Original Article

The Influence of Maternal Anthropometric Characteristics on the Birth Size of Term Singleton South-East Nigerian Newborn Infants

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Abstract

Objective: This study examined the usefulness of maternal anthropometry in predicting the birth size of term singleton newborn infants at NAUTH, Nnewi, Nigeria. **Materials and Methods:** A cross-sectional study was conducted among 301 mother/newborn infant pairs. **Results:** The mean birth weight was 3.27 ± 0.60 kg whereas the incidence of low birth weight and fetal macrosomia were 8.0% and 11.3%, respectively. The anthropometric indices varied in their ability to detect newborn babies who experienced abnormal intrauterine growth. The rate of subnormal intrauterine growth was 9.0%, 11.6%m and 18.6% using weight-for-gestational age (GA), ponderal index (PI), and mid-arm circumference (MAC)/occipito-frontal circumference (OFC) criteria, respectively. On the other hand, the rate of excessive intrauterine growth was 16.6% and 12.0% using weight-for-GA and PI criteria, respectively. Apart from maternal height, all the assessed maternal anthropometric parameters had a significant relationship with size at birth. Mothers of newborn infants who experienced subnormal intrauterine growth were more likely to have MAC < 25 cm, intrapartum weight < 65 kg, intrapartum BMI < 25 kg/m^2, and rate of third trimester weight gain < 250 g/week. On the other hand, mothers of newborn infants who experienced excessive intrauterine growth were more likely to have MAC > 30 cm, intrapartum BMI ≥ 30 kg/m^2, and rate of third trimester weight gain ≥ 500 g/week. **Conclusion/Recommendation:** Maternal anthropometry is a very useful tool in identifying mothers at risk of having newborn infants who experienced abnormal intrauterine growth. Therefore, its routine application is recommended to enable such mothers benefit from interventions targeted at ensuring optimal intrauterine growth and improved pregnancy outcomes.

Keywords: *Anthropometry, intrauterine growth, newborn infants*

Introduction

Size at birth is an important indicator of maternal, fetal, and neonatal health.[1] Hence, anthropometric indices at birth are important predictors of the chances of survival, growth pattern, long-term health, and psychosocial development of infants.[2] These indices are very useful in categorizing an individual newborn infant as having experienced subnormal, normal, or excessive growth *in utero*.

Anthropometric indices commonly used for the assessment of newborn infants include birth weight, length, or occipitofrontal circumference (OFC) in relation to gestational age (GA) at birth.[1] Body proportionality indices such as Rohrer's ponderal index and mid-arm/head circumference (MAC/OFC) ratio have been used to describe the timing of growth restriction *in utero* and predict the outcome of intrauterine growth restricted neonates.[1,3]

Both subnormal and excessive intrauterine growth have been associated with high risk of neonatal morbidity and mortality as well as chronic diseases later in life. Low birth weight underlies approximately 80% of all neonatal deaths and is associated with 37 times higher risk of death during infancy in Nigeria.[4,5] Large-for-gestational age (LGA) babies are also at increased risk of neonatal morbidity

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and mortality due to the high risk of birth trauma, birth asphyxia, and hypoglycemia, especially in infants of diabetic mothers.[1] The above facts imply that efforts at ensuring optimal intrauterine growth is vital to reducing the unacceptably high burden of neonatal deaths in Nigeria.

Factors that influence intrauterine growth may be fetal, maternal, or environmental.[6] Maternal nutritional status is the most commonly implicated risk factor for poor fetal growth in developing countries.[1,6] Useful maternal anthropometric indicators for assessing pregnancy outcomes include pre-pregnancy weight, body mass index (BMI), pregnancy weight gain, MAC, and height.[6,7] Although maternal anthropometry is routinely conducted during antenatal clinic visits, this important public health tool is often underutilized in ensuring optimal pregnancy outcomes. Early identification of mothers at risk of having babies with abnormal intrauterine growth is necessary as some interventions have been documented to improve pregnancy outcomes among them.[7,8] On the other hand, identification of such women in late pregnancy, after most of the fetal growth has occurred, can help in making decisions such as prepartum referral to an appropriate facility for labor, delivery, and neonatal care.

