Original Article

Comparison of Placental and Birth Weight Ratios in Term Neonates, Neonates with Low Apgar Score, and Stillbirths in Asian Indian Population: A Retrospective Observational Study

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ABSTRACT

Introduction: Unanticipated stillbirth or a low Apgar score baby at term gestation is an adverse outcome that is difficult to communicate to parents. Such conditions can be partly attributed to placental factors, indicated by low placental weight and a mismatch in the Birth Weight to Placental Weight (BW/PW) ratio. India has the largest burden of stillbirths; however, there is a lack of data from India on BW/PW ratios for stillbirths.

Aim: To determine if there are significant differences in PW between normal live births, live births with low Apgar scores and stillbirths at term using local population centiles.

Materials and Methods: A retrospective observational study was conducted using data retrieved from electronic medical records from January 2019 to December 2022 at the obstetrics department of Fernandez Hospital, a private tertiary referral perinatal institute with an Asian Indian population. All singleton term births were included after excluding multifoetal births,

medical disorders and placental pathologies. The population was divided into three groups: newborns with normal Apgar scores, those with low Apgar scores and stillborn infants. STATA v14.0 (College Station, TX, USA) was used for statistical analysis to assess differences between the groups, with newborns with normal Apgar scores as the reference group.

Results: There were 35,576 births during the study period, with 18,143 singleton term pregnancies, including 17,986 term normal Apgar births, 110 low Apgar births (0.36%), and 47 stillbirths (1.37 per 1,000). The mean BW, PW (p-value<0.001), and the proportion with PW <10th centile (p-value<0.001) differed significantly between the three groups. The BW/PW ratio was >90th centile in 10 stillbirths (21.74%), reflecting a mismatch in foetal and placental weight.

Conclusion: Lower PW and higher BW/PW ratio centiles in term stillbirths validate their use as measures of placental function in evaluating all term adverse outcomes.

Keywords: Centiles, Ethnicity, Singleton

INTRODUCTION

Significant impairment of placental function can be responsible for stillbirths or births with low Apgar scores, as they experience the stress of labour [1]. The placental reserve is designed to support normal foetal growth and to withstand the stress of uterine contractions during labour. Any decrease in placental reserve can affect foetal wellbeing with varying levels of severity. Placental function can be assessed by measuring PW and calculating the ratio of foetal BW to PW [2,3]. The BW/PW ratio can be used immediately after childbirth to identify babies that have a reduced placental reserve. Foetal Growth Restriction (FGR) is identified if there is a severe reduction in placental function; however, lesser degrees of growth reduction may be missed if only BW is used as the criterion to determine normal growth. The classification of small, appropriate, or large for gestational age (SGA, AGA, or LGA) is important, as SGA infants have the highest risk of adverse short- and long-term outcomes [4,5]. Conventionally, SGA infants are defined as those with BW below the 10th centile for the population. Babies with BW above the 10th centile (AGA or LGA) may still have decreased growth velocity, which can be identified as a precursor to adverse outcomes [6]. This decreased growth velocity can occur due to a small placenta in a baby that is defined as AGA solely by its birthweight.

India has the highest number of stillbirths in the world, and FGR is the most important cause [7]. The ability of antenatal care pathways to identify a foetus as SGA during the antenatal period is often

inaccurate, even with regular ultrasound assessments, with the first diagnosis typically made at childbirth. The categorisation of a newborn as SGA or AGA depends on the centile charts used, which are influenced by ethnicity and other factors [8]. The mean BW of an Asian Indian term baby is found to be lower when compared to other ethnicities, but most studies in the Asian Indian population have not employed local population-based centile charts [9-16]. Charts from non Indian and non Asian ethnicities may misclassify SGA and AGA births when used for an Asian Indian population. Customised centile charts and calculators were created using local population data in 2015 to address the issue of misclassification and PW centiles for the local population were established in 2024 [8]. This study aimed to compare the BW to PW ratio in term stillborn babies, term live-born babies with low Apgar scores and term live-born babies with normal Apgar scores within an Asian Indian population.

MATERIALS AND METHODS

A retrospective observational study was conducted using data retrieved from electronic medical records from January 2019 to December 2022 at a private tertiary referral perinatal institute with nearly 10,000 annual births. The data retrieval and analysis were performed from June 2023 to December 2024. The records of women who had singleton births at term were retrieved after approval from the institutional review board (EC Ref No 13-2021).

