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Placental Biometric Parameters: The Usefulness of Placental Weight Ratio and Birth/Placental Weight Ratio Percentile Curves for Singleton Gestations as a Function of Gestational age

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Abstract

Objective: To produce reference values for the placental weight (PW), Placental diameters (PDs), Placental thickness (PT), placental weight ratio (PW-R) and birth/placental weight ratio (BPW-R) in singleton gestations as a function of gestational age (GA).

Study Design and Setting: A retrospective 4-years case study of singleton placentas reports between, 1st of January 2014 to 31st of December 2017. The placentas were sent for histopathological diagnosis to Embryofetal Pathology Laboratory, Centro de Genetica Clínica (CGC), Porto, Portugal. In a cohort of singleton placentas, PW, PDs, PT, PW-R, and BPW-R were analyzed to produce percentile curves. Considering the inclusion criteria, 1,951 singleton placentas were selected from a sample of 7,321 placentas. We recorded the PW, PDs, PT, PW-R, and BPW-R between 12th and 41st GA.

Results: PW, PDs, PW-R and BPW-R tables and percentiles curves for singleton placentas across GA were produced.

Conclusions: Placental percentile curves may act as a reference for other populations as well until population-specific curves can be produced. PDs could predict placental volume and could help to estimate the prenatal PW-R and BPW-R.

Keywords: Placental weight; placental diameter; placental weight ratio; birth/placental weight ratio; percentiles; singleton gestation.

Introduction

Recently we have seen an increasing interest on the evaluation of biometric parameters of the placenta and its relation with the obstetric outcome. However, the relative lack of interest in the study of the placenta when compared to the fetal study was responsible for the existence of a great gap in the understanding of the biological significance of the placental lesions related to perinatal and neonatal context [1-5].

Macroscopic placental evaluation in the delivery room may improve a selection of placentas to histopathological study and, on the other hand, allow the evaluation of the placental weight (PW) and consequently the placental weight ratio (PW-R) and birth/placental weight ratio (BPW-R). Knowing these are factors that may be associated with pregnancy complications [1-5].

While birthweight (BW) percentile curves are relatively common in most countries, percentile curves for PW are rare, even in large series of placental studies [6,7]. At present we have available some fetal and placental percentiles curves which the majority refers to gestational age (GA) above 24 weeks [6,7]. However, some of the existing information may be out of date, as documented for the BW percentile curves [6,7]. Thus, the updating of percentile curves and their comparison between regions and even between countries are important to manage the pregnancy risks and to enhance the mother education and healthcare [1-4].

Although additional evidence is needed, the percentile curves are useful in evaluating fetal follow-up and maternal and child diseases. The percentile curves comprehension can optimize a targeted intervention in fetal adverse contexts such as intrauterine growth restriction(IUGR) and maternal diseases such as hypertension and diabetes also.

Objective

To produce gestational age-specific percentile curves for PW, placental diameters (PDs), placental thickness (PT), PW-R and BPW-R.

Material and methods

Sample and Definition

We conducted a retrospective case-study of 7,321 placentas sent to Embryo-fetal Pathology Laboratory, Centro de Genética Clínica (CGC), Unilabs, Porto, Portugal. The specimens had been sent for histopathological examination to confirm or determine suspected or unsuspected lesions that explain the obstetric outcome such as fetal demise and perinatal morbidity and mortality.

We collected information of 4-years placental pathological report performed between 1st of January of 2014 to 31st of December of 2017. The GA range of 12 to 41 weeks. Biometric parameters were collected from placentas and fetal deaths autopsy reports. Also, biometric parameters of newborns were obtained through the information contained in the clinical requisition of the placental pathological study. The registry involved data on maternal age and parity; GA; pathological placental reports; fetal autopsy reports and newborns clinical data. Placental parameters biometry's: PW, placental shape and diameter, umbilical cord length, diameters, and type insertion. Fetal deaths parameters acquired: weight and gender. Newborns parameters: weight and gender. Inclusion criteria: – 1. Known GA – 2. Maternal: i. Portuguese population-based woman; ii. Singleton deliveries ≥ 12 weeks of gestation. – 3. Placental: i. Formalin fixation equal or inferior lesser than 24 hours; ii. Absence of macroscopic lesions before 36th weeks of GA; iii. Macroscopic peripheral parenchymal lesion < 5% at ≥37 weeks of GA. – 4. Fetal deaths: i. Maceration is lesser than 12 hours; – 5. Newborns: i. Known birthweight. Exclusion criteria – 1. Maternal: i. Non-Portuguese woman; ii. Multiple pregnancies; iii. Singleton gestation relating to assisted reproductive technology. iv. Known chronic maternal disease (e.g., diabetes, hypertension with or without preeclampsia).–2. Placental: i. Macroscopic lesions more than 5% at any GA; ii. Gestational trophoblastic diseases; iii. Tumors; iv. Disease processes with high-grade histopathological lesions; v. Hydrops. vi. Incomplete, fragmented or disrupted placenta; vii. Placental curettage.–3. Fetal: i. maceration≥12h; ii. Hydrops; iii. intrauterine growth restriction (IUGR).–4. Newborn: i. Unknown BW; ii. IUGR.

The PW and FW were acquired using a balance GS6202 with measuring range 0.01g-620g – scale 0.01g (serial number 12105085, Kern); a balance MOD 470 with measuring range 0.5g-2,000g – scale 0.1g (serial number 42770096, Kern) and balance MOD 734 with measuring range 0g-20,000g – scale 0.1g (serie 1/1, Seca). The placental measures were acquired with a visual scale linear millmetric graduation ruler. Also, to smallest specimens, a comparative measures study achieved with a two linear scale ruler and a digital Vernier gauge 0-150mm scale Würth® was performed with similar results. BW was achieved in the delivery room care unit.

