 0.001
PI (g/cm3)	1.89 ± 0.12	2.32 ± 0.21	< 0.001
Sum of all	23.80 ± 1.25	25.81 ± 1.39	< 0.001

OFC (Occipito frontal circumference),
CC (Chest circumference),
MUAC (Mid-upper-arm circumference)
** t-test*

Pearson's correlation (r) of nutritional status CAN score with skin fold thickness variables, was statistically significant (p - value < 0.001), among which best was correlated with triceps and sub scapular. (Table 5).

DISCUSSION

In developing countries, LBW and FM are common clinical problems with long term implications on growth, neurodevelopment, morbidity and mortality. SFT, which is a measure of adiposity, indirectly assesses nutritional reserve.[12] It has been shown to correlate well with dual-energy X-ray absorptiometry values for subcutaneous fat and thus is indicated for its use to assess nutritional status. This study sought to explore the use of SFT in assessing nutritional status in neonates at birth and, by implication, foetal nutritional status. There was greater skinfold thickness at all sites in the females; however, this was not statistically significant. This was consistent with earlier reports that females accumulate more fat than males, especially in the third trimester.[12] The prevalence of FM by CAN score was 18.38**%,** which compares reasonably with rates of 18.8% and 19.6% reported from Ilesa, Nigeria and Pune, India, respectively.[13,14] The differences between the different studies may be partly due to differences in the nutritional status in the communities of study.

This study demonstrated that all the different skinfold thicknesses and their sum were significantly lower in malnourished babies than their well-nourished counterparts, a finding

Table 3. Association between foetal malnutrition with AGA / SGA / LGA

AGA / SGA / LGA	Malnourished	Well nourished	p-value*
AGA	6 (2.5%)	234 (97.5%)	< 0.001
LGA	0	5 (100%)	
SGA	62 (49.6%)	63 (50.4%)	
Total	68 (18.38%)	302 (81.62%)	

**chi-square*

Table 4. Mean (SD) skin fold thickness by foetal nutritional status (CAN score) (N = 370)

Skin fold measurement	CAN score		
	Malnourished	Well nourished	p - value*
Triceps (mm)	3.44 ± 0.63	4.57 ± 0.76	< 0.001
Biceps (mm)	2.40 ± 0.55	3.33 ± 0.707	< 0.001
Sub scapular (mm)	3.93 ± 0.63	5.10 ± 0.701	< 0.001
Supra-iliac (mm)	2.34 ± 0.507	3.11 ± 0.67	< 0.001
Quadriceps (mm)	4.32 ± 0.80	5.90 ± 1.101	< 0.001
Sum of all (mm)	3.28 ± 0.52	4.40 ± 0.78	< 0.001

** t-test*

Table 5. Correlation of CAN score with skin fold thickness (N = 370)

Skin fold thickness (mm)	Correlation coefficient (r)	p - value*
Triceps (mm)	0.681	< 0.001
Biceps (mm)	0.636	< 0.001
Sub scapular (mm)	0.697	< 0.001
Supra-iliac (mm)	0.558	< 0.001
Quadriceps (mm)	0.669	< 0.001
Sum of all (mm)	0.648	< 0.001

** Pearson's correlation*

consistent with the reduced or loss of subcutaneous fat, as expected in malnutrition.[5] Similar to the study by Farmer G[15] which found that the quadriceps skinfold and the sum of all the five skinfold thicknesses correlated best with foetal nutritional status, this study also found the sum of all the five skinfold thicknesses correlated best with the presence or absence of FM.

In the light of this, using the sum of five skinfold measurements as an alternative to the CAN score might not be the most suitable option as the expected advantage of conserving time is not there. Moreover, the degree of sensitivity and specificity of individual measurements and their sum is not sufficient to recommend it as a suitable alternative to CAN score. The sum of all five skinfold measurements, because of its convenience and simplicity, is a useful screening tool for FM, but it cannot be recommended as a replacement for the CAN score for assessing FM. The importance of such simple screening tool can be helpful to identify FM by peripheral health workers in the absence of paediatrician. This not only reduces the burden in the higher centres but also triages care to those who are truly malnourished. Although our study has a small sample size from a single centre, our study could be considered as a pilot study and hence larger multi-centric studies are required to validate this screening tool for identifying FM.

CONCLUSIONS

After assessment of FM with various technique and tools, we concluded that, sum of all five-site skin fold thickness measurement can be a useful screening tool in assessment of FM in country like ours where fertility rate is high and man power is limited. SFT measurement, because of its convenience and simplicity, can be a better predictor of FM assessment, but it cannot be recommended as a replacement for the CAN score for assessing FM.

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