Research Article

iMedPub Journals
www.imedpub.com

Health Science Journal
ISSN 1791-809X

2018
Vol.12 No.6:612

DOI: 10.21767/1791-809X.1000612

Sonographic Assessment of Foetal Ponderal Index and its Correlation with Maternal Anthropometry and Placenta Volume in Sagamu, Ogun State, Nigeria

Oluwafemi Olumide Egbeyemi[1], Anthony Chukwuka Ugwu[1] and Michael Promise Ogolodom[2*]

[1]Department of Radiography and Radiological Sciences, Faculty of Health Sciences and Technology, Nnamdi Azikiwe University Anambra State, Nigeria

[2]Rivers State Hospitals Management Board, Port Harcourt, Rivers State, Nigeria

[*]**Corresponding author**: Michael Promise Ogolodom, Rivers State Hospitals Management Board, Port Harcourt, Rivers State, Nigeria, Tel: +234803997393; E-mail: mpos2007@yahoo.com

Received date: 09 November 2018; **Accepted date:** 17 December 2018; **Published date:** 24 December 2018

Citation: Egbeyemi OO, Ugwu AC, Ogolodom MP (2018) Sonographic Assessment of Foetal Ponderal Index and its Correlation with Maternal Anthropometry and Placenta Volume in Sagamu, Ogun State, Nigeria. Health Sci J Vol.12.No.6:612.

Abstract

Background: Foetal Ponderal Index (FPI) is normally used to determine "proportionality" in small-for-gestational age (SGA) infants, as it is a weight- height related parameter.

Aim: We aimed to establish the normal values of FPI using ultrasound scan and determine its relationship with placenta volume and maternal body mass index (BMI).

Materials and methods: A prospective cross sectional study design was adopted. Participants who met the inclusion criteria were recruited using purposive sampling technique. The ultrasound examinations were performed with 3.5 MHz sector transducer of a SL1 Sonoline Siemen machine. Placenta volume (PV), Maternal BMI and FPI was estimated for each subject. Pearson's correlation analysis was used to establish the relationship between variables studied.

Results: Normal singleton fetuses had mean FPI range from 10.78 ± 3.19 g/cm^3 in the second trimester to 9.75 ± 1.66 g/cm^3 in the third trimester. There were significant correlations between FPI and PV (r=-0.680; p=0.000) and (r=-0.410; p=0.000) in the second and third trimesters. Significant correlation was also noted between FPI and maternal BMI in the second and third trimesters (r=0.156; p=0.041) and (r=-0.268; p=0.000).

Conclusion: Nomogram of estimated FPI in the second and third trimesters was derived in this study. The relationship between the FPI and PV is negative, while that of FPI and maternal BMI is both positive and negative in the second and third trimesters respectively.

Keywords: Foetal ponderal indices; Placenta volume; Second and third trimesters; Maternal BMI

Introduction

Ponderal Index (PI) is used to assess "proportionality" in small-for-gestational age (SGA) infants since it is a weight-height related parameter [1]. The SGA newborns constitute a special group of neonates who may have suffered intrauterine insults and deprivation [2]. Early intrauterine adverse insults resulting to foetal growth restriction or genetic disorders often occurred with proportionate small foetus [1,3]. Neonates have been classified into SGA, appropriate for gestational age (AGA) and large-for-gestational age [4]. High morbidity and mortality perinatal rate are normally associated with foetuses with growth restrictions [5].

