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**ORIGINAL ARTICLE /** *ARTIGO ORIGINAL*

# The performance of various anthropometric assessment methods for predicting low birth weight in adolescent pregnant women

## *O desempenho de diferentes métodos de avaliação antropométrica de gestantes adolescentes na predição do peso ao nascer*

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**ABSTRACT:** ***Objective:*** To evaluate the performance of various anthropometric evaluation methods for adolescent pregnant women in the prediction of birth weight. ***Methods:*** It is a cross-sectional study including 826 adolescent pregnant women. In the pre-pregnancy body mass index (BMI) classification, the recommendations of the World Health Organization were compared with that of the Brazilian Ministry of Health and the Institute of Medicine (IOM) of 1992 and 2006. The gestational weight gain adequacy was evaluated according to the classification of IOM of 1992, of 2006 and of the Brazilian Ministry of Health. The newborns were classified as low birth weight (LBW) or macrosomic. Multinomial logistic regression was used for statistical analysis and sensibility, specificity, accuracy, positive and negative predictive values were calculated. ***Results:*** The evaluation, according to the Brazilian Ministry of Health, showed the best prediction for LBW among pregnant women with low weight gain (specificity = 69.5%). The evaluation according to the IOM of 1992 showed the best prediction for macrosomia among pregnant women with high weight gain (specificity = 50.0%). The adequacy of weight gain according to the IOM of 1992 classification showed the best prediction for LBW (OR = 3.84; 95%CI 2.19 – 6.74), followed by the method of the Brazilian Ministry of Health (OR = 2.88, 95%CI 1.73 – 4.79), among pregnant women with low weight gain. ***Conclusion:*** It is recommended the adoption of the Brazilian Ministry of Health proposal, associated with BMI cut-offs specific for adolescents as an anthropometric assessment method for adolescent pregnant women.

***Keywords*:** Pregnancy in adolescence. Body mass index. Weight gain. Birth weight. Nutrition assessment. Anthropometry.

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**RESUMO:** ***Objetivo*:** Avaliar o desempenho de diferentes métodos de avaliação antropométrica para gestantes adolescentes na predição do peso ao nascer. ***Métodos:*** Trata-se de estudo transversal com dados de 826 puérperas adolescentes. Na classificação do índice de massa corporal (IMC) pré-gestacional, adotou-se as recomendações da *World Health Organization*, com a classificação proposta pelo Ministério da Saúde de 2006 e pelo *Institute of Medicine* (IOM) de 1992 e de 2009. A adequação do ganho de peso gestacional total foi avaliada segundo a classificação do IOM de 1992, de 2009 e do Ministério da Saúde. Os recém-nascidos foram classificados em baixo peso ao nascer (BPN) ou macrossômicos. Na análise estatística, obtiveram-se modelos de regressão logística multinomial e calculou-se sensibilidade, especificidade, valor preditivo positivo, valor preditivo negativo e acurácia. ***Resultados:*** A avaliação segundo o Ministério da Saúde apresentou a melhor predição (especificidade = 69,5%) para o BPN nas gestantes que tiveram ganho insuficiente, enquanto que a avaliação segundo o IOM de 1992 apresentou melhor predição (especificidade = 50,0%) para a macrossomia naquelas com ganho de peso acima da recomendação. A adequação do ganho de peso segundo a classificação do IOM de 1992 apresentou maior predição para o BPN (OR = 3,84; IC95% 2,19 – 6,74), seguida do método do Ministério da Saúde (OR = 2,88, IC95% 1,73 – 4,79), dentre as adolescentes com ganho de peso gestacional abaixo da recomendação. ***Conclusão*:** Recomenda-se a adoção da proposta do Ministério da Saúde, associada com a classificação do IMC com pontos de corte próprios para as adolescentes, como método de avaliação antropométrica de gestantes adolescentes.

***Palavras-chave*:** Gravidez na adolescência. Índice de massa corporal. Ganho de peso. Peso ao nascer. Avaliação nutricional. Antropometria.

## INTRODUCTION

Epidemiological studies show that the inadequacy of the anthropometric state of women, before and during pregnancy, constitutes a public health problem by promoting the development of gestational intercurrences and influencing their health conditions in the postpartum and conceptus periods[1,2].

