Customized birthweight standard for a Polish population

Anna Kajdy[1], Oliver Hugh[2], Jan Modzelewski[1], Michał Rabijewski[1], Andre Francis[2], Jason Gardosi[2]

[1]Centre of Postgraduate Medical Education, Department of Reproductive Health, Warsaw, Poland
[2]Perinatal Institute, Birmingham, UK

Submitted: 5 June 2020
Accepted: 19 July 2020

Arch Med Sci
DOI: https://doi.org/10.5114/aoms.2020.98351

Corresponding author:
Anna Kajdy MD, PhD
Department of Reproductive Health
Centre of Postgraduate Medical Education
90 Żelazna St
01-004 Warsaw, Poland
Phone: + 48 22 2559918
E-mail: akajdy@cmkp.edu.pl

Abstract

Introduction: There is a growing body of evidence supporting the role of customized growth charts in improving detection of fetal growth restriction (FGR) and decreasing false positive diagnoses. The aim of the study is to produce a customised birthweight standard for Poland.
Material and methods: Maternal height and weight, ethnicity, gestational age, weight and sex at birth as well as pre-existing and gestational complications were collected. Coefficients were derived using a backwards stepwise multiple regression technique. Smallness for gestational age by the customised standard was compared with the in-use Fenton standard in assessing risk of adverse outcomes using relative risk with 95% confidence intervals.
Results: Data from 4,270 pregnancies were used as the study cohort. Fenton and customised SGA rates were 6.6% and 11.9%, respectively. The customised standard identified more cases that were at significantly increased risk of stillbirth, admission to neonatal intensive care or other neonatal complications, many of which were missed by the Fenton standard.
Conclusions: The analysis confirmed the physiological variables that affect birthweight in studies from other countries and was able to quantify additional pathological factors of high maternal age and pregnancy-induced hypertension. Comparison with the Fenton standard showed that adverse outcomes associated with SGA birthweight are better identified by the customised standard in a Polish population.

Key words: customised coefficients, gestation related optimal weight, small for gestational age, birthweight, neonatal outcome.

Introduction

Fetal growth restriction (FGR) is the failure of the fetus to reach its growth potential [1]. It is commonly assessed by its proxy, small for gestational age (SGA), when full information about growth as a longitudinal measure is not available, as birthweight [2] or fetal weight [3] below the tenth population-based centile [4]. Fetal growth restriction is associated with an increased risk for perinatal morbidity and mortality [5], but in practice most cases of FGR remain undetected prenatally [6].

One approach aimed at improving detection of growth restriction is through the use of customised, rather than population-based growth charts. There is a growing body of evidence supporting the role of customized growth charts in improving detection of FGR and decreasing false positive diagnoses [7–12]. Implementation of customized charts at a population level has also been associated with a decrease in stillbirth

[12, 13]. In the UK, the Royal College of Obstetricians and Gynaecologists has recommended the use of a customized fetal weight reference for assessing fetal growth and birthweight [14].

The process for developing customized growth charts is based on three steps: first, developing a statistical model using population data to predict optimal birth weight adjusted for physiological factors – maternal parity, ethnicity, height and weight, and fetal gender; second, identifying and removing from the model pathological factors (such as pre-eclampsia and diabetes) that significantly affect growth in the population; last, the customized optimal birth weight is projected backward for all gestational age points, using an ultrasound-based proportionality curve so that fetal growth measurements at all gestations can be plotted on a customized chart that is based on the individual baby's growth potential at term [1, 15].

In this study, we aimed to produce a customised birthweight standard based on the significant variables found in a Polish population and compare this to the current in-use neonatal standard in Poland [16].

Material and methods

Data collection

This retrospective cohort study used data from pregnancies at St Sophia's Hospital, a tertiary maternity centre in Warsaw, Poland with approximately 6800 deliveries per year, and were collected as part of routine patient assessment. The cohort consisted of 5079 cases entered into an electronic maternity record (AMMS – Asseko Medical Management Solutions, Poland) which had complete data on gestation dates, maternal height and weight and pregnancy outcome.

This project had ethical approval from the Centre of Postgraduate Medical Education, Warsaw, Poland.

