Abstract

Objective: an accurate assessment of the nutritional status of an infant at birth is very important, since it provides information on early identification of pathological events related to intrauterine growth acceleration or retardation. Anthropometric ratios such as weight/length and mid-arm circumference/head circumference may be used as alternative tools for this purpose. The main objective of this study was to verify the correlation between triceps skinfold thickness with Rohrer Index, Body Mass Index, weight/length ratio, and mid-arm circumference/head circumference ratio.

Methods: a cross-sectional study was carried out with 390 full-term newborns delivered at the Maternity Ward of Instituto Materno Infantil of Pernambuco, from May to July 1999. The newborns had their birthweight, length, head and mid-arm circumferences and triceps skinfold thickness measured.

Results: the results showed that among the anthropometric indices studied the weight/length ratio showed the strongest correlation with triceps skinfold thickness (r = 0.63, P< 0.001) followed by mid-arm circumference/head circumference ratio (r = 0.59, P< 0.001). Rohrer index showed the weakest correlation (r = 0.43, P< 0.001). Multiple linear regression analyses revealed that weight/length ratio correlated best with skinfold thickness.

Conclusions: we concluded that among the studied indices, weight/length ratio showed to be the best alternative to assess the nutritional status of infants at birth.

Introdução

Nutritional assessment in the neonatal period reflects the average growth pattern from conception to birth. It serves as a basis for future assessments and helps to identify infants who are at risk for perinatal complications associated with abnormal fetal growth. Since the 1960’s, the nutritional status of newborns has been classified according to the duration of the gestation period and their birthweight, based on the study conducted by Battaglia & Lubchenco, as small for gestational age (SGA), appropriate for gestational age (AGA) age and big for gestational age (BGA). This criterion is purely statistical, ignoring the individual growth potential and reflecting only the total body mass for a given gestational age; in other words, it does not indicate how this body mass...
is distributed over the linear surface. The drawbacks of using a single criterion to assess the nutritional status at birth have led researchers to consider the use of anthropometric indicators and skinfold measurement as an alternative to a more precise method. The most frequently studied indicators are those that result from the relationship between weight and height (Rohrer index, body mass index, weight-for-height ratio) and also between arm circumference and head circumference.2-8

In fact, there is no agreement on which the best way to assess nutritional status at birth should be. The impact of early detection of intrauterine growth disorders will only be perceived when an appropriate criterion is routinely applied.

Although nutritional anthropometry in the neonatal period is largely discussed by researchers, we verify that there is little information about it or little interest in learning about its importance and interpretation. Since the currently used criteria are limited, it is necessary to find an indicator (or indicators) for the postnatal assessment of intrauterine growth quality that is reliable, easy to use and easy to calculate.

The present study aimed at assessing Rohrer index (PI), body mass index (BMI), weight for height (W/H) ratio and arm circumference/head circumference (AC/HC) ratio as indicators of the nutritional status of full-term newborns, identifying which of them better correlates with subcutaneous fat mass.

Methods

A descriptive, cross-sectional study was carried out at the Instituto Materno-Infantil de Pernambuco (IMIP), from May to July 1999. The IMIP is a non-governmental, privately-owned, non-profit organization, located in the city of Recife, which assists the population who seeks medical care at the Unified Health System. The institute is a statewide reference center for high-risk pregnancies. The sample consisted of 390 full-term newborns, result of a single pregnancy, either delivered naturally or by C-section. The study comprised newborns with evident signs of congenital infections, chromosomal anomalies and malformations.

The sample size was calculated using the Sample Power 1.0 software from the Statistical Package for the Social Sciences (SPSS), version 8.0. The value of 0.50 was considered to be the lowest acceptable correlation coefficient for a good predictor between skinfold measurement and anthropometric indicators, while 0.60 was the expected correlation coefficient for the population. These values were based on the study conducted by Yau & Chang.3 By considering an alpha error of 5% and a beta error of 20%, the sample size necessary to identify the lowest correlation coefficient with statistical significance would be 383 newborns.

