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C. A. KLUFIO, A. T. LASSEY, B. D. ANNAN and J.B. WILSON

ABSTRACT

Objectives: **To determine the birthweight distribution of singleton births at the Korle-Bu Teaching Hospital and to determine if selected socio-demographic and reproductive characteristics that are known to be associated with birthweight would show the association in our setting.**

Design: **A non-randomised cross-sectional survey of all deliveries within the study period.**

Setting: **Korle-Bu Teaching Hospital, a tertiary institution, delivering about 11,000 women a year.**

Study population: **From 1st November to 12th December 1994, 866 singleton normally formed livebirths and fresh stillbirths were sequentially enrolled.**

Data sources: **Data sources were the antenatal and delivery records of the subjects and an interviewer-administered questionnaire.**

Results: **The mean birthweight for the total sample was 3070g $\pm$ 616g. One hundred and fifteen (13.3%) babies were low birthweight. The mean birthweight for those with reliable dates and born at term was 3262g $\pm$ 488.8g. Multiple logistic regression analysis showed lack of antenatal malaria chemoprophylaxis and a history of previous low birthweight to be significantly associated with low birthweight.**

Conclusion: **Although the mean birthweight of Korle-Bu babies was lower than those of USA and UK babies, it was comparable with those from other developing countries. Antenatal malaria chemoprophylaxis is a practical intervention that can produce an increase in mean birthweight and reduce the risk of low birthweight in our population.**

INTRODUCTION

A baby's weight at birth has a tremendous impact on its journey into the outside world and on its life thereafter. The chances of normal vaginal birth, survival, optimal physical growth, and normal neurological and intellectual development, are best if the birthweight is within normal limits.

Apart from major congenital anomalies, low birthweight is perhaps the single most important determinant of the survival chances of a new-born and a good predictor of the infant's prospects for healthy growth and development(1). Babies born alive but weighing less than 1500g are very likely to die, regardless of gestational age(2). On the other hand, perinatal morbidity and mortality are increased for the macrosomic baby. Macrosomia, that is birthweight greater than 4000g, is associated with increased risk of obstructed labour and uterine rupture, operative vaginal or abdominal delivery, shoulder dystocia, traumatic injury to the infant's skeleton, abdominal organs, and brachial plexus, perinatal asphyxia, and even perinatal death(3).

Birthweight is first and foremost dependent on gestational age. Besides gestational age, birthweight is determined by the interaction of a multitude of genetic, behavioural, environmental, medical and obstetrical factors. These factors include: race and ethnicity, altitude, age, parity, socio-economic status, maternal nutrition, height, pre-pregnancy weight, antenatal weight gain, sex; pre-eclampsia, diabetes mellitus, urinary tract infection, malaria, sickle cell disease, syphilis, amniotic infection syndrome; substance abuse, especially smoking, alcohol, and cocaine. Thus, both nature and nurture are important influences.

For a given community, socio-economic and nutritional status, as well as the general health of women, are the most important determinants. As these characteristics change over time, the mean birthweight will also change. Birthweight may therefore be regarded as a measure of the longitudinal health of the community. It is therefore useful for a population to determine its birthweight distribution from time to time.

This was the primary objective of the study. A secondary objective was to determine whether selected socio-demographic and reproductive characteristics which are known to be associated with birthweight would show the association in our setting.

MATERIALS AND METHODS

This was a non-randomised sequential survey of all mothers delivered at the Korle-Bu Teaching Hospital (KBTH) from 1st November 1994 to 12th December 1994. Subjects were recruited after the study had been explained to them and they had given verbal

consent. All patients complied. The only other exclusion criterion was mental infirmity of a grade that made it impossible for the patient to be interviewed. The data sources were a standardised pre-tested questionnaire and the subjects' antenatal records. Medical students who were doing their senior clerkship in Obstetrics and Gynaecology were trained to administer the questionnaire. The data was collected on the patient's admission to the Lying-in ward. The researchers checked each questionnaire for omissions and errors before the subject's discharge from hospital.

Mothers with haemoglobinopathies or severe hypertensive disease were excluded. Macerated stillbirths and babies with major congenital anomalies were also excluded. The labour ward register was used to identify eligible subjects. The subjects were followed to the lying-in wards and the pre-tested standardised questionnaire administered to each patient. The rest of the data were obtained from the patient's hospital records. From 1st November 1994 to 12th December 1994, 866 subjects were recruited. The total number of women delivered during the study period was 978.