Developing countries have been showing distinct situations of nutritional deviation problems: a decline in malnutrition and an increase in overweight, obesity and chronic diseases[3-5]. Brazil, in especial, is going through a phase of epidemiological transition, characterized by the change in populational morbidity profile, in which infectious and parasitic diseases give place to nontransmissible chronic diseases, such as obesity[3]. According to data from the *Pesquisa de Orçamentos Familiares* (2008 – 2009), the use of a BMI-for-age anthropometric index, the weight deficit in adolescent girls and grown women was 3.0 and 3.6%, respectively. The excess of weight in adult women was 48% and, in adolescent girls, 19.4%. Obesity, in turn, was observed in 16.9% of adult women and in 4.0% of adolescent young women[6]. Given the increased risk of prematurity and maternal mortality in situations of low gestational weight and the association of obesity to a higher rate of diabetes,

hypertensive syndromes in pregnancy, birth sequelae and cesarean sections, the nutritional diagnosis of the pregnant woman and the recommendation weight gain are essential in order to ensure a positive obstetric outcome[7,8].

International standards of weight gain recommendations have been used and reviewed over the last 50 years, showing the relevance of choosing the most adequate method for maternal anthropometric evaluations in clinical practice[9-12].

In 2009[13], the Institute of Medicine (IOM) issued new recommendations for weight gain during pregnancy, based on the pre-gestational body mass index (BMI), based on the proposal originally published in 1990[14] and reviewed in 1992[15]. It is noteworthy that, for the adolescents, the IOM committee kept the same nutritional evaluation procedure suggested for the adults, by lack of scientific evidence that support the differentiated adoption of adequacy of weight gain for teenagers[13-15].

In Brazil, in the most recent guidelines of the Ministry of Health (MOH) for prenatal low-risk[7], the procedures recommended for the anthropometric and planning evaluation of gestational weight gain suggested for the grown ups were kept for the adolescents, without contemplating their specificities[13,14].

In 2007, the World Health Organization (WHO)[16] proposed the adoption of a new reference for the nutritional diagnosis of adolescents, based on the BMI, replacing the recommendations of the WHO in 1995[17], enabling the classification of adolescents according to an age appropriate (in years and months) reference. It was then possible to better reflect on the weight and height profile of the teenagers and the highest comparability between populations. However, this recommendation was not incorporated by the MOH[7,18] in the nutritional evaluation of pregnant teenagers, being used only for the non-pregnant ones[19].

Therefore, the proposals published so far by the international and national health committees for pregnant adolescents are still based on the recommendations proposed for pregnant adults. The reason for this classification has been based on the hypothesis that the adolescents would benefit from a higher weight gain program, at the expense of misclassifications such as low weight in the beginning of pregnancy[7,13]. On the other hand, studies indicate that gestational weight gain above what is recommended may be associated to future unwanted outcomes in the adult life of these pregnant teenagers, among them the retention of weight after labor, with consequences to the development of obesity associated diseases[20]. In addition to the above, the most used recommendations for weight gain planning during pregnancy[7,13,18] were not validated according to the prenatal results of adolescent.

Thus, the investigation on the best gestational anthropometric evaluation method, especially in teenagers, needs to be encouraged, and the topic should be discussed by researchers and professionals in the evaluation of prenatal care quality[1]. These methods are expected to present good sensitivity and specificity to classify, appropriately, the maternal nutritional status and to identify the risk situations for an unwanted obstetric outcome in pregnant adolescents[17].

Given the above, this study intends t o evaluate the performance of different methods of gestational anthropometric evaluation in a sample of pregnant teenagers in the city of

Rio de Janeiro, in order to assess their predictive ability as to the prenatal outcome of birth weight inadequacy.

## METHODS

The work is part of the *"Estudo da Morbi-mortalidade e da Atenção Peri e Neonatal no município do Rio de Janeiro, 1999–2001"* and was developed based on a sample of 10,072 postpartum women who were hospitalized in maternities of this municipality for the labor process, between July 1999 and March 2001. It is a cross-sectional study, and further methodological details are described by Leal et al.[21]. Out of the total sample, 19.6% of the mothers were teenagers, according to the WHO classification[17], which resulted in a total of 1,968 mothers, though none of them was under 12 years of age. For this study, 826 new adolescent moms were selected, according to the following inclusion criteria: to have weight (before pregnancy and at the end of it), height and gestational age at the moment of birth information according to the date of the last menstrual period (LMP); to have no chronic disease; to have a single-fetus pregnancy.

In the intention of controlling possible selection bias, this study used a comparative analysis of the socio-demographic variables, health and obstetric results between the group of selected adolescent mothers and the ones who did not meet the inclusion criteria. However, no significant differences were found regarding the obstetric results[22].