To produce percentile curves, 1,951 placentas were selected from a sample of 7,321 placental histopathological reports. Corresponding fetal gender, BW and FW registry were analyzed. We exclude non-native Portuguese woman (701); Newborn cases with missing data (846); Maceration traducing fetal demise with retention ≥ 12h (438); congenital abnormality was recorded as: no abnormalities, minor abnormalities, and major abnormalities (e.g., neural tube defects, such as, anencephaly, cranium-rachischisis, exencephaly and holoprosencephaly, skeletal dysplasia; limb body stalk complex). So, major defects were excluded (108); Fetal hydrops, or placental findings suggesting aneuploidy or metabolic storage diseases (306); IUGR (190); Multiple pregnancy (621); Partial hydatidiform moles (14); Extravillous trophoblastic diseases (4); Giant chorioangioma (7); Placental maternal vascular processes (652); Placental fetal vascular processes (314); histopathological pattern consistent with high grade immune / idiopathic inflammatory lesions (257) and infectious inflammatory lesions such as chronic plasma cell villitis (CMV, Parvovirus B19, Herpesvirus, Toxoplasma, listeria) (80) and chronic histiocytic intervillositis (CHI) (36); Other placental processes as massive fibrin deposition and maternal floor infarction (98); Single placenta gestation relating to assisted reproductive pregnancy technology (135); Incomplete, fragmented or disrupted placenta (474); Placenta accreta (37); and Placental curettage associated with retention (52). Knowing that PW increase approximately 5% after formal in fixation and the weight loss is little and most significant in hydropic or edematous placentas [6-9]. Initially, placentas were fixed in formalin for 24 hours. Then, after remoting the capsular membrane and umbilical cord, the PW, PDs and placental thickness (PT) were achieved in accordance with international guidelines. [8-9]. Placental disk dimensions include the measurements of the placenta in three dimensions at manual macroscopic examination in embryofetal pathology laboratory, and were achieved as: The maximum linear dimension (largest diameter = length) and the minimum linear dimension (smallest diameter = width) always acquired through the insertion point and perpendicular to each other. The maximum thickness was acquired in the central two-thirds of the disc, in accordance with international guidelines [8-9]. In addition, newborns were weighted in the delivery room care unit and fetus were weighted in the autopsy room. Placental macroscopic examination, sampling, and classification of placental lesions were performed in accordance with international guidelines [6-9].

All the samples used in the present study were unlinked and unidentified from their donors. Due to the retrospective nature of the study, the Local Ethical Review Committees of the involved institutions and Minho University Medicine School (Braga, Portugal) approved the work and waived the need for written informed consent.

Statistical Analysis

The percentiles curves for PW, PDs, PT, PW-R, and BPW-R were based on the same observations.The statistical analysis was conducted in IBMSPSS Statistics version 25 using the most appropriate tests according to the nature of the variables involved. To evaluate the normality, we used the Q-Q plots due to the sample size.

Results

The final sample was 1,951 singleton placentas. PW, PDs, PT, BPW-R, and PW-R mean, standard deviation (SD), median, minimum and maximum to maternal, placental and fetal or newborn quantitative and qualitative variables are summarized in (Table 1) and (Table 2). Maternal age range from 15 to 48 years. Sex was defined as either: female, male and ambiguous or unknown if the data was missing. So, the gender distribution was female in 818 (47.7%) cases, male in 884 (51.5%) cases and ambiguous in 13 (.8%) cases (Table 2). GA was a key variable for this research and played an integral role in establishing BPW-R and PW-R. For the purpose of this study, GA remained as a continuous integer variable, but only the gestational week was used, not the number of days. According to clinical practice, GA estimation was derived from the first day of the last menstrual period. Otherwise, GA was corrected on the basis of ultrasound measurements that are routinely obtained for all pregnant woman in Portuguese hospitals. Placental weight, Fetal and newborn BW was recorded in grams as a continuous variable.

Measures of interest for this study were PW, PDs [e.g., largest placental diameter (LPD or PD>) smallest placental diameter (SPD or PD<) and placental thickness (PT)], BW, BPW-R, and PW-R. The t-student test was used to compare the mean value of PW at each GA according to gender and likewise for the BW or FW. According to gender, with the exception of 27 weeks ($p = .033$), there were no statistically significant differences between mean PW for male and female fetuses ($p > .05$). These results are summarized in the graph of Figure 1. Also, except for 16 weeks ($p = .021$) and 40 weeks ($p = .018$), there were no statistically significant differences between mean BW for male and female fetuses ($p > .05$). These results are shown in the graph in Figure 2. Taking into account these results, it was decided to draw tables for percentiles, a number of observations, mean and standard deviation, minimum and maximum for the PW, BW (e.g., fetal weight and newborn weight). These results are shown in (Table 3) and (Table 4) respectively. The same analysis was

performed to BPW-R and PW-R percentiles as a function of GA.
These results are shown in (Table 5) and (Table 6) respectively.

Table 1. Summary statistics for some important fetal, placental and maternal quantitative variables

	Valid (N)	Mean	SD	Median	Min	Max
MA (y)	1947	31.8	6.1	32.1	15.1	48.2
GA (w)	1951	27	9	26	12	41
PW (g)	1951	233.25	159.25	195.00	6.00	995
PD (cm)	1949	13.5	5.0	13.0	1.7	32.0
PT (cm)	1947	2.11	.70	2.00	.30	5.50
FW (g)	1951	1248.70	1153.93	766.00	5.40	4880

Legend: SD, standard deviation; Min, minimum; Max, maximum; MA, maternal age; GA, gestational age; PW, placental weight; PD, placental diameter; PT, placental thickness; FW, fetal weight; y, years; w, weeks; g, grams; cm, centimeters.