Data limitations and definitions of terms: Age of the subject was considered reliable if the patient could give both her date of birth and her age, and if the two agreed. Where the given age was patently wrong, or where the patient could not give her age, the research assistant used calendar events to make an educated guess. Parity was the number of births before the index delivery. A nullipara (Para 0) was a subject who had not had a delivery before this birth; a grand multipara has had five or more deliveries before the index birth. A primigravida had no previous pregnancy; the index pregnancy was her first. Gestational age (GA) was taken as reliably established if the patient was sure of her dates and at the booking visit the fundal height was equal to the dates; or if the patient had an ultrasound scan dating before the 26th week. Probably, subjects who satisfied these conditions were not representative of the study population. A term delivery was delivery between 37 completed weeks and before 42 weeks' gestation. A preterm delivery is delivery before 37 completed weeks. A post-term delivery is delivery at 42 or more completed weeks.

Past low birthweight: A history of past low birthweight was accepted if the patient was able to tell the birthweight, or if she stated that the baby was small and was admitted to Neonatal Intensive Care Unit (NICU) on that account.

Last birth interval: This is the number of months between the penultimate delivery and the index birth.

Antenatal weight: Weight gain was obtained by substracting the first recorded weight from the last. To reduce the modifying effect of preterm delivery and late booking, only subjects whose first weights were taken not later than 26 weeks, and whose last weights were after 36 weeks were included in the analysis. Height was as measured and recorded during the antenatal period. A low birthweight baby is a baby whose birthweight was less than 2500g. A macrosomic baby is a baby that weighed 4000g or more at birth.

Lost antenatal records, measurements not recorded in the hospital notes and 'don't know' answers to items in the questionnaire were treated as missing values in analysis.

Data analysis: The Epi Info version 5 and the SPSS/PC+ software were used for statistical analyses. Descriptive statistics for continuous variables included: means, standard deviations (SD), medians, and percentiles. For categorical variables, frequency counts were calculated. The Kruskal-Wallis H and Fisher exact tests were used to examine relationships between mean birthweight and the selected independent variables. Differences with p values <0.05 were taken as significant. Variables that, in univariate analysis, showed significant association with low birthweight were included in a multiple logistic regression model.

RESULTS

Gestational age at delivery: Gestational age at delivery was reliably established in 461 (53.2%) of the 866 subjects. For this reliable dates subgroup, the mean delivery gestational age was 38.6±2.27 weeks. Sixty five (14.1%) of the 461 were preterm and 19 (4.1%) post-term, whilst the remaining 377 subjects delivered at term.

Birthweight descriptive statistics (Table 1): For the total sample of 866 infants, the mean birthweight was 3070±616g; the median was 3200g, and the 5th and 95th percentiles were 2000g and 4000g, respectively. For the 461 subjects with reliable dates, the mean 3165±583.2g, the median 3200g, and the 5th and 95th percentiles were 2250g and 4000g, respectively in the subgroup of reliable dates who delivered at term, the mean was 3262±488.8g; the median 3250g, and the 5th and 95th percentiles were 2500g and 4105g, respectively.

Table 1

Gestational age at delivery and birthweight distribution

Panel A. GA at delivery distribution (N=461)*					
GA in completed weeks	26-31	32-36	37-41	≥42	
Frequency (%)	8 (1.7)	57 (12.4)	377 (81.8)	19 (4.1)	
Panel B. Birthweight distribution over GA categories (N=461)*					
GA in completed weeks	26-31	32-36	37-41	≥42	
Mean birthweight (g)	1300	2706	3262	3401	
SD	371.3	505.0	488.8	618.9	
Panel C. Mean birthweight (g), median, and percentiles					
	N	Mean±SD	Median	5th PC	95th PC
Total sample	866	3070±616.0	3100	2000	4000
Reliable dates	461	3165±583.2	3200	2250	4100
Reliable dates, term	377	3262±488.8	3250	2500	4105
Panel D. Birthweight (g) categories					
	<1500g	1500-2499g	2500-3999g	≥4000	Total
Total sample (%)	20 (2.3)	95 (11.0)	712 (82.2)	39 (4.5)	866
Reliable dates (%)	6 (1.3)	36 (7.8)	390 (84.4)	29 (6.3)	461
Reliable term (%)	0 (0)	14 (3.7)	337 (89.4)	26 (6.9)	377

*Reliable dates subgroup. Bwt = birthweight. GA = gestational age. PC = percentile

One hundred and fifteen (13.3%) infants in the total sample were low birthweight, and 39 (4.5%) were macrosomic. In the reliable dates group 9.1% (42/461) were low birthweight and 6.3% (29/461) macrosomic. Among the reliable dates term infants, 3.7% (14/377) were low birthweight and 6.9% (26/377) were macrosomic.