Study population

All patients admitted to the hospital for maternity care had gestational age routinely verified by first trimester ultrasound (USS) and last menstrual period (LMP). If the difference between LMP and USS was less than 7 days, LMP was used; otherwise USS was used [17]. Maternal height and weight in early pregnancy were recorded during the first appointment. Patient history was recorded in an electronic database. Pathological variables including gestational diabetes, pre-existing diabetes, pregnancy-induced hypertension, pre-existing hypertension, asthma, anaemia and smoking were self-reported as yes/no responses. These were collected via interview, maternity records or from outpatient clinic staff. Pregnancies with ethnicity other than Polish were rare in this medical centre and were not included in this study.

Inclusion/exclusion criteria

Pregnancies with incomplete/invalid data of the critical variables for generating customised centiles (birthweight, gestational age, parity, fetal sex, maternal height and weight) were excluded from this analysis, leaving 4,800 pregnancies. To generate a standard to model optimal birthweight, pregnancies in which there was a pre-term birth (< 37 weeks gestation), multi-fetal pregnancy or congenital anomaly were excluded, leaving 4,270 pregnancies for analysis.

Model performance

The derived physiological coefficients were combined with the standard proportionality curve [15] to provide the gestation related optimal weight (GROW) tool to assess birthweight. To assess suitability for use in Poland, we tested this model's performance against the in-use Fenton standard [16]. Customised centiles were generated following the above model customising for maternal height, weight, parity and gender. The Fenton centiles were generated using published methods, adjusted only for sex [16]. This was performed on a subset of 4,800 pregnancies that had complete and valid data for calculating centiles. Births were designated as SGA (< 10^{th} centile) according to their respective standards. Subgroups of SGA by each standard were compared for risk of stillbirth, neonatal intensive care unit (NICU) admission or one or more neonatal complications (intraventricular haemorrhage, transient tachypnoea, respiratory distress syndrome, hypoxic ischaemic encephalopathy, broncho-pulmonary dysplasia, sepsis or seizure). Relative risk (RR) with 95% confidence interval and population attributable risk (PAR) were calculated.

Statistical analysis

The method to generate coefficients for customised birth-weight centiles was following that described previously [15]. Multivariate linear regression with stepwise backward elimination was used to obtain coefficients for significant variables with cut-off at probability 0.05. The regression analysis was run on the filtered 4,270 pregnancies.

To allow comparison with previous studies [18–20], the model was centred on a standard mother with height 163 cm, booking weight 64 kg, gestation 280 days and parity zero, and the baby's sex undefined, i.e. neutral or 'averaged' between male and female. As maternal height and weight have a non-linear relationship with birthweight, they were entered as polynomials up to the third

power. Pathological factors were included as categorical variables to quantify their effect on birthweight but then excluded when calculating the 'term optimal weight' to be free from known pathology. All analyses were performed using Stata (version 15.1; Statacorp, College Station, TX).

Results

The characteristics of the 4,800 pregnancies with complete data are listed in Table I. Over half (53.4%) of the pregnancies were nulliparous and 8.8% led to preterm birth (< 37 weeks gestation). The average body mass index was 21.6 kg/m^2 and the median maternal age at the beginning of pregnancy was 31 years.

The results of the multiple regression analysis are presented in Table II. Listed are the coefficients that have significant variables together with their standard error and *p*-values. The overall adjusted R^2 of the model was 0.261. The significant covariates used to model birthweight (in grams) included physiological variables (gestational age, maternal height, weight, parity, and the baby's sex) and pathological factors (high maternal age, anaemia, smoking and pregnancy induced hypertension). The birthweight constant adjusted to 280 days was 3477.1 g for a standard mother (163 cm height, 64 kg weight, nulliparous and of baby of 'average', i.e. unspecified sex). Pathological effects were included within the model but not in the centile calculation. Smoking had the largest negative effect (–267.2 g). The presence of anaemia (defined as < 11.0 mg/100 ml) [21] had a positive effect on birthweight (+100.1 g).

The comparative analysis of the association of SGA on pregnancy outcome is displayed in Table III. The Fenton standard in general use identified 315 pregnancies as SGA (6.6%) and the customised standard identified 570 pregnancies (11.9%). GROW designated 278 pregnancies as SGA that were not SGA according to Fenton ('GROW only'). This group identified additional cases in each of the 3 adverse outcome categories, all of which were significantly more at risk. The cases that were SGA by GROW only were 10 times more likely to experience a stillbirth than the general population, and all these cases were missed by the Fenton standard. Fenton designated 23 pregnancies as SGA that were not SGA by GROW, and these cases did not have increased risk of an adverse outcome.