This study was aimed at examining the relationship between maternal anthropometric characteristics and size at birth among term singleton newborn infants at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Nigeria. Results obtained will help in early identification of pregnant women at risk of having newborn infants with abnormal intrauterine growth pattern for possible prenatal or perinatal interventions. This will help in improving the quality of antenatal care and neonatal outcomes in Nigeria.

Materials and Methods

This descriptive cross-sectional study was conducted at NAUTH, a public tertiary hospital in Nnewi, South-East, Nigeria. The study was conducted between February and April 2012 among 301 mother/singleton term newborn infant pairs. Neonates whose mothers did not receive antenatal care at NAUTH as well as those with gross congenital malformation or stigmata of chromosomal abnormalities at birth were excluded from the study. Approval was obtained from the Research Ethics Committee of NAUTH prior to the commencement of the study. Participation was entirely voluntary and no financial inducement was involved. Mothers who participated in the the study gave a written informed consent. All consecutive eligible mother/newborn pairs were selected till sample size was attained. The anthropometric assessment of the neonates and mothers was performed employing standard methods.[9,10]

The rate of weight gain in the third trimester was calculated by dividing the difference (in grammes) between the first recorded third trimester weight and intrapartum weight by the duration of weight gain (in weeks). In this study, a third trimester weight gain rate of 250–499 g per week was considered to be normal. This was based on Institute of Medicine's recommended third trimester weekly weight gain rate, which ranges from 220 g among women who had obese pre-pregnancy BMI to 510 g among those that had underweight pre-pregnancy BMI.[11] Data was not available for calculation of pre-pregnancy BMI to enable categorization of weight gain rate according to pre-pregnancy BMI in this study. A previous report showed that pregnant women gain an average of 250 g per week throughout the period of pregnancy in Nigeria.[12]

Before commencing weighing on each day, the accuracy and reliability of the weighing scale was assessed with a known standard weight of 5 kg. The weighing scale was also cross-checked for zero adjustment before each use. Maternal weight was measured during labor with a weighing scale (SMIC Health Scale, Model ZT-120), which was placed on a flat and hard surface. The mothers were weighed in a light cotton gown, and their weight was recorded to the nearest 0.1 kg. Height was measured after delivery with a stadiometer which had a movable head-piece perpendicular to a well-calibrated meter scale and recorded to the nearest 0.1 cm. Based on previous reports, the cut-off values adopted for maternal weight and height in this study were 65 kg and 157 cm, respectively.[1,6,13] Similarly, maternal MAC range of 25–30 cm was considered to be normal in this study.[1,13,14]

Maternal BMI (in kg/m^2) was calculated using the formula: $weight/height^2$. In this study, maternal intrapartum BMI of 25–29.9 kg/m^2 was considered to be normal. The traditional definition of normal BMI as 18.5–24.9 kg/m^2 was not adopted in this study because it is based on pre-pregnancy values, and therefore, unlikely to remain sensitive in predicting good pregnancy outcomes if BMI is calculated using values obtained during the third trimester. This was demonstrated by a previous South-East Nigerian study which showed an increase in the 25th BMI percentile of the study population from 23.3 kg/m^2 during first trimester to 25.4 kg/m2 and 27.0 kg/m^2 during the second and third trimesters, respectively.[14] This could be attributed to maternal weight gain resulting from the fetus, enlarging organs, and fluid accumulation.

Neonatal data included sex, date of birth, mode of delivery, and GA at birth. For every recruited neonate, GA estimated from the mother's last menstrual period (LMP) was confirmed within 24 hours of birth using

Dubowitz's GA assessment chart.[15] A neonate was considered to be term if the GA at birth ranged from 37 to 42 completed weeks. The socioeconomic status of the family was assessed using the highest educational attainment and occupation of both parents, as described by Oyedeji.[16]

Anthropometry of the newborn infants (weight, recumbent length, OFC, MAC) was done as soon as possible within 24 hours of birth. The infants were weighed naked using an infant weighing scale (SALTER Model 180), and the values were recorded to the nearest 0.05 kg. The length of the infants was measured with an infantometer. The assistant, while gently cupping both ears, held the infant's head snugly touching the fixed vertical head-piece so that the inner and outer canthi of the eyes were in the vertical plane. Using the left hand, the researcher gently pressed the knees firmly against the board, and with the right hand, apposed the movable foot-piece against the heel, which was kept perpendicular to the board. The length was read from the attached measuring tape and recorded to the nearest 0.1 cm. The OFC was measured with a flexible inelastic tape. The tape was applied over the glabella, and passed around the head at the same level on each side and over the occipital prominence. The tape was pulled firmly to compress the hair and the OFC was recorded to the nearest 0.1 cm.

