ORIGINAL ARTICLE

# Factors related to birth weight: influence of gestational data

## *Fatores relacionados ao peso ao nascer: influência de dados gestacionais*

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DOI: 10.5935/2238-3182.20150037


### ABSTRACT

**Introduction:** birth weight is a determinant factor in the health of newborns. Factors related to health and maternal behaviors influence the birth conditions and, consequently, birth weight. **Objectives:** to determine the relationship between maternal characteristics and birth weight. **Patients and methods:** this was a longitudinal study performed in two stages including 87 women. In the first, pregnant women answered a questionnaire with socio-economic information, variables related to pregnancy, obstetric history, and 24 hours food recall. The second stage took place in the first postpartum month; nursing mothers were questioned through telephone contacts about their delivery characteristics, their newborn, and total weight gain during pregnancy. Logistic regression analysis was used to analyze the relationship between the pregnancy variables and birth weight. **Results:** the average consumption of iron, calcium, folic acid, and vitamin A were below the nutritional recommendations, except for vitamin C, which was appropriately consumed. After the logistic regression adjustments, the variables pre-pregnancy nutritional status (OR = 5.457; p = 0.012), start of prenatal care (OR = 1.509; p = 0.015), and density of dietary calcium (OR = 2.672; p = 0.048) remained associated with birth weight. **Conclusions:** the importance of medical and nutritional appropriate follow-up during the prenatal period is highlighted in order to minimize the occurrence of adverse effects on pregnancy and damage in the health status of newborns.


**Key words:** Birth Weight; Infant, Newborn; Pregnant Woman; Nutritional Status; Prenatal Care; Calcium.


### RESUMO

***Introdução:*** *o peso ao nascer é fator determinante do estado de saúde do recém-nascido. Fatores ligados à saúde e comportamento materno exercem influência nas condições de nascimento e, consequentemente, no peso ao nascer.* ***Objetivos:*** *determinar a relação entre as características maternas e o peso ao nascer.* ***Pacientes e métodos:*** *estudo longitudinal que incluiu 87 mulheres e realizado em duas etapas. Na primeira, as gestantes responderam um questionário contendo informações socioeconômicas, variáveis referentes à gestação, história obstétrica e recordatório alimentar 24 horas. A segunda etapa ocorreu no primeiro mês pós-parto e as nutrizes foram questionadas sobre as características do parto, do recém-nascido e o ganho de peso total na gestação, por meio de contato telefônico. Foi utilizada análise de regressão logística para analisar a relação entre as variáveis gestacionais e o peso ao nascer.* ***Resultados:*** *o consumo mediano de ferro, cálcio, ácido fólico e vitamina A estavam abaixo das recomendações nutricionais, exceto vitamina C, que apresentou consumo adequado. Após ajustes da regressão logística, per-*


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*Submitted:* 2014/04/25
*Approved:* 2014/07/27

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*maneceram associadas ao peso ao nascer as variáveis estado nutricional pré-gestacional (OR=5,457; p=0,012), início do pré-natal (OR=1,509; p=0,015) e densidade de cálcio dietético (OR=2,672; p=0,048).* ***Conclusões:*** *ressalta-se a importância de acompanhamento médico e nutricional adequado e de qualidade durante o pré-natal, para minimizar a ocorrência de consequências desfavoráveis na gestação e prejuízos no estado de saúde do recém-nascido.*

***Palavras-chave:*** *Peso ao Nascer; Recém-Nascido; Gestantes; Estado Nutricional; Cuidado Pré-Natal; Cálcio.*

## INTRODUCTION

The health of the newborn (RN) can be analyzed in various ways, one of which is birth weight. This is an important factor determining neonatal mortality and morbidity and post-neonatal mortality of great value to public health.[1]

Several factors have influence on birth weight including maternal nutritional status, which has a significant effect on fetal growth and development. The nutritional status is determined primarily by the ingestion of micro and macronutrients; an inadequate nutrient intake by pregnant women can harm the availability of nutrients needed for proper fetal growth.[2]

