Charts of Thai Fetal Biometries: 2. Biparietal Diameter

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Abstract

A cross-sectional study was conducted in order to construct a new reference chart for Thai fetal biparietal diameter (BPD). A total of 621 normal pregnant women between 12-41 weeks of gestation and their fetuses were recruited. Measurements were made once at a randomly assigned gestational age specifically for the purpose of this study only. Due to unfavorable fetal position in some cases, BPD data were available in 613 measurements. Linear regression models were fitted separately to estimate the mean and standard deviation as functions of gestational age. Reference centiles were constructed from both equations, assuming the data were normally distributed. A new reference centiles chart for BPD is presented and compared with previously published data. Our derived centiles were clearly lower than those from Western studies showing the importance of racial differences between populations. This elucidates the need to develop fetal biometries charts specifically for each region.

Key word : Fetal Biometries, Biparietal Diameter, Reference Centiles

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Fetal biparietal diameter (BPD) is one of the most common fetal biometries used in estimating gestational age as well as fetal growth in obstetric ultrasound examination[1,2]. In the past three decades, many authors have published standard charts for fetal BPD during normal pregnancy,[1-4] but many of these studies might have some weaknesses in the design and statistical analysis. Altman et al[5] have proposed a more appropriate approach for developing fetal size charts. We have adopted and applied such a technique to develop fetal size charts for Thai fetuses. Furthermore, previously developed charts may be appropriate for Western but not Thai fetuses partly due to racial differences,

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as mentioned by some investigators[3]. We have, therefore, constructed a new chart of Thai fetal BPD between 12-41 weeks of gestation, and also compared our results with other published data both from Western and Thai populations.

MATERIAL AND METHOD

This was a cross sectional study, conducted at the Maternal-Fetal Medicine Unit, Department of Obstetric and Gynecology, Siriraj Hospital. A total of 621 pregnant women between 12-41 weeks of gestation and their fetuses were enrolled. For each fetus, BPD was measured once at a randomly assigned gestational age for the purpose of this study only. The study design and sample selection are discussed in detail in the methodology part of this series.

The fetal BPD was measured in a standard axial plane at the level where the continuous midline echo is broken by the septum pellucidum cavum in the anterior third[6]. Measurements were made from the proximal echo of the fetal skull to the proximal edge of the border deep to the ultrasound beam (outer-inner diameter). All of the measurements were performed by only one well-trained investigator, using a 5 MHz convex probe of the Acuson Model 128 X P4 ultrasound machine.

Statistical Analysis

The analysis methods proposed by Altman et al[5] were used with our data. The technique is described in detail in the methodology part of this series. In brief, we fitted the stepwise linear regression model separately for the mean and standard deviation (SD) of the BPD as functions of gestational age. The method was based on the assumption that the measurements at each gestaional age were normally distributed. Goodness of fit and normality of data were carefully assessed before the final models were chosen. Standard deviation scores (SDS) were calculated by subtracting the fitted mean from the observed data, divided by the fitted SD and then the normal plot of SDS was examined. We plotted the SDS against gestational age and the proportion of observations below and above the 10th and 90th centiles were determined if they were close to the expected value. Reference centiles for BPD were then derived. The 100ath centile can be estimated from mean + $Z\alpha$(SD), where $Z\alpha$ is the corresponding value from the standard normal distribution.

RESULTS

Biparietal diameter data were available from 613 of 621 measurements due to unfavorable fetal position in some cases. The number of fetuses measured at each week of gestation is shown in Table 1.

The model for the mean BPD was estimated using the stepwise linear regression technique. Standard deviations (SD) were modeled as a function of gestational age using the same regression technique. The regression equations for mean and SD are

$$BPD = -5.712 + 1.22\,W + 0.102\,W^2 - 0.002\,W^3$$

$$SD = 1.096 + 0.0012\,W^2$$

where W = gestational age (weeks)

Fig. 1 shows a scatter plot of BPD against gestational age with the fitted line from the equation above. The regression model for the mean gave

Table 1. Number of fetuses measured at each week of gestation.

