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A customised fetal growth and birthweight standard for Qatar: a population-based cohort study

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Abstract

Objectives: Customized birthweight centiles have improved the detection of small for gestational age (SGA) and large for gestational age (LGA) babies compared to existing population standards. This study used perinatal registry data to derive coefficients for developing customized growth charts for Qatar.

Methods: The PEARL registry data on women delivering in Qatar (2017–2018) was used to develop a multivariable linear regression model predicting optimal birthweight. Physiological variables included gestational age, maternal height, weight, ethnicity, parity, and sex of the baby. Pathological variables such as hypertension, preexisting and gestational diabetes and smoking were calculated and excluded to derive the optimal weight at term.

Results: The regression model found a term optimal birthweight of 3,235 g for a Qatari nationality mother with median height (159 cm), booking weight (72 kg), parity (1) and gestation at birth (276 days) at the end of an uncomplicated pregnancy. Constitutional coefficients significantly affecting birthweight were gestational age, height, weight, and parity. The main pathological factors were preexisting diabetes (increase by +175.7 g) and smoking (decrease by −190.9 g). The SGA and LGA rates in the entire cohort after applying the population-specific customized centiles were 11.1 and 12.2 %, respectively (contrasting with the Hadlock standard: SGA-26.3 % and LGA-1.8 %, and Fenton standard: SGA-12.9 % and LGA-4.0 %).

Conclusions: Constitutional and pathological variations in fetal growth and birthweight apply in the maternity population in Qatar and have been quantified to allow the generation of customised charts for better identification of pregnancies with abnormal growth. Currently in-use population standards may misdiagnose many SGA and LGA babies.

Keywords: birthweight; customized growth charts; GROW; stillbirth; fetal growth restriction

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Introduction

One of the persistent challenges of modern obstetrics is abnormal fetal growth, which includes intrauterine fetal growth restriction (FGR), or the failure of the fetus to achieve its biological growth potential *in utero*. The concern exists because FGR in non-anomalous babies is a leading preventable cause of stillbirth, the risk increasing four times if it's undetected antenatally [1]. Additionally, these children have higher morbidity in their lives, such as insulin resistance, obesity, cardiovascular disease [2], impaired neurological development and cognition [3]. Detection of FGR is vital as it leads to appropriate antenatal surveillance and management.

There are no conclusive methods to detect FGR, and often, proxy methods are used, such as the small for gestational age (SGA) parameter defined as antenatal ultrasound estimated fetal weight, or abdominal circumference or birthweight less than the 10th percentile, commonly defined using universal standards [4]. However, many babies labelled SGA are constitutionally small but healthy with no placental insufficiency. Additionally, this parameter fails to detect growth-restricted babies who are not SGA, as observed in most late-onset FGR (third trimester), which accounts for 70 % of stillbirths at term [5]. This highlights the requirement for growth charts to detect growth velocity regardless of the fetal weight estimate.

A similar difficulty exists in detecting large for gestational age (LGA), defined as estimated fetal weight or birthweight above the 90th centile of standardized curves. These babies are more likely to require resuscitation at birth and intensive care admission, and the mothers are more likely to have complicated labour and operative deliveries [6]. However, the accuracy of standardized charts to detect LGA babies is still under review [7].

There is a recent shift towards using customised growth charts like the GROW percentile calculators that account for constitutional variation rather than a single universal standard, as the customised charts are better at classifying FGR and SGA babies and thereby reducing stillbirths [8, 9]. These charts define an optimised standard for each mother, better predicting growth velocity in low-risk pregnancies. The process involves generating coefficients for maternal factors from regression models predicting term optimal birthweight (TOW), excluding the influence of pathological factors, and then extrapolating this TOW to predict the optimal weight for all gestational ages as a proportion of ultrasound-estimated fetal weight standards (Gestation Related Optimal Weight – GROW); this generates growth curves individualised for each mother [10]. These coefficients have been generated from databases in multiple countries such as the UK, Sweden, Australia, New Zealand, France, Spain, USA, Ireland, and more recently in Iran [8, 11–18].