The MAC of the mothers and infants was measured at a level midway between the tip of acromion and olecranon on the left arm with the elbow flexed at right angle (90°). Measurement was taken with a flexible inelastic tape which was wrapped snugly around the arm without compressing the underlying tissue, and the value was recorded to the nearest 0.1 cm.

The anthropometric indices used for assessing the infants' nutritional status were weight-for-GA, ponderal index [birth weight (g)/Length $(cm)^3 \times 100$] and MAC/OFC ratio.[1,9,10,17] Infants were categorized as adequate-for-gestational age (AGA), LGA, and small-for-gestational age (SGA) based on their birth weight-for-GA percentile, which was determined using the intrauterine growth charts developed by Lubchencho.[18] The newborn infants were categorized as SGA and LGA if their birth weight-for-GA fell below the 10th percentile-for-GA and above the 90th percentile-for-GA, respectively. Newborn infants with ponderal index less than 2.32 g/cm^3 and above 2.85 g/cm^3 were categorized as being thin and obese, respectively, whereas those with MAC/OFC ratio were below 0.27 were also categorized as being thin.[1,19-21]

Results

Three hundred and one mother/newborn infant pairs were studied. Some maternal characteristics are shown in Table 1. The age of the mothers ranged from 16 to 44 years with a mean of 30.67 ± 5.09 years. Most of them were married (96.7%) and Christian (99.3%). All of them had some formal education, and the mothers were predominantly income earners (71.8%). Approximately half of the mothers belonged to the middle social class (47.8%) and were booked for antenatal care in the second trimester (48.8%) of pregnancy. Majority (77.7%) had vaginal delivery.

The anthropometric characteristics of the neonates are shown in Table 2. The male-to-female ratio was approximately 1:1 (47.5% versus 52.5%). The mean birth weight was 3.27 ± 0.60 kg. The incidence of low birth weight and fetal macrosomia were 8.0% and 11.3%, respectively. The rate of subnormal intrauterine growth was 9.0%, 11.6%, and 18.6% using birth weight-for-GA, ponderal index, and MAC/OFC ratio criteria,

Table 1: Some maternal sociodemographic and obstetric characteristics

Characteristic	Frequency	%
Marital status		
Married	291	96.7
Single	3	1.0
Divorced	3	1.0
Widow	4	1.3
Educational status		
Primary	16	5.3
Secondary	176	58.5
Tertiary	109	36.2
Employment status		
Employed	216	71.8
Unemployed	67	22.2
Student/apprentice	18	6.0
Socioeconomic class		
High	82	27.2
Middle	144	47.8
Low	75	24.9
Parity		
1	71	23.6
2 to 4	180	59.8
≥ 5	50	16.6
Trimester of ANC booking		
1st trimester	36	12.0
2nd trimester	147	48.8
3rd trimester	118	39.2
Mode of delivery		
Vaginal delivery	234	77.7
Caesarean section	67	22.3
Total	301	100.0

ANC, Antenatal care

Table 2: Anthropometric characteristics of babies

Characteristics	Frequency $n = 301$	%
Birth weight (kg)		
<2.5	24	8.0
2.5 to 3.9	243	80.7
≥4.0	34	11.3
Birth weight for GA		
SGA	27	9.0
AGA	224	74.4
LGA	50	16.6
MAC/OFC Ratio		
<0.27 (Thin)	56	18.6
≥ 0.27 (Normal)	245	81.4
Ponderal Index		
< 2.32 (Thin)	35	11.6
2.32 to 2.85 (Normal)	230	76.4
> 2.85 (Obese)	36	12.0

OFC, Occipito-frontal circumference; GA, Gestational age; MAC, Mid-arm circumference; AGA, Adequate for gestational age; SD, Standard deviation; LGA, Large for gestational age; SGA, Small for gestational age; PI, Ponderal index

respectively. On the other hand, the rate of excessive intrauterine growth was 12.0% and 16.6% using ponderal index and weight-for-GA criteria, respectively.

