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REVIEW

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Maternal factors in the aetiology of small-for-gestational age among term Nigerian babies

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Abstract *Background:* Babies are classified according to the relationship between birth weight and gestational age, the latter being the strongest determinant of birth weight. Small-for-gestational age (SGA) babies have birth weights less than the 10th percentile for age and sex or more than two standard deviations below the mean for age and sex.
Objective: The study was carried out to investigate the maternal factors associated with the delivery of term small-for-gestational age babies in a Nigerian Hospital.
Methods: In the cross-sectional survey, the anthropometric parameters of term singleton infants were related to maternal age, parity, socio-economic class, anthropometry and medical disorders in pregnancy.
Results: A total of 825 babies were surveyed within the first 24 hours of life. The mean birth weight of babies was 3233 ± 539g. The males had significantly longer mean crown-heel length and mean occipitofrontal circumference compared to females p = 0.048 and p < 0.000 respectively). The prevalence of infants with small-for-gestational age was 7.2% (5.7% and 8.8% among males and females respectively). The proportion of mothers who did not encounter significant illness in pregnancy was lowest among those who had SGA babies, followed by mothers of LGA babies and those of AGA babies in that order. With respect to maternal age, weight, height and body mass index (except inter-pregnancy interval), mothers of SGA babies had significantly lower values compared to mothers of the AGA and LGA babies ($p \leq 0.03$).
Conclusion: This study identified age, parity, anthropometry and hypertension-related disorders as major maternal factors associated with the birth of SGA babies in Nigeria.

Keywords: Anthropometry, Intrauterine growth restriction, maternal illness, Nigeria.

The term 'small- for-gestational age' (SGA) describes a baby whose birth weight is less than the 10th percentile for age and sex.[1] It may also be defined as birth weight more than two standard deviations below the mean for age and sex.[1]
Potential conditions that predispose babies to being small at birth are quite common in tropical practice. Some of which include general infections[2] and malarial infestations.[3] Several other factors may predispose to SGA delivery.[4] Maternal factors known to contribute to SGA delivery include biological factors, nutritional factors, brief inter-pregnancy intervals, low socio-economic class and poor education, medical and obstetric problems.[4] Maternal biological factors which may influence SGA delivery include extremes of maternal age (teenage and mothers older than 35 years),[2] primiparity and grand-multiparity.[2] Maternal nutritional status and anthropometry also play a major role in the birth size of a baby with low maternal weight, height and body mass index implicated in SGA delivery.[5, 6]

It is therefore expected that the prevalence of SGA babies will be relatively high in the tropics and sub-tropics. In some advanced countries, the prevalence of SGA ranged between 2.8 percent and 10 percent. A prevalence of 10% was reported in the United States with higher incidence among the black population.[7] A figure of 4.1% was reported in Britain,[8] as high as 16.5% among the Chinese and other Asian women.[9] While in Nigeria,[10,11] the prevalence is 12.8% and in Harare, Zimbabwe[12] 7.6% was reported.

It is important to identify the predisposing factors to SGA delivery because there is a dearth of information on the epidemiology of SGA and it is a known fact that the weight at birth not only reflects the quality of intra-uterine growth, but it also exerts a strong influence on the post-natal survival.[13] identifying the predisposing factors therefore will assist in making comprehensive perinatal and neonatal care plans.

There is, presently, a dearth of literature on the current pattern of aetiology of small for gestational age infants. Therefore, the current study is aimed at determining the maternal factors associated with term small-for-gestational age babies delivered in a major Nigerian city, Lagos.

Subjects and Methods

The study was conducted in the maternity section of the Lagos State University Teaching Hospital (LASUTH), Ikeja, south-west, Nigeria between September and December 2009. The hospital serves as a referral centre for private and public primary and secondary health institutions in both Lagos and the neighboring Ogun state. The maternity section shares a bed capacity of 165 with the gynaecological section. The average delivery rate is 4000 babies per annum, with term babies accounting for approximately 90%. There is no restriction on the type of cases admitted into this facility. Thus, women of all socioeconomic classes patronize the hospital.

Ethical clearance was obtained from the hospital's Research/Ethics Committee and written informed consent was taken from mothers of subjects at contact.
The study was hospital based and cross sectional. Subjects consisted of consecutive mother-baby pairs who fulfilled set study criteria. Inclusion criteria included term newborn babies, singleton birth of consenting mothers while exclusion criterion was babies with gross congenital abnormality. The babies were examined in the first 24 hours of life within the acceptable limits for physical examination as described by Ballard *et al*. [14] This 24-hour period also allowed for full recovery of mothers from the effects of anaesthesia and post operative pain in cases of operative deliveries.