The data collected from both mother's and newborn's medical records, in addition to interviews with the mothers immediately after labor, by Grant students of nursery and medicine, appropriately trained and supervised by the coordinators.

In order to evaluate the anthropometric nutritional status, there were used information regarding weight before and at the end of pregnancy and height self-reported by the teenagers at the moment of the interview. The use of self-reported data has been recommended in conducting large populational studies[23,24]; however, in this study, these were validated during field work of the original project[25]. For the classification of the pre-gestational nutritional status, according to the BMI, the cutoff points and the classification recommended by the committees: IOM[14,15] and WHO[16], were used, being this last one with the *Z* score adapted classification proposed for the food and nutritional surveillance in Brazil[19].

For the evaluation of adequacy of total gestational weight gain, after the classification of the pre-pregnancy BMI by the different methods, the total gain weight of the pregnant adolescent (final weight – pre-pregnancy weight) with a gestational weight gain recommended for each case, envisaged by the IOM[13,15] and the MOH[18], were compared. In the implementation of the recommendation by the MOH[18], it was adopted the BMI pre-pregnancy classification recommended by the WHO[16], adapted to Brasil[19]. It was also considered the cutoff point of 3 percent for the definition of low height and, in those cases, it was considered the lower limit of recommended weight gain for each pre-pregnancy BMI category as the appropriate total weight gain.

The remaining variables selected for the analysis were: maternal age, years of school education, menarcheal age, number of prenatal medical care visits, type of baby delivery and birth weight. Birth weight was classified in low, adequate and macrosomia. There were considered to be low weighted those with less than 2,500 g; adequate, with 3,999 g and macrosomic, equal or higher than 4, 000 g[17].

The agreement between the pre-pregnancy BMI classification proposed by the WHO[16] and by the IOM[13] was verified through the Kappa (k) statistic. The proposal of BMI values by the WHO[16] and the BMI classification according to the Z scores for teenagers in years of age recommended by the MOH[19] was considered as the gold standard in this study. In the concordance analysis, it was considered bad when k = 0; weak k = 0.01 – 0.20; poor k = 0.21 – 0.40; regular k = 0.41 – 0.60; good k = 0.61 – 0.80; great k = 0.81 – 1.00[26].

In the statistical analysis, the average and the standard deviation of the continuous variables were calculated, estimating the odds ratio (OR) among the exposure and disclosure factors — birth weight, with a confidence interval of 95% (95%CI).

In the multivariate analysis, it was used the multinomial logistic regression, stepwise method, with the calculation of raw and adjusted ORs and95%CI, in order to identify the predicting variables of the outcomes of interest and the association with the diagnostic of gestational weight adequacy, obtained according to the different methodologies tested in the study. The inclusion criterion of the variables in the model was $p < 0.05$ and, for exclusion, $p > 0.10$. In order to study the performance of the methods of gestational weight gain adequacy in predicting low birth weight and macrosomia, the values of sensitivity (Se), specificity (Sp), positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated.

The Project was approved by the Research Ethics Committee of the Fundação Oswaldo Cruz (FIOCRUZ), approval No 23, of 11/08/1999, and a Informed Consent was signed by the new mothers or, if necessary, by the guardians responsible for the teenagers, after agreeing to take part in this research. The analysis were made by the Statistical Package for the Social Sciences (SPSS) software for Windows, v. 17.0.

## RESULTS

The 826 adolescent mothers interviewed were, on average, 17.6 years old (standard deviation – SD = 1.35), 7.7 years of school education (SD = 2.33) and 7.2 Medical consultations for prenatal care (SD = 2.00). The coverage of prenatal care was 97.9%, with around 57.5% of them made 7 or more visits during pregnancy. The average birth weight was 3,113 g (SD = 613), the LBW prevalence was 10.8% and the macrosomia was 4.0%. The average gestational age at the time of birth was 38.5 weeks, considering 13% of the total were born before completing 37 weeks.

