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Birth weight variation according to maternal characteristics and gestational weight gain in Brazilian women

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Abstract

Objective: **This study aims to identify birth weight variation according to maternal characteristics and gestational weight gain.**

Methods: **It is a cross-sectional descriptive study with 433 puerperal women (≥ 20 years old) who attended a public maternity hospital in Rio de Janeiro. The data were collected through interviews with the women and access to their medical records. Several models were tested using linear regression, using the stepwise method to identify the predictive variables of birth weight.**

Results: **The mean maternal age and gestational age at the end of pregnancy were 27 years old (± 5.09 years) and 39 weeks (+ 1.68 weeks), respectively. The data shows that the mean number of prenatal and nutritional prenatal care appointments were 8.24 (± 2.98) and 2.26 (± 2.33), respectively. Among the predictor variables of birth weight, total gestational weight gain (β = 25.29; p = 0.000), pre-gestational BMI (β =13.02; p = 0.037), and the number of pre-natal care appointments (β = 28.21; p = 0.007) were highlighted. The association of weight gain in the three trimesters was also verified.**

Conclusions: **This study confirms the interface between adequacy of the pre-gestational and gestational nutritional status and some maternal characteristics with birth weight. Nutritional care should be recognised as part of the actions during pre-natal assistance.**

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Key words: *Pregnant women. Anthropometry. Weight gain. Newborns. Birth weight.*

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VARIACIÓN DEL PESO CORPORAL EN FUNCIÓN DE LAS CARACTERÍSTICAS MATERNAS Y LA GANANCIA DE PESO GESTACIONAL EN MUJERES BRASILEÑAS

Resumen

Objetivo: **Este estudio tiene por objeto identificar la variación de peso al nacimiento en función de las características maternas y la ganancia de peso gestacional.**

Métodos: **Se trata de un estudio transversal y descriptivo con 433 mujeres puérperas (≥ 20 años de edad) que acudieron a un hospital maternal de Río de Janeiro. Se recogieron los datos mediante entrevistas con las mujeres y acceso a sus historiales clínicos. Se ensayaron diversos modelos utilizando la regresión linear y el método por pasos para identificar las variables predictivas del peso al nacimiento.**

Resultados: **La edad media materna y la edad gestacional al final del embarazo fueron 27 años (± 5,09 años) y 39 semanas (± 1,68 semanas), respectivamente. Los datos muestran que el número medio de visitas prenatales y de educación nutricional prenatal fue de 8,24 (± 2,98) y 2,26 (± 2,33), respectivamente. Entre las variables predictivas del peso al nacimiento, destacaban la ganancia total de peso gestacional (β = 25,29; p = 0.000), el IMC pre-gestacional (β = 13,02; p = 0,037) y el número de visitas prenatales (β = 28,21; p = 0,007). También se verificó la asociación de ganancia de peso en los tres trimestres del embarazo.**

Conclusiones: **Este estudio confirma la interrelación entre un estado nutricional pre-gestacional y gestacional adecuado y algunas características maternas con el peso al nacimiento. Debería reconocerse la atención nutricional como parte de las acciones de la asistencia prenatal.**

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Palabras clave: *Mujeres gestantes. Antropometría. Ganancia de peso. Recién nacidos. Peso al nacimiento.*

Introducción

The maternal caractheristics has been considered an important indicator of pregnancy prognosis, of birth conditions, especially those related to birth weight and perinatal mortality. Birth weight plays an important role in infant mortality and morbidity, child development, and adult metabolic diseases.[1-6]

Several studies shows the influences of maternal genetic, socio-cultural, demographic, and behavioral factors on birth weight. For example, pre-pregnancy body mass index (BMI) and gestational weight gain influence newborn birth weight and play significant roles in adverse pregnancy outcomes.[2-6]

In this case, both insufficient and excessive weight gain during pregnancy are strongly associated with maternal-fetal complications such as gestational diabetes, hypertensive pregnancy disorders (HPD), macrosomia and low birth weight.[2-9] Moreover, excessive weight gain during pregnancy represents one of the factors most strongly associated with postpartum weight retention, and consequently to postpartum obesity.[7-9]

Facing these facts, the aim of the present study is to identify the maternal predictive characteristics of birth weight.