Even though antenatal care in Qatar is spread over the private and public sectors, most women deliver in secondary and tertiary public hospitals, impacting continuity of care and raising difficulties in adequately detecting FGR. This contributes towards a high stillbirth rate of 7.8 per 1,000 live births in the high-income society existing in Qatar [19]. The introduction of 'handheld' customised birthweight charts in this population can provide a point of reference between different care providers, thereby increasing SGA, FGR and LGA detection. This study aimed to generate coefficients and customised birthweight centiles for mothers within Qatar from a perinatal registry database.

Materials and methods

Study design and participants

This study used anonymised data from the PEARL-Peristat Study, a population-based retrospective cohort registry containing maternal and neonatal demographics and outcomes collected from all women delivering in Qatar between 2017 and 2018. The registry is funded by the Qatar National Research Fund (Grant number: NPRP 6-238-3-059) and approved by the Hamad Medical Corporation (HMC) Institutional Review Board, with a waiver of informed consent (HMC-IRB 13064/13).

We included women delivering a singleton livebirth of more than 24 weeks gestation between April 2017 and March 2018 at Women's Wellness and Research Centre (WWRC) in Doha, Qatar, which is the largest national maternity hospital and leading provider of secondary and tertiary health care facilities in the country (averaging 18,000 deliveries annually, and nearly 70 % of births in Qatar). For calculating the coefficients, all preterm births (<37 weeks gestation) and babies with congenital anomalies were excluded. There were no other exclusion criteria.

Data source and variables

The registry data was collected by independent data collectors from Cerner Millenium® electronic patient medical records. After applying the inclusion criteria, we extracted anonymised data and cleaned the dataset by removing outliers for gestational age, birth weight, maternal weight and height (<1 % of the total). Patient-identifying variables such as name, date of birth, hospital registration number, and date of delivery were retained in the registry, accessible only by the registry owners, and stored in password-protected databases saved on the hospital network.

The maternal variables included age in completed years, height and weight documented at the first antenatal visit, parity – defined as any previous birth >24 weeks gestational age, medical conditions like preexisting diabetes, hypertension (including essential and pregnancy-induced) and gestational diabetes – defined as abnormal 75 g glucose tolerance test performed during the pregnancy between 16 and 32 weeks gestation according to patient risk factors [20], and self-reported current smoking status (yes/no). Maternal age was categorised into four groups: <20 years, 20–28 years, 29–34 years and ≥35 years. The body mass index (BMI) was generated from maternal weight and height (kg/m^2) and categorised according to the WHO BMI categories [21].

Maternal nationality was extracted from the government health card details.

The gestational age (GA) in days was determined by a first-trimester dating ultrasound scan within 14 weeks of pregnancy measuring the crown-rump length or the last menstrual period (if a dating scan was unavailable). Other variables included preterm delivery – defined as any delivery before 37 completed weeks of gestation (259 days) [22], congenital anomalies – including any babies diagnosed with any chromosomal or congenital anomalies diagnosed antenatally or at birth by a neonatologist and biological sex of the baby at birth. The birthweight was documented in the hospital records as the newborn's weight measured in grams, using calibrated hospital scales, immediately after birth.

Statistical analysis

Continuous variables were recorded as mean ± standard deviation (SD) and median ± interquartile range (IQR). Frequencies and percentages of the total cohort were used to describe categorical variables. After eliminating outliers, the data from 12,845 women were used for univariate analysis. The regression model was based on 11,693 cases after excluding preterm births and babies with congenital anomalies.

The statistical methods used to derive the birthweight coefficients were as described previously [10]. A stepwise multiple linear regression with backward elimination (outcome – birthweight in grams) was performed, including patient characteristics such as GA at birth, maternal height, weight, ethnicity, parity, biological sex of the baby, maternal preexisting illness such as hypertension and diabetes, and smoking status. Quadratic and cubic terms for GA, weight and height were included in the model in addition to the linear terms to account for the non-linearity of the associations. The model was centred on the median GA at birth for the cohort. Variables with a p value less than 0.05 were retained in the model.

To allow comparison with models from other countries, the analysis was centred on a "standard" mother – a woman 163 cm tall weighing 64 kg, nulliparous (parity 0), with the baby's sex averaged between male and female. This is based on findings from the initial study performed in the UK population, defining an average-sized European mother, which was used as the standard for comparison with other models [10]. The term optimal birthweight (TOW) constant was then derived by adjusting the constant to 280 days gestation (40 weeks – considered full term) for a standard mother, excluding the effect of preexisting and gestational diabetes, hypertension, and smoking.