Discussion

This is to our knowledge the first study that has created a customised birthweight standard for a Polish population

To compare the Polish coefficients with those of other countries, we centred our regression analysis on a standard mother in her first pregnancy, with height 163 cm and weight 64 kg and delivery at a gestational age of 280 days [19]. The resultant standardised birthweight within this population was 3477.1 g (Table II). This is similar to a birthweight reference chart generated from a Polish population [22] which had a 40-week average birthweight of 3509 g. The constant is also similar to those from similarly standardised weights from other mothers of European descent: Slovenia (3451 g) [23], England (3456 g) [15], the US (3453 g) [20], Australia (3464 g) [18] and New Zealand (3464 g) [19].

The physiological variables shown to significantly affect birthweight are the same as those seen in previous analyses[8, 15, 18–20, 23, 24]; the magnitude of the effects are also comparable – for instance, the coefficient for maternal height is 6.5 g/cm and ranged from 6.4 to 9.6 g in a previous four - country comparison [20]; likewise for maternal weight the coefficient is 8.5 g/kg and in the previous comparison [20] it ranged from 7.6 to 9.2 g. Pathological variables included within the regression also showed similar effects to previous analyses; for instance pregnancy induced hypertension having a –106 g effect on average birthweight [23]. Maternal age categories had a stepwise negative effect, similar to those found in the Slovenian customised standard [23], both factors being consistent with observations of increased risk of placental dysfunction in older mothers [25]. The positive effect of anaemia (+100.1 g) on birthweight seems counter to multiple studies and a systematic review that found anaemia to be a significant risk factor of low birthweight [26] A possible explanation for the increase is that these women may have received iron supplements during pregnancy, which are known to increase birthweight [27, 28].

The GROW standard calculates a 280-day term optimal weight using a mother's height, weight, ethnicity and parity and uses a fetal proportionality curve to derive the centile lines to allow for antenatal and neonatal assessment [3]. It uses the same method to calculate fetal weight and newborn weight centiles. To compare the performance of the customised GROW standard, we tested it against the Fenton standard widely used in Poland. [16]. Fenton is a sex-specific birthweight chart that is created from multiple cohorts of pregnancy databases from Western Europe and North America and is a population-based standard, i.e. uniform for all mothers. Fenton's lower SGA rate (6.6% vs. 11.9% with GROW) is likely to represent the fact that Polish pregnancies result in larger neonatal weights than those of West European/North American countries from which the Fenton standard was created. These differences

Table I. Characteristics of study cohort (*n* = 4,800)

Paramater	*N*	%	Mean	SD	Median	IQR
Maternal height [cm]			167.1	5.8	167.0	7.0
Maternal weight [kg]			65.9	125.8	60.0	13.0
Maternal age [years]:			31.8	4.4	31.5	6.0
< 20	24	0.5				
20–30	1,648	34.3				
30–35	1,997	41.6				
35–45	971	20.2				
≥ 45	160	3.3				
Body mass index [kg/m²]:			23.6	44.6	21.6	4.0
< 18.5	454	9.5				
18.5–25	3,380	70.4				
25–30	712	14.8				
≥ 30	254	5.3				
Parity:						
0	2,563	53.4				
1	1,622	33.8				
2	464	9.7				
≥3	151	3.1				
Pregnancy induced hypertension	160	3.3				
Pre-existing hypertension	45	0.9				
Gestational diabetes	618	12.9				
Pre-existing diabetes	6	0.1				
Asthma	58	1.2				
Anaemia	215	4.5				
Smoker	27	0.6				
Gestation at delivery [days]:			275.2	14.3	277.9	12.7
Premature delivery (< 37 weeks)	421	8.8				
Birthweight [g]		3349.6	574.3	3400.0	627.5	
Sex:						
Male	2,457	51.2				
Female	2,343	48.8				
Congenital anomaly	69	1.4				
Multiple pregnancy	109	2.3				
Stillbirth	18	3.8/1000				
NICU admission:	678	14.1				
Length of NICU admission [days]			7.0	14.9	2.0	5.1
Apgar at 5 min score < 7	13	0.3				
Intraventricular haemorrhage	3	0.1				
Transient tachypnoea	57	1.2				
Respiratory distress syndrome	71	1.5				
Hypoxic ischaemic encephalopathy	3	0.1				
Broncho-pulmonary dysplasia	12	0.3				
Sepsis	2	0.0				
Seizure	7	0.1				

IQR – inter-quartile range, SD – standard deviation.