The inadequate intake of vitamins and minerals is associated with adverse pregnancy outcomes. There is a high proportion of women of childbearing age who consume diets with insufficient amounts of micronutrients; the highest deficits observed are for zinc, folate, iron, and calcium.[3] The recommendation of additional calcium in the diet aims to prevent complications such as hypertension, pre-eclampsia, and premature delivery as well as assisting in the formation of bone and dental structure and reducing the risk of low fetal birth weight.[4,5]

Prenatal care is another factor that influences birth weight and may contribute to more favorable outcomes by enabling the detection and timely treatment of diseases in addition to controlling risk factors that bring complications to the health of women and RN.[6] Moreover, women who receive care from the first trimester have better pregnancy outcomes than those that start prenatal care late.[7]

Socioeconomic conditions can influence low birth weight. Arreola et al.[8] demonstrated that a major risk factor for low birth weight was socioeconomic status regardless of other factors such as nutrition, reproduction, smoking, morbidity during pregnancy, access to health services, and prenatal care.

It is considered that factors linked to behavior and maternal health are directly related to the condition of birth. This study aimed to investigate the relationship between maternal characteristics (socioeconomic, gestational, obstetrical and food) and birth weight.

## PATIENTS AND METHODS

This was a longitudinal study that followed-up pregnant women from the third trimester until the first postpartum month evaluating the nursing mother and her infant. The study was conducted in all basic health units in the western and southern regions of the city of Juiz de Fora – MG, totaling eight health units.

The sample consisted of pregnant women who were invited to participate in the study at the time awaiting some procedure in the health unit making this a sample of convenience. Thus, the inclusion criterion was acceptance to participate, and there were no exclusion criteria. The total number of women evaluated was 111; 87 completed all evaluations. The second evaluation was made by telephone, which justifies some sample losses because some women could not be reached in the available phone numbers.

In the first stage of the study, pregnant women who agreed to participate signed the Voluntary Informed Consent Form and responded to a questionnaire containing socioeconomic information such as maternal and paternal education, marital status, maternal and paternal working condition, family income and per capita, and children under five years old in the household. The questionnaire also included and the assessment of variables related to the pregnancy such as maternal age, body mass index (BMI) before pregnancy, weight at the beginning of pregnancy, expected delivery date, start of prenatal care, number of prenatal consultations, complications during pregnancy, use of iron supplement or vitamin complex, smoking and alcohol consumption habits during pregnancy; obstetric history: number of children and birth interval, and history of abortion.

Macronutrients (carbohydrate, protein, and lipids) and micronutrients (folate, calcium, iron, vitamin A, and vitamin C) were quantified in the diet of the studied pregnant women using 24 hours dietary recall. The calculation of dietary data was conducted based on macro and micronutrients reference values in foods contained in food composition tables.

The nutrients were analyzed with gross consumption values considering the reference values of Dietary Reference Intakes (DRIs) as cutoff values, and also by the density of nutrients; the latter obtained from the formula [(mg of dietary nutrient/dietary calories) x 1000]. Due to the small proportion of individuals with adequate intake, the cutoff point in the univariate analyzes was considered as the intake median value.

In the second stage, which took place in the first postpartum month, the nursing mothers were evaluated by telephone contact. Nursing mothers were asked about the characteristics of birth and the newborn and the total weight gain during pregnancy. Newborns were classified by birth weight according to the World Health Organization (WHO) in low birthweight (<2,500 g), underweight (2500-2999 g), normal weight (3000-3999 g), and macrosomic (> 4,000 g). In the statistical analysis, birth weight was categorized as low weight and insufficient weight, and as appropriate weight and macrosomic. Women were also classified in relation to total weight gain during pregnancy as recommended by the Ministry of Health.[9]

They raw odds ratio values were used in the univariate analysis to identify the set of variables that most contributed to explaining underweight at birth. Subsequently, the variables that were significant in the univariate model ($p < 0.20$) were included in the logistic regression analysis, however, those that presented significance level of 5% ($p < 0.05$) were maintained. The data were processed using the SPSS software version 15.0.