The minimum sample size for the study was derived from a statistical formula[15,16] based on the prevalence of SGA delivery in a similar study conducted within the same locality. [10] The minimum sample size was estimated as 686 but a total of 825 were studied in order to allow for precision and attrition.

The recorded anthropometric parameters of the babies included birth weight, crown-heel length (CHL) and occipito-frontal circumference (OFC).
Each baby was weighed using the *RGZ-20* weighing scale. The scale records weights in grams to the nearest 25g. It was adjusted for zero error before each reading. Other measures taken to ensure reliability of results included weekly standardization of the weighing scale, using known weights. Length was measured in centimeters to one decimal place using a metal anthropometric linear rule fixed to a horizontal flat board using standard procedure. The OFC was measured to the nearest 0.1 cm with a non stretchable tape using the glabella and the tip of the occiput as the landmarks.[17]

The gestational age was determined calculating from the first day of last maternal menstrual period. This was corroborated by the scores obtained by using methods described by Ballard *et al*.[14] Where the difference between both techniques was more than two weeks, the gestational age obtained by using the New Ballard score was upheld and recorded. SGA was defined as babies whose birth weights are less than the 10^{th} percentile on the international growth chart (Lubchenco chart of Intrauterine growth pattern). [18] Appropriate-for-gestational age (AGA) babies weighed between 10^{th} and 90^{th} percentiles while Large-for-gestational age (LGA) weighed higher than the 90^{th} percentiles.

The maternal age, marital status, anthropometry, tribe, socio-economic status. parity, inter-pregnancy interval, maternal disease in pregnancy were all recorded. The body mass index was also calculated for each mother.
The data was analyzed using Microsoft Excel program and SPSS version 16.0. Descriptive and inferential statistics were applied in the course of analysis. *Pearson's Chi-square test* was used to assess relationships between categorical variable. The *Student t–test* was used to compare the means of continuous variable. Analysis of variance (ANOVA) was used to compare three or more group means. The *p*-value less than 0.05 defined statistical significance (95% confidence level).

Results

There were a total of 1,052 live births during the study period. Of this number, 195 pre-term babies, 27 products of multiple gestation, four babies with various congenital abnormalities and one with fractured femur were excluded. Thus, 825 consecutive term, singleton babies fulfilled the set criteria.

General characteristics

Of these 825 babies, 53.3% were males while 46.7% were females giving a male : female ratio of 1: 0.9. The majority of the study subjects belonged to the upper socio-economic class. Five hundred and seventeen babies (62.7%) were delivered by spontaneous vertex, 297 (36.0%) by caesarean section and the remaining eleven (1.3%) by various types of assisted deliveries.

The mean gestational age and birth weight of babies were 39.0 ± 1.29 weeks and 3233 ± 539g respectively. The overall mean CHL was 49.0 ± 2.46cm. The males had significantly longer mean CHL than females. The mean length for males was 49.17 ± 2.44cm while mean for females was 48.83 ± 2.48cm (t = 1.98, p = 0.048). The overall mean OFC was 34.6 ± 1.40cm with males having a significantly higher mean OFC compared to females (t = 4.06, p < 0.0000). Specifically, 59 neonates were adjudged SGA. Thus, the prevalence rate of SGA was 7.2% (5.7% and 8.8% in males and females respectively: x^2 = 3.07, p = 0.08). The corresponding prevalence rates of AGA and LGA babies were 635 (77.0%) and 131 (15.9%) respectively. Table 1 shows the distribution of infant's anthropometric values using an international intrauterine growth chart. [18]

Table 1: Distribution of infant's anthropometric values using an international intrauterine growth chart

	<10^{th} percentile	10^{th} to 90^{th} percentile	>90^{th} percentile
Measurements	N (%)	N (%)	N (%)
Birth weight (g)	59 (7.2)	635 (77.0)	131 (15.9)
Length (cm)	46 (5.6)	672 (81.5)	107 (13.0)
Occipitofrontal circumference (cm)	2 (0.2)	598 (72.5)	225 (27.3)
Ponderal Index (g/cm^3)	53 (6.4)	642 (77.8)	130 (15.8)

Figures in brackets are percentages of total number of study subjects (825)