Table II. Coefficients from multiple regression model (n = 4,270)

Parameter	β	SE	95% CI
Constant at 279 days	3452.7		
Constant adjusted for 280 days	3477.1		
Gestational age (based on 279 days):			
Linear	19.505	0.741	18.052 to 20.958
Quadratic	–0.5106	0.0617	–0.6315 to –0.3897
Gender:			
Male	81.9	11.42	59.5 to 104.3
Female	–81.9	11.42	–104.3 to –59.5
Height cm (from 163 cm):			
Linear	6.456	1.076	4.348 to 8.564
Weight kg (from 64 kg):			
Linear	8.483	0.637	7.235 to 9.732
Quadratic	–0.1697	0.0215	–0.2119 to –0.1274
Cubic	0.00075	0.00011	0.00053 to 0.00097
Parity (reference 0):			
1	130.4	13.1	104.8 to 156.0
2	205.3	20.9	164.3 to 246.3
3+	230.8	33.9	164.5 to 297.2
Maternal age (reference < 30 years):			
30–35	–27.5	13.5	–53.9 to –1.1
35–40	–48.7	17.2	–82.4 to –15
≥ 40	–78.7	33.7	–144.8 to –12.6
Pregnancy induced hypertension	–105.7	33.2	–170.8 to –40.7
Smoking	–267.2	81.8	–427.6 to –106.9
Anaemia	100.1	28.6	44.0 to 156.3

CI – confidence interval, SE – standard error. Model is centred on the median gestational age of delivery (279 days), with coefficients expressed for a 'standard mother' (parity 0, maternal height 163 cm, initial weight 64 kg) and gender neutral baby. Constant (optimised by excluding all pathological factors listed): 3452.7 g, SE 372.6, CV 0.11, Adj R^2 0.261.

are physiological and seen also in comparisons with other population-based standards [29–31]. Ultimately, a standard needs to relate to outcome, and as Table III shows, GROW identified as SGA many additional cases that were at increased risk of stillbirth, NICU admission and neonatal complications, while the in-use population standard by Fenton found no additional pregnancies at increased risk.

Our results add to the growing body of evidence against the use of population-based approaches to assess birthweight. The consequences of false designation as SGA could be the receipt of unnecessary treatment and diversion of resources that could be used elsewhere; while the consequences of missed SGA, as is the case with the currently used Fenton standard, are neonates not receiving the care they need in infancy.

The strength of our study was an ethnically homogeneous population with complete data for deriving customised birth weight standards, and inclusion of outcomes which allowed us to compare performance across mortality and morbidity. Variables were collected according to a standardised methodology and definitions were pre-defined.

A weakness of the study is that pathologies were often not recorded. A previous study from Poland [32] reported the smoking rate during the third trimester of pregnancy as 12%. Here, the smoking rate was 0.6% at booking, which rais-

Table III. GROW and Fenton detection of adverse outcome (n = 4,788)

Parameter	SGA by GROW		SGA by Fenton
Classified as SGA, *n* (%)	570 (11.9)		315 (6.6)
Stillbirth, *n* (/1000)	11 (19.3)		6 (19.0)
NICU admission, *n* (%)	133 (23.4)		59 (18.8)
Neonatal complication, *n* (%)	39 (6.8)		12 (3.8)
Parameter	**SGA by GROW only**	**SGA by both standards**	**SGA by Fenton only**
Classified as SGA, *n* (%)	278 (5.8)	291 (6.1)	23 (0.5)
Stillbirth:			
N (/1000)	5 (18.0)	6 (20.5)	0 (0.0)
Relative risk (95% CI)	10.1 (3.3–30.8)	13.2 (4.7–39.0)	–
Population attributable risk %	34.7	42.7	–
NICU admission:			
N (%)	75 (27.0)	58 (19.9)	1 (4.3)
Relative risk (95% CI)	2.0 (1.7–2.5)	1.5 (1.1–1.9)	0.3 (0.1–2.1)
Population attributable risk %	5.6	2.7	0
Neonatal complication (any):			
N (%)	27 (9.7)	12 (4.1)	0 (0.0)
Relative risk (95% CI)	3.9 (2.6–5.8)	1.4 (0.8–2.6)	–
Population attributable risk %	14.3	2.6	–