Table 2. Summary statistics for some important fetal, placental and maternal qualitative variables

		N	Percent
Mother Parity	1	820	45.2%
	2	595	32.8%
	3+	400	22.0%
	Total	**1815**	**100.0%**
Fetal Gender	F	818	47.7%
	M	884	51.5%
	A	13	.8%
	Total	**1715**	**100.0%**
Placental Shape	Normal	1731	88.7%
	Bilobed	113	5.8%
	Circumvallate	104	5.3%
	Membranacea	3	.2%
	Total	**1951**	**100,0%**

Legend: F, female; M, male; A, ambiguous.

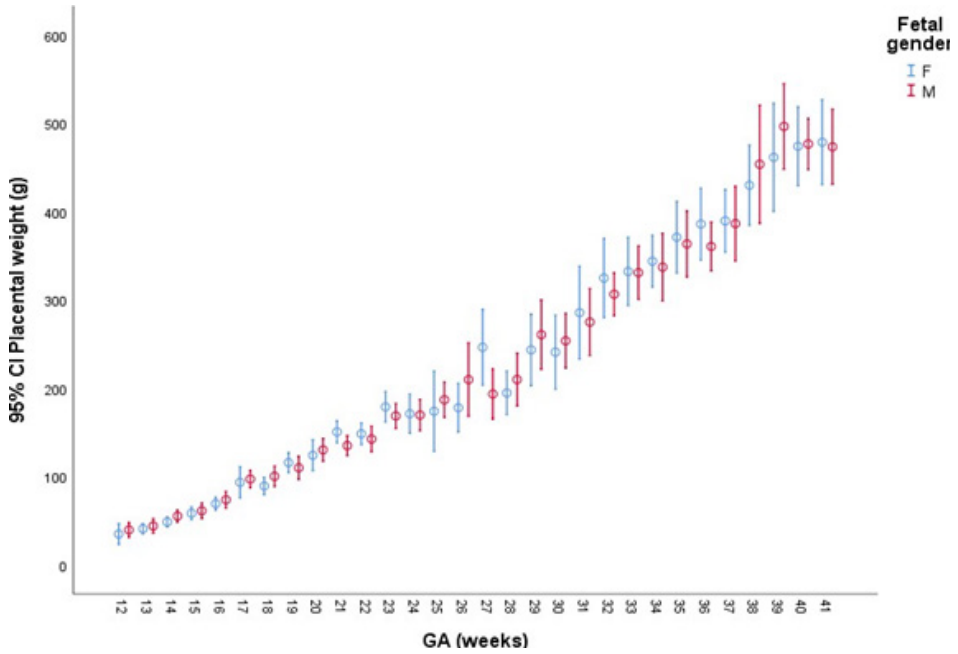

Figure1.–Mean and respective 95% confidence intervals for placental weight according to fetal gender for each GA.

Legend: CI, confidence interval; g, grams; GA, gestational age; F, female; M, male.

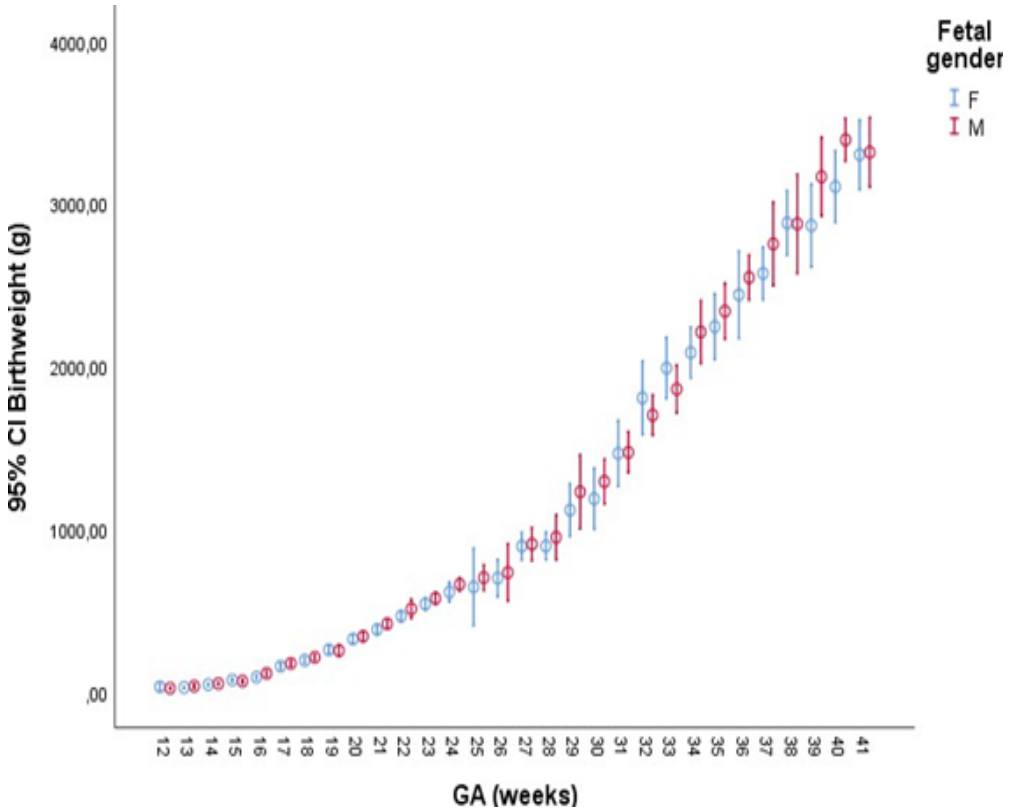

Figure 2. – Mean and respective 95% confidence intervals, for the birth weight according to the fetal gender for each GA.

Legend: CI, confidence interval; g, grams; GA, gestational age; F, female; M, male.