Foetal leanness has been assessed by foetal ponderal index (FPI) which determine pattern of growth and predicts pregnancy outcome [3,6]. Foetal ponderal index was defined as the inverse ratio of estimated foetal weight in grams to the third power of the femur length [6]. This means that the FPI is directly proportional to estimated foetal weight and inversely proportional to the third power of femur length. Foetal malnutrition which is evidence in foetal wasting is a condition mainly due to poor health and malnutrition of mother during pregnancy [3,7]. Geographical location, racial differences, ethnicity and socioeconomic status could have effect on foetal anthropometry; therefore each locality should develop its own standard of PI values [4]. The placenta is established early in intrauterine life. Its rapid growth in the early part of pregnancy is essential for the supply of the nutrients required to ensure adequate foetal growth through metabolic endocrine functions [8]. Foetal growth is largely measured by the availability of nutrients from the mother as well as placenta capability to supply these nutrients in proper quantities to the foetus [8]. A linear increase of the placenta size correlates with gestational age all through pregnancy [8]. Placenta size can help to determine pregnancy outcome [9]. Large placenta is indicative of maternal diabetes mellitus whilst placenta less than 2.5 cm thick is generally associated with intrauterine growth restriction [9,10]. Mothers of SGA babies were found to have significantly low anthropometric characteristics than mothers of normal and LGA babies, including weight, height and BMI [2,11]. Reduction in maternal nutrition during pregnancy has a direct relationship with the maternal BMI and may have adverse effect on the placenta and hence could impair intrauterine growth [8]. Maternal nutritional status has an important effect on foetal size and birth weight [12]. Foetal growth by sonographic measurement is directly related to maternal anthropometry and placenta volume in pregnancy and is mediated through maternal weight and weight gain [8]. The values of FPI have been assessed by the use of ultrasound [3,6]. Studies suggest associations between PV, maternal anthropometry, gestational age, foetal growth and birth outcome [8,13,14]. Literatures have shown that PI is prognostic factors in the evaluation of intrauterine growth restriction [2-4,15]. Association between placenta thickness and estimated foetal weight has been demonstrated by researchers [16,17]. This study intends to determine normal value of FPI according to gestation and its relationships with maternal anthropometry and placenta volume in the second and third trimesters. It is envisaged that established values of FPI would be useful in making assessment of intrauterine growth restriction in singleton foetus. Known value of FPI in relation to placenta volume and maternal BMI at a particular gestation would help clinician to have an understanding of foetus at risk and profile necessary dietary intake to expectant mother.

Materials and Methods

A total of 384 apparently health pregnant women at the time of this study, aged between 18 and 34 years in the second and third trimesters were prospectively enrolled into the study at the Radio diagnostic Department of City Gate Health Diagnostic Services, Ogijo Ogun State from June 2017 to September 2017. The study was approved by the Nigerian Institute for Medical Research Institutional Review Board (NIMR-IRB). Written informed consent was obtained from all the subjects after they were fully instructed about the investigation. Gestational ages estimated by using foetal biometry such as bi-parietal diameter (BPD), femur length (FL) and abdominal circumference (AC). Besides smokers and alcohol addicted mothers other exclusion criteria were abnormal blood pressure (BP), diabetes mellitus, history of IUGR, congenital malformations and multiple gestations. Each subject was scanned once, at the second and third trimesters (14-28 weeks and 29-40 weeks of gestation respectively), the maternal weight, height, body mass index (BMI), Blood sugar, blood pressure and data of ultrasound examination were recorded. All sonographic examinations were performed trans-abdominally using a Siemens real-time scanner (SL 1 Sonoline Siemen) with a 3.5 MHz sector and 5 MHz linear transducers. The placenta volume (PV) or estimated placenta volume (EPV) was measured in three dimensions (height, thickness and width) by placing the transducer perpendicular to the placenta plane and sweeping the transducer to achieve placenta full length as much as possible. In order to exclude inter and intra observer variation [18], the sonographic measurement was taken by only one experienced sonographer. The foetal ponderal index (FPI) was calculated as follow:

$$FPI=EFW/FL^3.$$

Where EFW is estimated foetal weight in g derived from the measurement of the AC, FL, BPD and HC. The FL is the foetal femur length in cm. The gestational age was expressed in weeks after sonographic measurement. The FPI was documented in grams per centimeter cube (g/cm^3). The PV was expressed in centimeter cube (cm^3). The maternal body mass index (BMI) was derived from the ratio of the mothers weight and the height and was measured in kilogram per centimeter square (kg/m^2). The gestational age was grouped into second and third trimesters. Data were analyzed in line with the objectives of this study using statistical package for social sciences (SPSS, Chicago, USA) version 20. Sonographic measurements of PV, FL, EFW and derived values (FPI and maternal BMI) at different gestational ages were expressed as mean plus or minus standard deviation. Pearson's correlation analysis was used to establish the association between FPI and PV as well as relationship between FPI and maternal BMI. P-value of less than 0.05 was considered statistically significant.