Weight for each gestational day was calculated using the proportionality equation [10], based on Hadlock's fetal weight standard [23]. Polynomial regression equations to the third order were used to plot the 10, 50 and 90 centile GROW curves, with the standard 11 % coefficient of variation of the model [10]. Based on these calculations, the proportions of SGA babies (<10 %) and LGA babies (>90 %) in the study cohort were determined. The birthweight distribution at 280 days according to the Hadlock fetal weight standard [23] and the Fenton neonatal weight standard [24], currently in clinical use in the country, was compared with the predicted birthweight distribution using GROW coefficients. This comparison was done for the entire cohort and for mothers of Qatari nationality separately. All analyses were performed using Stata release 17, StataCorp, TX, USA [25].

Results

The characteristics of 12,845 women included in the cohort are shown in Table 1. The mean maternal age was 29.6 (±5.6) years, with more than 40 % in the 20–28 years age group. The mean maternal height and weight at booking were 158.6 cm and 73.2 kg, respectively; the majority (~35 %) were in an overweight (≥25 kg/m^2) BMI category. The median parity was 1, with nearly 30 % of the pregnancies following three or more previous births. Qatar was the most common maternal nationality (35.7 %), followed by Egypt (10.1 %) and India (9.8 %). The median GA at birth was 276 days, with mean birthweight being 3,180 g (±515) and equal proportions of male and female babies. The incidence of preterm births and congenital anomalies in this cohort was 7.8 and 1.8 %, respectively.

The coefficients for the significant variables from the multiple regression model for predicting birthweight, run on 11,693 women, are shown in Table 2. Maternal age and BMI did not have a statistically significant impact on birthweight. The cohort 'standard mother' (163 cm height, 64 kg weight, parity 0) constant at 276 days was 3,136.0 g (3,228.4 at 280 days) and the adjusted R^2 for the model was 0.24 with a standard error of 374.5. The TOW for an average-size mother of Qatari nationality who is 159 cm tall (159 – 163 = – 4) and weighs 72 kg (72 – 64 = 8) at booking with median parity one can be calculated as: 3,136.0 + (–4 × 7.919) + (8 × 5.296) + (8^2 × – 0.039) + 90.8 = 3,235 g at the average GA of 276 days (3,312 g after adjusting to 280-days). This mother's 10th and 90th percentile limits can be calculated as ±1.28 × CV (0.11) = 0.1408 or ±14.1 % of the TOW (2,779 and 3,691 g at 276 days). The ethnicity with the greatest effect on birthweight was Palestinian, with birthweight on average 178.2 g heavier than mothers of Qatari nationality, whereas Indian mothers had the least difference (average

Table 1: Characteristics of study population (n=12,845).

Demographics	n	%	Mean ± SD	Median (IQR)
Maternal age, years			29.6 ± 5.6	29 (26–34)
<20	295	2.3		
20<29	5,413	42.1		
29<35	4,608	35.9		
≥35	2,529	19.7		
Maternal height, cm			158.6 ± 5.9	158.5 (154.7–163)
Maternal weight at booking, kg			73.2 ± 15.5	71.7 (62.2–82.3)
Body mass index, kg/m^2			29.1 ± 5.8	28.5 (24.9–32.5)
<18.5	178	1.4		
18.5<25	3,082	24.0		
25<30	4,462	34.7		
30<35	3,211	25.0		
≥35	1,912	14.9		
Ethnicity				
Qatari	4,592	35.7		
Egyptian	1,297	10.1		
Indian	1,255	9.8		
Pakistani	1,127	8.8		
Sudanese	646	5.0		
Filipino	606	4.7		
Yemeni	595	4.6		
Syrian	557	4.3		
Jordanian	428	3.3		
Saudi	403	3.1		
Tunisian	220	1.7		
Palestinian	205	1.6		
Iranian	182	1.4		
Sri Lankan	131	1.0		
Moroccan	121	0.9		
Ethiopian	112	0.9		
Bahrani	107	0.8		
Bangladeshi	100	0.8		
Lebanese	85	0.7		
Omani	76	0.6		
Parity				
0	3,586	27.9		
1	3,367	26.2		
2	2,405	18.7		
3+	3,487	27.1		
Gestational age at delivery, days[a]			272.9 ± 12.6	276 (266–280)
Preterm birth (<37 weeks)	1,005	7.8		
Sex				
Male	6,575	51.2		
Female	6,270	48.8		
Birthweight, g			3,179.8 ± 514.6	3,200 (2,900–3,520)
Smoker	22	0.2		
Hypertension	448	3.5		
Gestational diabetes	3,684	28.7		
Preexisting diabetes	316	2.5		
Congenital anomaly	225	17.5	/1,000	