Table 3. Percentiles, number of observations, the mean and standard deviation for placental weight as a function of GA

	Percentile						Placental weight (g)	
GA	**3rd**	**10th**	**50th**	**90th**	**97th**	**Number**	**Mean**	**SD**
12	10	13	33	67.3	96	53	36.72	23.93
13	10	21	38	60	74	61	40.79	17.29
14	20.6	30	49.5	75	88	68	51.22	17.96
15	16	36	58	90	108	72	60.03	23.53
16	23.8	43	71	100	108	72	71.36	25.04
17	44	57	89	126	160	69	95.39	38.05
18	51.3	60	95	132	149	73	95	32.49
19	41	68	114	160	169	72	113.39	35.67
20	57	83	120	166	190	69	126.69	45.79
21	68	103	143.3	184	200	71	141.89	35.44
22	74	104	141	191	220	71	145.28	39.37
23	88	123	174	223	243	72	172.19	44.78
24	97	107	153.5	241	260	68	170.6	55.81
25	74	82	184	270	330	48	181.94	69.42
26	88	100	190	288	319	43	190.67	71.35
27	76	131	238.65	289	291	35	220.3	73.23
28	96	123	202	307	351	61	203.38	67.66
29	134	154	240	365	434	43	254.84	89.83
30	99.6	151	247	345	423	47	249.1	77
31	114	145	293.5	405	462	56	280.46	90.97
32	182	203	307	471	512	67	314.61	89.16
33	190	222	334.5	442	515	72	336.67	88.37
34	195	253	344	448	496	72	341.94	84.01
35	200	237	356	546	654	75	374.79	123.68
36	237	267	350	490	515	77	361.16	80.6
37	242	275.3	364.5	507	593	72	380.02	91.21
38	273	296	405	590	755	72	433.61	136.89
39	259	312	444	610	678	71	450.38	128.09
40	335	378	459	580	632	77	475.44	90.66
41	327	353	470	615	690	72	478.18	105.99

Legend: GA, gestational age; g, grams; SD, standard deviation. Nogueira R, *et al.*, Portugal, Porto, Embryofetal Pathology Laboratory.

Table 4. Percentiles, number of observations, the mean and standard deviation for birthweight as a function of GA

	Percentile						Birthweight (g)	
GA	**3rd**	**10th**	**50th**	**90th**	**97th**	**Number**	**Mean**	**SD**
12	5.7	9.3	16	29	111	53	23.83	38.99
13	6.7	16	27	41	46	61	28.22	20.96
14	16	24	46	70	77	68	44.72	17.3
15	15	24	70.5	100	120	72	67.86	32.27
16	25	44	99.35	164	185	72	99.8	44.33
17	75	89	166	226	266	69	165.63	51.58
18	66.5	122	209	261	309	73	201.52	56.84
19	56	127	261	333	402	72	253.83	86.96
20	141	242	325	430	455	69	330.38	81.85
21	190	296	409	497	535	71	400.56	86.21
22	241	353	495	589	648	71	486.48	141.64
23	325	411	565.5	700	772	72	560.09	109.35
24	343	444	642.5	786	854	68	637.79	143.32
25	179	280	731	870	1175	48	678.61	332.26
26	364	460	640	925	1670	43	710.84	293.23
27	488	620	958	1150	1200	35	911.78	192.51
28	300	549	960	1240	1400	61	928.62	270.84
29	497	638	1075	1720	2160	43	1203.65	488.27
30	660	845	1275	1730	1860	47	1267.34	349.7
31	796	920	1469.5	1930	2180	56	1479.11	358.7
32	937	1219	1750	2250	2500	67	1759.27	487.78
33	1177	1500	1960	2360	2490	72	1931.08	391.98
34	1331	1515	2095	2690	2860	72	2136.57	443.36
35	1530	1720	2270	2850	3640	75	2337.69	561.11
36	1640	1860	2440	3175	3390	77	2454.43	457.96
37	2000	2140	2450	2995	3690	72	2570.04	513.11
38	2090	2200	2737.5	3580	4120	72	2846.26	587.45
39	1930	2230	2780	3660	3840	71	2882.54	590.53
40	2400	2580	3230	3860	3940	77	3253.27	477.65
41	2500	2600	3312.5	3900	4210	72	3308.19	507.44

Legend: GA, gestational age; g, grams; SD, standard deviation**.** Nogueira R*, et al.,* Portugal, Porto, Embryofetal Pathology Laboratory.

Table 5. Percentiles, number of observations, the mean and standard deviation for birth/placental weight ratio (BPW-R) as a function of GA

	Percentile						BPW-R	
GA	3rd	10th	50th	90th	97th	Number	Mean	SD
12	.21	.28	.51	1.22	1.97	53	.68	.47
13	.32	.41	.63	1.06	2.5	61	.76	.46
14	.35	.51	.94	1.32	1.38	68	.92	.32
15	.34	.53	1.1	1.92	2.48	72	1.19	.55
16	.54	.68	1.41	2.11	2.32	72	1.43	.52
17	.83	1	1.78	2.71	3.16	69	1.86	.68
18	1	1.37	2.18	3.04	3.66	73	2.25	.76
19	.93	1.47	2.28	3.06	3.77	72	2.28	.69
20	1.41	1.92	2.59	4	4.39	69	2.78	.81
21	1.6	2.13	2.84	3.99	4.5	71	2.95	.82
22	1.97	2.34	3.41	4.5	5.57	71	3.45	.88
23	2.12	2.38	3.36	4.69	5.21	72	3.43	.91
24	2.35	2.67	3.82	5.15	6.1	68	3.94	1
25	1.82	2.23	3.56	5.22	7	48	3.83	1.57
26	2.16	2.55	3.9	5.14	6.44	43	3.93	1.19
27	2.66	3.39	4.09	6.42	7.08	35	4.45	1.2
28	2.45	3.09	4.82	6.45	7.7	61	4.77	1.35
29	2.91	3.19	4.63	6.27	7.74	43	4.85	1.49
30	3.52	3.73	5.42	6.74	7.68	47	5.28	1.16
31	3.58	4.17	5.42	6.99	8.07	56	5.54	1.17
32	3.78	4.12	5.67	7.53	7.95	67	5.74	1.28
33	3.82	4.33	5.96	7.37	8.63	72	5.96	1.26
34	4.59	4.91	6.45	7.98	8.91	72	6.49	1.78
35	4.73	5.04	6.45	8.1	8.53	75	6.48	1.18
36	4.58	5.3	6.93	8.89	9.77	77	6.96	1.31
37	4.96	5.46	6.76	8.89	9.69	72	6.95	1.27
38	4.64	5.29	6.93	8.56	9.51	72	6.86	1.38
39	3.96	4.96	6.53	8.5	8.88	71	6.65	1.34
40	4.82	5.68	6.92	8.57	8.98	77	6.97	1.07
41	5.35	5.95	7	8	9.16	72	7.07	.94