Eight-hundred-and-eighteen mothers (99.2%) were married while seven (0.8%) were single mothers. Three-hundred-and-thirty-eight mothers (41.0%) were nulliparae, 460 (55.8%) were Para 2 to Para 4, while 27 (3.2%) were grandmultiparous ($\geq$ Para 5). Table 2 shows the mean maternal age, anthropometry, inter-pregnancy interval and their distribution according to intra-uterine growth status. In all the characteristics except inter-pregnancy interval, mothers of SGA babies had significantly lower values than mothers of the AGA and LGA babies (p $\leq$ 0.03). The same pattern was observed when analysis of SGA Vs (AGA + LGA) was done.

Table 2: Mean maternal age, anthropometry and inter-pregnancy interval according to intrauterine growth status

	SGA	AGA/LGA	t	p-values
Age (years)	29.1 ± 4.88 (17 - 41)	30.8 ± 4.74 (13 - 44)	2.63	0.01
Weight (kg)	68.6 ± 13.83 (40 – 109)	77.6 ± 15.02 (41 – 146)	4.79	0.000
Height (cm)	1.57 ± 0.08 (1.22 – 1.77)	1.60 ± 0.07 (1.40 – 1.85)	2.80	0.007
BMI (kg/m^2)	27.8 ± 4.40 (19.0 – 40.5)	30.2 ± 5.27 (18.5 – 52.5)	3.89	0.000
IPI (year)	2.83 ± 2.60 (n = 24)	2.91 ± 2.26 (n = 469)	0.15	0.88

SGA - Small-for-gestational age; AGA - Appropriate-for-gestational age; LGA - Large-for-gestational age; BMI - Body mass index; IPI - Inter-pregnancy interval (This interval applied to only 487 mothers who had at least one previous pregnancy).
Figures in brackets are ranges of values

The major illnesses recorded among the mothers included hypertensive diseases (89; 10.8%), HIV/AIDS (19; 2.3%), diabetes mellitus (18; 2.2%), malaria (14; 1.7%) and sickle cell anaemia (9; 1.1%). Mothers of AGA/LGA subjects were significantly less likely to have encountered a significant illness during the current pregnancy than those of SGA (p < 0.0001) as shown in Table 3.

Table 3: Relationship between maternal illness and intrauterine growth status

Maternal Illness	SGA	AGA/LGA	Total
Present	29 (49.2)	137 (17.9)	166 (20.1)
Absent	30 (50.8)	629 (82.1)	659 (79.9)
Total	59	766	825

SGA - Small-for-gestational age; AGA - Appropriate-for-gestational age; LGA - Large-for-gestational age
Figures in parentheses are percentages of the total in the respective column.

In the next phase of analysis, cutoff values of maternal characteristics were empirically chosen and the associated frequency of SGA, AGA and LGA babies determined. With respect to maternal age groups (Table 4), more than three quarters of mothers were aged between 20 years and 34 years. The highest SGA rate was associated with teenage motherhood (20.0%) but this was not significantly higher than for mothers aged 20 to 24 years (X^2 [Yates correction] = 0.31, p = 0.86). Also, the SGA rate was lowest among the 171 mothers aged 35 years or more but not significantly lower than that for mothers aged 20 to 34 years (4.7% Vs 7.7%: X^2 = 1.89, p = 0.17). Table 4 shows that the overall mean birth weight of babies whose mothers were aged 20 to 34 years was significantly higher than that for babies born to older mothers (p = 0.001).

Table 4: Relationship between maternal age-groups and intrauterine growth of babies with mean birth weights

Maternal age (years)	Overall	SGA	AGA	LGA
< 20	2710 ± 288g (n = 5)	2450g (n = 1)(20.0)	2775 ± 287g (n = 4) (80.0)	(n = 0) (0.0)
20 – 34	3219 ± 562g (n = 649)	2392 ± 210g (n = 50) (7.7)	3145 ± 385g (n = 494) (76.1)	4035 ± 354g (n = 105) (16.2)
$\geq$ 35	3041 ± 614g (n = 171)	2222 ± 274g (n = 8) (4.7)	3046 ± 352g (n = 137) (80.1)	4071 ± 309g (n = 26) (15.2)
	t-test; (p-value)	t-test; (p-value)	t-test; (p-value)	t-test; (p-value)
20 – 34 Vs < 20	3.43; 0.001	*	2.85; 0.005	*
20 – 34 Vs $\geq$ 35	3.96; 0.016	1.68; 0.13	2.56; 0.08	0.52

SGA - Small-for-gestational age; AGA - Appropriate-for-gestational age; LGA - Large-for-gestational age.
Figures in brackets are percentages of N
* t-test not feasible because the numbers are too few to generate standard deviation.