Results

Table 1 showed both maternal and foetal variables in the second and third trimesters. The mean age of the studied subjects was 27.3 ± 4.4 years. The mean maternal weight, height and BMI were 61.1 ± 5.8 kg, 1.6 ± 0.1 m and 23.5 ± 2.3 kg/m^2. The mean values of FPI, PV and maternal BMI according to gestational age were shown in **Table 2**. **Table 3** illustrated the mean value of FPI, PV and maternal BMI in the second and third trimesters separately. There was significant correlations between FPI and PV in the second trimester; r=-0.680, $p<0.05$ and in the third trimester; r=-0.410, $p<0.05$. Significant correlation was also noted between FPI and maternal BMI in the second trimester; r=0.156, $p<0.05$ and in the third trimester; r=-0.268, $p<0.05$. **Figures 1 and 2** show a fairly negative linear relationship between FPI and PV in the second and third trimesters. **Figures 3 and 4** showed both weakly positive and negative linear relationship between FPI and maternal BMI in second and third trimesters respectively.

Table 1 Descriptive statistics of measured maternal and foetal variables.

Maternal Variables	Minimum	Maximum	Mean	Standard deviation
Age (years)	18	34	27.3	4.4

Height (m)	1.4	1.8	1.6	0.1
Weight (kg)	42	75	61.1	5.8
BMI (kg/m^2)	14.7	29.4	23.5	2.3
Feotal variables				
GA (Weeks)	14	42	28.6	5.9
FPI (g/cm^3)	3.8	24.7	10.2	2.5
FL (cm)	1.6	7.8	5.5	1.4
PV (cm^3)	42.6	620.4	303.2	124.4
EFW (g)	91	4294	1803.1	970.3
AC (mm)	22	318	240	46.9
PV: Estimated Placenta Volume, EFW: Estimated Foetal Weight, AC: Abdominal Circumference				

Table 2 Descriptive statistics of Foetal Ponderal Index, placenta volume and maternal body index throughout gestation studied.

	Mean ± SD		
Gestational Age (weeks)	**FPI (g/cm^3)**	**PV (cm^3)**	**BMI (kg/m^2)**
14	23.4 ± 1.1	65.7 ± 3.3	24.2 ± 6.9
15	18.5 ± 0.3	82.2 ± 4.7	23.0 ± 0.9
16	11.5 ± 1.2	86.3 ± 12.8	20.0 ± 1.2
17	17.8 ± 0.8	88.7 ± 10.9	21.9 ± 2.7
18	14.8 ± 3.1	93.3 ± 8.5	21.0 ± 3.3
19	10.9 ± 1.9	92.6 ± 8.9	21.2 ± 3.0
20	10.8 ± 0.6	137.4 ± 9.5	22.5 ± 1.5
21	10.4 ± 1.5	147.4 ± 10.9	22.4 ± 1.3
22	9.7 ± 0.9	161.5 ± 11.4	21.9 ± 1.9
23	9.4 ± 1.9	185.6 ± 4.2	23.0 ± 0.7
24	9.9 ± 1.6	191.9 ± 6.4	22.4 ± 2.0
25	10.5 ± 1.6	216.2 ± 25.2	22.7 ± 1.8
26	10.3 ± 1.6	237.2 ± 23.8	23.6 ± 2.7
27	10.2 ± 1.6	250.6 ± 11.4	23.7 ± 1.8
28	10.4 ± 0.9	287.4 ± 2.3	23.5 ± 1.8
29	10.3 ± 0.6	304.9 ± 23.4	24.9 ± 3.7
30	9.8 ± 0.3	321.1 ± 6.1	24.1 ± 1.8
31	9.6 ± 0.5	343.2 ± 17.3	23.9 ± 1.6
32	9.5 ± 0.3	397.9 ± 1.9	24.4 ± 3.9
33	8.9 ± 1.1	412.8 ± 10.3	25.3 ± 2.9
34	9.1 ± 0.2	420.0 ± 18.0	23.3 ± 2.5
35	8.9 ± 0.6	423.4 ± 79.3	24.6 ± 1.6
36	8.9 ± 0.4	464.0 ± 6.4	23.6 ± 3.3
37	8.5 ± 0.4	466.9 ± 26.0	25.4 ± 0.6

