

Gestational age and birth weight centiles of singleton babies delivered normally following spontaneous labor, in Southern Sri Lanka

K Attanayake¹, S Munasinghe², M Goonewardene³, P Widanapathirana⁴, I Sandeepani⁴, L Sanjeewa⁴

Abstract

Aims To estimate the gestational age and birth weight centiles of babies delivered normally, without any obstetric intervention, in women with uncomplicated singleton pregnancies establishing spontaneous onset of labor.

Method Consecutive women with uncomplicated singleton pregnancies, attending the Academic Obstetrics and Gynecology Unit of the Teaching Hospital, Mahamodara, Galle, Sri Lanka, with confirmed dates and establishing spontaneous onset of labor and delivering vaginally between gestational age of 34-41 weeks, without any obstetric intervention, during the period September 2013 to February 2014 were studied. The gestational age at spontaneous onset of labor and vaginal delivery and the birth weights of the babies were recorded.

Results There were 3294 consecutive deliveries during this period, and of them 1602 (48.6%) met the inclusion criteria. Median gestational age at delivery was 275 days (range 238-291 days, IQR 269 to 280 days) and the median birth weight was 3000 g (range 1700g - 4350g; IQR 2750 - 3250g). The 10th, 50th and 90th birth weight centiles of the babies delivered at a gestational age of 275 days were approximately 2570 g, 3050 g and 3550 g respectively.

Conclusion The median gestational age among women with uncomplicated singleton pregnancies who established spontaneous onset of labor and delivered vaginally, without any obstetric intervention, was approximately five days shorter than the traditionally accepted 280 days. At a gestational age of 275 days, the mean birth weight was approximately 3038g and the 50th centile of the birth weight of the babies delivered was approximately 3050g.

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¹Academic Obstetric and Gynecology Unit, Teaching Hospital, Mahamodara, Galle, ²National Intensive Care Surveillance, Castle Street Hospital for Women, Colombo, ³Department of Obstetrics and Gynecology, International Medical University, Clinical Campus Seremban, Malaysia, ⁴Department of Obstetrics and Gynecology, University of Ruhuna, Faculty of Medicine, Galle, Sri Lanka.

Correspondence: MG, e-mail: <IndraMalikRodrigo@imu.edu.my>. Received 15 February 2018 and revised version accepted 20 February 2018.

Introduction

Pregnant women and their partners are anxious to know the “estimated date of delivery” (EDD). Accurate determination of the gestational age is vitally important for clinical management of a pregnancy. Like any biological variable there is a variance in the normal duration of a pregnancy and the gestational age from 37-42 weeks is defined as ‘Term’ [1].

Accurate estimation of gestational age is not easy. The combination of a calculation of 280 days from the first day of the last menstrual period (LMP) and a standardised, ultrasound crown-rump length measurement between 9-14 weeks, plotted on an appropriate chart, is considered the best method to confirm gestational age [2,3]. If the discrepancy between the crown-rump length and LMP estimates is less than seven days, the LMP is considered valid. It is thought that up to 30% of women have unreliable menstrual dates. In a study carried out in Washington DC, 56% of women accurately recalled their menstrual dates; 74% were within 1 day, and 81% were within 2 days [4]. A woman’s recall of her menstrual dates may be associated with digit preference. The estimated gestational age by LMP is approximately 2.8 days longer on average compared to the gestational age estimated by sonology [5]. When using LMP, mild variations of menstrual cycle length and the inherent variability in the timing of ovulation are not considered. During sonology, there could be sonographer errors as well as inter and intra observer variations, depending on how many measurements and how meticulously these measurements are obtained, the expertise of the sonographers, and their work load. Furthermore, ultrasound estimation of gestational age assumes that all fetuses with a given measurement will have the same gestational age. This is not a good scientific argument because the inherent biological variability, whether it is small or large, should be considered. The limitations of using reference charts for



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ultrasound biometry are also well documented [3,6,7]. This is the reason why in the large multicenter Intergrowth-21st Project, women were excluded from the study if the difference between the crown-rump length and LMP estimates was more than seven days [3]. However, in clinical practice, when there is a discrepancy of more than seven days, the dates obtained by sonology are used for further management [2]. However, considering basic scientific principles, the true value may indeed be between the two. Duration of the pregnancy could also be affected by ethnicity, maternal age, parity, body mass index, socio-economic deprivation, maternal cigarette smoking, medical complications and a history of previous preterm delivery. Therefore, considering the inherent variance of any biological parameter, the interpretation of the EDD obtained by whatever method is not easy.