SD, standard deviation; IQR, interquartile range; [a]Gestation recorded in completed weeks, converted into days.

Table 2: Coefficients from multiple regression (n=11,693).

Variables	Coeff	SE	95 % CI	p-Value
Constant at 276 days[a]	3,136.0			
Constant adjusted to 280 days[b]	3,228.4			
Gestational age (based on 276 days)				
Linear, days	19.5	0.4541	18.625 to 20.405	<0.01
Quadratic, days^2	−0.299	0.0483	−0.394 to −0.204	<0.01
Height, cm (from 163 cm)				
Linear, cm	7.919	0.639	6.667 to 9.171	<0.01
Weight, kg (from 64 kg)				
Linear, kg	5.296	0.376	4.559 to 6.033	<0.01
Quadratic, kg^2	−0.039	0.009	−0.0566 to −0.0210	<0.01
Parity (reference 0)				
1	90.8	9.47	72.2 to 109.3	<0.01
2	134.7	10.52	114.1 to 155.3	<0.01
3+	147.6	9.96	128.1 to 167.1	<0.01
Ethnicity (reference- Qatar)				
Egyptian	134.6	12.0	111.1 to 158.1	<0.01
Filipino	118.7	17.3	84.8 to 152.7	<0.01
Indian	35.5	12.3	11.3 to 59.6	<0.01
Jordanian	133.7	19.5	95.5 to 172.0	<0.01
Moroccan	156.6	35.7	86.7 to 226.6	<0.01
Pakistani	28.6	12.7	3.7 to 53.5	0.03
Palestinian	178.2	27.6	124.0 to 232.3	<0.01
Sri Lankan	75.3	35.0	6.8 to 143.8	<0.01
Syrian	112.8	17.1	79.3 to 146.4	0.03
Tunisian	161.4	27.0	108.4 to 214.4	<0.01
Sex				
Male	59.7	11.6	36.9 to 82.4	<0.01
Female	−59.7	11.6	−82.4 to −36.9	<0.01
Hypertension	−59.4	21.69	−102.0 to −16.9	<0.01
Gestational diabetes	30.6	7.96	15.0 to 46.2	<0.01
Preexisting diabetes	175.7	24.37	127.9 to 223.4	<0.01
Smoker	−190.9	86.11	−359.7 to −22.1	0.03

[a]The constant of the model is centred on median gestation (276 days). The coefficients are expressed for ‘average’ sex, nulliparity, maternal height 163 cm, and maternal weight 64 kg; The model is optimised or adjusted to exclude all pathological variables, namely hypertension, gestational diabetes, preexisting diabetes and smoking. Variables in Table 1 which were not significant (p>0.05) were excluded from the regression analyses.

35.5 g heavier). Applying this model to our population gives an SGA and LGA rate in the cohort of 11.1 and 12.2 %, respectively.

The GA and booking weight had significant quadratic terms in the model, highlighting their nonlinear relationship with birthweight. The coefficients for parity showed an incremental rise according to an increase in parity, with a parity ≥3 increasing the expected birthweight by 148 g. The pathological variable with the largest positive effect was preexisting diabetes (+175.7 g), whereas smoking status had the most detrimental effect on birthweight (−190.9 g).