Gestational age (weeks)	Number of fetuses	Percentage
12	13	2.12
13	15	2.45
14	14	2.28
15	19	3.10
16	22	3.59
17	22	3.59
18	21	3.43
19	22	3.59
20	21	3.43
21	21	3.43
22	24	3.92
23	26	4.24
24	22	3.59
25	26	4.24
26	27	4.40
27	23	3.75
28	22	3.59
29	20	3.26
30	27	4.40
31	19	3.10
32	20	3.26
33	22	3.59
34	20	3.26
35	17	2.77
36	23	3.75
37	19	3.10
38	17	2.77
39	18	2.94
40	16	2.61
41	15	2.45
Total	613	100

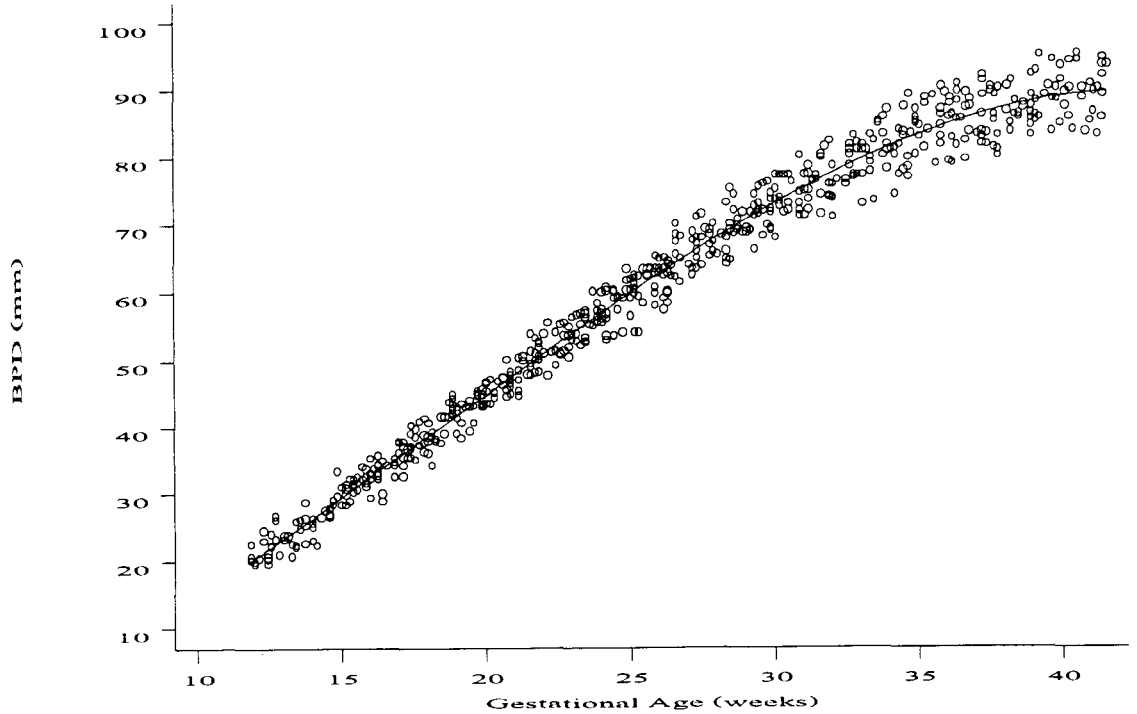

Fig. 1. Scatter plot of biparietal diameter and gestational age with curve of the fitted mean.