The mean maternal intrapartum BMI, weight, and MAC were 29.89 ± 4.60 kg/m^2, 80.08 ± 14.18 kg, and 29.30 ± 3.71 cm, respectively. The mean rate of third trimester weight gain and maternal height were 361.76 ± 167.02 g/week and 1.63 ± 0.06 m, respectively.

As shown in Table 3, Table 4 and Table 5, all the assessed maternal anthropometric parameters, apart from height, had a significant relationship with neonatal size at birth. Mothers of newborn infants who experienced subnormal intrauterine growth were more likely to have MAC < 25 cm, intrapartum weight < 65 kg, intrapartum BMI < 25 kg/m^2, and rate of third trimester weight gain < 250 g/week. On the other hand, mothers of newborn infants who experienced excessive intrauterine growth were more likely to have MAC > 30 cm, intrapartum BMI ≥ 30 kg/m^2, and rate of third trimester weight gain ≥ 500 g/week.

Table 3: Relationship between maternal anthropometric characteristics and weight for GA

Maternal anthropometric Characteristics	Newborn's weight-for-GA				χ^2	*P*-value
Height (in meters)	AGA	LGA	SGA	Total		
<1.57	21 (9.4)	2 (4.0)	5 (18.5)	28 (9.3)		
≥1.57	203 (90.6)	48 (96.0)	22 (81.5)	273 (90.7)	4.39	0.112
Intrapartum weight						
<65	33 (14.7)	0 (0.0)	11 (40.7)	44 (14.6)		
≥65	191 (85.3)	50 (100.0)	16 (59.3)	257 (85.4)	23.32	0.000*
Intrapartum BMI						
BMI (kg/m^2)						
≤24.9	27 (12.1)	2 (4.0)	12 (44.4)	41 (13.6)		
25 to 29.9	106 (47.3)	12 (24.0)	10 (37.0)	128 (42.5)	41.59	0.000*
≥30	91 (40.6)	36 (72.0)	5 (18.5)	132 (43.9)		
Predelivery						
MAC (cm)						
≤ 24.9	26 (11.6)	0 (0.0)	12 (44.4)	38 (12.6)		
25 to 30	112 (50.0)	22 (44.0)	12 (44.4)	146 (48.5)	37.69	0.000*
>30	86 (38.4)	28 (56.0)	3 (11.1)	117 (38.9)		
Third trimester						
Weight gain rate						
(g/week)						
<250	47 (21.0)	7 (14.0)	13 (48.1)	67 (22.3)		
250 to 499	133 (59.4)	21 (42.0)	12 (44.4)	166 (55.1)	26.44	0.000*
≥500	44 (19.6)	22 (44.0)	2 (7.4)	68 (22.6)		
Total(%)	224 (74.4)	50 (16.6)	27 (9.0)	301 (100.0)		

*Statistically significant BMI, Body mass index; AGA, Adequate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age; MAC, Mid-arm circumference; LBW, Low birth weight

Table 4: Relationship between maternal anthropometric characteristics and ponderal index

Maternal anthropometric Characteristics	Newborn's Ponderal Index				χ^2	*P*-value
Height (in meters)	Thin	Normal	Obese	Total		
<1.57	3 (8.6)	22 (9.6)	3 (8.3)	28 (9.3)		
≥1.57	32 (91.4)	208 (90.4)	33 (91.7)	273 (90.7)	0.081	0.96
Intra-partum weight						
<65	6 (17.1)	38 (16.5)	0 (0.0)	44 (14.6)	7.01	0.030*
≥65	29 (82.9)	192 (83.5)	36 (100.0)	257 (85.4)		
Predelivery BMI (kg/m²)						
≤24.9	7 (20.0)	34 (14.8)	0 (0.0)	41 (13.6)		
25 to 29.9	15 (42.9)	103 (44.8)	10 (27.8)	128 (42.5)	15.87	0.003*
≥ 30	13 (37.1)	93 (40.4)	26 (72.2)	132 (43.9)		
Predelivery MAC (cm)						
≤24.9	7 (20.0)	31 (13.5)	0 (0.0)	38 (12.6)		
25 to 30	21 (60.0)	109 (47.4)	16 (44.4)	146 (48.5)	13.11	0.011*
>30	7 (20.0)	90 (39.1)	20 (55.6)	117 (38.9)		
Third trimester Weight gain rate (g/week)						
<250	16 (45.7)	46 (20.0)	5 (13.9)	67 (22.3)		
250 to 499	12 (34.3)	139 (60.4)	15 (41.7)	166 (55.1)	26.44	0.000*
≥500	7 (20.0)	45 (19.6)	16 (44.4)	68 (22.6)		
Total (%)	35 (11.6)	230 (76.4)	36 (12.0)	301 (100.0)		