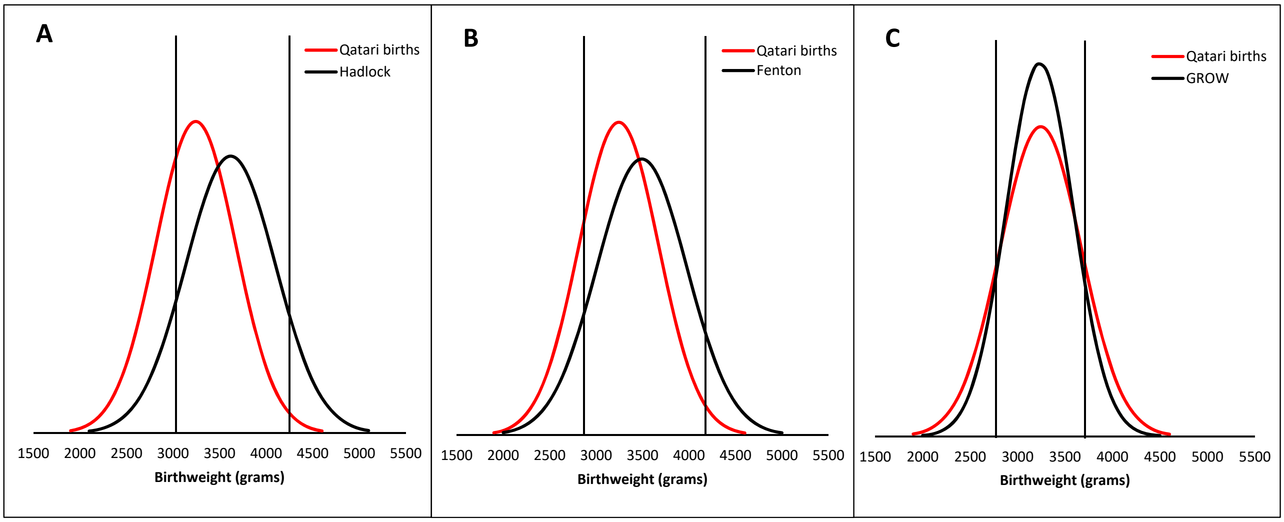

Figure 1: Comparison of birthweight distributions at 280 days with (A) Hadlock fetal weight standard (B) Fenton neonatal weight standard and (C) GROW standard with the study coefficients in women of Qatari nationality; the vertical lines indicate the 10th and 90th centile limits of the respective weight standard. Birthweight distribution is centered on 280 days. Respective SGA and LGA rates in mothers of Qatari nationality according to: (A) Hadlock: 28.5 %, 1.4 %; (B) Fenton: 13.8 %, 3.4 %; (C) GROW: 11.2 %, 11.8 %.

The distribution of all the birthweights in the cohort at 280 days GA, including those with pathologies listed in Table 1, were compared with the Hadlock fetal weight standards [23], the Fenton neonatal standards [24] and the GROW standards based on these new coefficients from this study. The cohort birthweight curve lies on the left of the Hadlock and Fenton standards, resulting in SGA rates of 26.3 and 12.9 % for our cohort, respectively. The corresponding LGA rates were 1.8 % (Hadlock) and 4.0 % (Fenton). In contrast, the GROW standard overlapped the cohort distribution better, giving SGA and LGA rates of 11.1 and 12.2 %, respectively. For women of Qatari nationality, the SGA and LGA rates were 28.5 and 1.4 % for Hadlock, 13.8 and 3.4 % for Fenton and 11.2 and 11.8 % for GROW, respectively. The birthweight distributions for babies born to mothers of Qatari nationality are shown in Figure 1.

Discussion

Main results

This is the first study generating customised birthweight standards and coefficients in a multi-ethnic population in Qatar, determining the TOW using the maternal physiological variables. The gestational age, maternal height and weight at booking were significantly associated with birthweight, the relationship assuming a nonlinear parabolic curve due to the significant quadratic terms for gestational age and weight. Additionally, the biological sex of the baby and maternal parity significantly influenced birthweight.

The model allows adjusting the predicted birthweight according to the physiological characteristics of each mother. The centile calculators are available via the Gestation network (www.gestation.net), and they currently include coefficients from at least 100 different ethnic or country-of-origin groups [8]. The model generated in this study will make the charts accessible and customised for the multi-ethnic Qatar maternity population. The GROW charts can be produced early in pregnancy (after the dating scan or the first antenatal visit) and attached to the antenatal sheet of patients; the fundal height measurements during antenatal visits and estimated fetal weight from growth scans can be plotted onto the GROW charts, which can tremendously improve abnormal fetal growth detection.