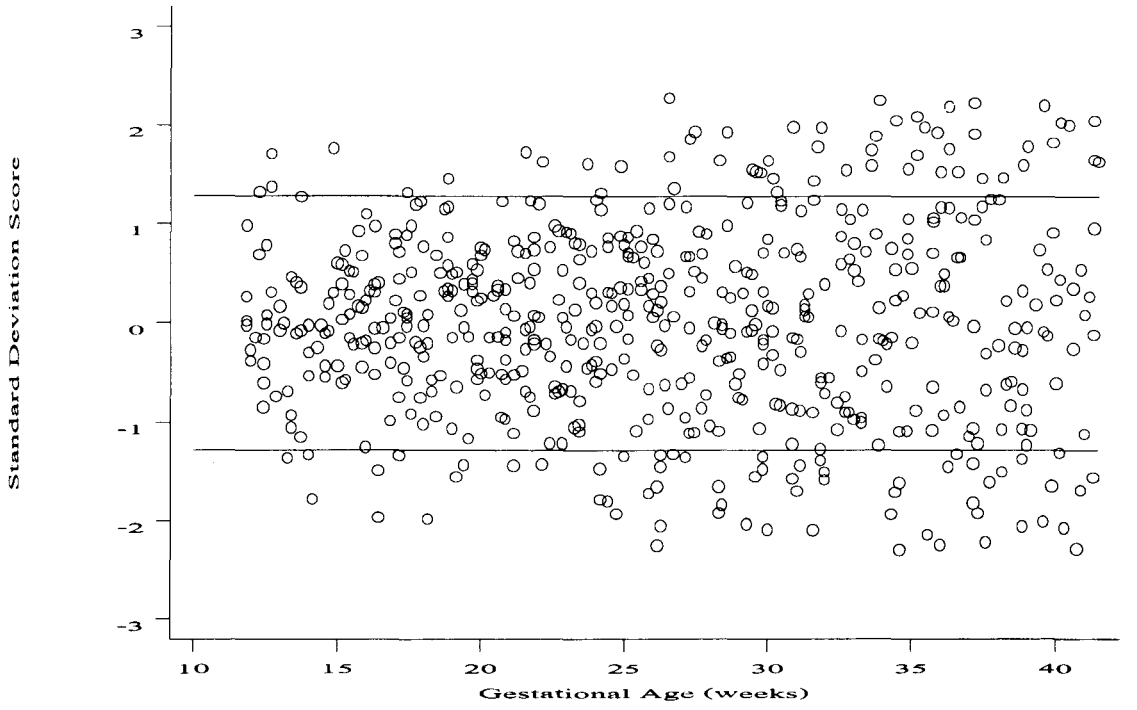

Fig. 2. Plot of SDS against gestational age, with the expected 10th and 90th centile lines.

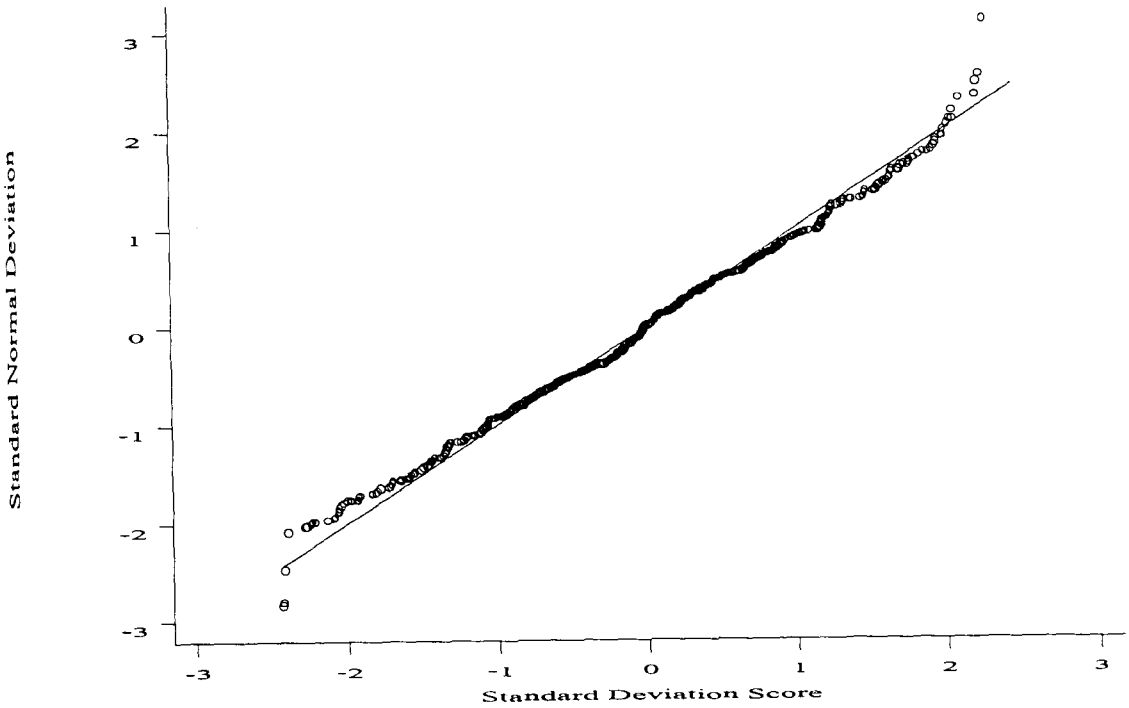

Fig. 3. Normal plot of SDS.