Maternal characteristics associated with birthweight: In univariate analysis of the total sample, the following characteristics were significantly associated with smaller mean birthweights (Table 2): mother never been to school, maternal height under 150cm, nulliparity, past delivery of a low birthweight infant, no antenatal care, no malaria chemoprophylaxis during pregnancy, the lowest haemoglobin concentration recorded during index pregnancy less than 8.0g/dl, and infant sex female. When the analysis was restricted to subjects with reliable dates who delivered at term, the association remained significant for nulliparity, past delivery of a low birthweight infant, first antenatal weight under 64kg, last antenatal weight under 70kg, antenatal weight gain less than 6kg, and female sex of infant. Malaria chemoprophylaxis, maternal height <150cm, and lowest antenatal haemoglobin <8g/dl were not significant in this subgroup (Table 3). Antenatal care could not be examined in this subgroup, since only those who had antenatal care satisfied the condition of "reliable gestational age".

Table 2

Univariate analysis of mean birth weight by selected maternal characteristics

Variable	Yes Mean±SD	No Mean±SD	K-W H p value
Schooling (N=865)	3100±613.1	2936±614.3	0.00*
Height <150cm (N=803)	2923±388.6	3077±629.7	0.03*
Age >35yrs (N=551**)	3285±638.1	3104±603.6	0.02*
Nulliparity (N=866)	2963±595.0	3157±619.7	0.00*
Past low bwt (N=321†)	2889±673.7	3222±596.5	0.00*
Antenatal care (N=866)	3090±598.4	2752±785.1	0.00*
Malaria prophylaxis (N=855)	3141±576.1	2934±664.4	0.00*
Lowest antenatal Hb <8g (N=698)	2893±622.5	3131±584.8	0.02*
Sex of infant (N=866)	3028±580.7	3106±643.1	0.04*
Age <18yrs (N=551**)	2867±684.2	3133±604.6	0.06
Past perinatal death (N=476††)	3170±710.4	3155±601.3	0.76
Grand multiparity (N=866)	3187±614.0	3063±615.7	0.16
Birth interval <2 years (N=476††)	3210±618.2	3139±620.04	0.31
Clinical malaria (N=864)	3083±620.5	3066±615.8	0.78

K-W H = Kruskal-Wallis H test. *Significant. **Subjects with unreliable ages excluded. †Nulliparae excluded. Bwt = birth weight. ††Nulliparae excluded.

Table 3

Mean birth weight by significant maternal characteristics in subjects with reliable dates who delivered at term

Variable	Yes Mean±SD	No Mean±SD	K-WH p value
Nulliparity (N=377)	3160±490.7	3339±474.0	0.00*
Past low bwt (N=161**)	3059±386.8	3378±461.9	0.02*
First antenatal wt <64kg (N=193†)	3144±456.2	3485±484.2	0.00*
Last antenatal wt <70kg (N=193†)	3132±428.0	3476±501.5	0.00*
Antenatal wt gain <6kg (N=193†)	3190±431.0	3426±524.1	0.01*
Sex of infant female (N=377)	3185±439.9	3327±519.0	0.01*
Malaria prophylaxis (N=377)	3261±493.7	3264±472.4	0.68
Maternal height <150 cm (N=347)	3068±397.4	3282±491.4	0.09
Lowest antenatal Hb <8g/dl (N=355)	3151±429.9	3279±489.9	0.38

K-W H = Kruskal-Wallis H test
*Significant **Nulliparae excluded
†Includes only subjects with booking weight at ≤26wks and last weight at ≥37wks
Bwt=birth weight

In univariate analysis, the following showed significant association with low birthweight: lowest antenatal haemoglobin concentration recorded during pregnancy was <8.0g/dl, mother never been to school, no malaria chemoprophylaxis during index pregnancy, past delivery of a low birthweight infant, nulliparity, and no antenatal care (Table 4). However, when these variables were included in a multiple logistic regression model, only lack of antenatal malaria chemoprophylaxis and previous low birthweight remained significant.