Legend: GA, gestational age; SD, standard deviation. Nogueira R, *et al.,* Portugal, Porto, Embryofetal Pathology Laboratory.

Table 6. Percentiles, number of observations, mean and standard deviation for placental weight ratio (PW-R) as a function of GA

	Percentile						PW-R	
GA	**3rd**	**10th**	**50th**	**90th**	**97th**	**Number**	**Mean**	**SD**
12	.51	.82	1.96	3.55	4.84	53	2.22	1.77
13	.40	.94	1.59	2.45	3.10	61	1.63	.67
14	.72	.76	1.07	1.96	2.83	68	1.27	.60
15	.40	.52	.91	1.89	2.90	72	1.08	.72
16	.43	.47	.71	1.47	1.86	72	.84	.47
17	.32	.37	.56	1.00	1.20	69	.62	.26
18	.27	.33	.46	.73	1.00	73	.50	.20
19	.27	.33	.44	.68	1.07	72	.50	.28
20	.23	.25	.39	.52	.71	69	.40	.15
21	.22	.25	.35	.47	.63	71	.37	.10
22	.18	.22	.29	.43	.51	71	.31	.08
23	.19	.21	.30	.42	.47	72	.31	.08
24	.16	.19	.26	.37	.43	68	.27	.07
25	.14	.19	.28	.45	.55	48	.29	.10
26	.16	.19	.26	.39	.46	43	.28	.09
27	.14	.16	.24	.30	.38	35	.24	.07
28	.13	.16	.21	.32	.41	61	.23	.07
29	.13	.16	.22	.31	.34	43	.22	.06
30	.13	.15	.18	.27	.28	47	.20	.05
31	.12	.14	.18	.24	.28	56	.19	.04
32	.13	.13	.18	.24	.26	67	.19	.07
33	.12	.14	.17	.23	.26	72	.18	.05
34	.11	.13	.15	.20	.22	72	.16	.03
35	.12	.12	.16	.20	.21	75	.16	.03
36	.10	.11	.14	.19	.22	77	.15	.03
37	.10	.11	.15	.18	.20	72	.15	.03
38	.11	.12	.14	.19	.22	72	.15	.03
39	.11	.12	.15	.20	.25	71	.16	.04
40	.11	.12	.14	.18	.21	77	.15	.02
41	.11	.13	.14	.17	.19	72	.14	.02

Legend: GA, gestational age; SD, standard deviation. Nogueira R, et al., Portugal, Porto, Embryofetal Pathology Laboratory.

Percentiles curves for PW, BW, PBW-R, and PW-R, between 12th and 41st weeks of GA, were produced. These results are shown in (Figure 3), (Figure 4), (Figure 5) and (Figure 6) respectively. An approach to placental volume (PV) was determined using the calculation [LPD x SPD x PT]. So, graphs to evaluate PV – PW, and PDs – PW correspondences were produced. These results are shown in (Figure 7).

To assess whether there was an association between PW and PV a Pearson correlation test was performed to evaluate the linear association between variables. The results obtained are found in the matrix (Table 7). It is verified that there is significant linear association with: Positive Very Strong association between: LPD and SPD ($r=.918$, $p<.01$); Positive Strong association between: PW and PV ($r=.833$, $p<.01$); PW and LPD ($r=.826$, $p<.01$); PW and SPD ($r=.829$, $p<.01$); PV and LPD ($r=.833$, $p<.01$), and PV and SPD ($r=.877$, $p<.01$); Moderate Positive association between: PW and PT ($r=.619$, $p<.01$) and PV and PT ($r=.621$, $p<.01$); Weak Positive association between: LPD and PT ($r=.396$, $p<.01$) and SPD and PT ($r=.398$, $p<.01$).

