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Do South Indian newborn babies have higher fat percentage for a given birth weight?

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ABSTRACT

Background: India is experiencing rapidly escalating epidemics of diabetes and cardiovascular disease. High fat percent in Indian adults may have its origins at birth (Fetal origin hypothesis). Conflicting evidence from India have shown increased or similar fat mass in Indian newborn babies compared to western countries.
Aim: To compare body composition of term infants with data from similar studies in India and developed countries.
Study design: Cross-sectional study in newborn infants at the antenatal ward of a tertiary care hospital in South India.
Subjects: 626 mothers and their newborn babies.
Outcome measures.
Maternal body weight and height, baby weight, length, head circumference, skin folds at three sites. Body fat, arm muscle area and arm muscle index were calculated based on known methods.
Results: Mean (SD) birth weight of newborn babies was 2.80 (0.37) kg and 43% of them were small for gestational age. Birth weight was significantly related to subscapular ($r = 0.445$; $p < 0.001$) and triceps ($r = 0.567$; $p < 0.001$) skin fold thickness. Mean (CI) Subscapular skin fold thickness and total body fat % was 3.81 mm (3.74–3.97) and 10.5% (10.2–10.8). Mean total body fat % for small for gestational age (SGA) (9.57%) was significantly lower than appropriate for gestational age (AGA) babies (11.7%).
Conclusions: The mean body fat percent in AGA infants was similar to that of studies reported on term infants of developed countries, suggesting that South Indian babies may accumulate similar fat mass with increasing birth weight and gestational age.

1. Introduction

Birth weight is routinely used worldwide as a good indicator of fetal growth. Fetal growth restriction/small for gestational age (FGR/SGA), primarily due to inadequate dietary intakes and poor nutritional status of the pregnant mother, is the main cause of high prevalence of low birth weight in India [1,2]. Fetal origin hypothesis states that nutritional deprivation in early life when followed by nutritional adequacy or relative excess later leads to abdominal adiposity and adult chronic diseases [3–5]. India is experiencing rapidly escalating epidemics of diabetes and cardiovascular disease [6,7]. There is much reason to worry whether intra uterine growth retardation resulting in increasing adiposity may be the cause of this epidemic. Studies have shown that body composition of newborns could be traced to childhood [8] and is associated with increasing insulin resistance [9]. However, it is still unclear whether Indian newborn babies who are thin (based on birth weight) have higher body fat (based on skin fold thickness) compared to newborn babies of developed countries. Studies from Pune, by Yajnik et al., demonstrated higher body fat percent in Indian babies compared to matched controls from Southampton, UK [10]. In contrast, Muthayya et al. from Bengaluru have demonstrated that skin fold thicknesses (SFT) of Indian babies were similar to those reported in western populations with similar birth weights [11].

The above studies have taken skin fold thickness (SFT) measurements as indicators of adiposity in newborn. Although SFT measurements may indicate relative adiposity at comparable birth weights it is not known whether Indian babies really have greater adiposity as assessed by body fat percent. Especially, keeping in view the assumption that increased body fat for a given BMI in Indian adults [12,13] has its origin at birth, it is important to ascertain if babies in India have more adiposity for a given birth weight. In addition, though birth weight reflects overall picture of intrauterine nutrition and growth, SGA may result in either symmetrical growth restriction or asymmetrical growth restriction depending on the timing of nutrition insult. While under nutrition, in early pregnancy affects all aspects of fetal growth that leads to symmetrically growth restricted SGA babies; in later part of pregnancy, it results in

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disproportionate or asymmetrically growth restricted SGA babies; wherein length is spared, but weight of the baby is affected adversely [14]. The nutritional inadequacy in early and mid-pregnancy and calorie sufficiency in later part of pregnancy as observed in SGA babies may result in excessive fat deposition even before birth leading to altered body composition of the newborn at birth [15]. The fetal insulin hypothesis on the other hand envisages that the association between low birth weight and diabetes could have common genetic determinants but highlights the suggestion that the intrauterine environment may influence this relationship [16]. With this background it was hypothesized that neonatal body composition may differ based on growth during fetal life, which is related to intra uterine fetal nutrition and timing of nutritional deprivation and growth.

2. Material and methods

The study was conducted in 2008, in a government maternity hospital, which is a tertiary care referral hospital catering to low and middle income group population in the city of Hyderabad. Ethical approval was taken before the start of the study by the Institutional review board. The principles outlined in the Declaration of Helsinki were followed. 650 pregnant women and their attendants were contacted at the time of admission into antenatal ward for delivery and were invited to participate in the study. The study protocol was explained to them and informed consent was obtained. Infants admitted to sick nursery for complications during delivery and babies delivered to mothers with complications were excluded from the study. Socio demographic data were collected, from 626 mother infant pairs who fulfilled the inclusion criteria, through a questionnaire by the nursing staff. Details regarding antenatal care, obstetric history and any other investigations like hemoglobin, ultra sound examination were collected from antenatal records. Maternal and cord blood were collected for biochemical estimations and maternal age, height and weight were recorded soon after delivery.