Table 4

Low birthweight by characteristics which showed significant association in univariate analysis

Variable	Proportion of low bwt in Yes & No groups of variable		OR (95% CI)	M-H p
	Yes	No		
Lowest Hb <8.0g/dl	23.5% (12/51)	10.8% (70/647)	2.54 (1.19-5.34)	0.007
Ever been to school	11.8% (84/710)	20.0% (31/155)	1.86 (1.15-3.02)	0.007
Nulliparity	16.2% (63/390)	10.9% (52/476)	1.57 (1.04-2.58)	0.024
Antenatal care	12.4% (101/814)	26.9% (14/52)	0.38 (0.19-0.77)	0.003
Previous low bwt	23.1% (9/39)	7.8% (22/282)	3.38 (1.30-8.63)	0.004*
Malaria prophylaxis	9.1% (52/574)	21.3% (60.281)	0.37 (0.24-0.56)	0.000*

Bwt = birthweight OR=Odds ratio CI=confidence interval
M-H p=Mantel-Haenszel chi square p value
*Variables that remained significant in multiple logistic regression analysis

Table 5

Univariate analysis of delivery gestational age and variables that showed a significant association with mean birthweight in reliable dates subjects

Variable	Yes Mean±SD	No Mean±SD	K-W H p value
Schooling (N=461)	38.7±2.24	37.9±2.45	0.02*
Past low birthweight (N=193**)	37.9±2.01	38.8±2.03	0.03*
Grand multiparity (N=461)	38.0±1.53	38.7±2.29	0.04*
Maternal height <150cm (N=426)	37.8±1.61	38.6±2.32	0.02*
Lowest Hb <8g/dl (N=431)	38.7±1.67	38.7±2.17	0.70
Malaria prophylaxis (N=460)	38.8±1.99	38.1±2.96	0.29
Antenatal care (N=461)	38.7±2.15	33.3±6.70	0.09
Sex of infant male (N=461)	38.5±2.53	38.8±1.90	0.75

*Significant **Nulliparae excluded
†Only four subjects did not have antenatal care

Gestational age at delivery and selected maternal characteristics (Table 5): Mean delivery gestational age was significantly lower in the presence of the following subject characteristics: never been to school, previous delivery of a low birthweight infant, not a grand multipara, and height <150cm. There was no significant association between gestational age at delivery and the remaining variables that were associated with mean birthweight.

DISCUSSION

It is generally accepted that mean birthweights vary across countries, and in the same country, they vary between different racial and ethnic groups. Mean birthweights are higher in the developed world than in the tropical developing countries. In the USA, the mean birthweight at 40 weeks is 3335g with a range of 3280 to 3400g. White babies at term weigh more than black babies, the birthweight of blacks being 200-250g lower than the birthweight of whites(4). In the UK the mean birthweight at term was 3450g(2). At University College Hospital, Ibadan, Nigeria, the mean birthweight was 3150g for males and 2950g for females(5). At the Jos University Teaching Hospital, also in Nigeria, the mean birthweights for male and female infants were 3203±350g and 3186±338g respectively(6). The Jos study however, excluded birthweights less than 2500g. In Zaria, Nigeria, the mean birthweight was 3042g(7). The mean birthweight of 3262g for our subset with reliable dates who reached term is very similar to the 3251g found in Port Moresby, Papua New Guinea(8), but lower than the figures for the USA and the UK. The mean birthweight for our total sample was 3070g, which is similar to the Zaria figure.

In 1980, WHO estimated the global rate of low

birthweight to be between 17% and 18%, with rates in the developing world ranging as high as 10%-30%, and rates in the developed world as low as 3%-8%(9). In 1987 in the USA, the incidence of low birthweight was 6.9% of live births, with the approximately 12% rate in African-Americans twice the rate in whites. The preterm delivery rate was 10.1%, with 17.8% for African-Americans and 8.5% for whites(10). The low birthweight rate in our total sample was 13.3%, a rate not very different from that in African-Americans. Among our 461 infants with reliable dates, the preterm rate was 9.1%, half the rate in African-Americans. In 1995, Airede reviewed the literature on birthweight in Nigeria up to that date and found the incidence of low birthweight to range from 14.6% to 21.3%(11).