A pilot study was carried out in the last two weeks of April 1999 with the aim of inspecting the equipment and testing the research protocol. The weight assessment technique was checked by the on-duty staff of the maternity ward, and the scales was inspected by INMETRO (Brazilian Institute of Metrology and Industrial Quality). The techniques used for anthropometric assessment were those recommended by Gibson.9 The following criteria were used: birthweight was checked in the first hour of life by the on-duty staff (doctors, resident doctors or medical students) at the neonatal unit or by the main researcher, when present during delivery. The height, head circumference, arm circumference and triceps skinfold were evaluated by the main researcher within the first 24 hours of life, taking into consideration the highest value of three consecutive measures. The height and head circumference measurements were limited to five per shift, with a compression time of 0.3 mm, a third measure was performed, and the mean of the two nearest values was considered. The compression time for measuring skinfold was 15 seconds. Arm circumference and triceps skinfold measurements were performed on the left arm, at the midpoint between the acromion and olecranon. The following measurement devices were used: electronic scales (Filizola, model BP no. 620/95), with a 15-kg capacity, dismountable anthropometer with fixed scale, fiberglass measuring tape and Harpenden caliper, with a constant pressure of 10 g/mm² and an accuracy of 0.2 mm. The anthropometric measurements were limited to five per shift so that their quality could be maintained. The gestational age was estimated by clinical evaluation within the first 24 hours of life by the method devised by Capurro et al.10

After anthropometric measurement, the values for the following anthropometric indicators were obtained: Rohrer index (weight/height³ x 100), body mass index (weight/height²), weight-for-height ratio, and arm circumference/head circumference ratio.

For the quality control of data, an assessment of the intraobserver variation for anthropometric indicators (height, head circumference, arm circumference, and triceps skinfold) was made using the technical error of measurement (TEM) and the reliability coefficient (R),11 in a subsample, which represented 10% of the total number of analyzed newborns.

The present measurements showed a technical error of measurement less than 0.1, and a 99% intraobserver reliability for arm circumference, 97% for head circumference, 96% for height measurements, and 91% for triceps skinfold.

The EPI-Info version 6.04 was used for the processing and preliminary analyses of data. The consistency of double data entry was checked by the Validate subprogram. Initially, the distribution symmetry of anthropometric indicators was assessed by the histogram. Afterwards, the degree of...
association between the triceps skinfold and anthropometric indicators was evaluated by Pearson correlation coefficient. The dispersion diagram (on Excel) was used for the graphical representation of the correlation between anthropometric indicators, using the triceps skinfold as dependent variable. A multiple linear regression analysis was performed with SPSS version 8.0, by the stepwise method, in order to determine which of the analyzed anthropometric indicators is the best predictor for triceps skinfold. The statistical significance level was established at 0.05.

After verbal agreement, the patients’ mothers signed an informed consent form, allowing their infants to participate in the study. The research project was approved by the Ethics and Research Committee of the Center for Health Sciences of Universidade Federal de Pernambuco.

Results

Among the 390 evaluated newborns, 197 (50.5%) were males and 193 (49.5%) were females. The mean gestational age was 39 weeks (SD 2.0).

We observed that the triceps skinfold had a statistically significant correlation with all the analyzed indicators, of which the weight-for-height ratio had the best correlation coefficient, followed by the arm circumference/head circumference ratio. Rohrer index was the one that best correlated with the triceps skinfold (Table 1 and Figures 1 to 4). The results of the multivariate linear regression analysis presented in Table 2 show that only the weight-for-height ratio and the arm circumference/head circumference ratio significantly contributed towards the prediction of triceps skinfold fat mass. In this case, the weight-for-height ratio was the best predictor. The body mass index and the ponderal index lost their statistical significance in the multivariate analysis, yielding P values of 0.29 and 0.33, respectively.