## RESULTS

Table 1 presents the characteristics of the sample. The study included 87 women between 14 and 40 years old. As for the pre-gestational nutritional status (IMCPG), there was a predominance of eutrophic women and most were multiparous. Most women did not have any complications (diabetes mellitus, hypertension, heart disease, or other complications), and almost 59.8% began prenatal care during the third trimester. The socioeconomic variables showed that most had high school education level and were married.

Table 2 describes the dietary and nutrient density values. It was observed that the average consumption is below the nutritional recommendations, except for vitamin C. These data corroborated the low percentages of adequate intake of these nutrients; in the case of calcium, only 13.78% of women showed adequate intake. Vitamin A was also close to this value, with 13.79%. However, the vitamin C intake showed percentage appropriateness higher than that of other vitamins, with 58.62%. With respect to iron and folic acid, only 1.14% of adequate intake was observed.

**Table 1** - Descriptive data of pregnant women evaluated in eight health units of the Western and Southern regions of Juiz de Fora, MG, 2011-2012

| Variable | Frequency (%) |
|---|---|
| **Age** | |
| Adolescents (< 19 years old) | 20.69 |
| Adults | 79.31 |
| **Anthropometric – IMCPG** | |
| Low weight | 16.1 |
| Eutrophic | 46 |
| Overweight | 20.7 |
| Obese | 14.9 |
| Not informed* | 2.3 |
| **Obstetric – Number of gestations** | |
| Primiparous | 44.8 |
| Multiparous | 55.2 |
| **Current gestation – Complications** | |
| Yes | 44.8 |
| No | 55.2 |
| **Start of prenatal care** | |
| Up to the third trimester | 59.8 |
| After the third trimester | 40.2 |
| **Total weight gain during pregnancy** | |
| Insufficient | 33.3 |
| Adequate | 37.9 |
| Excessive | 23.0 |
| Not informed** | 5.8 |
| **Socioeconomic – Maternal education** | |
| ≤ 8 years | 47.1 |
| ≥ 8 years | 52.9 |
| **Marital status** | |
| Married | 63.2 |
| Single/Separated/Widower | 36.8 |

IMCPG = Pre-pregnancy Body Mass Index.
* 2 women were not able to inform the pre-pregnancy weight.
**5 women were not able to inform their weight gain during gestation.

The children in the sample were classified according to birth weight. Among the 87 children, 55.17% were born with adequate weight, 6.9% macrosomic, 4.6% underweight, and 33.3% with insufficient weight.

**Table 2** - Dietetic data of pregnant women evaluated in eight health units of the Western and Southern regions of Juiz de Fora, MG, 2011-2012

| Dietetic variables | Median | Minimum--Maximum |
|---|---|---|
| Calories (kcal day) | 1807.99 | 798.96 – 5069.73 |
| Calcium (mg) | 460.28 | 81.2 – 2720.3 |
| Calcium Density (µg /1000 Kcal) | 253.88 | 58.9 – 1228.3 |
| Iron (mg) | 8.45 | 3.6 – 23.6 |
| Iron density (µg/1000 kcal) | 4.62 | 1.8 – 10.6 |
| Folic acid (ug) | 105.13 | 14.1 – 580.3 |
| Folic acid density (µg/1000 kcal) | 60.81 | 6.3 – 237.7 |
| Vitamin A (ug) | 156.36 | 0 – 26554.3 |
| Vitamin A density (µg/1000 Kcal) | 89.65 | 0 – 10877.0 |
| Vitamin C (mg) | 84.02 | 1.8 – 1763.4 |
| Density Vitamin C (µg/1000 Kcal) | 50.79 | 9.0 – 1131.0 |

The studied variables selected for the logistic regression model presented p <0.20 (Table 3). Other variables such as parity, abortion, last pregnancy interval, complications in the current pregnancy, number of prenatal consultations, use of iron supplement or vitamin complex, total weight gain during pregnancy, gestational duration, birth type, children under five years old in the household, smoking and alcohol consumption habits, physical activity, paternal education, mother and father working condition, family income per capita, and consumption of protein, lipid, folic acid, iron, vitamin A, and Vitamin C did not explain the results on birth weight of the evaluated children (p> 0.20). After logistic regression adjustments, the pre-gestational nutritional status, dietary calcium density, and early prenatal care variables remained associated with birth weight (Table 4).