African and Asian fetuses are thought to mature more rapidly than Caucasian fetuses. Therefore, their normal gestation is shorter with a median of approximately 273 days compared to approximately 280 days in European women [8-14]. This effect appears to be more related to the mother's ethnicity than father's ethnicity [11]. In addition, features of fetal post maturity such as passage of meconium, placental changes, increased rates of Death in Utero are observed more in Asian and African women after 37 weeks' gestation compared to European women, which also supports this hypothesis [8,15].

A global reference for fetal weight and birth weight percentiles has been described [16]. This global reference was obtained using the following; mean birth weight and standard deviation at 40 weeks' gestation in the populations studied, the concept of growth potential and of proportionality of growth described by Gardosi and colleagues, fetal weight estimates based on gestation specific references obtained by the application of a formula based on ultra sound measurements as described by Hadlock and colleagues, an assumption that the birth weights at each gestation are normally distributed around the mean birth weight for each gestation, and a constant of 3705 g which is the mean birth weight at 40.5 weeks in Hadlock's formula [17,18]. A total of 14,708 women from Sri Lanka had been included in generating the data for the global reference [16].

Data regarding the normal duration of a singleton pregnancy for women in Sri Lanka are not available. Therefore the current study was designed to a) estimate the median gestational age at which women with uncomplicated singleton pregnancies would establish spontaneous onset of labor and deliver vaginally without any obstetric intervention, b) to obtain the gestation specific centiles of the birth weights of the babies, and compare them with the calculated birth weight percentiles obtained by the application of the weight percentiles calculator of the global reference for fetal weight and birth weight percentiles [16].

Methods

Since no similar studies have been carried out in Sri Lanka we used the median gestational age reported from India of 39 weeks + 2 days, and reports from a large study carried out in Asians in England of 39 weeks [8,11]. It was assumed that the median gestational age in the population under study would be approximately 39 weeks and that approximately 50% of women with uncomplicated singleton pregnancies would establish spontaneous onset of labor and deliver vaginally without any obstetric interventions by 39 weeks gestation. Therefore, the minimum sample size required to detect this 50%, with a precision of 5%, was calculated to be 385 [20]. In women establishing spontaneous onset of labor, the proportion of women who would deliver vaginally without any obstetric interventions was not known. Therefore, as this was only an observational study all women with uncomplicated singleton pregnancies, attending the Academic Obstetrics and Gynecology Unit of the Teaching Hospital, Mahamodara, Galle, Sri Lanka, with accurate dating of pregnancy, establishing spontaneous onset of labor and delivering vaginally between gestational age of 34-41 weeks, without any obstetric intervention during the period September 2013 to February 2014, were included in the study.

In the unit, all pregnancies were dated by the combination of LMP and fetal biometry obtained with a GE Logiq3 ultra sound scanner (Wipro GE Healthcare Pvt Ltd, Chennai, India). For gestational age between nine to fourteen weeks, if the discrepancy between the estimates by LMP and estimates by crown-rump length were less than seven days, the gestational age estimate obtained by the LMP was considered to be correct. If the discrepancy between the two estimates of gestational age was more than seven days, the gestational age obtained from the crown-rump length measurement was considered to be correct. The estimates from the measurement of the head circumference were considered to be correct if the discrepancy between the two estimates was more than seven days between 14 to 16 weeks gestation and if the discrepancy between the two estimates was more than ten days between 16-22 weeks gestation [2,21]. Data were collected from the case notes of women, within 24 hours of the delivery of their babies. Women not having had a dating scan prior to the 22nd week of gestation were excluded from the study. The gestational age at spontaneous onset of labor and vaginal delivery without any obstetric intervention, was recorded. The birth weight of the baby were recorded with a precision of 5g using a Seca 725 weighing machine (Seca, Hamburg Germany).