The prevalence of SGA delivery showed significant disparity among the various maternal groups (p = 0.007) as shown in Table 5. The rate was highest among nulliparous mothers being more than twice the value observed for mothers in the Para 2 to Para 4 group (10.4% Vs 4.8%: X^2 = 9.12, p = 0.003). In addition, the mean birth weight of babies born to mothers who have had two to four prior babies was significantly higher than that of babies of nulliparous mothers (p = 0.0001) and babies of grandmultiparous mothers (p = 0.01)

(Table 5). More specifically, SGA babies born to nulliparous mothers had a highly significantly lower mean birth weight than their counterparts born to mothers in the Para 2 to Para 4 group (p = 0.0001).

Table 5: Relationship between maternal parity and intrauterine growth status of babies with mean birth weights

Maternal Parity	Overall	SGA	AGA	LGA
1	3151 ± 583g (n = 338)	2197 ± 208g (n =35) (10.4)	3108 ± 340g (n = 257) (76.0)	4120 ± 418g (n = 46)(13.6)
2 – 4	3303 ± 499g (n = 460)	2527 ± 72g (n = 22)(4.8)	3179 ± 341g (n =355)(77.2)	4040 ± 336g (n = 83)(18.0)
≥ 5	3072 ± 442g (n = 27)	2700g (n =2)(7.4)	3050 ± 426g (n = 23)(85.2)	3700g (n = 2)(7.4)
	t-test; p-value	t-test; p-value	t-test; p-value	t-test; p-value
Para 1 Vs Para 2 - 4	3.86; 0.0001	8.60; 0.0001	2.55; 0.01	1.11; 0.27
Para 1 Vs Para ≥ 5	0.87; 0.39	**	0.64; 0.53	**
Para 2 - 4 Vs Para ≥ 5	52.62; 0.01	**	1.42; 0.17	**

SGA - Small-for-gestational age; AGA - Appropriate-for-gestational age; LGA - Large-for-gestational age.
Figures in brackets are percentages of N
** t-test not feasible because the numbers are too few to generate standard deviation.

The frequency of SGA delivery reduced progressively while that of LGA delivery increased with increasing maternal weight (p = 0.000) as shown in Table 6. Mothers shorter than 155cm were significantly more likely to deliver SGA babies than their taller counterparts (p = 0.009). On the contrary, the taller mothers were more likely to give birth to LGA babies than shorter ones (X^2 = 10.86, p = 0.001). The same pattern was observed for increasing maternal body mass index (p = 0.000). Mothers who had BMI above 30kg/m^2 were significantly less likely to give birth to SGA babies than those with BMI less than 24.9kg/m^2 (X^2 = 5.26, p = 0.022). They were, in addition, less likely to deliver SGA babies than those with BMI between 25 and 29.9kg/m^2 but this difference was not statistically significant. Also, mothers of LGA babies were more likely to have BMI of 30 kg/m^{2}or more than mothers of AGA (X^2 = 13.3, p = 0.000) or SGA subjects (X^2 = 15.74, p = 0.000).

Table 6: Frequency of SGA, AGA and LGA according to cutoff points of maternal anthropometry

	N	SGA	AGA	LGA	X^2	p
Weight kg						
< 60	88	17 (19.3)	69 (78.4)	2 (2.3)		
60 to 80	420	31 (7.4)	341 (81.2)	48 (11.4)	60.1	0.000
> 80	317	11 (3.5)	225 (71.0)	81 (25.6)		
Height cm						
< 155	170	20 (11.8)	137 (80.8)	13 (7.6)		
> 155	655	39 (6.0)	498 (76.0)	118 (18.0)	6.86	0.009
Body Mass Index kg/m^2						
< 25	25	13 (11.0)	100 (84.8)	5 (4.2)		
25 to < 30	310	26 (8.4)	247 (79.7)	37 (11.9)	34.8	0.000
> 30	397	20 (5.0)	288 (72.6)	89 (22.4)		

SGA - Small-for-gestational age; AGA - Appropriate-for-gestational age; LGA - Large-for-gestational age
Figures in brackets are percentages

