

Factors Associated with Placenta Weight and Placental Weight/Birthweight Percent (Placental Ratio) among Mothers in Ilesa, Southwestern Nigeria

¹O.J. Adebami, ²J.A. Owa and ²G.A. Oyedeji

¹Department of Paediatrics and Child Health,
Ladoke Akintola University of Technology, Teaching Hospital, Osogbo, Nigeria

²Department of Paediatrics and Child Health,
Obafemi Awolowo University, Ile-Ife, 220005, Nigeria

Abstract: The aim of the study is to determine birth weights, placental weight and Placental to Birth Weight Percentages (PBWP) in consecutive, live singleton term births and study their relationship with some maternal and foetal factors. Subjects were mothers of consecutive, live, singleton, full term neonates delivered at the Wesley Guild Hospital, Ilesa, Nigeria between January and August 2002. Each placenta was weighed and the placental to birth weight percent was calculated. The socio-economic classes of the parents, nutritional status of the mothers using the Body Mass Index (BMI), age and parity of the mothers, gestational ages of the babies derived from the mothers LMP and/ or Dubowitz score, as well as the weight and ponderal index of babies were all recorded. Foetal malnutrition/wasting was diagnosed using Clinical Assessment of Foetal Nutritional Status (CANS) and the score (CANSORE) as adapted by Metcalf. The mean placental weights were examined in relation to maternal age, BMI, parity and socioeconomic class and the babies ponderal index, birth weight, length, occipitofrontal circumference and presence or absence of Foetal Malnutrition (FM). A total of 473 mothers and their babies were assessed. These babies consisted of 246 [52%] males and 227 [48%] females giving a male: Female ratio of 1.08:1. The placental to birth weight percent (placental ratio) ranged between 17.8 and 18.7% with a mean of 18.4%. The mean placental weight for males was significantly higher than for females 577.44 (SD130.58)g versus 551.94 (SD108.62)g, $t = 2.3$, $p < 0.025$. The mean placental to birth weight percent for males and females were 18.2 and 18.5%, respectively. Younger aged mothers, low BMI ($< 18.5 \text{ kg m}^{-2}$), low socioeconomic class (III-V) and lower parity (I and II) mothers had lower placental. Female sex, low birthweight babies, presence of Foetal Malnutrition (FM) and low ponderal index ($< 2.32 \text{ g cm}^{-3}$) babies had significantly lower placental weight than otherwise ($p < 0.05$ at least). The estimates of regression coefficients distribution for the variables also show that high Placental to Birth Weight Percentage (PBWP) has significant independent effects on the presence of low birth weight at term, low ponderal index and presence of severe birth asphyxia. Placental weight and placental to birth weight percent are therefore, useful in the identification of babies at risk of foetal malnutrition. Low placental weight and foetal malnutrition may have similar aetiopathogenesis. Further study of the placentas may therefore, give information which may be useful in preventing these complications.

Key words: Placenta weight, placental to birth weight percent (placental ratio), foetal malnutrition, Nigeria

INTRODUCTION

The placental organ is genetically and biologically part of the fetus (Pepe and Albrecht, 1995; Saji *et al.*, 1994; Assali, 1989). It has metabolic, endocrine, immunogenic functions and also forms a barrier, the placental barrier filtering noxious substances from the baby. Many abnormalities in the babies have been traced to problems in the placenta. The gross examination of and especially the weight of the placenta has been found to be relevant as a source of immediate information in the

delivery room for the Paediatrician on the intrauterine wellbeing of the baby (Peltonen and Peltonen, 1976). Placental weight is also known to have a direct relationship with birth weight (Thomas *et al.*, 1969). This shows that what affects the placenta is also likely to affect the baby. As with the baby the integrity of the placenta is subject to numerous pathological processes that may make it less efficient and so disturb or impair the growth and development of the fetus (Las Heras, 1978; Lao, 1998). There is however, no consensus on the role of routine histological examination of the placentas

especially in low-risk term pregnancies. More than 80% of such placentas have been reported to be found histologically normal (Ventolini *et al.*, 2004).

