

Original Article

Relationship between placental weight, birth weight, maternal biosocial characteristics and placental-to-birth-weight ratio

Abiodun S. Adeniran, Kikelomo T. Adesina, Grace G. Ezeoke, Adegboyega A. Fawole,
Abiodun P. Aboyeji, Munirdeen A. Ijaiya

*Obstetrics & Gynaecology Department, University of Ilorin/ University of Ilorin Teaching Hospital,
Ilorin, Nigeria.*

ABSTRACT

Background: The placental weight is routinely measured at birth and its relationship to birth weight and maternal biosocial characteristics can provide information on both neonatal and maternal health status.

Aim: To determine the relationship between placental weight (PW) at birth, birth weight (BW), maternal biosocial characteristics and placental-to-birth-weight ratio (PBWR) as well as generate a reference range in an African population.

Methods: A cross-sectional study involving parturient who had singleton deliveries at ≥ 32 weeks gestation with comparison of maternal biosocial parameters, PW, BW and PBWR. Deliveries < 32 weeks gestation, multiple gestation and incomplete placenta were excluded from the study. Data was retrieved from the institutional birth registry; data management included determination and comparison of mean values and ratio of individual parameters using SPSS version 21.0.

Result: Among the 8645 participants, the mean PW was 589.2 ± 146 g and it increased with maternal age.

The mean BW increased with maternal age with a decline from 35 years while PBWR declined until age 30 years with a rise afterwards. The mean PW increased with parity, the BW increased till the fourth delivery when it began to decline but PBWR did not follow a regular pattern with parity. The PW and BW increased with gestational age while PBWR increased till 36th week, declined from 37th to 42nd week with a rise from 43rd week. The mean PW and BW increased with maternal educational status while booked participants had higher PW and BW but lower PBWR compared to unbooked women.

Conclusion: The placental weight is a central index for the interpretation of measurements at birth and the relationship to maternal biosocial characteristics; therefore, reference ranges should be generated for various populations.

INTRODUCTION

Available routine data at delivery include maternal biosocial characteristics, birth weight (BW) and placental weight (PW). The human placenta is responsible for promoting pregnancy and foetal development by facilitating materno-foetal transfer of food and nutrients.¹ At term, the placenta is a round disc-shaped organ of 22 cm in diameter, central thickness 2.5 cm and weighs 450-500 g although the weight varies with the mode of delivery.² The placenta physiology, function and

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Corresponding author:

Abiodun Adeniran
Obstetrics & Gynaecology Department,
University of Ilorin PMB 1515, Ilorin, Nigeria.
Tel: +234 805 753 4788
E mail: acrowncord@hotmail.com

weight can be a reflection of the maternal nutrition, foetal growth status and effect of environmental stressors.^{3,4} The placental and foetal weights are affected by maternal or foetal disorders including maternal severe anaemia, hypertension and foetal hydrops among others; thus it may be an indicator for the presence of these and other complications.⁵ A relationship has been established between placental and birth weight with chronic diseases such as hypertension and diabetes in later life.⁶ However, although PW at delivery is routinely measured and documented, the interpretation and evaluation for foetal weight abnormalities and probable risk for chronic diseases in later life is rarely explored.⁷ Therefore the value of placental and birth weights as well as the relationship to a reference range provides a reference for comparison to detect abnormalities in a particular population.⁶

In a longitudinal study from Northern Finland, there were significant positive associations between placental size (weight, surface area and placental-to-birth-weight ratio) especially increased PW and mental health problems i.e. probable psychiatric disturbance and antisocial behavior among boys at age 8 and 16 years of life.⁸ There have been suggestions that the placenta may be significant in translating maternal influences to the foetus in-utero which may affect the development and adult life.⁹ Also, evidence suggests that the placenta responds to alterations in the maternal environment with structural and functional adaptations including changes in placental growth.¹⁰ Alterations in foetal nutrient and hormone supply can result in abnormal placental growth which may cause adaptations in the foetus with a risk for developing diseases in adult life.¹¹ Comparison of PW and its relationship to BW based on trimmed, formalin-fixed placentas have been described as inaccurate for routine delivery room interpretations and practical delivery room application.⁶ In clinical practice, weights of placentas are derived from fresh, wet, placenta without trimming of the membranes and umbilical cord; for the purpose of establishing population reference scales therefore, fresh PW in unselected

population are preferred.¹² A 45-year longitudinal follow up study from birth to adulthood reported that PBWR was positively associated with cardiovascular disease mortality later in life with disproportionately large placenta relative to birth weight being associated with increased risk of cardiovascular deaths.¹³ While such longitudinal studies are unavailable in low-income countries, a starting point will be the generation of population reference ranges as a baseline for further studies.