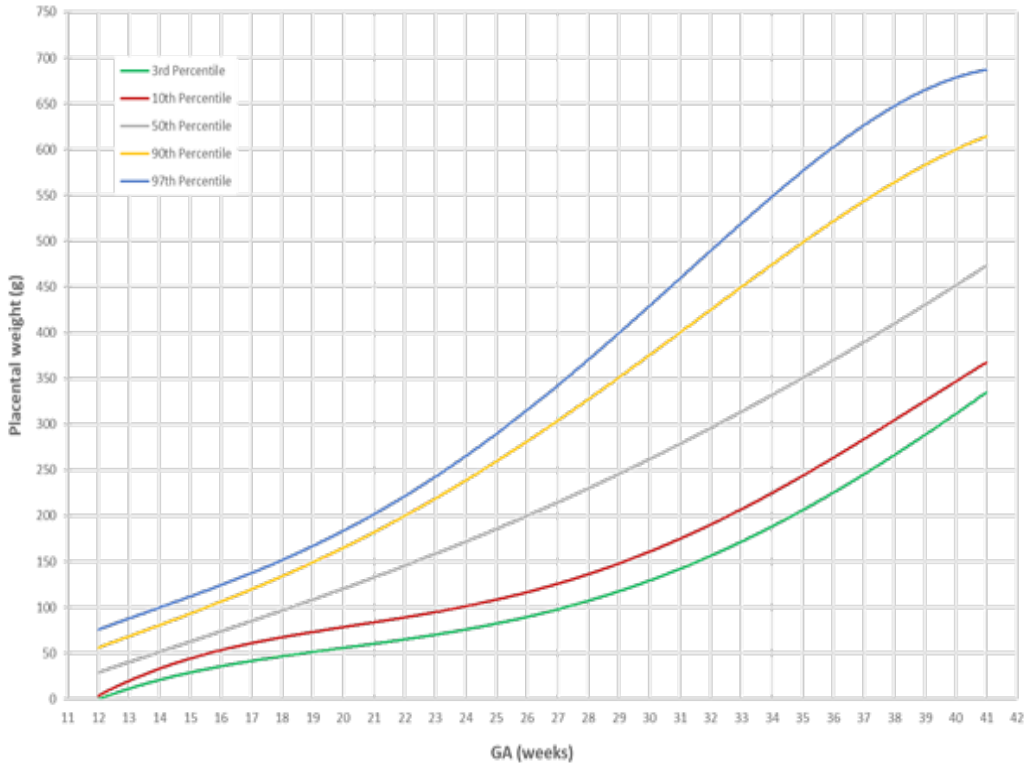

Figure 3. – Placental weight percentile curves by gestational age, Nogueira R, et al., Portugal, Porto, Embryofetal Pathology Laboratory.

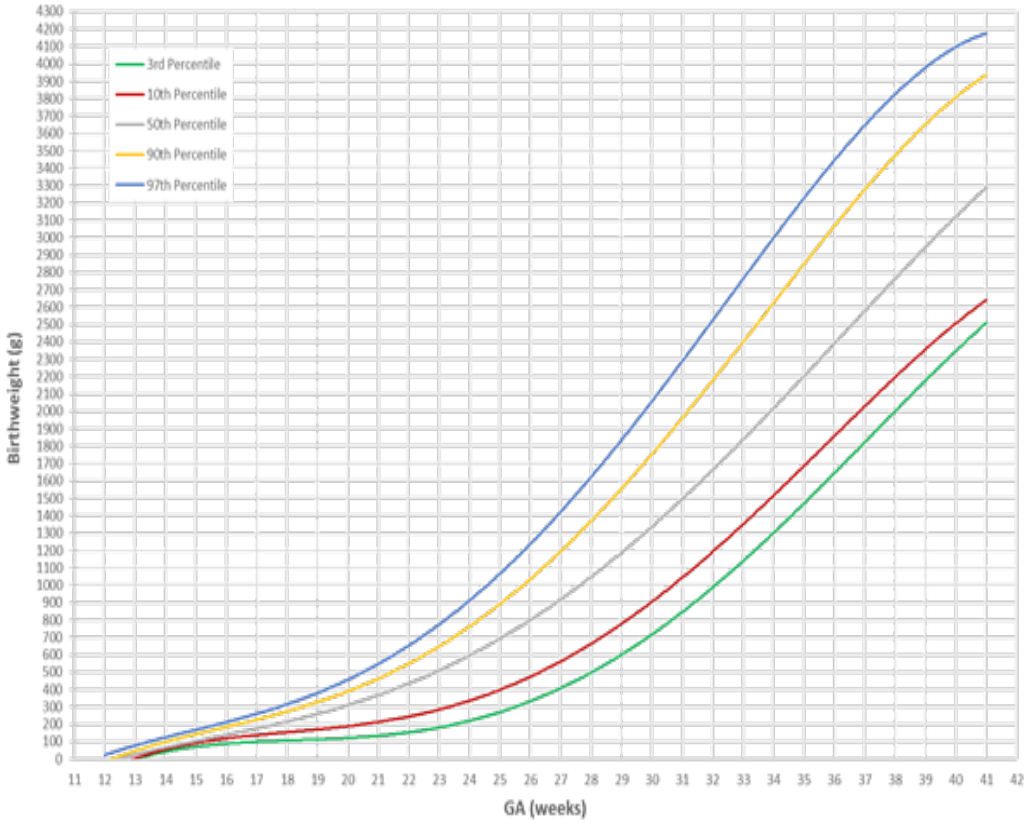

Figure 4.–Birthweight percentile curves by gestational age, Nogueira R, et al. Portugal, Porto, Embryofetal Pathology-Laboratory.