Some cohort studies have shown evidence of a correlation between placental weight and placental to birth weight percent and future chronic diseases notably hypertension and diabetes mellitus in adult life (Barker *et al.*, 1990; Burkhardt *et al.*, 2006; Williams *et al.*, 1997; Little *et al.*, 2003). Even though, the relationship between the placental weight and placental weight to birthweight percent (placental ratio) has been well studied among the Asians, Europeans and Afro-Americans (Perry *et al.*, 1995) this has not been the case in the sub-Saharan Africa. As birth weight varies from one community to another, so also placental weight and placental weight to birth weight percent is expected to vary Perry *et al.* (1995). Racial and ethnic variations in the placental weight and placenta birthweight percent have been observed by previous authors Perry *et al.* (1995). The present study is therefore, to access the placental weight and its relationship to birth weight and some other fetal factors and examine the roles of maternal factors of age, parity, socioeconomic factors and Body Mass Index (BMI) on placental weight.

MATERIALS AND METHODS

Before the commencement of the study, clearance was obtained from the hospitals ethical committee. Informed consent was also obtained from the parents of each baby. Permission as well as cooperation was obtained from the consultants and the nursing staff of the maternity and neonatal units. From January 1st 2002-August 31st 2002, the placentas obtained from pregnancy of consecutive, singleton, term (37-42 weeks gestation) live birth, neonates delivered at the maternity unit of the hospital were collected and assessed. Excluded from the study were placentas of mothers of post-term babies (> 42 completed weeks), preterm babies (<37 weeks), incomplete placentas and term babies with obvious congenital malformations and stigmata of chromosomal anomaly.

Each placenta was held by the cord under running water to wash off the blood smears and clots. The foetal surface was examined for: Colour, insertion of the cord, distribution of the blood vessels, number of blood vessels in the cord, state of membrane and presence of deposits/infarcts. The chorion was stripped from amnion and the maternal surface was then examined for: Colour, completeness of cotyledons and any abnormality. Each complete placenta was weighed in grams to the nearest 10 g.

Maternal data, including name and age, hospital number, date of Last Menstrual Period (LMP), parity,

place of Antenatal Care (ANC), number of clinic attendances, duration of pregnancy and the gestational age at booking were recorded. Any maternal illness and time of illness during pregnancy, especially, anaemia, malaria, pregnancy induced hypertension, ante partum haemorrhage, diabetes mellitus, history of rash or jaundice was recorded. Drugs taken during pregnancy, exposure to irradiation and the details of the past medical history and of cigarette smoking were documented. Nutritional status of the mother was determined by calculating the Body Mass Index (BMI). $BMI = \text{Weight (kg)} / \text{Height (m)}^2$. When BMI was less than 18.5 Kg m^{-2} , mother was classified as underweight or malnourished (Waterlow, 1989).

The socio-economic class of the parents was assessed based on occupation and educational levels attained by both parents as described by Oyedeji (1985).

All the neonates had complete physical examination noting the temperature, activity, presence of congenital anomaly and stigmata of chromosomal disorder. The Gestational Age (GA) in weeks was determined using the mother's date and Dubowitz gestational assessment chart which has been found reliable in Nigerian neonates (Brueton *et al.*, 1973; Dawodu and Effiong, 1977). Where there was a discrepancy of more than 2 weeks, 'Dubowitz' score was used Brueton *et al.* (1973).

Anthropometric data: Birthweight, length and mid upper arm circumference of each baby were measured. The nutritional status of each baby was also assessed using the Clinical Assessment of Fetal Nutritional Status (CANS) and the score (CANSORE) as described by Metcoff (1994). The placental to birth weight percent was calculated by dividing the placental weight by the birthweight percent (Lao, 1998; Burkhardt *et al.*, 2006; Little *et al.*, 2003; Perry *et al.*, 1995).

Data obtained were analyzed using SPSS for Windows version 11. Means and standard deviations were determined for continuous variables like weight, length and chest circumference. Proportions and percentages were compared using chi-square (χ^2) test. P values, <0.05 was taken as statistically significant. Multiple linear regression analysis was also used to determine the independent effects of each of the maternal and foetal factors on the weight of the placenta and placental to birthweight percent.

RESULTS

Placenta, placental weight, placental to birth weight percent and maternal factors: Four hundred and seventy three placentas of consecutive, singleton, term live babies who met the inclusion criteria were studied. The weights of the placenta ranged from 250-1250 g with the mean of $565.20 \pm 121.088 \text{ g}$.