In low-income countries, the importance of routine birth measurements is mostly limited to identification of low birth weight and macrosomic babies. There is sparse information on the relationship between the placental-to-birth-weight ratio (PBWR), as well as the correlation between PW and maternal biosocial characteristics; population reference scales are unavailable while available studies contain comparable small sample size.

The study aimed to establish a reference range of PW and BW across gestational ages for the study population, the PBWR as well as the relationship of the PW to maternal biosocial characteristics.

METHODS

The study was a cross-sectional study conducted at the University of Ilorin Teaching Hospital (UITH), Ilorin, Nigeria. Participants were women who delivered at the facility over a ten year period while the study data was obtained from the birth registry of the hospital which contains details of all deliveries conducted at the centre. The inclusion criteria were singleton pregnancies delivered at ≥ 32 weeks of gestation with available records in the institutional registry. The exclusion criteria included multiple gestation, congenital anomaly at birth and missing data for gestational age at delivery, BW or PW. Also, deliveries where PW was not measured or deemed inaccurate due to presence of morbidly adherent placenta, placenta praevia, incomplete placentas and those requiring uterine curettage after delivery were excluded from the study. The institutional protocol involves measurement of PW immediately after

delivery using standardized computerized weighing scale together with the membranes and umbilical cord after removing obvious blood clots to verify completeness. The BW was measured immediately after delivery using standardized computerized infant weighing scale.

After calculation of the mean values for placental and birth weight, the PBWR was calculated as the ratio of PW to BW multiplied by 100.⁶ Institutional ethical approval for the study was obtained from the ethical review committee of the University of Ilorin Teaching Hospital (UITH) before commencement of the study. The data was analyzed using Statistical Package for Social Sciences (SPSS) version 21.0 and presented in tables of mean values for comparison.

RESULTS

There were 8645 participants in the study and the mean PW was 589.2±146g. From table 1, the mean PW increased with maternal age being lowest for teenagers (535±132g) and it was lower for women <35years (560g±113g vs. 580±370g) compared to those ≥35years old. The mean BW increased with maternal age with a decline from ≥35years. There was a gradual decline in the mean placenta-to-birth-weight ratio (PBWR) until age 30years when it began to increase; however, the PBWR was higher for women <35years (18.0 vs.18.5) compared to those ≥35years. The mean PW increased with parity (except for para 4 women) while the mean BW increased gradually up to the fourth delivery when it began to decline. However, the PBWR did not follow a regular pattern although it was lowest for fourth delivery 4 (17.6) and highest for the seventh delivery (37.6). The PW increased gradually with gestational age from 442±154g at 32weeks to 626±366g at 44weeks gestational age. The BW increased with gestational age while the PBWR increased with gestational age till the 36th week, declined from 37th to 42nd week with a gradual rise from 43rd week of gestation. The mean PW and BW increased with the level of formal education;

however, the PBWR was highest for women with secondary (18.6) and lowest for tertiary (17.6) education. The mean PW was higher for booked (596±112g vs. 575±217g) compared to unbooked women; the mean BW was higher for booked women (3341±392g vs. 3056±457g) while the PBWR was lower for booked (17.8vs. 18.8) compared to unbooked women.

Table 2 represents a reference range for the study population with the median (50th percentile), the 5th percentile as well as 95th percentile for gestational ages 32 to 44 weeks for the PW, BW and PBWR for population comparison. PW measurements beyond the 95th percentile represent the limit that requires individualized neonatal follow up.

Table 1: Relationship between maternal biosocial characteristics, placental and birth weight

Parameter	Frequency (%)	Mean Placental weight (g) (SD)	Mean birth weight (g) (SD)	Placental-to-Birth-weight Ratio
Maternal Age				
<20	62 (0.7)	535 (132)	2641 (564)	20.3
20-24	1485 (17.2)	548 (136)	2844 (349)	19.3
25-29	4188 (48.4)	561 (959)	3056 (397)	18.4
30-34	1545 (17.9)	577 (118)	3118 (456)	18.5
35-39	1264 (14.6)	585 (119)	3103 (373)	18.8
=40	101 (1.2)	663 (985)	3031 (583)	21.9
<35	7884 (91.2)	560 (113)	3104 (414)	18.0
≥35	761 (8.8)	580 (370)	3144 (403)	18.5
Parity				
0	3996 (46.2)	552 (102)	2948 (353)	18.7
1	2252 (26.0)	553 (116)	3101 (420)	17.8
2	1078 (12.5)	580 (119)	3114 (419)	18.6
3	502 (5.8)	589 (140)	3117 (548)	18.9
4	682 (7.9)	581 (113)	3295 (404)	17.6
5	83 (1.0)	600 (152)	3194 (498)	18.8
6	36 (0.4)	604 (162)	3127 (661)	19.3
7	16 (0.2)	638 (448)	3028 (757)	37.6
Gestational Age				
32	24 (0.3)	442 (154)	2204 (851)	20.1
33	11 (0.1)	505 (119)	2350 (665)	21.5
34	69 (0.8)	511 (113)	2412 (651)	21.2
35	46 (0.5)	529 (152)	2474 (689)	21.4
36	563 (6.5)	545 (284)	2511 (415)	21.7
37	439 (5.1)	556 (193)	2632 (289)	21.1
38	6351 (73.5)	566 (165)	3069 (409)	18.4
39	902 (10.4)	569 (267)	3261 (389)	17.5
40	57 (0.7)	571 (114)	3487 (440)	16.5
41	35 (0.4)	580 (133)	3507 (468)	16.5
42	37 (0.4)	589 (86)	3544 (362)	16.6
43	85 (1.0)	612 (412)	3588 (314)	17.1
44	26 (0.3)	626 (366)	3604 (409)	17.4
Education				
Primary	1445 (16.7)	546 (138)	3019 (414)	18.1
Secondary	3388 (39.2)	596 (198)	3204 (442)	18.6
Tertiary	3812 (44.1)	615 (105)	3494 (382)	17.6
Booking Status				
Booked	5842 (67.6)	596 (112)	3341 (392)	17.8
Unbooked	2803 (32.4)	575 (217)	3056 (457)	18.8