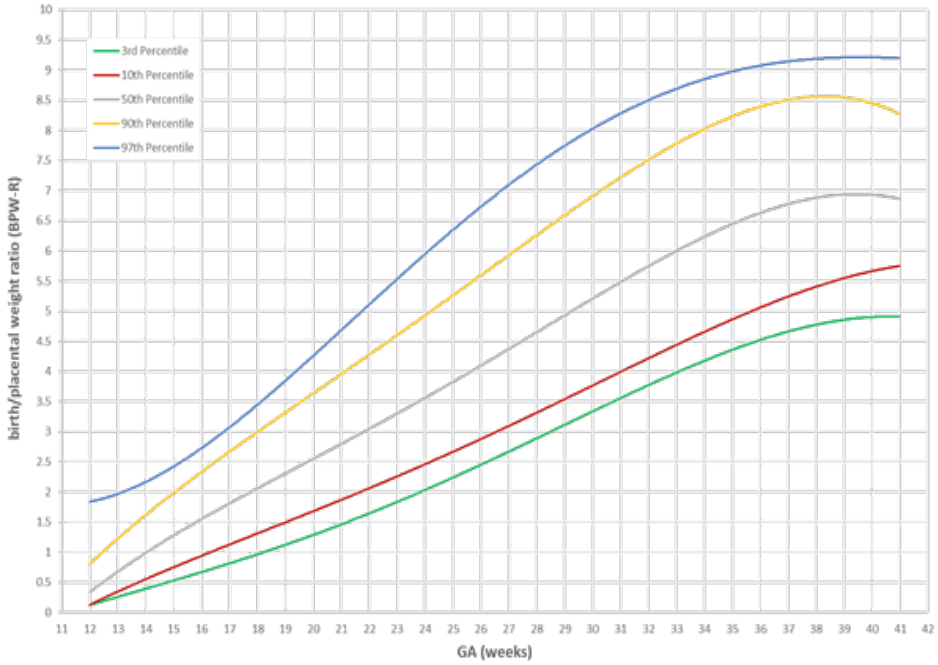

Figure 5. – Birth/placental weight ratio percentile curves by gestational age, Nogueira R, et al., Portugal, Porto, Embryofetal Pathology Laboratory.

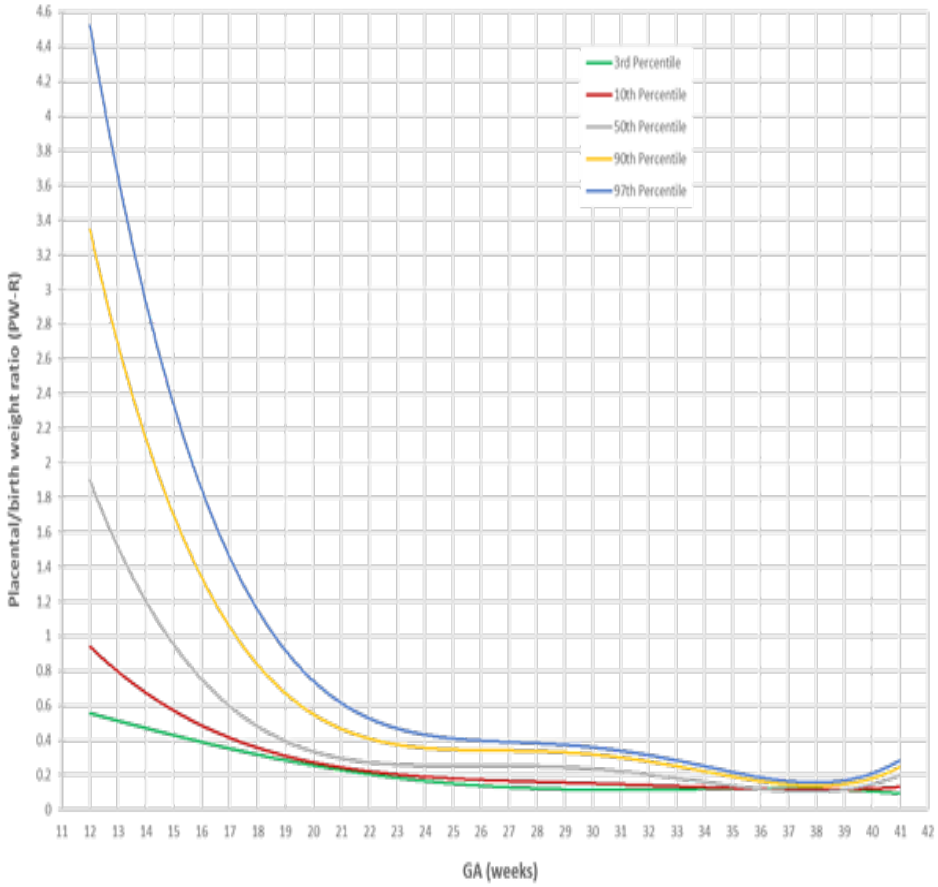

Figure 6. – Placental/birth weight ratio (PW-R) percentile curves by gestational age, Nogueira R, et al., Portugal, Porto, Embryofetal Pathology Laboratory.

