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Symphysis-Fundal Height and Abdominal Circumference Measurements as Indicators for Low Birth Weight

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ABSTRACT

The study was conducted to determine if symphysis-fundal height and abdominal circumference measurements at the umbilical level could be used as indicators of risk for low birth weight infants. Thereby simple equations could be derived to predict birth weights. Five hundred pregnant women in their first trimester, belonging to the middle and upper socioeconomic families from Mysore City, India, participated in the study. They were monitored till one-week post delivery period. The mean symphysis-fundal height at the end of second and third trimesters was 25.2±1.9 and 32.5±2.5 cm, respectively. Significant associations between birth weight and symphysis-fundal height ($r = 0.219$, $P<0.01$) or abdominal circumference ($r = 0.438$, $P<0.01$) or weight gain was noticed at the end of the second trimester, suggesting these to be valuable indicators. A symphysis-fundal measurement of less than 25 cm or abdominal circumference of less than 95 cm in the second trimester is significantly associated with low birth weight infants. Maternal weight gain of less than 3 kg at 28±2 week of pregnancy had a higher association with low birth weight. These should be used as monitoring parameters for risk pregnancies. These parameters can be applied in the prediction of low birth weight babies and allow appropriate interventions to be undertaken during the antenatal period.

INTRODUCTION

In humans, the foetal growth curve has a very characteristic shape; almost linear during 28-38 weeks of gestation followed by a progressive reduction in growth rate which is more marked and occurs earlier in the under-privileged social class. This faltering is possibly nutritional in origin (Agarwal *et al.*, 2002). The proportion of babies with low birth weight (LBW)(<2500 g) ranges between 13% and 43% in the low socio-economic strata of many countries, including some developed nations. Average birth weights in rural areas of the developing world were usually 400 to 1000 g lower than in industrialised nations, contributing to high levels of neonatal and post-neonatal mortality in such communities (Grover *et al.*, 1991). As for survival, these neonates have higher morbidity and mortality during their first year of life and exhibit low mental development (Agarwal, Agarwal & Upadhyay, 1995). Foetal growth assessment is therefore, an important part of antenatal care. Clinical palpation of fundal height in relation to

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anatomical landmarks such as umbilicus and xiphisternum, serial measurement of symphysis-fundal height (SFH) and serial sonography are the three available methods for foetal growth assessment. Palpation is subjective and has not been very useful, as distance between anatomical landmarks vary. Serial sonography, though accurate, is not practical due to its high cost in developing countries (Westin, 1997; Rai, Kurien & Kumar, 1995; Ayustawati *et al.*, 2003).

Simple techniques such as measurements of body dimensional changes may be useful parameters. SFH and abdominal circumference (AC) are known to be the alternative methods which can be utilised by paramedical workers as screening procedures. Mongelli & Gardosi (2004) have found SFH and AC measurements to be more scientific, objective, reproducible and reliable when assessing foetal growth. SFH reflects the crown rump length of the foetus (Indira *et al.*, 1990). However, SFH and also AC vary in women belonging to a different population or race (Challis *et al.*, 2002). Hence SFH and AC reference standards should be prepared in a population so as to be able to identify risk pregnancies. In this study, we prospectively evaluated the SFH and AC at different periods of gestation to derive a formula to predict birth weight at the end of second trimester for the population in South India.

MATERIALS AND METHODS

Five hundred healthy women with uncomplicated singleton pregnancies formed the subjects for the study. They were selected randomly from the Outpatient Prenatal Clinic in private hospitals and nursing homes in urban Mysore City. Written consent to participate in the study was obtained from each subject. Gestational age was confirmed through medical records as well as ultrasound results. Maternal weight was measured with a spring balance, accurate to 0.1 kg (calibrated after every 10 measurements). Abdomen circumference was measured using fiberglass tape at the level of the umbilicus by cross-over technique. Fundal height was measured as the distance between the symphysis pubis and the highest point of the uterine fundus, defined with a gentle pressure on a plane at right angle of the abdominal wall, and was marked. Measurements were taken at the end of the first (14±2 week), second (28±2 week) and third (38±2 week) trimesters. At least five readings were obtained per assessment. Birth weight was recorded on a Beam Scale. Infant length was measured using an infantometer.