Table 2: Range for placental weight, birth weight and placental-birth-weight ratio relative to gestational age among participants

GA (weeks)	5 th percentile			50 th percentile			95 th percentile		
	Mean PW g (SD)	Mean BW g (SD)	PBWR	Mean PW g (SD)	Mean BW g (SD)	PBWR	Mean PW g (SD)	Mean BW g (SD)	PBWR
32	200 (150)	1350(690)	0.15	400 (150)	2920 (690)	0.14	750 (140)	3800 (690)	0.19
33	300 (110)	1500(620)	0.20	500 (110)	2600(620)	0.19	700 (110)	3400 (620)	0.21
34	300(110)	2100(560)	0.14	550 (110)	3100(560)	0.18	700 (110)	3600 (560)	0.19
35	300 (140)	2000(530)	0.15	600 (140)	3400 (530)	0.80	720 (140)	3600 (530)	0.20
36	450 (100)	2600(380)	0.17	600 (100)	3300 (380)	0.18	700 (100)	3550 (380)	0.20
37	300(190)	2630(280)	0.12	550(195)	2700(280)	0.20	700 (190)	3450 (280)	0.20
38	400 (180)	2500(380)	0.16	550 (180)	3200(380)	0.17	750 (180)	3700 (380)	0.20
39	400 (80)	2500(390)	0.16	550 (80)	308 (390)	0.18	650 (80)	3500 (390)	0.19
40	400 (120)	2500(340)	0.16	600 (120)	3020(340)	0.20	750 (120)	3700 (340)	0.20
41	380 (130)	2590(450)	0.17	600 (130)	3250(450)	0.19	750 (130)	4050 (450)	0.19
42	420 (90)	2700(370)	0.16	600(90)	3200 (370)	0.20	700 (90)	3900 (370)	0.18
43	500(60)	2700(320)	0.19	560 (60)	3000 (320)	0.18	600 (60)	3500 (320)	0.17
44	500 (70)	2800(440)	0.18	600 (70)	3250 (440)	0.19	800 (70)	4600 (440)	0.17

GA: Gestational age; BW: Mean birth weight; PW: Mean placental weight;

PBWR: Placental-to-birth-weight ratio

DISCUSSION

The mean placental weight for the study was 589.2±46g; it increased with maternal age, parity, gestational age at delivery, increasing level of formal education and was higher for booked participants. The mean birth weight increased with maternal age (with a decline from 35 years of age), gestational age at delivery, and increasing level of formal education and booking status; it increased till the fourth delivery when it began to decline. The mean PBWR increased with maternal age, it was higher for the unbooked patient, it rose then followed a decline with increasing level of formal education, it decreased with gestational age at delivery and did not show a linear pattern with parity

The mean placental weight in the study compares with previous reports of 529±119g,¹⁴ 590±82g,¹⁵ 630g¹⁶ and 657.5±96.1g¹⁷ from Nigeria, 537±96g from Mexico,⁴ 588g from Asia⁶ and 643g from western Europe¹⁸ with a sharp contrast to 384.5±81.6g from India¹⁹ and 470g from Ukraine.²⁰ The variation may be due to genetic factors, variations in study methodology, differences in weighing and cord clamping time as well as some other undetermined factors.¹² However, reports

indicated that dry or wet placental to birth weight ratio can be interchanged due to their high correlation, however wet placental weight was used in the study being the routinely available data in most delivery rooms.¹² Another report concluded that while the blood holding capacity of the placenta and maternal-dietary factors influence placental weight, variations in the hormonal environment in utero as well as pathologic adaptation of the placenta due to racial factors significantly contributed to the size of the newborn baby.¹⁴