Table 1: The mean birth and placental weights and mean placental to birth weight percent according to the sexes at different gestations

Gestational age (weeks)	Males			Females			PBW
	N	Mean birth Weight±SD (kg)	Mean placental Weight (g)	N	Mean birth Weight±SD (kg)	Mean placental Weight (g)	
37	21	2.95±0.43	507.14±124.79	32	2.80±0.44	519.05±80.38	18.5
38	74	3.05±0.47	559.32±119.26	61	2.92±0.44	540.98±114.13	18.5
39	64	3.05±0.47	604.06±148.99	55	3.04±0.50	559.09±109.38	18.4
40	48	3.23±0.58	595.83±108.19	44	3.02±0.43	571.59±96.45	18.9
41	21	3.26±0.55	578.10±141.58	22	3.07±0.47	561.62±141.34	18.3
42	18	3.34±0.50	589.44±129.73	13	3.18±0.46	570.77±111.91	17.9
Total	246	3.17±0.52	577.44±130.58	227	2.98±0.46	551.94±108.62	18.5

For weight: $t = 4.3$, $p = 0.00001$ when males are compared with females, For placenta, $t = 2.3$, $p = 0.022$ when males are compared with females, PBW = Placental weight over birth weight percent (Placental ratio) $p > 0.2$

Table 2: Analysis of variance table to test the effect of gestational age on placental weight

Source of variation	Sum of Square	Degree of freedom	Mean square	F	Sig
Between group	245663.6	5	49132.72	3.437	0.005
Within group	667494.2	467	14293.24		
Total	6920606.6	472			

Table 3: The relationship of Mean Placental Weight (MPW), mean birth weight, placental to birth weight percent and the maternal factors

Variable	No of Subjects n	Mean placental weight±SD(g)	Mean birth weight±SD(g)	Placental to birth weight (%)
Maternal age				
<18 years	6	541.67±188.19	2533±520	21.4
18-34	380	564.42±123.69	3087±501	18.3
35- 45	87	570.23±104.54	3081±496.	18.5
BMI				
<18.5kg m ⁻²	10	530.00±94.87	3015±423	17.6
≥18.5kg m ⁻²	459	565.10±121.34	3080±507	18.3
Socioeconomic				
Class I-II	129	581.78±119.82	3192±571	18.2
Class III-V	344	558.98±121.15	3037±470	18.3
Parity				
1and2	265	553.36±125.62	3017±472	18.3
3and4	143	582.62±115.17	3186±544	18.3
≥4	65	575.38±110.70	3098±501	18.6

There were 246 [52.0%] males and 227 [48.0%] female babies giving a male: Female ratio of 1.08:1. Table 1 shows the Mean Placental Weight (MPW) and Placental to Birth Weight Percent (PBWP) in relation to the gestational age. While the birthweight increases progressively with gestational age, MPW and PBWP form a bimodal pattern with peak value at 40 week. The placental to birth weight percent (placental ratio) also ranged between 17.8% and 18.7% with a mean of 18.4%. Also, the mean placental weight for males was significantly higher than for female 577.44 (130.58) versus 551.94 (108.62) $t = 2.3$, $p = 0.02$. The mean placental to birth weight percent for males and females was 18.2 and 18.5%, respectively. There was no significant difference in the placental to birth weight percent ($p > 0.2$). Table 2 shows analysis of variance to test the effect of gestational age on placental weight. It indicates that placental weight varies as the gestational age.

Table 3 shows relationship between maternal factors and mean placenta weight. Though, younger aged mothers, low BMI (<18.5kg m⁻²), low socioeconomic class (III-V) and lower parity (I and II) mothers had lower placental weight, it is not at a statistically significant level.

Table 4: Relationship between foetal factors and mean placenta weight

Variable	No of subjects n	Mean placental weight (g)	SD	p-value
Sex				
Male	246	577.44	130.58	
Female	227	551.94	108.62	<0.05
Weight for GA				
<2.50kg	53	450.94	108.97	
≥2.50kg	420	579.62	114.82	<0.001
FM				
FM+	89	476.29	124.80	
No FM	384	585.81	110.58	<0.001
Ponderal index				
<2.32g cm ⁻³	95	507.68	108.70	
≥2.32g cm ⁻³	378	579.66	119.87	<0.001
Severe asphyxia				
<4 at 1min	43	563.40	122.60	
≥4 at 1min	430	583.26	104.31	NS

FM = CANSCORE <25; No FM = CANSCORE = 25. FM = Foetal Malnutrition, SD = Standard Deviation, GA = Gestational Age

Except for the younger age mothers with significantly higher placental to birth weight percent of 21.4%, the PWR was relatively constant irrespective of socioeconomic class, BMI, parity and presence of malaria parasite in the placentas.