Data processing and statistical analyses were performed using SPSS 10.0. These were expressed as mean and standard deviation. Student's T-test and multiple regression analysis were performed.

RESULTS

General information about the selected subjects is presented in Table 1. The mean age of women was 24.0±4.2 years with an age range of 19 to 38 years. Majority of the women (43.8%) were graduates. Only a small percentage, however, was economically active (8.8%), more than 90% of the subjects were housewives. Mean parity status was 1.6. The mean duration of gestation was 39.6 ± 1.3 weeks. Anthropometric profile of newborns is also presented in Table 1. The mean height and weight of newborns were 48.3 ± 0.3 cm and 2914.0 ± 398.0 g, respectively, and 19.6% of newborns had LBW (< 2500 g).

As shown in Table 2, mean SFH increased from 25.2±1.9 cm at 28±2 week to 32.5±2.5 cm at 38±2 week, while AC increased from 95.4±5.3 cm at 28±2 week to 105.1±6.6 cm at 38±2 week. The mean

Table 1. General characteristics of the subjects and their singleton newborns (N=500)*

Characteristic	*Value*
Mother	
Age (yr) (%)	24.0 ± 4.2 (19-38)
Education (%)	
Elementary	11.8
College	38.0
Graduate	43.8
Professional	6.4
Occupation (%)	
Employed	8.8
Unemployed	91.2
Family size	4.2 ± 1.7 (2-6)
Parity	1.6 ± 0.7 (1-4)
Newborn	
Height (cm)	48.3 ± 0.3 (48.0-51.2)
Birth weight (g)	2914.0 ± 398.0 (2200-4000)
< 2500 (%)	19.6
≥ 2500 (%)	80.4
Gestational age (wk)	39.6 ± 1.3 (37-42)

* Mean ± SD, range in parentheses

Table 2. Body dimensional changes among the selected women during pregnancy

Measurement	*I trimester (14±2 wk)*	*II trimester (28±2 wk)*	*III trimester (38±2 wk)*
Fundal height (cm)	85.2±1.3 (80-87)	25.2 ±1.9 (21-28)	32.5±2.5 (26-38)
Abdominal circumference (cm)	1.2±0.6 (0-2)	95.4±5.3 (89-101)	105.1±6.6 (100-110)
Weight gain (kg)*		3.6±1.5 (1-8)	3.8±1.8 (1.5-10)

Mean ± SD, range in parentheses
* Weight gain at I trimester was calculated as difference between pre-pregnancy weight and weight at 14±2 week

weight gain during these periods of gestation was used as a corollary measure to birth weight. The mean weight gain at second and third trimesters was 3.6±1.5 and 3.8±1.8 kg, respectively.

A detailed analysis was done to establish clearly the relationship between the selected maternal parameters with birth weight. It is evident from Table 3 that SFH was significantly associated with birth weight (P<0.05). Birth weights were compared using cut-off levels of 25 cm at the end of the second trimester and 30 cm at the end of the third trimester. Women (both primi and multi para) who had fundal height below the cut-off levels gave

Table 3. Association between symphysis-fundal height and pregnancy outcome among selected pregnant women