Anthropometric data including skin fold thickness was recorded for all infants within 24 h of delivery. Birth weight was recorded using a digital weighing machine with a sensitivity of 10 g and length was recorded in supine position using infantometer to the nearest 1 mm. Skin fold thickness at biceps, triceps and subscapular were measured using harpenden calipers. Circumferences of head, chest, mid upper arm, and leg were measured using a non-stretchable tape to the nearest of 1 mm, for determination of body composition using the equations developed by M J Dauncey and coworkers for infants [17]. All the anthropometric measurements were obtained by two trained staff and inter-rater reliability and reproducibility were tested once in every six months. Arm muscle–bone area (AMA) of the neonate was calculated with measures of MUAC and triceps skinfold thickness using the formula: AMA (cm^2) = $(MUAC - \pi \times triceps)^2 / 4\pi$. Arm muscle index (AMI) was calculated using the equation $\{AMA / (MUAC / 2\pi/)^2\} \times 100$. Gestational age was determined from the antenatal records, either by last menstrual period and wherever available from antenatal ultra sound reports. Small for gestational age (SGA) babies were defined based on birth weights less than 10th centile, and AGA from 10th to 89th centile.

As the WHO growth standards 2006 have proved that there are no ethnic or regional differences in birth weights provided there is optimum care during antenatal period and no constraints to growth, we have used Canadian reference for birth weight at different gestational ages for classifying the babies as SGA or AGA [18]. Ponderal index (PI) was calculated by birth weight in kilograms divided by cube of birth length in meters [19]. Asymmetrical babies were defined as those with a PI of less than 2.30 and symmetrical babies were defined as those with a PI of more than 2.30 [19].

All analyses were done with the SPSS program (version 19.0; SPSS, Chicago, IL, USA). The analysis focused on the assessment of body composition of the babies, as well as birth weight and maternal BMI. Results are presented as mean and standard errors and proportions. Association between birth weight with skinfold thickness and AMA, AMI of the neonates were assessed using Pearson's correlation coefficient and simple linear regression. Measured and computed anthropometric variables of SGA babies were compared with those of AGA by student t test. Two-sided p-values < 0.05 were considered statistically significant. R Programming software (Version 3.0.1) was used to create graphs.

3. Results

Data on 626 mother-infant pairs were available for analysis. Mean (SD) antenatal visits were 3.9 ± 2.4. A proportion of 51.6%, 45.9% and 42.1% consumed iron folic acid, calcium and vitamin B supplements respectively (Table 1). Of the 626, 218 (34.8%) were primies. 55% and 45% gave birth to male and female babies respectively. 17.3% of babies were low birth weight babies (≤2.5 kg). Mean birth weight was 2.80 kg and Mean length was 48.0 cm (Table 1). Gestational age could not be assessed properly in 95 mothers and therefore were excluded from the analysis. Mean of all the anthropometric parameters of the babies and the mothers including the fat percent are given in Table 1. The mean maternal weight and height were 49.3 kg and 151.8 cm respectively. 43.1% of babies were SGA babies. Mean (SD) ponderal index (PI) of the study neonates was 2.53 (0.034) and was significantly ($p < 0.001$) lower in SGA babies (2.42 (0.03)) compared to AGA babies (2.61 (0.04)). Among the SGA babies 31.0% were asymmetrical growth restricted (PI < 2.30) and the rest were symmetrical growth restricted babies (PI > 2.30).

Mean (SD) maternal hemoglobin was 11.1 (1.26) g/dl and 10.6 (1.52) g/dl in the first trimester and the third trimester of pregnancy respectively. Mean (SD) maternal BMI was 21.3 (2.99) in the third trimester of pregnancy. Mean postpartum weight, heights of the mothers and body measurements of their babies are given in Table 1. Birth weights increased significantly with increasing parity; with 2.72 kg in primipara and 2.88 kg in multiparous women. Similarly, birth weights of the babies increased significantly with increasing BMI of the mothers (Fig. 1).

The Mean (SD) body fat (BF) percent and fat free mass (FFM) were 10.8 (3.6) and 2.5 (2.9) kg respectively. The total body fat, BF percent (8.3 vs 10.9) and FFM (2.1 vs 2.6 kg) were significantly ($p < 0.001$) lower in LBW babies and also in SGA babies (Table 2). Similarly, the total body fat, FFM and BF percent were significantly higher in babies with higher ponderal index (PI) compared to those with lower PI (Table 2). Moreover, the total body fat, BF percent and FFM increased significantly with increasing gestational age, birth weight and increasing maternal BMI (Table 2).

Associations of birth weight with SSSF, TSF, AMA and AMI were assessed using Pearson's correlation coefficient and simple linear regression (Fig. 2). As per Pearson's correlation, birth weight was significantly related to each measured skin fold thickness of the

Table 1
Maternal and neonatal characteristics of study subjects.

	Mean (n = 626)	95% CI (LL, UL)
Antenatal visits number	3.9	3.7, 4.0
Hemoglobin % g/dl	10.6	10.5, 10.8
IFA consumption (tablets) %	51.6	48.8, 54.3
Calcium consumption (tablets) %	45.9	42.6, 49.2
B complex consumption (tablets) %	42.1	39.4, 44.7
Maternal weight (kg)	49.3	48.7, 50.0
Maternal height (cm)	151.8	151.4, 152.3
Maternal Body Mass Index (kg/cm^2)	21.4	21.1, 21.6
Birth weight (g)	2777	2748, 2806
Length of baby (cm)	48.0	47.9, 48.2
Head circumference (cm)	32.7	32.5, 32.8
Mid arm circumference (cm)	9.7	9.6, 9.8
Subscapular skinfold thickness (mm)	3.8	3.7, 3.9
Triceps skinfold (mm) thickness	4.7	4.6, 4.8
Body fat %	10.5	10.2, 10.8