Table 4 shows the relationship between fetal factors and mean placental weight. Female sex, low birthweight

Table 5: The relationship between Mean Placental Weights (MPW), mean birth weight, placental to birth weight percent and the foetal factors

Variable	No of Subjects n	Mean placental weight±SD (g)	Mean birth weight±SD (g)	Placental to birth weight(%)
Sex				
Male	246	577.44±130.58	3173±523	18.2
Female	227	551.94±108.62	2977±461	18.5
Weight for GA				
<2.50kg	53	450.94±108.97	2264±162	19.9
≥2.50kg	420	579.62±114.82	3181±434	18.2
FM				
FM+	89	476.29±124.80	2598±446	18.3
No FM	384	585.81±110.58	3191±448	18.4
Ponderal index				
<2.32g cm ⁻³	95	507.68±108.70	2634±374	19.3
≥2.32g cm ⁻³	378	579.66±119.87	3131±470	18.5
Severe asphyxia				
<4 at 1min	43	583.26±104.31	3056±487	19.1
≥4 at 1min	430	563.40±122.60	3081±506	18.3

FM = CANSCORE <25; No FM= CANSCORE =25. FM= Foetal Malnutrition

Table 6: Estimates of regression coefficients in the multivariate analysis of placenta birthweight percent distribution

Variable	Regression coefficient (B)	Standard error of B	F-ratio	Significance
Maternal				
Parity	0.0598	0.355	0.028	NS
Maternal BMI (kg m ⁻²)				
-0.357	0.857	0.174	NS	
Maternal age(years)	0.08615	0.401	0.046	NS
Maternal socioeconomic status	0.177	0.368	0.232	NS
Fetal				
Baby sex	0.412	0.327	1.586	NS
Weight for gestational age				
<2.50kg ; >2.5kg	-1.596	0.514	9.631	S
FM	0.035	0.419	0.007	NS
Ponderal index g cm ³	-2.090	0.507	16.992	S
Severe birth asphyxia				
(Apgar score <4 at 1min)	-0.796	0.332	5.752	S

Key: S= Significant at 5% probability level, NS= Not Significant at 5% probability level. BMI= Body Mass Index, FM= Foetal Malnutrition

babies, presence of Foetal Malnutrition (FM) and low ponderal index (<2.32g cm⁻³) babies had significantly lower placental weight than otherwise (p<0.05 at least).

Table 5 shows the relationship of Mean Placental Weight (MPW), Mean Birth Weight (MBW), Placental to Birth Weight Percent (PBWP) and the fetal factors.

Table 6 shows the estimates of regression coefficients distribution for the variables. It shows that high Placental to Birth Weight Percent (PBWP) has significant independent effects on presence of low birth weight at term, low ponderal index and presence of severe birth asphyxia.

DISCUSSION

The findings in the present study suggest that significant information about the health of the baby can be obtained from the weight of the placenta. The mean placental weight and Placental to Birth Weight Percent (PBWP) in the present study was 565.2g and 18.4% respectively. The mean weight of 565.2g recorded in the present study is higher than 470g recorded among the Americans Little *et al.* (2003) 519 g in Thailand

Janthanaphan *et al.* (2006) and 537g in Mexico Sanin *et al.* (2001) but lower than 646.2g among the Chinese Burkhardt *et al.* (2006). Placental weight is known to vary from region to region (Perry *et al.*, 1995). Placental weight was found to be lower among the Asians than the Europeans and Afro-Caribbean women (Perry *et al.*, 1995) and the increased placental weight found in the present study may be due to racial variation. Large placentas have been known to be associated with maternal anaemia (Lao and Wong, 1997; Wingerd *et al.*, 1976) diabetes mellitus (Naeye, 1987; Clarson *et al.*, 1989) Syphilitic or parvovirus B19 infection in pregnancy Lao (1998).