38	8.6 ± 0.7	517.0 ± 3.5	25.7 ± 2.4
39	8.4 ± 0.0	522.1 ± 6.5	26.2 ± 2.9
40	7.9 ± 00	572.2 ± 7.2	27.7 ± 1.1
41	7.9 ± 00	620.4 ± 9.7	28.7 ± 1.3
42	7.9 ± 00	622.1 ± 6.2	29.2 ± 1.6
Total	10.2 ± 2.5	303.2 ± 124.4	23.5 ± 2.3

Table 3 Comparison analysis of variables studied in second and third trimester.

Variables	Trimester	Mean ± SD	t-value	p-value
FPI (g/cm^3)	Second	10.8 ± 3.2	4.071	0
	Third	9.8 ± 1.7		
BMI (kg/m^2)	Second	24.5 ± 1.6	0.359	0.72
	Third	24.1 ± 1.5		
PV (cm^3)	Second	292.9 ± 132.9	-1.476	0.141
	Third	311.7 ± 116.6		
SD: Standard deviation				

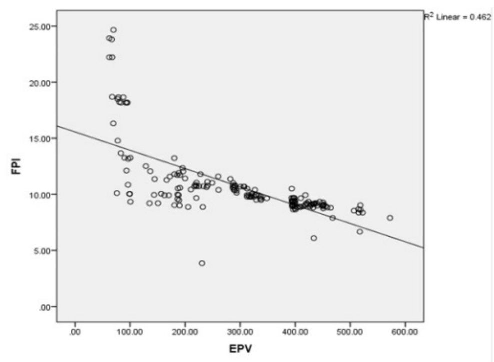

Figure 1 Scatter plot of foetal ponderal index against estimated placenta volume in second trimester.

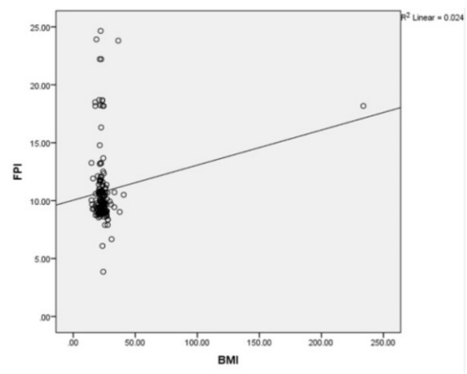

Figure 3 Scatter plot of foetal ponderal index against maternal body mass index in second trimester.

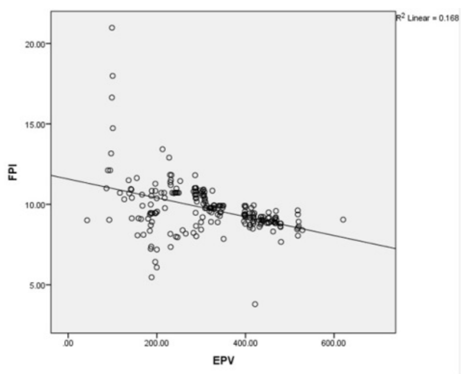

Figure 2 Scatter plot of foetal ponderal index against estimated placenta volume in third trimester.

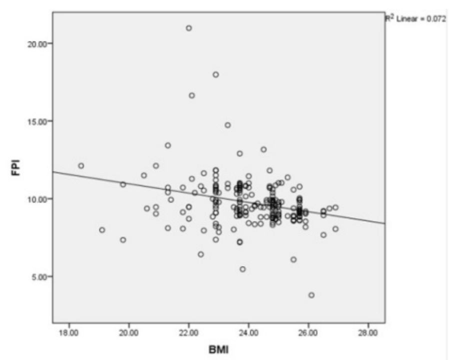

Figure 4 Scatter plot of foetal ponderal index against maternal body mass index in third trimester.