Statistical analysis

The median gestational age and the inter quartile range (IQR) was calculated. Thereafter, gestation specific birth weight centile charts were developed using the methods described by Altman and Chitty [22]. Separate

polynomial regression models were fitted to the mean and standard deviation (SD) of birth weights as functions of the gestational age. The linear cubic model gave the best fit. The centiles were derived assuming that at each gestational age the birth weights would have a normal distribution. The standard deviation scores (SDS) for the birth weights were calculated and the goodness of fit of the regression model was assessed by examining the plot of the standard deviation scores to see whether its variability had any pattern, checking whether the standard deviation scores had a normal distribution at each gestational age and calculating the proportion of birth weights falling outside the 10th and 90th centiles. The gestation specific birth weight centiles obtained from the study were compared with the birth weight centiles obtained by applying the mean birth weight at 40 weeks' gestation and its coefficient of variation (standard deviation expressed as a percentage of the mean birth weight of those who delivered at 40 weeks' gestation) in the study sample to the weight percentiles calculator of the global reference for fetal weight and birth weight percentiles [16].

Ethics approval for the study was obtained from the Ethics Review Committee, Faculty of Medicine, University of Ruhuna. Permission to carry out the study was obtained from the Director, Teaching Hospital, Mahamodara, Galle.

Results

Of the 3294 deliveries carried out during the study period, 1602 (48.6%) women with uncomplicated singleton pregnancies established spontaneous onset of labor between gestational age of 34-41 weeks and delivered vaginally, without any obstetric intervention. All women included in the study were married and were non-smokers. Their median gestational age at spontaneous onset of labor and vaginal delivery was 275 days (range 238-291 days, IQR 269 to 280 days) and the mean birth weight of the total sample was 2999 g (range 1700 g to 4350g, 95%

CI 2979 g - 3019 g), and the median birth weight was 3000g (IQR 2750 - 3250 g) (Table 1). Only 80 (5.0%) women delivered on the 280th day with a total of 1207 (75.3%) having delivered by this day. There were 464 (28.9%) deliveries between 280-286 days (Figure 1, Table 2).

Table 1. Characteristics of the study sample

		Range
Age (years) Mean (SD)	27.9 (5.3)	16-46
Parity Median (IQR)	2 (1-2)	1-4
Gestational age at delivery (days) Mean (95% CI)	273.7 (273.3-274.2)	238-291
Birth weight of the baby Mean (95% CI)	2999.0g (2978.7-3019.2)	1700-4350

There were no significant association between maternal age and parity and the median gestational age at spontaneous onset of labor and vaginal delivery. The gestation specific mean birth weights, their 95% CI and the 10th 50th and 90th centiles are shown in Table 2. There were 101 babies delivered at a gestational age of 275 days and their 10th 50th and 90th birth weight centiles were approximately 2570 g, 3050 g and 3550 g respectively. Figure 1 demonstrates the modeling of the mean birth weight by fitting a polynomial regression according to gestational age. Figure 2 shows a random distribution of the standard deviations with no definite pattern. Figure 3 shows that the standard deviations have a normal distribution (virtually a straight line). There were 155 (9.7%) birth weights above the 90th centile and 150 (9.4%) birth weights below the 10th centile.

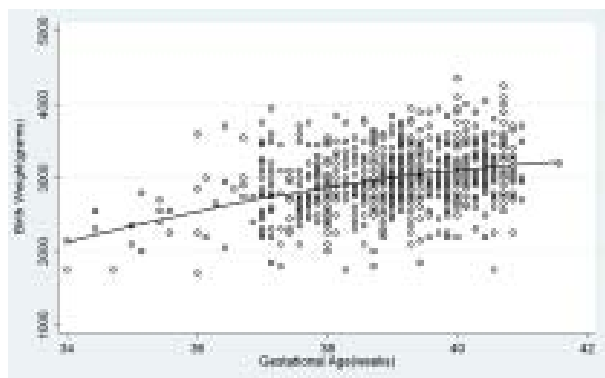


Figure 1. Fitted curve describing the mean birth weight (n=1602).