Inclusion criteria: Term singleton births were included in the study.

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Exclusion criteria: Multifoetal pregnancies, preterm births, missing data and women of non Asian Indian ethnicities. Live births with documented placental pathology (such as abruption, placenta previa, manual removal of the placenta, and adherent placenta) were excluded from the study, as these conditions can affect the accuracy of PW measurements.

Study Procedure

The study population was categorised into term stillbirths and live births and the live births were further subdivided into low Apgar births (with scores of less than seven at five minutes after birth) and normal Apgar births (as shown in the flow chart in [Table/Fig-1]).
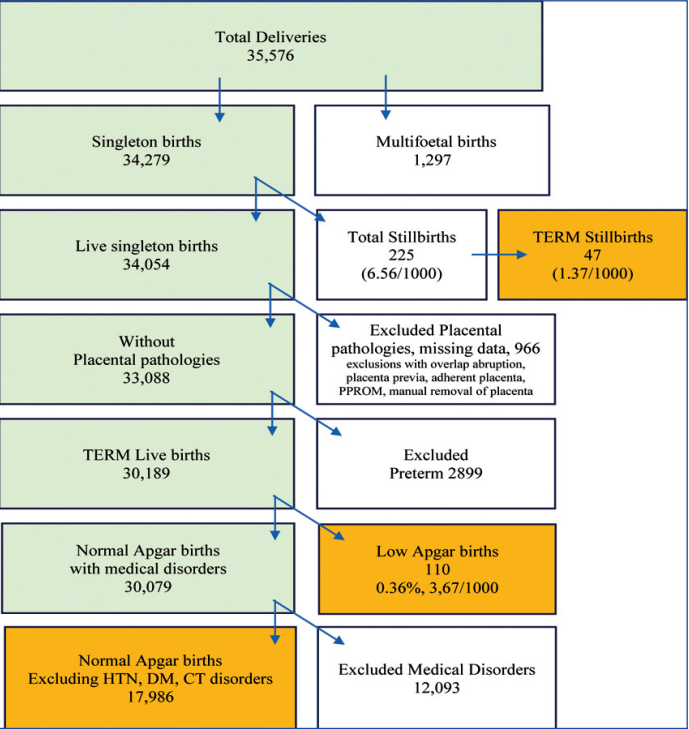
[Table/Fig-1]: Flow chart of study.

Both BW and PW were measured in grams sensitive to two decimal places using an electronic scale. The PW recorded in the birth records was an untrimmed PW that included the umbilical cord. According to the institutional labour and birth protocol, the cord was clamped at a length of five centimetres from the baby and cord blood gases were collected without cutting a segment of the cord. The BW/PW ratio was calculated using the untrimmed PW, as this was the weight captured in the electronic records at the study institute. PW and BW/PW centile charts were created for Appropriate-for-Gestational-Age (AGA), live, singleton births. The data used to create the PW centile distribution for the normal Apgar group excluded medical disorders (such as hypertension, diabetes and connective tissue disorders) and placental pathologies that could skew the centile distribution, such as abruption and manual removal of the placenta. Apgar scores were assessed by a team of neonatologists present at every birth. Term singleton births with Apgar scores greater than 6 at five minutes after birth from the aforementioned cohort were selected as the control group. Low Apgar was defined as Apgar scores of less than or equal to 6 at five minutes after birth [17]. Babies born with no signs of life at term Gestational Age (GA), after 37 weeks of gestation, were defined as term stillbirths. The PW and BW/PW ratio of these term stillbirths and low Apgar births were compared with the control group. Data on maternal age, weight, Body Mass Index (BMI), parity, GA, BW, gender, BW centiles, Apgar scores and birth outcomes were collected. BW centiles were calculated to one decimal place using the Perinatal Institute, UK, customised GROW centiles calculator for this population [8].

STATISTICAL ANALYSIS

The data were anonymised and entered into an MS Excel spreadsheet before being exported to STATA v14.0 (College Station, TX, USA)

for statistical analysis. The distribution of categorical variables was estimated as proportions, while continuous variables were represented as means and standard deviations. The Chi-square test was used to compare proportions and the Student's t-test and one-way Analysis of Variance (ANOVA) were employed to compare means between the term normal live-born, term stillbirth and term live-born with low Apgar groups. The 10th and 90th centiles of the PW (created for each gestational week) were selected for the analysis in alignment with the conventional 10th and 90th centiles used to classify SGA and LGA babies. A p-value<0.05 was considered statistically significant.