Discussion

Foetal Ponderal Index (FPI) was determined by ultrasound which has been possible in previous studies [3,6]. This study provides foetal ponderal index nomogram for normal pregnancies in the second and third trimesters. Foetal ponderal index in this study gradually decreases in the second trimester as the gestational age advances, with the same pattern maintained in the third trimester up to term. Similarly, the studies of Oluwafemi et al. [2] and Rashidi et al. [7] done on neonates 24 hours after delivery showed that PI decreases as gestational age advances up to 42 weeks gestational age in the third trimester. This present study revealed that the range of FPI in the second trimester is between 13 g/cm^3 and 10 g/cm^3 and in the third trimester is between 9 g/cm^3 and 8 g/cm^3. Study done by Vilbergsson et al. [6] revealed that this range of PI is possible in-utero. The FPI values obtained in this study for the different gestational age in the second and third trimester are however not precisely the same with the previous studies of Vilgerbsson et al. [6] and Thame [12]. The absolute standards of the FPI of previous studies were different from each other too, when the studies were compared for a given gestational age. This variability could have arisen due to environmental location of the subjects, race and possibly socio economic factors. Studies carried out by Morris et al. [19] and Rondo [20] in Brazilian was in agreement with the result of the present study. Studies carried out by Haggarty et al. [21] and Onyiriuka et al. [22] reported lower values of PI than the normal range as the gestational age increased to term (≥40 weeks). This value was possible because of expectant mothers' ill-health conditions. The present study is in keeping with the previous studies conducted by Roje et al. [4], Oluwafemi et al. [2] and Rashidi et al. [7] which showed that FPI standards have to be defined for specific population in order to eliminate variations resulting from geographical locations, race and socioeconomic groups. The range of placenta volume across gestational age was 42.60 cm^3 to 620.40 cm^3 which is similar to results obtained in some previous studies [8,12]. This study and previous studies [8,12] showed that placenta volume increases gradually as the gestational age increased in the second and third trimesters. The method adopted for the estimation of placenta volume in this present study is in line with the method used by Azpurua et al. [23]. This method is simple, rapid and accurate. It makes it practical for routine prenatal care. Significant fairly strong correlations were found between the foetal ponderal index and estimated placenta volume in both the second and third trimesters. This was in agreement with most of the previous studies of Thame et al. [8], Thame [12] and Hasegawa et al. [24], which reported that FPI is correlated with placenta volume in the second and third trimesters. The present study shows no information about the first trimester foetuses. Although, some studies [8,12,25] conducted in the first trimester reported on placenta volume, they did not give any information on its correlation with FPI, but reported in their studies that PV may influence FPI. Thame [12] opined that PV was shown to be an earlier predictor of FPI in his study to investigate maternal nutrition and its effect on birth outcome. Significant weak correlations were found between the FPI and maternal BMI in the second and third trimesters. Most previous studies appreciated the fact that maternal BMI is influenced by weight gained in pregnancy which affect foetal outcome [4,8,12]. An earlier study by Haggarty et al. [21] disagrees with subsequent studies of Roje et al. [4], Thame et al. [8] and Thame [12] on the influence of FPI in predicting IUGR. Although, studies of Thame et al. [8], Roje et al. [4] and Thame [12] showed good correlation between ponderal index and maternal BMI, this present study confirmed the level of correlation in the second and third trimesters.

Conclusion

Nomogram of foetal of ponderal index in both second and third trimesters has been established by this study. Foetal ponderal index decreases with increase in gestational age in the second and third trimester up to term. In this study, the FPI has fairly strong negative significant relationship with PV in both second and third trimesters. There was a weak positive significant relationship between FPI and maternal BMI in the second and also weak, but negative significant relationship in the third trimester.