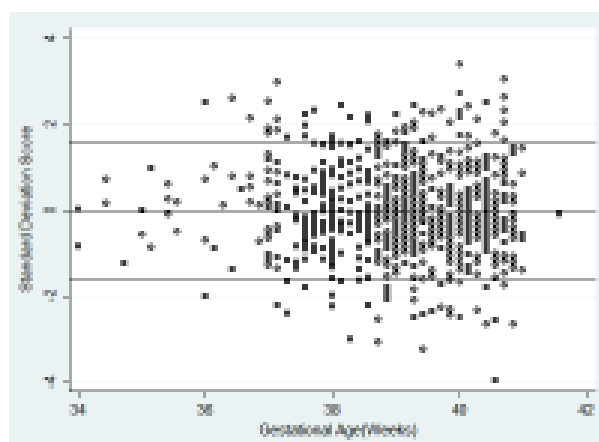


Figure 2. Residuals from model describing mean birth weight with expected 10th and 90th centiles (n=1602).

As the distributional assumptions were satisfied, the 10th, 50th and 90th centiles of the birth weights of the neonates delivered vaginally at gestational age between 34 to 41 without any obstetric intervention ($n=1602$) were calculated (Table 3) and they were superimposed on a scatter diagram (Figure 4).

On comparison of the actual birth weight centiles of the study with the calculated birth weight centiles obtained by using the weight percentiles calculator of the global reference for fetal weight and birth weight

percentiles, the following differences were observed. At 38 weeks' gestation, the actual 10th centile was approximately 7% less than the calculated centile. At 35 and 36 weeks of gestation, the actual 50th centiles were greater (by approximately 8% and 15% respectively) than the calculated 50th centiles. The actual 90th centiles were larger than the calculated 90th centiles prior to 40 weeks' gestation, ranging from an increment of 5% at 39 weeks' gestation to an increment of approximately 21% at 36 weeks' gestation (Table 3 and Figure 5).

Table 2. The gestation specific means, their 95% confidence intervals, and the 10th, 50th and 90th centiles of the birth weights in grams, of the babies delivered vaginally without any obstetric intervention (n = 1602)

Gestational age	Mean	SD	CV	95 % CI	Range	10 th Centile	50 th Centile	90 th Centile
34 weeks n=13 (0.8%)	2150	329	15.3	1468-2777	1750-2550	1750	2150	2550
35 weeks n=14 (0.9%)	2450	227	9.3	2005-2894	2000-2800	2050	2475	2750
36 weeks n=32 (2.0%)	2727	453	16.6	1838-3613	1700-3700	2095	2850	3385
37 weeks n=203 (12.7%)	2809	408	14.5	2007-3610	1800-3950	2300	2750	3450
38 weeks n=349 (21.8%)	2898	422	14.6	2854-2942	1750-3850	2300	2900	3500
39 weeks n=516 (32%)	3057	354	11.6	3026-3087	1850-3950	2700	3000	3550
40 weeks n=464 (29%)	3146	371	11.8	3112-3180	1750-4350	2700	3100	3600
41 weeks n=11 (0.7%)	3286	352	10.7	2596-3975	2700-3700	2750	3200	3700
39 weeks+ 2 days n=101 (6.3%)	3038	364	12.0	2965-3109	2100-3950	2570	3050	3550

95% CI = 95% confidence Interval; SD = standard deviation; CV = Coefficient of Variation (SD as a percentage of the mean)

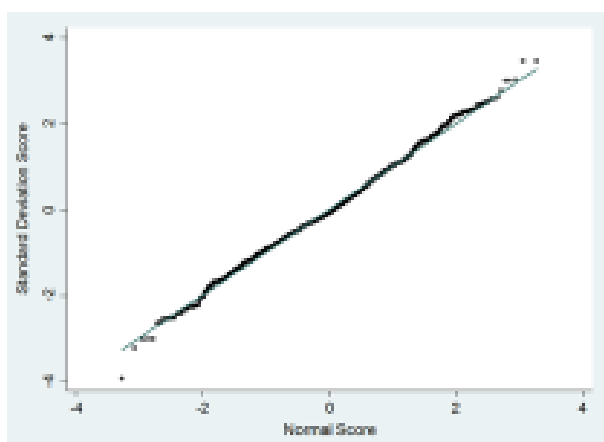


Figure 3. Normal plot of standard deviation scores of birth weights (n=1602).