RESULTS

There were 35,576 births during the study period, including 1,297 multifoetal pregnancies and 225 stillbirths (0.65%). After exclusions, 17,986 term normal Apgar births, 110 low Apgar births (0.36%), and 47 stillbirths (1.37 per 1,000) were considered for analysis. One stillbirth at 37 weeks was excluded from the analysis due to an error in the PW entry. The maximum number of stillbirths and the stillbirth rate occurred at 37 weeks [Table/Fig-2].

Characteristics	Normal Apgar term live born n=17,986	Low Apgar term live birth n=110	Term stillbirths[a] n=46	p-value[b]
Mean maternal age in years±SD	27.92 ±3.99	27.77±4.26	28.15±3.82	0.85
Mean maternal BMI (kg/m²)±SD	25.88±4.62	26.66±5.21	27.62±5.61	0.01
Nulliparous (n, %)	9874 (54.89)	85 (77.27)	30 (65.22)	<0.001
Mean gestation in weeks±SD	38.69± 1.10	38.92±1.22	38.23±1.03	0.002
37 weeks (n, %)	3299 (18.34)	21 (19.09)	18 (39.13)	0.001
38 weeks (n, %)	5108 (28.40)	29 (26.36)	14 (30.43)	0.85
39 weeks (n, %)	5211 (28.97)	28 (25.45)	8 (17.39)	0.16
40 weeks (n, %)	3881 (21.58)	23 (20.91)	6 (13.04)	0.37
41 weeks (n, %)	487 (2.71)	9 (8.18)	0	0.001
Female (n, %)	9039 (50.26)	52 (47.27)	24 (52.17)	0.78

[Table/Fig-2]: Characteristics of the study groups.
a. Term stillbirths were 47, however, one stillbirth at 37 weeks was excluded from analysis due to an error in Placental Weight (PW) entry. The study analysis was done for 46 stillbirths; b. The p-value was calculated using the Chi-square test to compare proportions, and the Students' t-test and One-way ANOVA test were used to compare means

BW and SGA: The mean birthweight (p-value <0.01) and mean birthweight centiles (p-value=0.001), as well as the number of birthweight centiles below the 10th centile (p-value=0.004), differed significantly between term stillbirths and normal live births. However, there were no significant differences between low Apgar and normal live births [Table/Fig-3].

Characteristics	Normal Apgar term live born n=17,986	Low Apgar term live birth n=110	Low APGAR vs Normal p-value[a]	Term stillbirths (SB) n=46	Term SB vs Normal p-value[a]
Mean birthweight	3017.57± 401	2956.81± 440	0.11	2751.52± 499	<0.001
Mean birth centiles	49.89± 28.31	45.9± 29.19	0.14	36.6± 31.13	0.001
Less than 10th centile	1470 (8.17)	12 (10.9)	0.99	11 (23.91)	0.004
Less than 3rd centile	292 (1.62)	5 (4.54)	0.02	5 (10.89)	<0.001
More than 90th centile	1832 (10.18)	10 (9.09)	0.71	4 (8.69)	0.74
More than 97th centile	642 (3.56)	4 (3.63)	0.96	1 (2.17)	0.61
Mean Placental Weight (PW)	562.57± 115	558.77± 133	0.73	485.97± 110	<0.001

Mean BW/PW ratio	5.51±0.97	5.45±0.88	0.51	5.81±1.09	0.04
PW less than 10th centile	1988 (11.05)	19 (17.27)	0.04	15 (32.61)	<0.001
PW more than 90th centile	2420 (13.45)	21 (19.09)	0.08	3 (6.52)	0.16
BW/PW ratio less than 10th centile	1486 (8.26)	14 (12.73)	0.09	2 (4.35)	0.33
BW/PW ratio more than 90th centile	1983 (11.03)	10 (9.09)	0.52	10 (21.74)	0.02

[Table/Fig-3]: Primary outcomes in the three groups; normal Apgar, low Apgar live births and stillbirths.
a. The p-value was calculated using the Chi-square test to compare proportions, and the students' t-test and One-way ANOVA test were used to compare means.