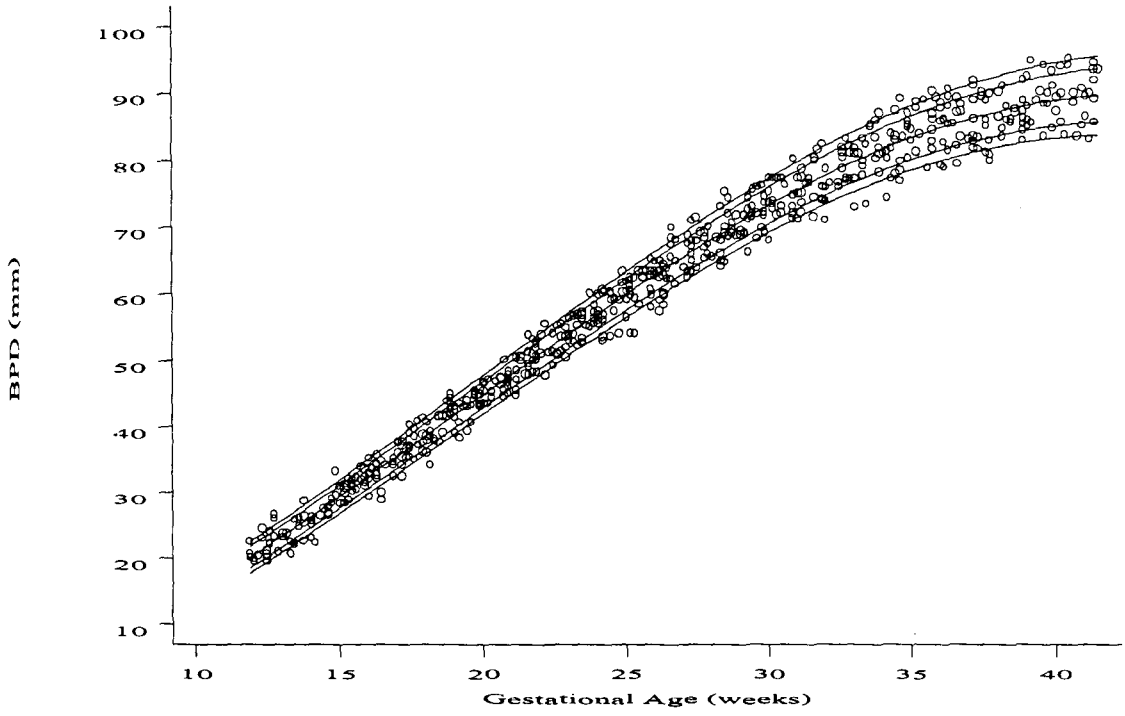

Fig. 4. Biparietal diameter data with fitted 3rd, 10th, 50th, 90th, and 97th centile lines.

Table 2. Fitted centiles of Thai fetal biparietal diameter.

GA (weeks)	Centile					SD
	3rd	10th	50th	90th	97th	
12	18.09	18.85	20.47	22.10	22.86	1.27
13	20.94	21.72	23.39	25.05	25.83	1.30
14	23.86	24.65	26.36	28.07	28.87	1.33
15	26.82	27.64	29.39	31.14	31.96	1.37
16	29.82	30.65	32.45	34.25	35.09	1.40
17	32.83	33.70	35.55	37.40	38.26	1.44
18	35.87	36.76	38.66	40.57	41.45	1.49
19	38.90	39.82	41.78	43.74	44.66	1.53
20	41.93	42.87	44.89	46.91	47.86	1.58
21	44.94	45.91	47.99	50.07	51.04	1.63
22	47.91	48.91	51.06	53.21	54.22	1.68
23	50.84	51.88	54.10	56.32	57.35	1.73
24	53.72	54.79	57.08	59.38	60.45	1.79
25	56.54	57.64	60.01	62.38	63.48	1.85
26	59.28	60.42	62.87	65.31	66.45	1.91
27	61.93	63.11	65.64	68.17	69.35	1.97
28	64.49	65.71	68.32	70.94	72.16	2.04
29	66.94	68.20	70.90	73.61	74.87	2.11
30	69.28	70.58	73.37	76.16	77.46	2.18
31	71.48	72.82	75.71	78.59	79.94	2.25
32	73.54	74.93	77.91	80.90	82.29	2.33
33	75.45	76.89	79.97	83.05	84.49	2.40
34	77.20	78.68	81.87	85.05	86.54	2.49
35	78.77	80.30	83.69	86.89	88.43	2.57
36	80.16	81.74	85.15	88.55	90.13	2.65
37	81.35	82.99	86.50	90.02	91.66	2.74
38	82.34	84.03	87.66	91.29	92.98	2.83
39	83.12	84.85	88.60	92.35	94.10	2.92
40	83.65	85.45	89.32	93.19	94.10	3.02
41	83.95	85.81	89.80	93.80	95.66	3.12