Discussion

Anthropometric indicators show body proportion and have been proposed as an alternative to improve the accuracy of the nutritional status assessment of newborns. In general, most authors found a good correlation between the variation of predictive values of these indicators and perinatal morbidity and mortality.3,4,12-16

Table 1 - Correlation coefficient between the anthropometric indices and the triceps skinfold thickness in 390 full-term newborns - IMIP, 1999

<table>
<thead>
<tr>
<th>Anthropometric indices</th>
<th>r</th>
<th>CI 95%</th>
<th>Statistical analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight/length ratio</td>
<td>0.63</td>
<td>(0.56 - 0.68)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Arm circumference/ head circumference ratio</td>
<td>0.59</td>
<td>(0.52 - 0.65)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Body mass index</td>
<td>0.58</td>
<td>(0.50 - 0.64)</td>
<td>P &lt; 0.001</td>
</tr>
<tr>
<td>Rohrer index</td>
<td>0.43</td>
<td>(0.34 - 0.50)</td>
<td>P &lt; 0.001</td>
</tr>
</tbody>
</table>

r = Pearson’s correlation coefficient.
Skin fat mass is early affected by changes in nutritional status, increasing or decreasing its contents, since its mobilization is an important source of calories. Triceps skinfold measurements have greater values in BGA newborns, if compared to AGA newborns, and can help distinguish actually malnourished newborns from those whose body constitution is naturally small.17,18

Figure 2 - Dispersion of triceps skinfold thickness and arm circumference/head circumference (AC/HC) ratio in full-term newborns, IMIP - 1999

By analyzing the correlation between the anthropometric indicators discussed here and the triceps skinfold, we attempted to find the indicator that could better define nutritional status at birth. These anthropometric indicators can be easily obtained and simply performed, and are part of the routine physical examination of newborns, except for the arm circumference measurement.

Most studies on anthropometric indicators as a way to define nutritional status in the neonatal period are related to Rohrer index, which has been increasingly used on newborns, and to the arm circumference/head circumference ratio. The association of these indicators with gestational age, birthweight, and neonatal morbidity and mortality has been largely studied. Few studies assess the correlation of these indicators with subcutaneous fat mass.3,19

Among the four indicators discussed here, the simple correlation between weight and height proved to be the best correlation coefficient with subcutaneous fat mass ($r = 0.63$;
P <0.001), which is in conformity with studies carried out in China and in Israel. The same occurred with the multiple linear regression analysis.

The order of the correlation degree of anthropometric indicators in the present study coincides with that observed in the studies mentioned above. Rohrer index had the lowest correlation coefficient with subcutaneous fat mass, whether it is correlated with the skinfold of one or several body sites. It was also observed that, between the indicators that relate weight and height, the correlation coefficient decreases as the height is squared in the body mass index, and as it is cubed in Rohrer index, thus confirming the observations of some authors that question the use of these indicators, especially Rohrer index, since, if the height is cubed, an indicator that is extremely prone to measurement failures is validated.

The significant correlation between the analyzed indicators and subcutaneous fat mass showed that the use of these indicators can improve the accuracy of nutritional assessment of newborns. However, the use of Rohrer index should be questioned, since it had the lowest correlation coefficient with subcutaneous fat mass (r = 0.43; P < 0.001), and also because its calculation is hard to be used in clinical practice. On the other hand, we observed that the arm circumference/head circumference ratio, after the weight for height ratio, was the indicator that presented the best correlation coefficient with skinfold measurement; however, its routine use implies introducing one more indicator into physical examination since arm circumference is not part of the assessment of newborns.

The weight-for-height ratio can play an important role in the assessment of nutritional status in newborns, since it is easy to calculate, results from simple indicators whose assessment are part of the daily routine, and because it had the best correlation with subcutaneous fat mass in this study.

We should not forget that the use of this indicator or any other indicator as a way to determine neonatal nutritional status requires that normal cutoff points be known. According to Abramson, normality can be defined in several ways: as something usual, based on statistical criteria, or as a desirable situation, a standard to be achieved or, still, a state that requires no intervention. In general, the statistical criterion is used; however, we believe that prospective studies that follow the evolution of newborns in the medium and long run can be more appropriate to establish these cutoff points.

We conclude that, among the analyzed anthropometric indicators (PI, BMI, W/H, AC/HC), the indicator resulting from the simple relationship between weight-for-height (W/H) was the one that best correlated with triceps skinfold, proving to be a good alternative to nutritional assessment at birth.

References


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