In this study, placental weight was lowest among teenagers and increased with maternal age until age 35 years when it began to decline. In a similar study, placental weight increased with maternal age with most low weight placentas recorded among teenage women while another report corroborated an increased placental weight with maternal age until age 35 years when it began to decline.^{14,17} This can explain the adverse pregnancy outcome associated with advanced maternal age and may be attributed to the sub-optimal physiological adaptation to pregnancy manifesting as poorly compliant maternal blood vessels which hinders the formation of a healthy placenta.²¹

Maternal booking status influenced placental weight, birth weight and PBWR in this study. The unbooked women had smaller placenta, lower birth weight and lower PBWR similar to a similar study in Nigeria which recorded lower mean values for placental weight ($664 \pm 495\text{g}$ vs. $751 \pm 213\text{g}$), birth weight ($2545 \pm 982\text{g}$ vs. $3225 \pm 545\text{g}$) and PBWR (4.30 ± 2.29 vs. 4.61 ± 2.00) among unbooked compared to booked women.²² However, another study reported higher mean placental weight for booked women (715.9 ± 204.3 vs. 707.6 ± 111.1).¹⁷ Unbooked women run the risk for pregnancy complications which may not be recognized early nor allow initiation of treatments thereby resulting in feto-placental problems.²³

Placental overgrowth is often a compensatory response to intrauterine insults from maternal problems.^{10,24} It was hypothesized that an enlarged placenta may reduce its nutrient supply to the foetus leading to foetal adaptations that may jeopardize foetal structure and physiology with increased risk for diseases.⁸ Therefore, a large placental size from adverse maternal environment may alter foetal nutrient supply and foetal brain development with risk of psychiatric problems in later life.²⁵ While this may present as high PBWR, compensatory mechanisms may result in the delivery of a normal weight baby. Thus, an enlarged placenta is the strongest predictor of psychopathological disorders and may represent an important link between disturbances in the maternal environment, disturbed foetal brain development and mental disorders in later life.⁸

The increase in placental weight with parity observed in this study corroborates reports of earlier authors; placentas from multiparous women from 32 weeks onwards had been reported to be heavier than those from Primipara.¹⁷ Other authors report a rise in placental weight with parity until the sixth delivery after which it began to decline and an increase in mean placental weight with parity up to the third delivery after which the placental weight began to decline.^{15,14}

The observed increase in placental weight with advancing gestational age may be evidence of development of the foetus and other components. However, the proportional increase in birth weight is greater than that of placental weight; thus, the PBWR decreases with gestational age throughout pregnancy.^{3,5,10,18} In another study, the placental weight increased from $504 \pm 84\text{g}$ at 37 weeks to $631 \pm 55\text{g}$ at 42 weeks while the PBWR reduced from 19.1 to 18.2 although a general increase in birth weight, placenta weight and PBWR with gestational age has been documented.^{5,19} In a population study in Norway, the mean placental weight for gestational age increased from 24 to 42 weeks followed by a decline afterwards which is similar to this study.⁷

The increase in birth weight correlates with increase in placental weight as gestational age advances such that the PBWR serves as a reflection of the balance between foetal and placental growth.¹⁴ Generally, feto-placental weight ratio rises steadily with gestational age with an abrupt decline from 42 weeks gestation as the foetus outgrows the placenta and then a sharp decline from 43 weeks.^{14,15} This shows that prolonged pregnancy represents an increased risk for foetal adverse effects due to placental insufficiency.¹⁵ This information is a guide in planning delivery in pregnant women. A relationship between PBWR has been reported for each gram of placenta weight, but this relationship is not linear due to a higher increase in birth weight relative to placental weight.⁴ Thus, the PWR is a useful marker for foetal nutrition and utero-placental function.²⁶ Reported mean PBWR ranges from 18.2% in Nigeria to 13.9% in Ukraine, 17.08% in Thailand, 19.5% in Asia and 20.0% in western Europe.^{15,20,21,6,18}

There has been a concern about the influence of race on birth and placental weights in view of race-associated variations in size of humans. In a multi-country study, although birth weight and placental weight were lower in Asian women, the mean PBWR was similar in Asian (19.5%; SD 3.3), European (20.0%; SD 4.0) and Afro-Caribbean women (20.4%; SD 5.3).²⁷ Also, the mean PBWR

was not significantly higher in women with gestational hypertension (20.4%; SD 4.5) and pre-eclampsia (23.3%; SD 7.3) than in normal women (19.8%; SD 3.8) thereby justifying their inclusion in population normogram.⁸

The study concludes that routine measurement of birth and placental weights can be harnessed to provide an insight into the intrauterine environment, an explanation for the observed measurement at birth and a source of information about maternal health status.

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