Thus, mothers who had low weight before pregnancy were five times more likely to have children weighing less than 3,000 grams compared to other mothers (OR = 5.457; p = 0.012). Regarding the start of prenatal care, those mothers who started consultations after the third trimester were more likely to have children with inadequate weight (OR = 1.509; p = 0.015) compared to those who initiated prenatal care during the third trimester.

The calcium density was also a determining factor because women who had less than the median consumption were approximately 2.5 times more likely to bear children with inadequate birth weight (OR = 2.672; p = 0.048).

**Table 3** - Distribution of study variables according to gross Odds Ratio (OR) and their respective confidence intervals at 95% (IC95%) in pregnant women evaluated in eight Health Units in the Western and Southern regions of Juiz de Fora, MG, 2011-2012

| Variable | OR | IC | p |
|---|---|---|---|
| **IMCPG** | | | |
| EU/SO/OB | 1,0 | 1,063 – 11,688 | 0,039 |
| BP | 3,525 | | |
| **Calcium Density (µg /1000 Kcal)** | | | |
| ≥ Median | 1,0 | 1,042 – 6,218 | 0,040 |
| < Median | 2,545 | | |
| **Presence of anemia during gestation** | | | |
| No | 1,0 | 0,966 – 90,55 | 0,057 |
| Yes | 2,957 | | |
| **Start of prenatal care** | | | |
| Up to the third trimester | 1,0 | 0,990 – 1,767 | 0,059 |
| After the third trimester | 1,323 | | |
| **Maternal Education** | | | |
| > 8 years | 1,0 | 0,182 – 1,099 | 0,079 |
| ≤ 8 years | 0,447 | | |
| **Carbohydrate consumption** | | | |
| ≥ Median | 1,0 | 0,216 – 1,255 | 0,146 |
| < Median | 0,520 | | |

EU = Eutrophic, SO = Overweight, OB = Obesity, BP = Low weight.

**Table 4** - Distribution of study variables according to Odds Ratio (OR) adjusted according to the Logistic Regression Model and their respective confidence intervals at 95% (IC95%) in pregnant women evaluated in eight Health Units in the Western and Southern regions of Juiz de Fora, MG, 2011-2012

| Variable | OR | IC | p |
|---|---|---|---|
| **IMCPG** | | | |
| EU/SO/OB | 1,0 | 1,442 – 20,656 | 0,012 |
| BP | 5,457 | | |
| **Start of prenatal care** | | | |
| Up to the third trimester | 1,0 | 1,083 – 2,103 | 0,015 |
| After the third trimester | 1,509 | | |
| **Calcium Density (µg /1000 Kcal)** | | | |
| ≥ Median | 1,0 | 1,007 – 7,089 | 0,04 |
| < Median | 2,672 | | |

EU = Eutrophic, SO = Overweight, OB = Obesity, BP = Low weight.

## DISCUSSION

The maternal environment is critical to fetal growth and development; thus birth weight depends on many factors that may have lower or higher individ-

ual impacts, which has been the focus of studies in the recent decades.[2,7,10-25] In this study, insufficient birth weight was associated with body mass index before pregnancy, early prenatal care, and calcium intake.

It is known that birth weight is considered an important factor in determining child survival; underweight children are more at risk of becoming ill or dying in the first year of life.[10] Studies that identify factors influencing this variable in different life and health conditions are of fundamental importance to make this theme the subject of the public health agenda to support public health policies for the mother-child group.