SGA – small for gestational age, GROW – gestation-related optimal weight, Fenton – 2013 Fenton preterm growth charts, standard, CI – confidence interval. Neonatal complication includes: intraventricular haemorrhage, transient tachypnoea, respiratory distress syndrome, hypoxic ischaemic encephalopathy, broncho-pulmonary dysplasia, sepsis or seizure.

es questions as to ascertainment or accuracy of self reporting. The resultant effect on birthweight (Table II), of –267 g, would suggest heavy smoking according to previous models [33, 34], and because of the binary definition of smoking, we were unable to quantify the previously described dose-dependent effect related to number of cigarettes.

In conclusion, the customised standard identifies better than the Fenton growth chart neonates at increased risk of stillbirth, NICU admission and neonatal complications. False designation of SGA could result in unnecessary treatment, while missed SGA, as is the case with the currently used Fenton standard, could result in neonates not receiving adequate care they need in infancy.

Development of customised birthweight standards for a Polish population will aid clinicians caring for Polish mothers to refine the distinction between normal and abnormal small-for-gestational age fetuses [9]. The coefficients thus derived can be used to develop a country - specific, individually customisable antenatal GROW tool to improve the surveillance of fetal growth in Poland.

Conflict of interest

OH, AF and JG work for the Perinatal Institute, a not for profit organisation that provides training and software for customised GROW charts.

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Figueras F, Gardosi J. Intrauterine growth restriction: new concepts in antenatal surveillance, diagnosis, and management. Am J Obstet Gynecol 2011; 204: 288-300.
2. Alexander G, Himes J, Kaufman R, Mor J, Kogan M. A united states national reference for fetal growth. Obstet Gynecol 1996; 87: 163-8.
3. Hadlock FP, Harrist RB, Martinez-Poyer J. In utero analysis of fetal growth: a sonographic weight standard. Radiology 1991; 181: 129-33.
4. American College of Obstetricians and Gynecologists' Committee on Practice Bulletins – Obstetrics and the Society for Maternal-Fetal Medicin. ACOG Practice Bulletin No. 204: fetal growth restriction. Obstet Gynecol 2019; 133: 97-109.
5. Kady S, Gardosi J. Perinatal mortality and fetal growth restriction. Best Pract Res Clin Obst Gynaecol 2004; 18: 397-410.