PW and the BW/PW ratio: The mean PW (p-value<0.001) and mean BW/PW ratio (p-value=0.04) differed significantly between normal births and term stillbirths [Table/Fig-3]. The 10th and 90th centiles for the BW/PW ratio were calculated for each gestational week from 37 to 41 weeks (4.18-6.46 for 37 weeks, 4.29-6.59 for 38 weeks, 4.38-6.70 for 39 weeks, 4.45-6.81 for 40 weeks, and 4.49-6.90 for 41 weeks). The percentage of BW/PW ratios above the 90th centile was double in the stillbirth group compared to normal live-born babies (21.74% vs 11.03%, p-value=0.02), but there was no significant difference between term normal and low Apgar births (p-value=0.52) [Table/Fig-3].

A subgroup analysis was conducted for all SGA (n=1,493) and AGA (n=14,803) births within the aforementioned groups [Table/Fig-4,5]. The SGA stillbirths and low Apgar babies had 36.36% and 66.67% of placental weight below the 10th centile, and the BW/PW ratio was above the 90th centile in 9.09% and 25%, respectively [Table/Fig-4]. The AGA babies were analysed, including 14,684 normal Apgar, 88 low Apgar, and 31 stillbirths and are presented in [Table/Fig-5]. The distribution of the BW/PW ratios against the centile charts for the low Apgar and stillbirth groups is shown in [Table/Fig-6].

|	Normal Apgar term SGA N=1470	Low Apgar term SGA N=12	Term SGA Stillbirths N=11
Placental Weight (PW) <10th centile	539 (36.67)	8 (66.67)	4 (36.36)
PW >90th centile	26 (1.77)	0	0
BW/PW ratio <10th centile	157 (10.68)	1 (8.33)	1 (9.09)
BW/PW ratio >90th centile	156 (10.61)	3 (25)	1 (9.09)

[Table/Fig-4]: Placental Weight (PW) and BW/PW ratio in SGA babies (less than 10th centile).
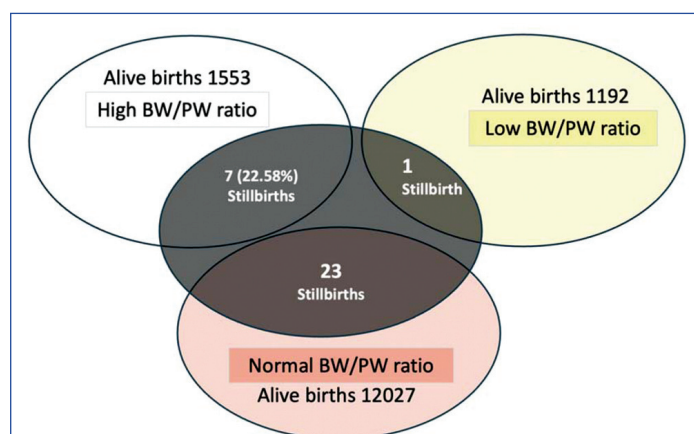
[Table/Fig-5]: BW/PW ratio in AGA live born (n=14,772) and stillbirths (n=31).

DISCUSSION

The study reported a term stillbirth rate of 0.13% (n=47) and a low Apgar rate of 0.38% (n=110) during the study period. The number of SGA babies in the normal live birth group at term gestation was
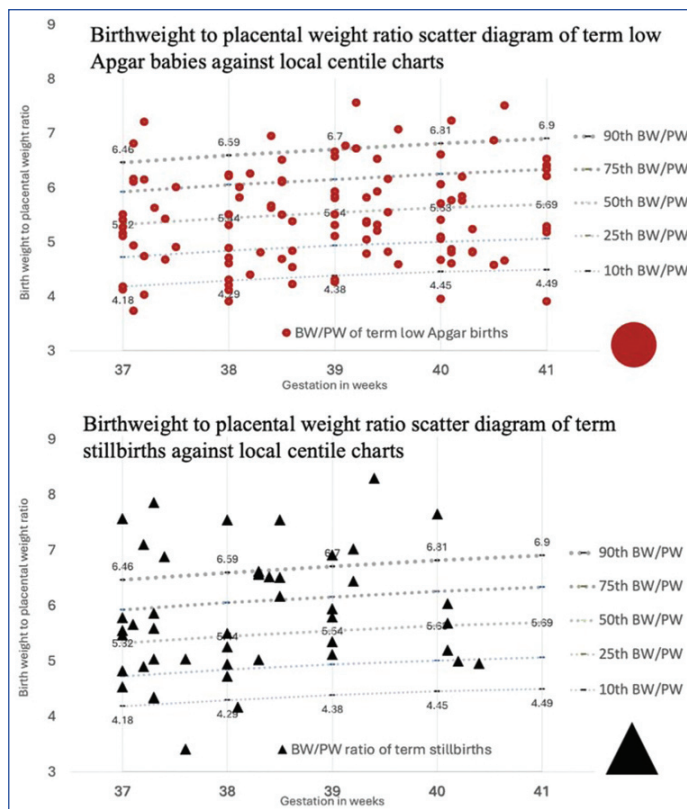
[Table/Fig-6]: Distribution of Birth Weight (BW) to Placental Weight (PW) ratios on centile charts.