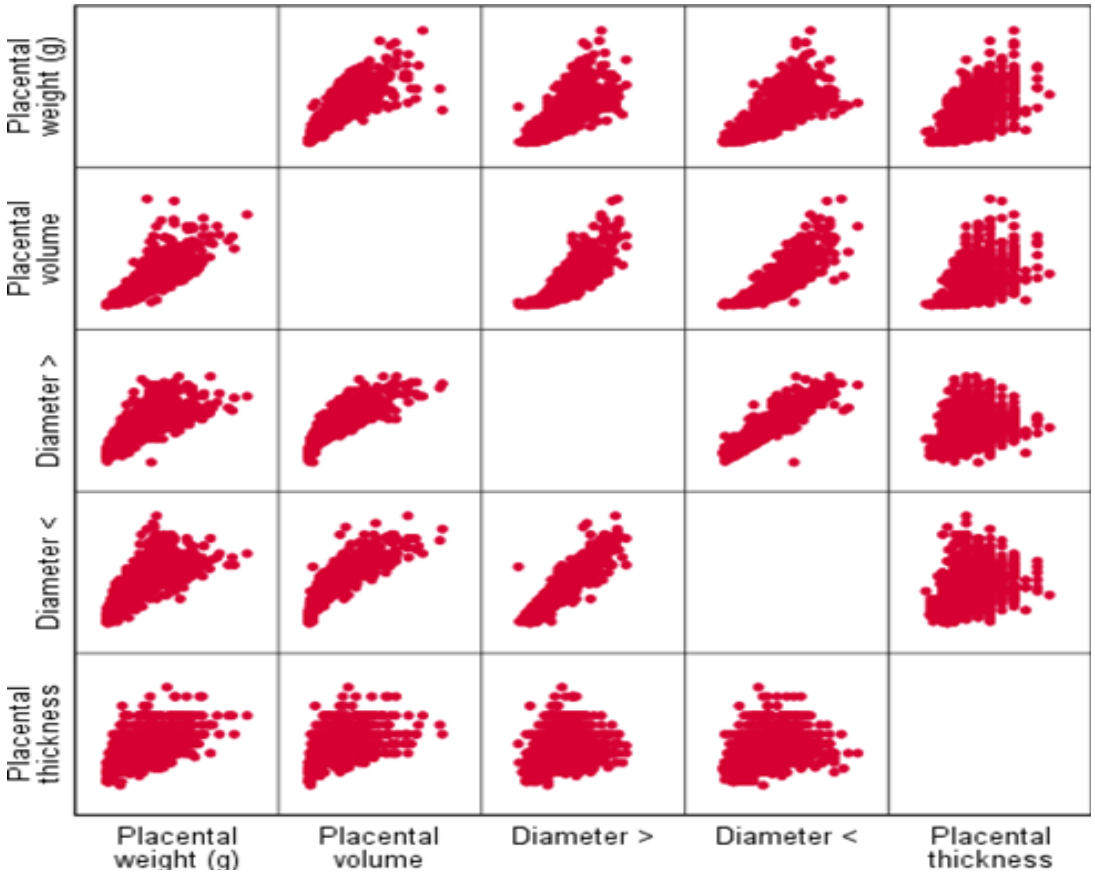

Figure 7. – Relation between placental measures.
Legend: g, grams; Diameter >, largest placental diameter; Diameter <, smallest placental diameter.

Discussion

The placental examination has been important in documenting a pathophysiological complex process associated with poor obstetric outcomes such as fetal and neonatal morbidity and mortality and chronic diseases in later life [1-5].

Over the years there has been the production of percentile curves for BW as a function of GA to guide physicians and parents about fetal and newborn growth [5-7]. Those mostly charts are restricted to 3rd trimester gestation [5-7]. Also, some of these studies address specific contexts such as fetal gender, parity, and ethnicity [10-12]. Beings a positive association between PW and BW with ethnicity and parity [10-12]. Moreover multiparous increases the odds of having a PW-R≥90th percentile, and the effect is most pronounced in the infants born at ≤32 weeks [10]. Knowing that fetal gender shows association with PW, the categorization into male and female-specific curves is important because male weigh more than female at each GA [11-18]. Unlikely, the present study discloses non-statistically significant differences between gender for PW, FW, and BW, except for the PW at 27 weeks of GA (p=.033) and BW at 25 weeks (p=.021) and 40 weeks (p=.018). This suggest that the association between or BW and gender will not be relevant at early GA.

There is some evidence that the shape and size of the placenta are factors that may be statistically associated with pregnancy complications (e.g, IUGR, reduced fetal movements) and an individual's long-term health [19-24].

Besides PW has been described as an independent predictor of BW and a good predictor for chronic diseases in later life [2,3,11,13,15,17-24]. PW percentile curves are rare and mostly refer to GA ≥ 24 weeks [14-18,21,22]. BPW-R (e.g. the BW over the PW) and PW-R (e.g. PW over the BW) percentile curves were a significant contribution to the literature and medicine practice [14-18,21,22] However, rare population curves to date have looked at an early GA such as 12th weeks or earliest [25].

Although reversed, PW-R percentile curves are more specific to the purpose of the present study see (Figure 5) and (Figure 6). Also, a significant linear association with a very strong

Table 7. Correlation between placental measures, placental weight and placental volume

Correlations

		Placental Weight (g)	Placental Volume	Largest Placental Diameter	Smallest Placental Diameter	Placental Thickness
Placental Weight (g)	Pearson Correlation	1	,883**	,826**	,829**	,619**
	Sig. (2-tailed)		,000	,000	,000	,000
	N	1951	1944	1949	1948	1947
Placental Volume	Pearson Correlation	,883**	1	,883**	,877**	,621**
	Sig. (2-tailed)	,000		,000	,000	,000
	N	1944	1944	1944	1944	1944
Largest Placental Diameter	Pearson Correlation	,826**	,883**	1	,918**	,396**
	Sig. (2-tailed)	,000	,000		,000	,000
	N	1949	1944	1949	1948	1945
Smallest Placental Diameter	Pearson Correlation	,829**	,877**	,918**	1	,398**
	Sig. (2-tailed)	,000	,000	,000		,000
	N	1948	1944	1948	1948	1944
Placental Thickness	Pearson Correlation	,619**	,621**	,396**	,398**	1
	Sig. (2-tailed)	,000	,000	,000	,000	
	N	1947	1944	1945	1944	1947

**Correlation is significant at the 0.01 level (2-tailed). Nogueira R, *et al.*, Portugal, Porto, Embryofetal Pathology Laboratory.

or strong positive association between placental biometries may improve the charaterization of the PW and PV and consequently the placental function evaluation.

Knowing that BPW-R and PW-R are important parameters for the balance between fetal and placental growth and considering the functional reserve capacity of the placenta, those may be the greatest predictors of IUGR and diseases in later life than PW and BW alone [1,12,15-18,21,22]. PW-R appears to reflect differences in growth pattern and placental efficiency and correlates significantly with fetal morbidity and short-term adverse perinatal outcomes also [19-24].

Thus, the existence of a linear correlation between placental measurements and a good association with placental volume demonstrated in the present study, may improve prenatal diagnosis and anticipate measures in specific placental and/or fetal situations to prevent the adverse outcome of pregnancy.

Conclusions

Gestational-age-specific placental percentile curves for PW, BPW-R, and PW-R for singleton delivery between 12th and 41st weeks of gestation are available to liken results between countries and regions. The significant association between placental measurements contributes to the assessment of placental function (related to size and volume) and its implication in fetal growth, assisting clinicians in preventing fetal life risks and improving maternal and child health.

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