After applying the model, the SGA (<10 centile) for mothers of Qatari nationality was 11.2 %. Previous studies report an SGA rate of 6.7 % for babies of Qatari nationality from the same dataset – SGA defined using the Intergrowth 21st 10th centile universal standards [26]. The customised growth charts successfully reclassified a minimum of 4 % of babies as SGA. The risk of LGA in the previous study was 13.6 % compared to 12.2 % for the entire cohort in this study. Figure 1 compares the Hadlock and Fenton standard distributions to the Qatari nationality birthweights observed in the cohort. Using these standards resulted in an overestimation of the SGA rate (28.5 vs. 11.2 %) and an underestimation of the risk of LGA (1.4 vs. 11.8 %), highlighting the issues of applying these universal standards to the maternal population in Qatar.

The incidence of diabetes affecting pregnancies in Qatar is nearly 25 % [27]. These high rates likely contributed to the high proportion of LGA identified by the GROW curves and missed by the other standardized curves. Hence, GROW curves can determine SGA/LGA rates customized to the true population distribution.

A 2023 study, including 2.2 million live births in UK, compared the customized centiles to the Intergrowth 21, Hadlock and WHO population standards [28]. The GROW centiles produced similar rates of SGA when comparing ethnicities, whereas the other standards produced a wide variation. Moreover, GROW was able to pick up the increase in stillbirths in SGA babies in mothers with higher BMI. Similar results were shown in a French study reporting increased perinatal mortality in the babies reclassified as SGA by GROW [14]. Future studies need to assess the impact of customized charts on FGR and stillbirth risk in the population in Qatar.

Comparison with previous models

Table 3 compares the coefficients generated in other populations [8, 11–13, 15–18, 29, 30] with those in this dataset using a 'standard mother' (height 164, weight 63 kg, 'average' fetal sex, and gestational age adjusted to 280 days) which gives a population TOW of 3,228.4 g. This TOW is at least 250 g less than that in Europe, USA, and Australia. The pattern of the other coefficients is very similar across all populations, highlighting that the differences noted are part of a natural variation between populations. As previously reported, fetal growth is slower between 26 and 36 weeks gestation and then increases linearly till term [31]–this phenomenon is reflected in the coefficients as GA has a nonlinear parabolic relationship with birthweight with significant quadratic terms. The rationale behind not using BMI as a predictor is that maternal height and weight have additive associations with birthweight, which would not be picked up by BMI alone. The maternal age was not significant in most models after adjusting for parity, although age more than 30 years was included in the Slovenian model [29], having up to 28.4 g impact on birthweight (age ≥40 years).

Ethnicity is an important predictor of birthweight. The UK, Australia and Ireland models adjust for Middle-Eastern ethnicity and report a decrease in TOW from 90 to 170 g, much less than the 250 g difference noted in our model. This highlights the importance of this study and generating coefficients specific to the population in Qatar rather than extrapolating from previous models. We have included several other nationalities in our model and report the ones that significantly impact birthweight, which has not been reported in previous models. Some models include other

Table 3: Comparison of physiological coefficients generated in this study with those from other countries (Refs. [8, 10–12, 14–17, 29]).