*Statistically significant BMI, Body mass index; AGA, Adequate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age; MAC, Mid-arm circumference; LBW, Low birth weight

Table 5: Relationship between maternal anthropometric characteristics and newborns MAC/OFC ratio

Maternal anthropometric Characteristics	Newborns' MAC/OFC Ratio			χ^2	*P* value
Height (in meters)	≤0.27	>0.27	Total		
<1.57	8 (14.3)	20 (8.1)	28 (9.3)		
≥1.57	48 (85.7)	225 (91.8)	273 (90.7)	2.03	0.16
Intrapartum weight					
<65	18 (32.1)	26 (10.6)	44 (14.6)		
≥65	38 (67.9)	219 (89.4)	257 (85.4)	16.93	0.000*
Predelivery BMI (kg/m²)					
≤24.9	19 (33.9)	22 (9.0)	41 (13.6)		
25 to 29.9	23 (41.1)	105 (42.9)	128 (42.5)	26.40	0.000*
≥30	14 (25.0)	118 (48.1)	132 (43.9)		
Pre-delivery MAC (cm)					
≤24.9	19 (33.9)	19 (7.8)	38 (12.6)		
25 to 30	23 (41.1)	123 (50.2)	146 (48.5)	28.92	0.000*
>30	14 (25.0)	103 (42.0)	117 (38.9)		
Third trimester Weight gain rate (g/week)					
<250	27 (48.2)	40 (16.3)	67 (22.3)		
250 to 499	21 (37.5)	145 (59.2)	166 (55.1)	26.81	0.000*
≥500	8 (14.3)	60 (24.5)	68 (22.6)		
Total(%)	56 (18.6)	245 (81.4)	301 (100.0)		

*Statistically significant BMI, Body mass index; AGA, Adequate for gestational age; SGA, Small for gestational age; LGA, Large for gestational age; MAC, Mid-arm circumference; LBW, Low birth weight

Discussion

The incidence of low birth weight in this study is lower than rates reported by previous South-East Nigerian studies (8.0% versus 10.76% in Enugu and 16.0% in Abakaliki).[22,23] This discrepancy may be attributed to the exclusion of premature neonates from the index study while the majority of low birth weight neonates in the other South-East Nigerian studies were preterm. In contrast, the rate of macrosomia in the index study is higher than the rate reported in Abakaliki, South-East Nigeria (11.3% versus 4.5%).[24] This may also be attributed to the exclusion of preterm neonates and products of multiple gestation from the index study.

The anthropometric characteristics of the newborn infants suggest a variation in the ability of different anthropometric indices to identify neonates with abnormal growth *in utero*, which is similar to findings from previous studies.[3,19-21,25] Hence, findings support previous reports that birth weight alone is inadequate for accessing nutritional status at birth. A number of studies have suggested a higher sensitivity of clinical assessment of nutrition score (CANSCORE) and MAC/OFC ratio compared to other parameters used in identifying newborn infants with subnormal intrauterine growth.[3,17,19-21,25,26] However, there is no consensus on the best anthropometric indicator of abnormal intrauterine growth. Hence, a combination of at least two indicators is currently recommended.[25] Of all the anthropometric indices used in categorizing neonates as having experienced subnormal intrauterine growth in this study, MAC/OFC ratio had the highest frequency of low values. On the other hand, weight-for-GA had the highest frequency among the indices used in identifying excessive intrauterine growth.