6. Hepburn M, Rosenberg K. An audit of the detection and management of small-for-gestational age babies. Br J Obstet Gynaecol 1986; 93: 212-6.
7. Ego A, Subtil D, Grange G, et al. Customized versus population-based birth weight standards for identifying growth restricted infants: a French multicenter study. Am J Obstet Gynecol 2006; 194: 1042-9.
8. Figueras F, Figueras J, Meler E, et al. Customised birthweight standards accurately predict perinatal morbidity. Arch Dis Childhood Fetal Neonatal Ed 2007; 92: F277-80.
9. Gardosi J, Francis A. Adverse pregnancy outcome and association with small for gestational age birthweight by customized and population-based percentiles. Am J Obstet Gynecol 2009; 201: 28.e1-8.
10. Malhotra A, Allison BJ, Castillo-Melendez M, Jenkin G, Polglase GR, Miller SL. Neonatal morbidities of fetal growth restriction: pathophysiology and impact. Front Endocrinol 2019; 10: 55.
11. Gardosi J. Counterpoint. Am J Obstet Gynecol 2019; 220: 74-82.
12. Gardosi J, Francis A, Turner S, Williams M. Customized growth charts: rationale, validation and clinical benefits. Am J Obstet Gynecol 2018; 218: S609-18.
13. Gardosi J, Giddings S, Buller S, Southam M, Williams M. Preventing stillbirths through improved antenatal recognition of pregnancies at risk due to fetal growth restriction. Public Health 2014; 128: 698-702.
14. Coomarasamy A, Gee H. The investigation and management of the small-for-gestational-age fetus. Royal Coll Obstet Gynaecol 2002; Guidelines 31.
15. Gardosi J, Mongelli M, Wilcox M, Chang A. An adjustable fetal weight standard. Ultrasound Obstet Gynecol 1995; 6: 168-74.
16. Fenton TR, Kim JH. A systematic review and meta-analysis to revise the Fenton growth chart for preterm infants. BMC Pediatr 2013; 13: 59.
17. ACOG. Committee Opinion No 700: Methods for Estimating the Due Date. Obstet Gynecol 2017; 129: e150-4.
18. Mongelli M, Figueras F, Francis A, Gardosi J. A customised birthweight centile calculator developed for an Australian population. Aust New Zeal J Obstet Gynaec 2007; 47: 128-31.
19. McCowan L, Stewart AW, Francis A, Gardosi J. A customised birthweight centile calculator developed for a New Zealand population. Aust New Zeal J Obstet Gynaec 2004; 44: 428-31.
20. Gardosi J, Francis A. A customized standard to assess fetal growth in a US population. Am J Obstet Gynecol 2009; 201: 25.e1-7.
21. Debski R, Hus I, Kotarski J, et al. Statement of the Polish Gynecological Society Expert Group on the prevention of iron deficiency and of anemia caused by iron deficiency with a low dose heme iron in women. Ginekol Pol 2013; 85: 74-8.
22. Kajdy A, Modzelewski J, Filipecka-Tyczka D, Pokropek A, Rabijewski M. Development of birth weight for gestational age charts and comparison with currently used charts: defining growth in the Polish population. J Matern Fetal Neonatal Med 2019; 1-8. doi: 10.1080/14767058.2019.1676412.
23. Premru-Srsen T, Verdenik I, Mihevc Ponikvar B, Hugh O, Francis A, Gardosi J. Customised birthweight standard for a Slovenian population. J Perin Med 2019; 47: 270-5.
24. Nasri K, Hantoushzadeh S, Hugh O, et al. Customized birthweight standard for an Iranian population. J Matern Fetal Neonatal Med 2019; 1-6. doi: 10.1080/14767058.2019.1689557.
25. Lean SC, Derricott H, Jones RL, Heazell AEP. Advanced maternal age and adverse pregnancy outcomes: a systematic review and meta-analysis. PLoS One 2017; 12: e0186287.
26. Rahman MM, Abe SK, Rahman MS, et al. Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: systematic review and meta-analysis. Am J Clin Nutr 2016; 103: 495-504.
27. Yang J, Cheng Y, Pei L, et al. Maternal iron intake during pregnancy and birth outcomes: a cross-sectional study in Northwest China. Br J Nutr 2017; 117: 862-71.
28. Haider BA, Olofin I, Wang M, et al. Anaemia, prenatal iron use, and risk of adverse pregnancy outcomes: systematic review and meta-analysis. BMJ 2013; 346: f3443.
29. Francis A, Hugh O, Gardosi J. Customized vs. INTERGROWTH-21st standards for the assessment of birthweight and stillbirth risk at term. Am J Obstet Gynecol 2018; 218 (2 Suppl): S692-9.
30. Francis A, Gardosi J. Comparison of INTERGROWTH-21 newborn weight standard with the customised GROW standard to define SGA birthweight in the UK. BJOG 2015; Vol. 122, p. 125-128.
31. Pritchard NL, Hiscock RJ, Lockie E, et al. Identification of the optimal growth charts for use in a preterm population: an Australian state-wide retrospective cohort study. PLoS Med 2019; 16: e1002923.
32. Wojtyła A, Goździewska M, Paprzycki P, Biliński P. Tobacco-related foetal origin of adult diseases hypothesis – population studies in Poland. Ann Agric Environ Med 2012; 19: 117-28.
33. Wojtyła C, Wojtyła-Buciora P, Ciebiera M, Orzechowski S, Wojtyła A. The effect of active and passive maternal smoking before and during pregnancy on neonatal weight at birth. Arch Med Sci 2018 doi:10.5114/aoms.2018.79629.
34. Chełchowska M, Gajewska J, Mazur J, Ambroszkiewicz J, Maciejewski T, Leibschang J. Serum pregnancy-associated plasma protein A levels in the first, second and third trimester of pregnancy: relation to newborn anthropometric parameters and maternal tobacco smoking. Arch Med Sci 2016; 12: 1256-62.