The relationship between schooling and birthweight is well known(10) and was found in this study; those who had never been to school had a significantly lower mean birthweight. When birthweight was examined as a categorical variable, that is, low birthweight (yes, no), the association with schooling was again significant. Many studies have found the <18year and the >35year olds to have a higher risk of low birthweight (4,10-13). Although the mean birthweight of our <18year olds was lower, the difference was not significant (p=0.057); but surprisingly, the >35year olds had significantly heavier babies than those younger (p=0.020).

As was found in this study, first babies are known to be lighter than later babies, at least through Para 2-3(10); height and birthweight are also associated(2).

Past delivery of a low birthweight infant is an independent predictor of low birthweight in the index pregnancy(2) The relationship was demonstrated in this study; and also when birthweight was treated as a continuous variable.

To test if infants with the significant characteristics were smaller because they were born at earlier gestational ages, we used the subgroup with reliable dates to compare the mean delivery gestational ages of subjects with and without these characteristics. Subjects who had never been to school, subjects with a previous history of low birthweight, and subjects who were less than 150cm in height had significantly lower mean gestational ages. This would suggest that delivery at an earlier maturity could at least in part, explain the smaller mean birthweight in women with these three characteristics. It was interesting to find that the grand multiparae also had a significantly larger mean gestational age. The difference of 0.7weeks was, however, small. Pre-pregnancy weight and antenatal weight gain have a positive association with birthweight(4,14-17). Maternal weight gain accounts for the largest proportion of variation in infant birthweight among term infants(4). In developed countries, a pre-pregnancy weight of more than 50kg and a mean weight gain of 12kg are regarded as normal. In a prospective study of normal singleton pregnancies followed from the first trimester till delivery at term in Ibadan, Nigeria, mean maternal weight gained was found to be 13.3±4.56kg. All mothers who gained <5kg had low birthweight babies. No mother who gained ≥5kg had a low birthweight baby and no mother who gained ≤10kg delivered a macrosomic baby(17). The Institute of Medicine, USA, recommends that women with lower pre-pregnancy body mass indices should strive for larger weight gains(14). In a study of high-risk multiparous African-Americans and white women, the infants of the African-Americans showed a consistent increase in birthweight and a consistent decrease in fetal growth retardation as maternal weight gain met and exceeded the Institute of Medicine recommendations(15). We chose the thresholds of 64kg for the booking antenatal weight, 70kg for the last antenatal weight, and 6kg for antenatal weight gain because a study in our institution showed these to be the median values for these variables.

It was impossible to examine weight gain satisfactorily in the present study because pre-pregnancy weight was not known and only a few of our patients booked in the first trimester. To reduce the confounding effects of varying gestational age at booking and of delivery at different gestational ages, the analysis was restricted to those who booked at ≤26 weeks and delivered at >37 weeks. In this sub-sample, first antenatal weight <64.0kg, last antenatal weight <70.0kg, and antenatal weight gain <6.0kg were associated with significantly lower mean birthweights.

Numerous studies have established that a short birth interval, (that is, interval <2years), is an independent risk factor of low birthweight(18,19). The association was not demonstrated in the present study.

Other variables which are known to have a positive association with lower birthweight but which association could not be shown in this study included: grand multiparity, slum residence, previous induced abortion, previous spontaneous abortion, past perinatal death, clinical malaria, and alcohol. The last could be because not many of our women drink and those who do, are only social drinkers. Only 13 out of 864 subjects admitted to drinking alcoholic beverages daily.

Non-use of antenatal malaria prophylaxis and lowest haemoglobin value recorded during pregnancy was <8g/dl were associated with delivery at significantly earlier gestational ages and with lower birthweight. It is well known that chronic anaemia and malaria are associated with low birthweight(20,21). Placental parasitisation with clogging of the intervillous space would reduce intervillous blood flow(20). In a study in Madang, Papua New Guinea, Brabin *et al*(21) found a significantly increased risk of low birthweight for primigravidae with haemoglobin levels below 8g/dl and parasitaemia in the first trimester. However, in this study, clinical malaria by itself did not show any effect on birthweight. This could be because the numbers were too small and most of our subjects booked after the first trimester.

Happily, only 0.5% (4/865) of subjects admitted they smoked. The number was too small to allow examination of this variable that has been repeatedly shown to cause low birthweight and other adverse effects in the baby.

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