Materials and methods

Design

This is a cross-sectional descriptive study, using the data collected in Maternidade Escola (ME) of Universidade Federal do Rio de Janeiro (UFRJ).The sample was composed by 433 puerperal women (≥ 20 years old), who did not suffer from chronic diseases, with gestational age determined by last menstrual period or ultrasound assessment, single-fetus pregnancy, known pre-gestational weight or weight measured up to the end of the 13th gestational week, access to prenatal care and no dietary restrictions. Characteristics of the newborns were also studied.

This Health Unit assists patients with characteristics similar to those presented by patients assisted in other Public Health Units in the city of Rio de Janeiro, according to the variables maternal age and number of prenatal care appointments.[7,8]

Data was collected through interviews with the women and access to their medical records.

Maternal and newborn anthropometric status assessment

Data about pre-gestacional weight (either informed by women during pre-natal appointments or measured up to the end of the 13th gestational week[9-11]); weight measured on the last prenatal care appointment,[12] or weight at the partum moment and maternal height were collected. All women in the study attended prenatal care service at ME/UFRJ or at other health units, and their anthropometric measures were recorded in their medical records.

Pre-gestational BMI was calculated according to reported or measured pre-gestational weight and total gestational weight gain was calculated subtracting pre-gestational weight from either weight at the partum moment or the weight measured on the last prenatal care appointment before delivery.

BMI cut-offs used to evaluate pre-gestational BMI used were < 18.5 kg/m^2 for *low weight*; BMI between 18.5 e 24.9 kg/m^2 for *normal weight*; BMI between 25 e 29.9 kg/m^2 for *overweight* and BMI > 30 kg/m^2 for *obesity*.[13] Recommended weight gain ranges are 12.5-18 kg, 11.5-16 kg, 7-11.5 kg, and 7 kg for low weight, normal weight, overweight and obese pregnant women, respectively.[14,15]

In a sub-sample (n = 208), weight gains during the first trimester (up to the end of the 13th gestational week), the second trimester (from the 14th to the 28th gestational weeks) and the third trimester (from the 28th gestational week on) were estimated.

Ethical questions

This study was approved by the Ethic Committee and all participants signed an informed consent form.

Data reliability

Aiming at standardizing data collection procedures, the researchers involved in this study were trained, recycled and supervised. Data reliability was evaluated by a retest applied to a sub-sample and a duplicated data collected independently by two different interviewers assessing the same medical records.

Statistical analysis

Measures of central tendency and dispersion of variables were calculated in the exploratory analysis of data.

T-student and ANOVA tests were used to test statistical similarity among means, and the pos-hoc test chosen was Tukey. To test the homogeneity of variables the *Levene* test was applied. A 5% statistical significance level was considered.

To identify predictor variables of birth weight (dependent variable), a linear regression model was tested using the *stepwise* method.

In this analysis, $p > 0.10$ and $p < 0.05$ were considered as the significance limits to the exclusion and inclusion of variables, respectively. Statistical analysis was performed using the SPSS statistical package for Windows version 13.0.

Table I
Maternal anthropometric and socio-demographic characteristics. ME/UFRJ, Rio de Janeiro, RJ, Brazil

Maternal characteristics	*%*
Pre-gestational nutritional status (n = 418)*	
Low weight	16.3
Normal	64.8
Overweight	10.5
Obesity	8.4
Skin color (n = 433)	
White	40.9
Non-white	59.1
Marital status (n = 433)	
Married/living with partner	77.4
Single, divorced or widow	22.6
Educational status (n = 433)	
Illiterate	1.2
Elementary education - incomplete	32.1
Elementary education - complete	16.2
High school education - incomplete	17.1
High school education - complete	25.6
College education	7.9
Sanitary conditions at home (n = 433)	
Adequate	96.1
Inadequate	3.9

*according to IOM (1990; 1992).