BMI provides information on energy reserves and can be used to determine and monitor weight gain based on nutritional status before pregnancy.[11] The association between pre-pregnancy BMI and birth weight is already known. Therefore, an adequate BMI (BMI 19.8 to 26.0 kg/m$^2$) followed by appropriate weight gain during pregnancy influences the reduction of low birth weight.[12]

In this study, an association between pre-pregnancy BMI and underweight at birth was also observed; mothers who showed low weight prior to pregnancy were more likely to have children weighing less than 3,000 grams. Yekta et al.[13] demonstrated that inadequate IMCPG acts as a marker for newborn weight, and thus recognized the importance of monitoring the anthropometric evolution during prenatal care for good obstetric outcomes. A cross-sectional study with 433 postpartum women and their newborns in developing countries reports increased chance of low birth weight among women with IMCPG rated as underweight (OR = 7.1; IC95% = 1.9 -27.5).[14]

Prenatal care is another important factor because when performed correctly it exerts a protective effect on low birth weight.[15] Data from the National Survey on Demography and Health[16] indicate that prenatal care is conducted in 95.1% nationally, being a positive factor revealing that most Brazilian women are followed-up during pregnancy.

A cross-sectional study in a maternity of Teresina, Piauí reports that 63.9% of women began prenatal care in the first trimester of pregnancy and attended more than six consultations, i.e., complying with the minimum appropriate schedule. This compliance allowed proper and timely assistance are reducing the risk of pregnancy complications and favoring appropriate birth weight. Women who received care from the first trimester have better pregnancy outcomes than those with a late start.[7]

In this study, a relationship between the start of prenatal care and birth weight was observed demonstrating that mothers who initiated consultations late were more likely to have children with inadequate weight.

Calcium is a crucial element in the body playing an important role in bone mineralization and participating in the formation and maintenance of the structure and rigidity of the skeleton.[17,18] The demand for calcium is increased during pregnancy because of its increased need during this period. In order to the organism to fulfill this need, physiological responses including an increase in absorption, renal excretion, and bone metabolism occurs.[4,18]

Despite the increased need, an adequate intake of this nutrient among pregnant women is often not observed. In this study, only 13.78% of women ingested the optimum amount of calcium, which was observed in other studies,[19] irrespective of skin color. In Chile, Castillo[3] found that this intake by women did not cover the needs of this nutrient during pregnancy. Durán[20] showed that 54.7% of pregnant women had calcium intakes of less than 75% of the daily requirement. In New Zealand, Watson and McDonald[21] evaluated calcium intake in pregnant women in different seasons and showed that it was always inadequate.

The low calcium intake constituted a risk for poor birth weight in this study. It is known that calcium deficiency during pregnancy is rare. However, it is associated with preeclampsia and can lead to intrauterine growth retardation (RCIU).[4] During pregnancy, any disorder that primarily affects mineral metabolism, such as depletion and diseases or mineral placental transfer, can affect fetal bone mineralization.[22] Therefore, low calcium maternal intake affects fetal skeletal growth and development.[22,23]

Another relevant factor to consider is the supplementation of calcium. Hofmeyr et al.[24] revealed that the supplementation during pregnancy reduced the incidence of premature birth. In women with low calcium intake, the supplementation resulted in increased neonatal bone density and body total bone mineral content.[25] However, Cochrane[26] showed no significant improvement regarding premature births and low birth weight with the use of calcium supplementation in 21 randomized controlled trials that included 16,602 women. To date, the effect of this supplementation is not clear yet, and there is no consensus on its benefits.[24]

The main limitation of this study is related to the use of 24h dietary recall because it does not allow the evaluation of habitual intake of nutrients. Despite this limitation, this instrument is widely used in epidemiological studies and has many advantages by being a fast instrument, relatively inexpensive, easy to apply, and with little influence on dietary behavior.[27]

## CONCLUSION

In this study, low pre-pregnancy weight, delayed start of prenatal care, and low density in calcium intake were related to underweight at birth showing the direct influence of maternal health behavior in the RN health. It emphasizes the importance of quality and proper medical and nutritional follow-up during the prenatal care to minimize the occurrence of adverse effects during pregnancy and damage the newborn's health. Moreover, the evidence found reinforces the need to develop and establish actions directed to the mother and child clientele involving the promotion of healthy lifestyles to ensure maternal and child health and reduce comorbidities.

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