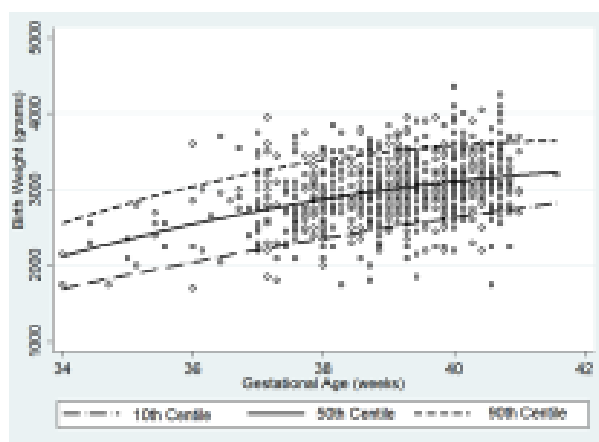


Figure 4. Gestational age specific birth weights with fitted 10th, 50th and 90th centiles (n=1602).

Table 3, The gestation specific birth weight centiles obtained from the study compared with the calculated centiles obtained by applying the mean birth weight and its coefficient of variation of those who delivered at 40 weeks gestation to the weight percentiles calculator of the global reference for fetal weight and birth weight percentiles [16] (n=1602)

Gestational age in weeks	Birth weight in grams								
	10 th centile			50 th centile			90 th centile		
	From Calculator	Current Study	Difference	From Calculator	Current Study	Difference	From Calculator	Current Study	Difference
34 weeks n=13 (0.8%)	1840	1750	-4.9%	2111	2150	+1.8%	2382	2550	+7.1%*
35 weeks n=14 (0.8%)	2002	2050	+2.4%	2297	2475	+7.7%*	2591	2750	+6.1%*
36 weeks n=32 (1.9%)	2162	2095	-3.1%	2481	2850	+14.9%*	2799	3385	+20.9%*
37 weeks n=203 (12.6%)	2319	2300	-0.8%	2661	2750	+3.3%	3002	3450	+14.9%*
38 weeks n=349 (21.8%)	2470	2300	-6.9%*	2834	2900	+2.3%	3197	3500	+9.5%*
39 weeks n=516 (32.2%)	2612	2700	+3.4%	2996	3000	+0.1%	3381	3550	+5%*
40 weeks n=464 (29%)	2742	2700	-1.5%	3146	3100	-1.5%	3550	3600	+1.4%
41 weeks n=11 (0.7%)	2859	2750	-3.8%	3280	3200	-2.4%	3701	3700	-0%

*Differences of >5%

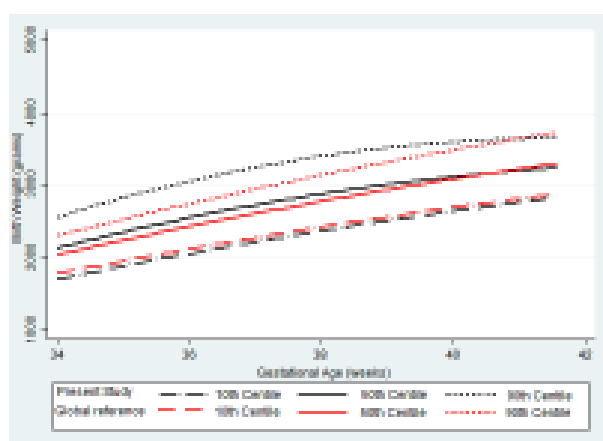


Figure 5. Gestational age specific birth weights with fitted 10th, 50th and 90th centiles compared with gestation specific birth weights centiles obtained by applying the mean birth weight at 40 weeks gestation and its coefficient of variation (standard deviation expressed as a percentage of the mean birth weight) in the study sample to the weight percentiles calculator of the global reference for fetal weight and birth weight percentiles [16] (n=1602).

Discussion

In the current study, the median gestational age at spontaneous onset of labor and vaginal delivery of approximately 275 days was comparable with reports from India and England, and supports the hypothesis that Asian fetuses mature relatively earlier and are spontaneously delivered, without any obstetric intervention, at an earlier gestational age compared to Caucasian fetuses. This is of great significance not only for counseling the pregnant mother and her partner but also when considering the problem of 'post-datism' and deciding on the optimum timing for induction of labor in prolonged pregnancies.