1,470 (8.17%), as the hospital protocol dictates planning for birth at 37 weeks only if there are features of FGR according to ISUOG criteria [18]. The proportion of SGA babies in the stillbirth group was higher (23.91%), suggesting that foetal growth is a significant factor in term foetal deaths and indicating the possibility of missing the identification of all SGA cases before birth. The low Apgar group exhibited a significantly higher number of severe FGR cases below the 3rd centile (5 out of 110, 4.54%, p-value=0.02). This finding is important for intrapartum care, as the management differs if FGR is identified, and the timing of birth for known FGR is planned for 37 weeks. Low Apgar births had similar mean birth weights and placental weights compared to normal controls, suggesting that we may not be able to identify babies with subtle placental dysfunction if we rely solely on weight assessments.

The baby BW to PW ratio centiles applied to the normal Apgar group showed that 8.26% had ratios below the 10th centile and 11.03% had ratios exceeding the 90th centile. A higher ratio indicates a smaller placenta for that birth weight, and the stillbirth group included 10 babies (21.74%, p-value=0.02) that exhibited this discrepancy. Interestingly, only one of these ten stillbirths had an SGA birth weight of the 7.3 centile; the remainder were all AGA births. Two of these were LGA with birth weights of 4.1 and 3.75 kg, resulting in BW/PW ratios of 7.52 and 7.81, respectively. These larger babies demonstrated a mismatch with a smaller placenta for every unit of birth weight.

The mean BW/PW ratio (5.51) was comparable to that found in a previous study of an Indian population [19]. The creation of centiles for the BW/PW ratio for each SGA enables categorisation into those below the 10th centile and above the 90th centile, rather than merely comparing means. The customised population centiles for BW with Indian ethnicity allowed for categorisation based on centiles into SGA and LGA for every gestational week rather than using the low BW category of <2,500 grams, which may not accurately reflect growth disorders. The results of this study indicate that not all SGA births have a higher BW/PW ratio and not all high BW/PW ratios correspond to small babies. One in five AGA stillbirths (22.58%) exhibited a high BW/PW ratio above the 90th centile for that SGA [Table/Fig-5]. This finding may help identify

a group of babies with lesser degrees of placental failure, which could warrant closer monitoring after childbirth. Stillbirths and low Apgar scores at term are infrequent; thus, large volumes of data are required for statistically significant analysis and inference. The sample size and the use of locally relevant centiles are the primary strengths of this study.

Limitation(s)

The retrospective nature of the study was a limitation, but this was offset by electronic data capture, which mandates the entry of birth outcomes and PW. The use of untrimmed weight, including the umbilical cord, was also a limitation; however, the hospital protocol requires measuring and recording the total weight. Previous studies have shown a correlation of 0.98 between untrimmed and trimmed PW [20]. Present study did not adjust for the umbilical cord weight, as the placental centile charts were also based on untrimmed PWs. The use of a subjective Apgar score of less than 7 at five minutes can be seen as a limitation of this study, rather than relying on umbilical cord acid-base analysis (cord ABG). Present study did not include cord ABG due to the lack of uniform testing for this measure in the normal Apgar group. The hospital has a policy of mandatory attendance by a neonatologist for every birth, and the Apgar score was available for all live births.

CONCLUSION(S)

The function of the placenta is to support foetal growth. The ratio of BW to PW is associated with adverse outcomes at birth and can serve as an indicator of uteroplacental reserve. The study suggests that measuring PW and calculating the BW/PW ratio may be beneficial for assessing all adverse outcomes at birth.

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