R^2 value of 0.98 which means that the model can explain 98 per cent of the variability. Standard deviation scores (SDS) were calculated and plotted against gestational age and it shows no pattern, as shown in Fig. 2. The proportion of observation below and above the expected 10th and 90th centiles were 9.8 per cent (60 of 613) and 11.1 per cent (68 of 613) respectively. Fig. 3 shows the normal plot of SDS with the values lying almost in a straight line. This suggested that the models provided a good fit to the observed data and the data are normally distributed.

Reference centiles were calculated from the estimated mean and SD at each week of gestation. The 100αth centile can be derived from mean + $Z\alpha$(SD), where the values of $Z\alpha$ are -1.88, -1.28, 0, 1.28, and 1.88 for the 3rd, 10th, 50th, 90th, and 97th centiles respectively. All the fitted centiles are shown in Table 2 and they were plotted with BPD data and are shown in Fig. 4.

We compared our derived centiles for BPD with those of Chitty et al,[7] as shown in Fig. 5. The plane of measurement and methodology were the same in both studies. The 10th, 50th, 90th centile lines of our study were slightly higher at lower gestational age (before 15 weeks) but become lower afterwards.

DISCUSSION

In obstetric clinical practice, accurate assessment of gestational age is very important. Biparietal diameter is one of the most common fetal biometries that has been used to estimate gestational age. In the past, many authors have proposed a normogram for BPD,[1-4] but their methodology and analysis technique might not be appropriate. We have applied an alternative approach for deriving fetal size charts proposed by Altman et al[5]. We used the parametric method, i.e., linear regression technique in modeling the mean BPD.