Model parameters	Qatar (current study)	UK	Australia	New Zealand	Spain	USA	Ireland	Slovenia	Poland	Iran
TOW, grams	3,228.4	3,455.6	3,463.6	3,464.6	3,269.5	3,453.4	3,490.7	3,451.3	3,477.1	3,390.0
Standard error	374.5	389.0	410.4	420.4		382.6	411.1	375.9	372.6	366.1
R^2	0.24			0.30	0.24	0.27	0.29	0.26	0.26	0.18
Gestational age										
Linear	19.5	20.7	19.1	19.5	16.7	22.9	20.9	19.1	19.5	16.8
Quadratic	−0.30	−0.21	−0.34	−0.28	–	−0.31	−0.46	−0.48	−0.51	−0.31
Cubic	–	−0.0002	–	0.0006	–	−0.007	–	−0.004	–	–
Sex of the baby										
Male	59.7	48.9	66.9	57.7	51.8	66.0	66.8	78.4	81.9	63.5
Female	−59.7	−48.9	−66.9	−57.7	−51.8	−66.0	−66.8	−78.4	−81.9	−63.5
Maternal height										
Linear	7.92	6.7	7.8	9.60	8.77	6.40	6.55	7.9	6.46	6.42
Quadratic	–	–	–	–	–	–	–	–	–	–
Cubic	–	–	–	–	−0.008	−0.003	–	–	–	–
Maternal weight										
Linear	5.30	9.2	9.0	8.44	6.90	7.58	9.03	8.7	8.48	5.36
Quadratic	−0.039	−0.150	−0.150	−0.114	−0.120	−0.087	−0.093	−0.12	−0.170	−0.105
Cubic	–	0.001	0.001	0.0007	0.001	0.0005	–	0.0007	0.0008	–
Parity										
1	90.8	101.9	94.8	101.6	97.9	96.2	130.7	108.3	130.4	53.8
2/2+	134.7	133.7	115.2	101.8	127.0	121.9	174.3	140.5	205.3	82.6
3/3+	147.6	140.2	116	123.3	152.3	125.9	142.1	159.0	230.8	–
4+	–	162.7	99.2	175.5	–	122.7	–	–	–	–
Middle eastern ethnicity	–	−89.9	−110.0	–	–	–	−170.6	–	–	–

Constants are adjusted to 280 days for comparison; they express coefficients for a "standard" mother (as defined in methods) and exclude the effect of pathological factors. TOW, term optimal weight.

constitutional variables like paternal height and weight, maternal age and even BMI – however, the similarity of the coefficients shows that these variables probably had a minimum additional impact on birthweight.

The pathological variables included in most models are similar, such as hypertension, preexisting and gestational diabetes and smoking. The coefficients are similar in direction and magnitude for these variables, with all models reporting the biggest coefficients for preexisting diabetes and the largest negative coefficients for smoking. Some models show a dose-response effect for smoking based on the number of cigarettes [10, 16, 29], which was not possible in our cohort due to the unavailability of this data.

The R^2 for our model is 0.24, which is similar to those from other models (Table 3) and seems modest despite customisation. This is because the model predicts birthweight in pregnancies with normal outcomes only rather than the variations at upper and lower extremes, which are primarily due to pathological factors. The effect of customisation on the predictive ability of the significant coefficients being adjusted for is illustrated when excluding upper and lower extremes by assessing the mid-tertile part of the distribution [8], where the R^2 value increases stepwise with each variable added (sex, parity, ethnicity, maternal height, maternal weight) up to a more respectable R^2 of 0.76.

Strengths and limitations

A strength of this study is that we used an ethnically heterogeneous population for our analysis, allowing customised growth charts to be created for multiple ethnicities for women in Qatar. Additionally, nearly 70 % of deliveries in the country occur at the study site; hence, the study cohort is representative of the population. Nearly 12,000 women were included in the model, further increasing the representativeness and generalizability of the results. The PEARL registry provides quality information, with minimum missing data, collected by well-trained independent data collectors based on pre-defined standardized definitions.

Some limitations need to be kept in mind. Previous reports document a smoking rate of 3 % in women of Qatar in 2021 [32]. This study showed a self-reported smoking rate of 0.5 %, the accuracy of which needs to be questioned as expectant mothers might deny this history due to social pressures. Regardless, smoking had the highest detrimental impact on birthweight, with coefficients similar to the moderate-to-high levels of smoking reported in other models [10, 16, 29]. There could be human errors in the documentation of height and weight; however, the data entries were always double-checked, and the outliers were removed before analysis.

Conclusions

In conclusion, individually customized birthweight centiles and growth charts can help delineate the constitutionally small but healthy babies with no FGR from those who are genuinely growth-restricted. It will reclassify SGA babies missed by the population standards and help identify growth restriction in babies who are not SGA but subject to placental insufficiency in late gestation. The new model better reflects the distribution of birthweight in Qatar than currently used uncustomised standards derived from other populations, and applying these charts is likely to positively impact the detection of at-risk pregnancies and our stillbirth rates.

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