Groups	*Cut-off levels Fundal height (cm)*	*N*	*Birth weight (%)*		*Birth weight (g) M±SD*	*T Value*
			LBW	*Normal*		
Primi para						
II trimester (28±2 wk)						
	< 25	72	19 (26.4)	53 (73.6)	2786.0±393.7	2.728*
	≥ 25	184	31 (16.8)	153 (83.2)	2972.0±389.0	
III trimester (38±2 wk)						
	< 30	55	48 (87.3)	7 (12.7)	2440.0±216.9	9.359*
	≥ 30	201	1 (0.5)	200 (99.5)	3052.0±355.2	
Multi para						
II trimester (28±2 wk)						
	< 25	77	35 (45.5)	42 (54.5)	2807.0±338.3	2.400*
	≥ 25	167	14 (8.4)	153 (91.6)	3026.0±382.1	
III trimester (38±2 wk)						
	< 30	60	49 (81.7)	11 (18.3)	2380.0±189.4	2.428*
	≥ 30	184	4 (2.2)	180 (97.8)	3079.0±360.0	

Figures in parentheses represent percentages
* Significant at 5% level

birth to LBW infants. The mean birth weight of babies born to mothers with a fundal height below 25 cm in the second trimester was significantly lower (2786.0±393.7 and 2807.0±338.3 g) than those with fundal height of more than 25 cm (2972.0±389.0 and 3026.0±382.1 g).

A similar exercise was performed to establish the relationship between AC and birth weight (Table 4). It is noteworthy that birth weight was significantly associated with AC in all groups ($P<0.05$). Mean differences in birth weight observed for SFH and AC between the cut-off levels were found to be large at the end of the second trimester and were statistically significant.

It is evident from Table 5 that cut-off levels of weight gain below 3 kg at the second trimester indicates LBW in both primi and multi-para women. Women who gained less than 3 kg delivered babies with birth weights varying from 2661.0±299.5 to 2700.0±263.6 g. However, women who gained more weight (≥3 kg) gave birth to babies weighing 2980.0±364.2 and 3127.0±303.2 g. Mean birth weight in all categories differed significantly ($P<0.05$). This also suggests that the cut-off level of 3 kg at the end of the second trimester can serve as a supportive parameter for AC or SFH to establish pregnancy outcome.

Results from multiple regression analysis about the impact of SFH, AC and weight gain on birth weight at the end of the second trimester is shown in Table 6. It is evident that the three parameters

Table 4. Association between abdomen circumference and pregnancy outcome among selected pregnant women

Groups	*Cut-off levels Abdominal circumference (cm)*	*N*	*Birth weight (%)*		*Birth weight (g) M±SD*	*T Value*
			LBW	*Normal*		
Primi para						
II trimester (28±2 wk)						
	< 95	99	24 (24.2)	75 (75.8)	2604.0±327.6	9.344*
	≥ 95	157	26 (16.6)	131 (83.4)	3119.0±382.9	
III trimester (38±2 wk)						
	< 100	38	17 (44.7)	21 (55.3)	2357.0±100.1	8.575*
	≥ 100	218	33 (15.1)	185 (84.9)	3018.0±373.5	
Multi para						
II trimester (28±2 wk)						
	< 95	85	41 (48.2)	44 (51.8)	2571.0±299.5	8.6530*
	≥ 95	159	8 (5.0)	151 (95.0)	3086.0±364.2	
III trimester (38±2 wk)						
	< 100	41	39 (95.1)	2 (4.9)	2327.0±128.1	9.379*
	≥ 100	203	10 (4.9)	193 (95.1)	3024.0±370.3	

Figures in parentheses represent percentages
* Significant at 5% level

Table 5. Maternal weight gain and birth weight at the end of the second trimester

Groups	*Cut-off levels Weight gain (kg) at (28±2 wk)*	*N*	*Birth weight (%)*		*Birth weight (g) M±SD*	*T Value*
			LBW	*Normal*		
Primi para	< 3	83	15 (18.1)	65 (81.9)	2700.0±263.6	4.823*
	≥ 3	173	35 (20.2)	138 (79.8)	3127.0±303.2	
Multi para	< 3	90	19 (21.1)	71 (78.9)	2661.0±299.5	2.580*
	≥ 3	154	30 (19.5)	124 (80.5)	2980.0±364.2	

Figures in parentheses represent percentages
* Significant at 5% level

Table 6. Final regression models of effect of maternal factors on birth weight at the end of the second trimester[1]