Also, the placental to birth weight percent of 18.4 in the present study is higher than 13.6% among the Ukraine women Little *et al.* (2003), 17.08% in Thailand Janthanaphan *et al.* (2006) and 17.6% in China Burkhardt *et al.* (2006). The reason for increased placental to birth weight percent in the present study can readily be understood since birth weight varies in these regions. While the mean birthweight in the present study was 3.079 kg, mean birthweight was 3.369 kg in Mexico Sanin *et al.* (2001) and 3.235 kg in China Burkhardt *et al.* (2006). Lower birthweight and increased placental weight

as obtained in the present study will give rise to increased placental to birth weight percent. Increased placental to birth weight percent has been described as an adaptative process by the feto-placental unit in an unfavourable maternal environment Lao (1998). Where there is limitation imposed on the fetal growth velocity due to nutritional deficiencies, the placental hypertrophy may occur in response to fetal or placental hypoxia Lao (1998). Therefore, an increased placental to birth weight percent could be a sign of fetal growth disturbance, for example, increased placental to birth weight percent has also been associated with maternal smoking (Wingerd *et al.*, 1976) and residence in higher altitudes through the mechanism of fetal hypoxaemia and resultant placental hypertrophy (Clarson *et al.*, 1989). None of the mothers in the present study smoked. Racial difference is a possible explanation. However, residence in high altitude has not been controlled for Perry *et al.* (1995). Perry *et al.* (1995) did not find racial difference in placental to birth weight percent among Asian, European and Afro-Caribbean women.

In relation to gestational ages, the placental weight and placental to birth weight ratio has a bimodal appearance, peaking at 39 weeks for males and 40 weeks for females. Little *et al.* (2003) and Dombrowski *et al.* (1994) also found that placental to birth weight percent increases with gestational age, up to gestational age of 40 weeks in a Thailand study Dombrowski *et al.* (1994). The present finding of decrease in placental weight after 40 weeks may also be due to progressive aging of the placentas.

In the present study, even though, young mothers (<18 years), low BMI (<18.5 kg m⁻²), low socioeconomic groups III to V and early parity of 1 and 2 had lower placental weight and birth weights than mothers not so affected, the differences in placental weight were not at a statistically significant level as those in the birth weights. However, the placental to birth weight percent appears relatively constant. One of the limitations in the use of placental weight in assessing fetal well being is the fact that it may be constant where the dependent factors of placental weight and birthweight vary in same direction (Saji *et al.*, 1994) the value may remain constant viz a viz, a small placenta and small baby or a big placenta and big baby may give similar value.

Fetal factors found in the present study to be significantly associated with reduced placental weights were female sex, low birthweight, presence of foetal malnutrition, low ponderal index. These findings suggest that the causes of intrauterine malnutrition may also affect the placenta. Presence of relatively smaller placenta in low birthweight babies and those with foetal malnutrition could be inferred since placenta is the major metabolic

organ in utero Lao (1998). Compromised placenta may result in wasting in the babies even though the detailed histologic examinations of the placentas were not done in the present study. William's *et al.* (1997) found placental weight to vary with the sex of the baby as we also have found in the present study. They did not observe any difference between the placental weight and some anthropometrics like ponderal index and birth weights. Male sexes are known to be heavier than female (Feleke and Enquoselassie, 1999; Larry, 1977; Lo *et al.*, 2002) due to non-defined influence of the Y chromosome. However, presence of birth asphyxia was not significantly associated with varying placental weights as previously reported by others BMJ Editorial (1997). Also, the observation by William's *et al.* (1997) that placental weight may not be an accurate marker of foetal growth may be plausible in view of the many interwoven factors associated with intrauterine nutrition in babies. Again, we find that the hypothesis surrounding foetal malnutrition and placental weight variation in the development of chronic diseases like hypertension, ischaemic heart diseases, coronary heart diseases, non-insulin dependent diabetes mellitus, chronic obstructive air-way diseases, high plasma concentration of the haemostatic factor and autoimmune thyroid diseases in later life (Barker *et al.*, 1990; Stephanie *et al.*, 1997; Barker *et al.*, 1989) are similar. Could it be that foetal malnutrition and placental abnormalities have similar pathogenesis? Therefore, more detailed study on the placenta may give more information on the pathogenesis of some problems in the newborn.

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