References

1. Armangil D, Yurdakok M, Korkmaz A, Yigit S, Tekinalp G (2011) Ponderal index of large for gestational age infants: comparison between infants of diabetic and nondiabetic mothers. Turkish J Pediatr 53: 169-172.
2. Oluwafemi OR, Njokanma FO, Disu EA, Ogunlesi T A (2013) Current pattern of ponderal index of term small-for-gestational age in a population of Nigerian Babies. BMC Pediatr 110: 1471-2431.
3. Fayyaz J (2005) "Ponderal index". J Pak Med Assoc 55: 228-229.
4. Roje D, Ivo B, Ivica T, Mirjana V, Vesna C, et al. (2004) Gestational Age –the most important factor for neonatal ponderal index. Yonsei Med J 45: 273-280.
5. Nili F, Makipour M, Mobini J (2003) The value of Ponderal Index as a prognostic factor in predicting complications in term neonates. MJIRI 17: 197-201.
6. Vilbergsson G, Wennergren M (1992) Fetal ponderal index as an instrument for further classification of intra-uterine growth retardation. Acta Obstetricia Gynecologica Scandinavica 71: 186-190.
7. Rashidi AA, Kiani O, Norouzy A, Heidarzadeh M, Nematy M, et al. (2016) Estimation of foetal malnutrition by ponderal index in iranian neonates. Research Gate. International Nutrition of Congress. The 2nd international and the 14th Iraninan Nutrition Congress.
8. Thame M, Osmond C, Bennett F, Wilks R, Forrester T (2004) Foetal growth is directly related to maternal anthropometry and placenta volume. Eur J Clinical Nutr 58: 894-900.
9. Ju H, Chadha Y, Donovan T, O'Rourke P (2009) Foetal Macrosomia and pregnancy outcomes. Aust N Z J Obstet Gynaecol 49: 504 -509.
10. Ohagwu CC, Abu PO, Ezeokeke UO, Ugwu AC (2009) The relationship between placental thickness and growth

parameters in normal Nigerian Foetuses. Afr J Biotechnol 8: 133-138.

11. Jeminusi OA, Sholeye OO, Abosede OA (2015) Maternal anthropometry in the rural and urban area of Ogun state senatorial district, Nigeria: A comparative study. Int J Nutr Metabo 7: 39-45.

12. Thame M (2012) The Jamaican foetus-overview of various studies. West Ind Med J 61: 323.

13. Mohsen MA, Wafay HA (2007) Influence of Maternal Anthropometric Measurements and Serum Biochemical Nutritional Indicators on Foetal Growth. J Med Sci 7: 1330-1334.

14. Erbil N, Toprak N, Acikgoz O, Gelen S, Arik N (2015) The Relationship between Maternal placental and New born parameters. Middle Black Sea J Health Sci 1: 11-18.

15. Akram DS, Arif F (2005) Ponderal index of low birth weight babies –a hospital based study. J Pak Med Assoc 55: 229-231.

16. Abu PO, Ohagwu CC, Eze JC, Ochie K (2009) Correlation between placental thickness and estimated foetal weight in Nigerian Women. Ibnosina J Med Biomed Sci 1: 80

17. Adeyekun AA, Ikuor JE (2015) Relatioship between two dimensional ultrasound measurement of placenta thickness and estimated fetal weight. Sahel Med J 18: 1-4.

18. Eze CU, Eze CU, Marchie TT, Ohagwu CC, Ochie K (2013) Observer variability in sonographic measurement of kidney size among children in Benin City, Nigeria. West Ind Med J 62: 817-824.

19. Morris SS, Victora CG, Barros FC, Halpern R, Menezes AMB, et al. (1998) Length and Ponderal Index at Birth: associations with mortality, hospitalizations, development and post-natal growth in Brazilian infants. Int J Epidemiol 27: 242-247.

20. Rondo PHC (1998) Weight, length, ponderal index, and intrauterine growth retardation in Brazil. J Trop Pediatr 44: 12-16.

21. Haggarty P, Campbell DM, Bendomir A, Gray ES, Abramovich DR (2004) Ponderal Index is poor predictor of in utero groeth retardation. Br J Obstet Gynaecol 111: 113-119.

22. Onyiriuka AN, Okolo AA (2005) Small for gestational age, ponderal index and neonatal Polycythaemia: A study of their association with Maternal hypertension among Nigerian Women. Annals Afr Med 4: 154-159.

23. Azpurua H, Funai EF, Coraluzzi LM, Doherty LF, Sasson IE, et al. (2009) Determination of Placental Weight Using Two-dimensional Sonography and Volumetric Mathematic Modeling. Am J Perinatol 5: 1-5.

24. Hasegawa J, Arakaki T, Nakamura M, Takita H, Sekizawa A (2015) Placenta Volume measurement in Clinical Practice. J Ultrasound Obstet Gynecol 9: 408-412.

25. Effendi M, Demers S, Giguere Y, Forest JC, Brassard N, et al. (2013) Association between first and second trimester placenta volume and birth weight. Placenta 35: 99-102.