Results

The mean mother age was 27 years old (± 5.09 years), 26.3% (n = 114) of them were nulliparous and the mean gestational age at the end of pregnancy was 39 weeks (± 1.68 weeks). The mean birth interval was 56 months (± 36.72 months).

Based on table I, we notice that about 32% of the women began pregnancy with some weight deviation, low weight, overweight or obesity, and the great majority had a stable relationship with partner (77.4%) and good sanitary conditions at home (96.1%), meaning the availability of sanitary facilities such as running water, garbage disposal and sanitation. 5.5% of the women (n = 24) were smokers.

As to the maternal anthropometric assessment, the means of pre-gestational BMI and total gestational weight gain were 23.23 kg/m^2 (± 3.81 kg) and 12.99 kg (± 5.21 kg), respectively (table II).

Prenatal care data show that the mean number of prenatal and nutritional prenatal care appointments were 8.24 (± 2.98) and 2.26 (± 2.33), respectively. The mean maternal height was 1.59 m (± 0.006 m), and the percentiles 3, 10, 50, 90 and 97 were 1.47 m, 1.51 m, 1.59 m, 1.68 m and 1.74 m, respectively. Regarding newborns, the mean birth weight was 3,285.23 g (± 479.62 g) and the mean birth length was 49.07 cm (± 2.79 cm) (table IV). Preterm delivery index (< 37 weeks) was 6.3% (n = 27), and 4.6% (n = 20) presented low birth weight.

Table II
Maternal and newborn characteristics. ME/UFRJ, Rio de Janeiro, RJ, Brazil

Characteristics	*n*	*Mean*	*Standard Deviation*
Total family income (minimum wages)	400	4.58	3.72
Pre-gestational weight (kg)	413	58.71	10.73
Height (m)	422	1.59	0.006
Pre-gestacional BMI (kg/m^2)	418	23.23	3.81
Total gestational weight gain (kg)	418	12.99	5.21
Number of pregnancies	433	2.25	1.47
Birth weight (kg)	428	3,285.23	47.96
Birth length (cm)	418	49.70	2.79
Gestacional age upon birth according to last menstrual period (weeks)	427	39.15	1.68
Number of prenatal care appointments	431	8.24	2.46
Number of prenatal nutritional care appointments	433	2.26	2.33

Linear regression showed association between maternal variables ~~tot~~al gestational weight gain, pre-gestational BMI, maternal age and number of prenatal care appointments ~~an~~d the dependent variable birth weight. The variables number of prenatal nutritional care appointments, gestational intercurrences and parity were omitted from the final model (table III).

Due to the considerable significance of gestational weight gain as a predictive factor of birth weight, it was considered opportune to follow gestational weight gain during the three trimesters of pregnancy and verify its contribution to birth weight. Thus, in the linear regression model, trimester weight gain was substituted for total weight gain. In this analysis, weight gains in the three trimesters remained significantly in the model, together with prenatal care. In the first trimester, maternal age was also associated with birth weight, each year in maternal age contributing with a decrease of about 14 g to birth weight (table IV).

Table III
Linear regression results of predictor variables of birth weight. ME/UFRJ, Rio de Janeiro, RJ, Brazil

Variables	*β*	*p*
Total gestational weight gain (kg)	25.29	0.000
Pre-gestacional BMI (kg/m^2)	13.02	0.037
Maternal age (years old)	-10.28	0.024
Number of prenatal care appointments	28.21	0.007

Variables omitted from the final model: number of prenatal nutritional care appointments, gestational intercurrences and parity.

Table IV
Linear regression results of predictor variables of birth weight, second gestational trimester. ME/UFRJ, Rio de Janeiro, RJ, Brazil

Variables	*β*	*p*
First trimester		
Age (years old)	-14.0	0.039
Weight gain (kg)	29.6	0.040
Number of prenatal care appointments	76.4	0.000
Second trimester		
Weight gain (kg)	27.2	0.045
Number of prenatal care appointments	77.7	0.000
Third trimester		
Weight gain (kg)	42.6	0.001
Number of prenatal care appointments	69.8	0.000

Variables omitted from the final model: number of prenatal nutritional care appointments, gestational intercurrences and parity.