In Table 1, it is observed that birth weight was associated with adequate gestational weight gain regardless the anthropometric evaluation method adopted in the study. In relation to

Table 1. Socio-demographic, antenatal care and anthropometric characteristics according to birth weight of adolescents in postpartum period. City of Rio de Janeiro, Brazil, 1999 – 2001.

| Variables (n) | Birth weight (%) | | | | |
|---|---|---|---|---|---|
| | Low weight | Adequate | Macrosomia | Total (n) | p-value |
| Age in years (799) | | | | | 0.184 |
| 12 – 15 | 13.8 | 78.5 | 7.7 | 8.1 (65) | |
| 16 – 17 | 11.2 | 86.7 | 2.2 | 34.8 (278) | |
| 18 – 19 | 10.1 | 85.3 | 4.6 | 57.1 (456) | |
| Caucasian (793) | | | | | 0.806 |
| Yes | 11.3 | 84.4 | 4.3 | 50.2 (398) | |
| No | 10.1 | 86.1 | 3.8 | 49.8 (395) | |
| Water supply source (799) | | | | | 0.906 |
| Piped water at home | 10.9 | 85.2 | 3.9 | 92.1 (736) | |
| Outside home | 9.5 | 85.7 | 4.8 | 7.9 (63) | |
| Years of school education (798) | | | | | 0.189 |
| Up to 3 | 7.1 | 92.9 | 0.0 | 3.5 (28) | |
| 4 to 5 | 11.0 | 81.6 | 7.4 | 17.0 (136) | |
| 6 or more | 10.9 | 85.6 | 3.5 | 79.4 (634) | |
| Prenatal medical visits (772) | | | | | 0.002 |
| Up to 4 | 26.7 | 70.0 | 3.3 | 7.8 (60) | |
| 5 to 6 | 10.8 | 85.4 | 3.7 | 34.7 (268) | |
| 7 or more | 7.7 | 87.8 | 4.5 | 57.5 (444) | |
| Type of birth labor (798) | | | | | 0.342 |
| Normal | 11.3 | 85.3 | 3.4 | 66.4 (530) | |
| Caesarean | 9.3 | 85.4 | 5.2 | 33.6 (268) | |
| Adequacy of gestational WG* (799) | | | | | 0.000 |
| Low | 20.1 | 79.2 | 0.7 | 37.3 (298) | |
| Adequate | 5.9 | 89.2 | 4.9 | 36.0 (288) | |
| High | 4.2 | 88.3 | 7.5 | 26.7 (213) | |
| Adequacy of gestational WG ** (799) | | | | | 0.000 |
| Low | 19.6 | 80.0 | 0.4 | 35.0 (280) | |
| Adequate | 7.5 | 87.5 | 5.0 | 35.0 (280) | |
| High | 4.2 | 88.7 | 7.1 | 29.9 (239) | |
| Adequacy of gestational WG *** (799) | | | | | 0.000 |
| Low | 19.7 | 78.9 | 1.3 | 37.4 (299) | |
| Adequate | 6.2 | 89.4 | 4.4 | 34.2 (73) | |
| High | 4.4 | 88.5 | 7.0 | 28.4 (227) | |

Continue...

Tabela 1. Continuation.

| Variables (n) | Birth weight (%) | | | | |
|---|---|---|---|---|---|
| | Low weight | Adequate | Macrosomia | Total (n) | p-value |
| Apgar acore at minute 1 < 7 (739) | | | | | 0.000 |
| Yes | 24.8 | 67.3 | 7.9 | 13.7 (101) | |
| Gestational Diabetes (789) | | | | | 0.024 |
| Yes | 0.0 | 80.0 | 20.0 | 1.3 (10) | |
| Gestational age < 37 weeks (799) | | | | | 0.000 |
| Yes | 48.1 | 50.0 | 1.9 | 13.0 (104) | |
| Infant death (791) | | | | | 0.000 |
| Yes | 57.1 | 42.9 | 0.0 | 1.8 (14) | |
| Global Total (799) | 10.8 | 85.2 | 4 | 100.0 | |

*According to total gestational weight gain, considering the recommendation of weight gain based on IOM (1992)[15] cut-offs of pre-gestational body mass index; **according to total gestational weight gain, considering the recommendation of weight gain based on IOM (2009)[13] cut-offs of pre-gestational body mass index; ***according to total gestational weight gain, considering the recommendation of weight gain based on the Brazilian Ministry of Health (2006)[18] and WHO (2007)[16] cut-offs of pre-gestational body mass index, specific for adolescents.

the sociodemographic, anthropometric, prenatal care and gestational outcomes variables, these were not associated with birth weight.

Table 2 presents the concordance of the pre-pregnancy anthropometric nutritional status classification according to the recommendation of the WHO[16], in relation to the recommendations by the IOM[13,15] for adolescent mothers. The results show a better agreement between the classification by the WHO[16] and the one by the IOM (2009)[13] (k = 0.80; 95%CI 0.74 – 0.86). When compared to the IOM (1992)[15], it was observed a lack of concordance for all classes, showing that 40% of the teenagers were classified in different categories, a result confirmed by the low kappa value found, even after being adjusted (k = 0.47; 95%CI 0.40 – 0.54).