Discussion

Several factors have been identified as being responsible for SGA.[2] The various factors may be grouped into maternal, utero-placental and fetal factors. Maternal biologic factors known to contribute to SGA delivery in developing countries include anthropometry, nutritional deficiencies[10] and medical problems occurring in or coinciding with pregnancy.[2] The influence of maternal size on infant's birth weight was apparent in the present study with low maternal weight, height and BMI being associated with increased frequency of SGA babies. This is in agreement with earlier studies from Nigeria, [10, 19] other developing countries [20] and the developed countries [21] all of which observed that maternal size is an important determinant of intrauterine growth. The explanation is not far-fetched. Anthropometry is a well known index for nutritional status. Better nutritional status in the mother translates to improved transplacental nutrient supply to the fetus. It is also known that fetal size is dependent on innate/genetic as well as nutritional factors. It is plausible therefore that the positive relationship between maternal anthropometry and that of the infant is partly a reflection of inherent genetic factor in the determination of birth size.

The influence of extremes of maternal age was also investigated but the number of teenage mothers in the current study (5) was too small to permit an in-depth analysis or comments. Thus, although the SGA rate among teenagers was higher than other maternal groups, this observation remains anecdotal in view of the current limitation regarding statistical analysis. However, teenage motherhood is often cited as being associated with lower birth weight profiles. [10] Using different methods, workers in Ile-Ife, Nigeria [6] also established an association between compromised intrauterine growth and teenage motherhood. A number of arguments may be raised to explain this line of observation. It may be that teenage parturients are not fully developed physically and emotionally to cope with the nutritional and metabolic demands of pregnancy.[22] It may also be related to several social issues peculiar to unplanned teenage pregnancies. At the other end of the age spectrum, it is noteworthy that the lowest rate of contrast to findings in some other studies which reported the best fetal growth results in association with mothers aged 30 to 34 years [10] with those aged 35 years or more being at a distinct disadvantage. [10, 20] The reasons for the differences in findings are not clear but could be indicative of the fact that maternal age on its own is not the sole determinant of infant's size.

With respect to maternal parity and other pregnancy-related indices, our finding of a strong relationship between nulliparity and SGA agrees with earlier reports [20, 21] in which birth weight was lowest with first-time mothers. A number of reasons may explain this relationship. It may be argued that the smaller birth size associated with nulliparity is a reflection of smaller intrauterine volume, which in turn is correlated closely with birth size.[23] Short inter-pregnancy interval, particularly if it is shorter than six months had earlier been associated with high prevalence of SGA delivery. [21] A related observation in the current study is the noteworthy absence of mothers with identifiable high risk factor of a short inter-pregnancy interval particularly with a duration of < 6 months. On the contrary, mothers of SGA babies had a mean interval almost identical to that of mothers of AGA babies. It may therefore be concluded that other causes besides short inter-pregnancy interval was responsible for the babies in the present study being small for gestational age.

The spectrum of pregnancy-associated morbidities illnesses identified among the mothers involved in the study is similar to those of earlier Nigerian reports.[10] Specifically, maternal hypertensive disorders were significantly associated with SGA delivery. This finding is consistent with that of an earlier report by Obed and Aniteye in Ghana, [24] it also agrees with that reported by Sadoh [19] in Benin. Workers in Ilesa [6] also demonstrated that maternal hypertensive disease was present in 25% of neonates who suffered fetal malnutrition. The finding is not surprising considering the potential negative effects of hypertension on placental function. Hypertension is reportedly associated with pathological changes in placental blood vessels, including shallow invasion by fetal trophoblasts in maternal spiral arteries and narrowing with consequent reduction of blood flow and a corresponding reduction in oxygen and nutrient delivery to the fetus. [2] The end result is a varying degree of intrauterine growth restriction and the delivery of babies of smaller growth achievements.

Conclusion

Some maternal factors (anthropometry and gestational illness) were found to be significantly associated with birth size and the frequency of SGA delivery. Identified maternal factors associated with SGA delivery were primparity, low maternal weight (< 60 kg), short maternal height (< 1.5 meters), body mass index below 25kg/ m^2 and hypertension-related illnesses.

Clearly, the identified predisposing factors to SGA delivery in this study constitute a valid prerequisite for evolving the relevant intervention strategies. It is therefore recommended that steps be taken to improve the nutritional status of mothers before and during pregnancy, as well as improve utilization of antenatal services in order to ameliorate the identified risk factors.

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