Among the anthropometric indices used in assessing neonates at birth, MAC/OFC ratio has been documented to most readily identify late gestational growth restricted neonates.[3] This anthropometric index combines a parameter that is most likely to be affected during acute intrauterine malnutrition (MAC) with another that is least affected during chronic or severe intrauterine malnutrition (OFC).[27] The low MAC/OFC rate of 18.6% in this study is significantly higher than 2.8% reported in Lagos, Nigeria.[26] This may be attributed to the use of different methods in the two studies. The index study used a cut-off value whereas the Lagos study used MAC/OFC curve developed for Nigerian newborn infants. Use of the Nigerian curve may mask the true prevalence of subnormal intrauterine growth if late gestational growth restriction is common in the country. This may explain the extremely poor performance of MAC/OFC ratio when compared to ponderal index, CANSCORE, and BMI in the same Lagos study.[26] Previously, MAC/OFC ratio has been documented to have a strong correlation with CANSCORE.[3,17] This may explain the similarity between the rate of subnormal intrauterine growth in this study and the 18.8% rate of fetal malnutrition using CANSCORE among similar population in Ilesa, South-West, Nigeria.[19] MAC/OFC ratio has been documented to have the highest ability to predict the occurrence of postpartum complications such as hypoglycemia.[20] Therefore, the finding of a high rate of low MAC/OFC ratio in this study is worrisome. However, further studies are needed to confirm the specificity of the index.

The mean maternal intrapartum BMI (29.89 ± 4.60 kg/m^2) and MAC (29.30 ± 3.71 cm) recorded in this study is comparable to the mean maternal third trimester BMI (30.72 ± 4.80 kg/m^2) and MAC (30.15 ± 3.85 cm) previously reported among Enugu, South-East Nigerian women.[14]

The usefulness of maternal anthropometric parameters in identifying pregnant women at risk of having babies with subnormal or excessive intrauterine growth was demonstrated in this study. The significant relationship between maternal nutritional status and weight-for-GA, in this study, agrees with previous reports.[1,6,11,28] The significant relationship is not surprising because the fetus is completely dependent on the mother for supply of nutrients required for growth. Therefore, low availability of nutrients from poorly nourished mothers would be expected to lead to poor intrauterine growth.

Maternal MAC and BMI reflect current nutritional status and findings of this study are consistent with previous reports on the impact of these parameters on birth weight.[1,6,7] MAC increases minimally, if at all, during pregnancy and is often used as a proxy for maternal pre-pregnancy and early pregnancy weights.[1,7] According to the WHO,[1] pregnant women with MAC less than 21-23 cm are at risk of poor pregnancy outcomes. On the other hand, maternal BMI has been considered to be the best predictor of low birth weight.[29] However, there is no universally accepted reference standard for BMI per GA. Maternal obese ($\geq$ 30 kg/m^2)) or underweight (< 18.5 kg/m^2)) BMI obtained before or during pregnancy have been associated with poor pregnancy outcomes.[1,7,15,30] However, little is known regarding the impact of traditional normal (18.5 to 24.9 kg/m^2)) or overweight (25 to 29.9 kg/m^2)) BMI categories on pregnancy outcomes if measurements were taken during the second or third trimester of pregnancy. Findings of this study provide additional insight on the impact of different maternal intrapartum BMI categories on pregnancy outcomes and suggest <25 kg/m^2) and $\geq$30 kg/m^2) as cut-off values for predicting an increased risk of subnormal and excessive intrauterine growth, respectively.

The lack of significant relationship between maternal height and anthropometric characteristics of term newborn infants is at variance with previous reports, which showed that maternal height is a strong predictor of birth weight.[1,6,28] However, the finding of this study is not surprising because maternal height neither reflects current nutritional status nor response to nutritional interventions.[1,6,7] Moreover, this study used 157 cm as cut-off for short maternal stature, which is higher than 140 to 150 cm recommended by WHO[1] as no mother was less than 140 cm. Despite this, only 28 (9.3%) mothers were less than 157 cm. Therefore, majority of the mothers were of "normal," height and there were too few women of short stature to show a meaningful effect. Hence, findings may underestimate the influence of maternal height on size at birth. According to WHO,[1,7] maternal height is not sensitive in predicting poor intrauterine growth when the cut-off is at 25th percentile of study population or more. Larger studies are needed to confirm the true magnitude of the impact of short maternal height on intrauterine growth.

Conclusion

Maternal anthropometry is a very useful tool in identifying mothers at risk of having newborn infants with subnormal or excessive intrauterine growth, which are both associated with higher risk of perinatal morbidity. Therefore, maternal anthropometry should be routinely applied to minimize missed opportunities for mothers that may benefit from interventions targeted at ensuring optimal intrauterine growth and improved pregnancy outcomes.

Limitations of the study

This was a tertiary hospital-based study and the patients may represent a biased sample because they benefited from high quality antenatal care compared to other populations of pregnant women.

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Conflicts of interest

There are no conflicts of interest.

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