Discussion

In this study, the predictor variables of birth weight were total gestational weight gain, pre-gestational BMI, maternal age and number of prenatal care appointments. Socio-demographic obstetric and prenatal care characteristics were controlled. This data corroborate the findings of several other studies, which recognize the association between gestational weight gain and birth conditions.[16]

Nowadays, maternal anthropometric aspects such as pre-gestational nutritional status and gestational weight gain are considered to be changeable determiners of great relevance to adequate fetal growth. Prenatal nutritional intervention is related to favorable outcomes and should be incorporated in prenatal care.[3,16-19]

In this study, maternal age contributed negatively to birth weight. It is worth mentioning that there are few studies which relate these variables among adult women, especially those over 40 years old. As a general rule, studies focus on LBW risk among adolescents.[20] Nevertheless, in a recent review about biological aspects determining maternal weight gain, the IOM[6] presents data which emphasize a tendency among adult pregnant women to show lower weight gain rates. This might explain the reverse impact of maternal age on observed birth weight.

Yekta et al.[21] suggest that deviations in maternal gestational weight gain, as well as inadequate pre-gestational BMI, act as newborn birth weight markers. In the same study, the authors recognize the importance of following prenatal weight gain, aiming at better outcomes. This monitoring would allow early identification of nutritional risk, thus proposing nutritional counseling as one major goal.

In face of this context, prenatal care is used as an indicator of measure qualities and care with the mother-child binomial, neutralizing risk factors associated with pregnancy. Considering that one of the aims of prenatal care is to early identify the risk of unfavorable outcomes, adequate intervention measures can be implemented.[11,15] Effectiveness of nutritional intervention during pregnancy, based on growing evidence about the benefits of adequate nutrition, has been suggested not only to obstetric outcome, but also to children during their first years of life.[22-24]

More recently, the WHO[16] has recognized nutritional factors, among other measures capable of predicting favorable perinatal and neonatal results, as an indicator of prenatal care quality. Therefore, this corroborates the current tendency towards recognition of many complications during pregnancy being caused by pregestational behaviors and circumstances, mostly nutritional aspects.[16,25,26]

The close association found between the number of prenatal care appointments and birth weight reinforces the role of measures concerning the mother-child binomial in order to optimize the obstetric result. In a systematic revision of prenatal adequacy and birth weight, findings are that, generally, transversal studies pointed out a protector effect of prenatal over birth weight. However, random transversal studies are necessary to clarify this association. On the other hand, the early beginning of prenatal care observed in this study might have brought a decisive contribution to birth weight, as an opportune beginning indicates good practice in promoting mother and child health.[27]

Omitting the number of prenatal nutritional care appointments from the predictor model of birth weight might be due to its small quantity: the mean number of appointments was 2.26 (± 2.33). Thus, it calls for a reinforcement of the importance of an early beginning bearing in mind a minimum number of nutritional assistance appointments.

To corroborate an early and opportune beginning of prenatal care, it was verified in this study that gestational weight gain in the first trimester is a significant predictive of birth weight, which goes against the statement made by some authors that the relevant maternal weight gain to birth weight occurs only in the second and third trimesters.[5] However, it is known fact that literature does not reach a consensus concerning the gestational period of most impact on birth weight.

Neufeld et al.[28], in an investigation about the relationship between weight gains in different gestational periods, highlighted that the first trimester is the most important predictive of fetal linear growth. Besides, evidence shows the origin of limitations to fetal growth related to aggravations in the first trimester, which reinforces that some intercurrences at the end of pregnancy might have their origin in this period.[29] Findings reported by Brown et al.[30] show weight gains in the first and second trimesters as predictives of birth weight, representing 31 g and 14 g of it, respectively. However, evaluating the impact of maternal weight gain on child weight index, it was observed that deeply expressive

results were obtained only in the first and third trimesters.