All women in the current study were married and were non-smokers. Other studies carried out in the unit have shown that > 78% of women delivering in the unit have been educated above grade 10 and the median reported monthly family income was approximately Rs 25,000- 30,000 (USD 200-250) [23]. Therefore, these confounders are unlikely to be important contributors to the relatively shorter duration of pregnancy observed in the current study.

In the study used for the validation of the global reference for fetal weight and birth weight percentiles for use in Sri Lanka, 207 out of 411 women had delivered

between 280-286 days gestation, while in the current study there were 464 out of the 1602 births occurring between 280-286 days gestation [19]. Furthermore, in the global reference for fetal weight and birth weight percentiles, “an average gestational age of 40.5 weeks” has been used for the calculations, while in the current study the median gestational age at delivery was 275 days gestation [16]. Therefore, the differences observed between the actual birth weight centiles obtained from the current study and the calculated birth weight centiles obtained by using the weight percentiles calculator of the global reference for fetal weight and birth weight percentiles should be considered important. A difference of 5% was considered as the minimum difference of clinical significance between the two continuous variables – the birthweights. The 10th centiles showed the least difference and moderate differences were seen between the 50th centiles. However, large differences were observed between the 90th centiles. In preterm babies the actual 50th and especially the 90th centiles showed a tendency to be larger than the respective centiles obtained by using the weight percentiles calculator. This may be an artifact due to the relatively smaller number of babies born before 37 weeks (59/1602). However, this could also be due to a true difference, and this should be explored further by a larger, multicenter, national study. The number of preterm deliveries and their observed birth weights, were not reported in the sample of 411 used for the study which validated the global reference for fetal weight and birth weight percentiles for use in Sri Lanka [19].

The main strength of this study is the adoption of all the methodological standards recommended for the development of centile charts [22]. Another strength of the study is that none of the women had any identifiable antenatal or intra partum complications, and that they established spontaneous onset of labor and delivered vaginally without any obstetric intervention. Therefore, this study describes the natural process, which includes some preterm deliveries as well as relatively small for gestational age fetuses and relatively large for gestational age fetuses who were allowed to be delivered vaginally following spontaneous onset of labor, without any obstetric interventions. Therefore, the results of this study reflect what occurs in actual clinical practice.

Although this was not a community based study, 99.9% of deliveries in Sri Lanka occur in hospitals [24] and > 90% of mothers in Galle deliver at the Teaching Hospital, Mahamodara, Galle, the balance delivering in private hospitals [24,25]. However, the findings of this study may not be directly generalizable to the population studied. Furthermore, only vaginally delivered babies, after spontaneous onset of labor (approximately half the number of the total deliveries during the period) were included in this study on the basis that numerous confounding factors could be associated if babies that needed any form of intervention were included. However, this could affect the generalizability of the findings. The main limitation in

carrying out this study was the lack of a computerized data entry system in the unit. Data had to be physically obtained from the case notes before the mother was discharged home. Furthermore, there could have been human errors during the weighing of the babies and recording the weight in the case notes. Although, these are inevitable in any study of this nature, but it is possible gross errors were not noticed upon studying the data. Furthermore because of the very large sample, it is unlikely that small errors in weighing or recording could have significantly affected the results. Although not an integral component of this study, it would have been interesting to note the outcome of the babies. Unfortunately, this data was not collected for analysis. Almost all the women in the study had a dating scan before 14 weeks gestation but some had presented late and therefore dating scans had been carried out up to 22 weeks of gestation and the accuracy could have decreased in the dating scans carried out after 14 weeks gestation.

In conclusion, the findings of this study indicate that the median gestational age among women with uncomplicated singleton pregnancies who establish spontaneous onset of labor and deliver vaginally, without any obstetric intervention at the Teaching Hospital, Mahamodara, Galle, Sri Lanka, is approximately five days shorter than the traditionally accepted 280 days. At 275 days’ gestation the mean and the 50th centile of the birth weight of their babies were approximately 3038g and 3050g respectively. A larger multicenter community based study, adjusting for possible confounders, could be the way forward for accurately establishing the gestational age specific mean birth weights and birth weight centiles when women with uncomplicated singleton pregnancies establish spontaneous onset of labor and deliver in Sri Lanka.

Conflicts of interest

There are no conflicts of interest.

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