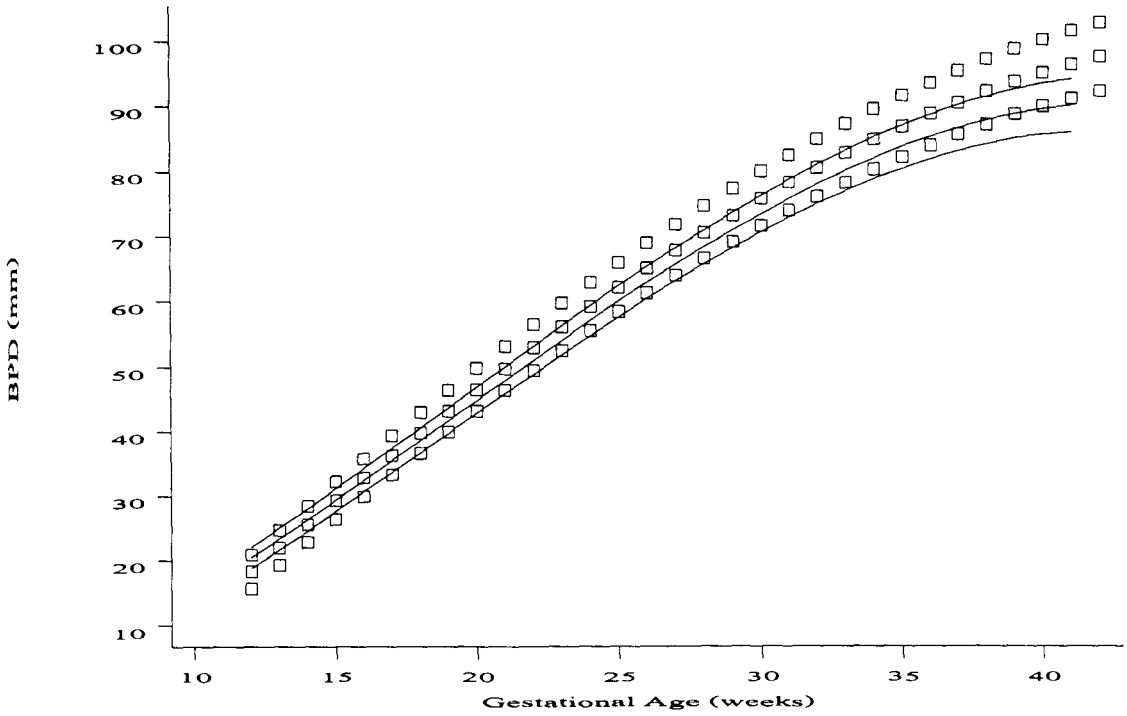

Fig. 5. Comparison of derived biparietal diameter centiles (10th, 50th, and 90th) between our study (line) and Chitty et al (square).

This gave us the centile curves that change smoothly with gestational age. We allowed the change of variability of the mean by modeling the residuals as a function of gestational age, which is another advantage of this analysis technique that helps make the result more realistic.

Previously reported fetal size charts were usually derived from the measurements of Western populations. It may not be appropriate to use such data as the standard for Thai fetuses. In this paper, we derived reference centiles of BPD for Thai fetuses between 12-41 weeks gestation. When comparing our results with those of Chitty et al[7] who used the same design and analysis technique, we found that our centile lines lie slightly higher at the beginning of pregnancy until about 15 weeks of gestation, after which our centile lines become lower. Our 90th and 50th centile lines are close to 50th and 10th centile lines of their study respectively (Fig. 5). On the other hand, our estimated 50th centile values are close to the mean values of southern Thai women reported by Koranantakul et al[4]. This elucidates the importance of racial differences between populations on fetal size. Many have suggested that it is important to establish fetal size charts for populations of each separate region[8-11].

SUMMARY

We have presented a new centile chart for fetal BPD measurements derived from a carefully designed prospective cross sectional study. Each fetus was measured for BPD only once at a randomly assigned gestational age, specifically for the purpose of this study. The mean and SD of BPD at each gestational age were estimated using the stepwise linear regression model and reference centiles were then derived. Comparing the centiles with those of others, we found that the newly developed centiles would be more appropriate for Thai fetuses than those previously published from Western countries.

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ตารางอ้างอิงสำหรับขนาดทารกในครรภ์ : 2. เส้นผ่าศูนย์กลางไบพาไรอีตัล

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ได้ทำการศึกษาแบบตัดขวางเพื่อสร้างตารางอ้างอิง สำหรับ Biparietal diameter (BPD) ของทารกไทย ซึ่งวัดจากการตรวจด้วยเครื่องตรวจคลื่นเสียงความถี่สูง โดยทำการศึกษาสตรีตั้งครรภ์ปกติ จำนวน 621 ราย อายุครรภ์ระหว่าง 12–41 สัปดาห์ ทำการวัดขนาด BPD ของทารกในครรภ์แต่ละรายที่อายุครรภ์ต่างๆ กัน โดยการสุ่ม เพื่อการศึกษาครั้งนี้โดยเฉพาะสามารถวัดขนาด BPD ได้ทั้งหมด 613 ราย ทำการวิเคราะห์ข้อมูลโดยหาสมการถดถอยเชิงเส้น สำหรับค่าเฉลี่ยและส่วนเบี่ยงเบนมาตรฐานของ BPD ในช่วงอายุครรภ์ต่างๆ จากนั้นจึงทำการสร้างตารางอ้างอิงจากสมการทั้งสอง

ในรายงานนี้ได้นำเสนอตารางอ้างอิงสำหรับขนาด BPD ของทารกไทย และทำการเปรียบเทียบกับข้อมูลจากต่างประเทศ พบว่าขนาด BPD ของทารกไทยเล็กกว่า BPD ของทารกในประเทศทางตะวันตก แสดงถึงความสำคัญของเชื้อชาติต่อขนาดของทารกในครรภ์ ดังนั้นจึงมีความจำเป็นที่จะต้องสร้างตารางอ้างอิงเฉพาะสำหรับแต่ละภูมิภาค

คำสำคัญ : ขนาดทารกในครรภ์, เส้นผ่าศูนย์กลางไบพาไรอีตัล, ตารางอ้างอิง

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