Gestational weight gain in the third trimester has an important role in LBW prevention, which might potentially contribute to prevent chronic diseases associated to such outcome.[30]

It is worth noticing in this study that maternal age as a predictor variable of birth weight remains in the statistical model only in the first trimester, each year in maternal age contributing with a decrease of about 14 g in birth weight. This finding suggests that maternal age influences physiological adaptations and placental structure alterations. It is a fact that the consequences of these alterations will be more evident in the first trimester of pregnancy, because embryogenesis is strongly determined in this period. Along this period, embryo development is extremely sensitive to environment factors, and there is growing evidence that even infinitely subtle influences might also influence pregnancy outcomes.[16,31]

The IOM guidelines, based on the weight gain ranges according to pre-gestational BMI have been the most internationally used ones for over a decade.[32]

Throughout the years, a direct proportionality between maternal nutrition and newborn birth weight has been demonstrated, using the recommendations by the IOM to evaluate perinatal risks. Several authors have concluded that gestational weight gain, according the variations stated by the referred committee, predicts birth conditions and is favorable to maternal nutritional status after delivery.[33-35]

Studies testing the Brazilian adaptations proposed by the Ministry of Health[11] have not been published yet. The referred proposal does not consider a minimum gestational weight gain for low-height pregnant women and limits to 7 kg the total weight gain to obese pregnant women. Although the recommended weight gain ranges are similar to those recommended by the IOM, the cut-offs to classify pre-gestational BMI are not presented, which causes doubts. Prenatal care units adopt both the IOM[13,14] and the WHO[9] cut-offs for pre-gestational BMI.

The findings suggest that the low-height value (< 1,57 m) recommended by the American committee may not be adequate to the Brazilian population, due to different height patterns among both populations. Moreover, there is a questioning about cut-offs to be adopted to pre-gestational nutritional status classification, and further discussion is necessary. In this casuistry, adequacy of the gestational weight gain made by the pre-gestational BMI classification according to the criteria stated by both the WHO[9] and the IOM[13,14] was associated with birth weight.

It becomes necessary to effectively implement prenatal nutritional care, due to the fact that anthropometry alone presents limitations to the nutritional diagnosis of pregnant women, especially to the identification of specific nutritional deficits risk situations, such as anemia and vitamin A deficiency. Their impact in short, medium and long terms are also related with birth conditions, and may have consequences throughout childhood and adulthood, as well as a great impact on maternal a child morbimortality.[8,16,36]

Another aspect that makes prenatal care extremely important is the omission of gestational intercurrences from the regression model, which indicates an efficient care and quality prevention of harm. On the other hand, omission of prenatal nutritional assistance might have happened due to the mean number of appointments (2,46 ± 2,33), a lower value than the established, which is, ideally, 4 throughout pregnancy or, at least, one in each trimester.

Within the limitations of this research is the use of informed pre-gestational weight endorsed by preliminary study of part of the sample and of literature, where there is an agreement between the informed and measured weights. Also, the inclusion of smoker pregnant women could be seen as a selection factor, although the number of smokers was less than 5%, thus acceptable, when compared to other studies.

Conclusion

Inadequacy of nutritional status within reproductive age and pregnancy is an important health and nutritional problem among women and their children, which might bring undesirable consequences to reproductive health, as well as negatively contribute to child development, with reflections on birth conditions and morbimortality rates.

In this analysis, among other maternal characteristics, age, total gestational weight gain, pre-gestational BMI and the number of prenatal care appointments are recognized as predictive factor to birth weight. Also, the results show a need for monitoring gestational weight gain from the first trimester and throughout pregnancy, as weight gain in all trimesters significantly contributed to birth weight.

Nevertheless, there should be further discussion concerning the BMI values recommended to different populations.

To meet the expectations of the health committees and the scientific community, efforts must be made in an attempt to make nutritional assistance part of prenatal care. Nutritional counseling must focus not only on anthropometric assessment, but also on dietary quantitative and qualitative aspects, aiming at an interdisciplinary context within prenatal care.

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