Variables	*Birth Weight*		
	β	*SE*	*P value*
Constant	-2271.0	466.55	.000
Abdominal circumference (cm)	41.08	4.02	.000
Symphysis-fundal height (cm)	46.19	13.86	.001
Weight gain (kg)	38.15	13.33	.004

[1]For birth weight model F= 47.848, P= 0.000, and R^2= 0.224

selected have a high significant association with birth weight. However, AC exhibited the most influence as compared to SFH and weight gain. Although SFH and weight gain have followed the second and third position in order of significance, they were also independently associated with birth weight. It can be concluded that risk assessment should be based on the three parameters at the end of the second trimester.

Using the regression curves, equations were derived to predict birth weight based on SFH and AC at the end of the second trimester (28±2 wk):

1. Using SFH : Birth weight (g) = 108.24 × [symphysis fundal height (cm)] - 164.26. (r= 0.219, P < 0.01)
2. Using AC: Birth weight (g) = 43.79 × [abdominal circumference (cm)] - 1226.53. (r= 0.438, P < 0.01)

DISCUSSION

Women receiving nutrition supplements showed significant increase in SFH as well as AC, and their babies' birth weight was higher by 56 g. Low nutritional intake is possibly an important factor in the later part of pregnancy affecting SFH and birth weight. The role of calorie and protein intakes in the third trimester is important (Agarwal *et al.*, 2002).

Literature suggests measurable changes (SFH and AC) suggestive of risk of LBW based on observations of the third trimester (Bothner, Gulmezglu & Hofmeyr, 2000; Ghate, Pratinidhi & Gupte, 1996; Walraven *et al.*, 1995; Segre, Colletto & Bertagnon, 2001; Onah, Ikeme & Nkwo, 2002; Jeffery, Pattinson & Makin, 2001). However, this does not provide a scope for remedial interventions. It is imperative to identify markers at an earlier period so as to establish the risks and extent of required interventions to improve the overall conditions during pregnancy.

The pattern of increase in SFH and AC during the course of pregnancy exhibits regional differences, since variations were observed in the reported values from different workers (Bothner, Gulmezglu & Hofmeyr, 2000; Ayustawati *et al.*, 2003). Rai, Kurien and Kumar (1995) reported a maximum increase in SFH to occur between the 20th and 32nd week. However, our observations also noticed a coincidental increase in both SFH and AC during the 20th and 32nd week of pregnancy. Hence, it is clear that the end of the second trimester is an important landmark for completion of maximum changes in foetal development. SFH and AC were used to study their association with birth weight at the end of the second trimester.

Our results indicated that SFH and AC are highly useful as monitoring parameters to identify risk pregnancies.

The admission of the differences observed for SFH and AC in the third trimester is pronounced and clearly indicates the risk. However, identifying the risk of LBW at an earlier period is important so as to introduce corrective measures. Therefore, our study brought to light the importance of using SFH and AC measurements in identifying the risk of LBW deliveries.

Strauss & Dietz (1999) had reported that weight gain is a continuous process throughout pregnancy, with a peak occurring in the second trimester. It is, therefore, considered as a supportive parameter to confirm the risk for LBW. The present study also confirms a significant influence of weight gain on birth weight, although it is ranked third among the selected parameters. Monitoring prenatal health based on these indicators throughout pregnancy at prenatal clinics would help to identify the risks of pregnancies as early as the end of the second trimester. A minimum of two indicators may be applied to identify women who are in need of prenatal care and interventions.

It can be concluded that SFH less than 25 cm, AC less than 95 cm and maternal weight gain less than 3 kg at the end of the second trimester confirms poor foetal development. These are simple, reliable and inexpensive methods in the screening for high-risk pregnancies. SFH, AC and weight gain, when related to the gestational age, can predict the neonatal birth weight. Screening women with high-risk pregnancies is possible at an earlier period. Such screening procedures would enable the extension of nutrition and medical support to prevent serious consequences.

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