In Table 3, the values of Se, Sp, PPV and NPV values and the accuracy of the appropriate evaluation method for gestational weight gain in relation to the child's weight at the time of birth are presented. In order to identify the LBW, the Se varied from 61.6 (MS, 2006)[18] to 68.6%[15]; the Sp, from 69.5[18] to 66.4%[15] and the better accuracy values were obtained with the methods proposed by the MOH[18] and the IOM (2009)[13]. As opposed to that, for the identification of macrosomy, the Se varied from 29.9[18] to 25.4%[15]; the Sp, from 31.3[18] to 50.0%[15], and the best accuracy value were obtained through the method proposed by the MOH[18].

Table 4 shows simple and complex logistic regressions for the three adequacy models for gestational weight gain and other independent variables with explanatory potential for outcomes — low birth weight and macrosomia.

Table 2. Proportion of adolescents in postpartum period according to pre-gestational anthropometric nutritional status based on WHO (2007)[16], IOM (1992)[15] and IOM (2009)[13] cut-offs and gold standard concordance with other methods. City of Rio de Janeiro, Brazil, 1999 – 2001.

| | Pre-gestational nutritional status classification method | | | | |
|---|---|---|---|---|---|
| | WHO (2007)* | IOM (2009) | | IOM (1992) | |
| Pre-gestational nutritional status (n = 826) | % of mothers | % of mothers | % of concordance with the WHO (2007) | % of mothers | % of concordance with the WHO (2007) |
| Low weight | 2.5 | 3.3 | 99.3 | 36.6 | 66.0 |
| Adequate | 83.9 | 86.9 | 95.5 | 55.3 | 60.5 |
| Overweight | 11.5 | 8.5 | 95.5 | 5.9 | 94.2 |
| Obesity | 2.1 | 1.3 | 99.3 | 2.2 | 99.6 |
| Total | | | 94.8 | | 60.2 |
| K | | | 0.80 (95%CI 0.74 – 0.86) | | 0.23 (95%CI 0.18 – 0.28) |
| Adjusted k | | | 0.93 | | 0.47 (95%CI 0.40 – 0.54) |

*Gold standard.
k: Kappa statistic.

It is observed that the adequacy of gestational weight gain through the method proposed by the IOM[15] presented a higher prediction for LBW (raw OR = 3.84; 95%CI 2.19 – 6.74), according to the method proposed by the MOH[18] (raw OR = 2.88; 95%CI 1.73 – 4.79), among the adolescents who presented gestational weight gain below the recommendation. The pregnant adolescent who gained weight below the recommendation and attended to six or more medical prenatal consultations had lower chance of having low birth weight babies.

In the prediction of macrosomia, the appropriate gestational weight gain method proposed by the MOH[18] presented a better performance among the adolescents with gestational weight gain above the recommendation (adjusted OR = 2.37; 95%IC 1.03 – 6.80), in relation to other methods. The pregnant teenagers who gained more weight than recommended and with more than six years of school education had a smaller chance of having newborns with macrosomia.

## DISCUSSION

The study shows that adolescent mothers present good sociodemographic, anthropometric and prenatal care conditions, with averages close to satisfactory for the populations in general[17,27].

Table 3. The performance of anthropometric assessment methods in pregnancy for predicting birth weight. City of Rio de Janeiro, Brazil, 1999 – 2001.

| Birth weight | Weight gain adequacy | Se (%) | Sp (%) | PPV (%) | NPV (%) | Accuracy (%) |
|---|---|---|---|---|---|---|
| Low weight | IOM (1992)* | 68.6 | 66.4 | 19.7 | 5.4 | 66.6 |
| | IOM (2009)** | 62.8 | 68.3 | 19.2 | 6.1 | 67.7 |
| | (MOH, 2006)*** | 61.6 | 69.5 | 19.5 | 6.2 | 68.6 |
| Macrosomia | IOM (1992)* | 25.4 | 50.0 | 92.6 | 97.3 | 26.3 |
| | IOM (2009)** | 28.8 | 43.8 | 92.6 | 97.6 | 29.4 |
| | (MOH, 2006)*** | 29.9 | 31.3 | 91.4 | 98.2 | 30.0 |

*According to total gestational weight gain, considering the recommendation of weight gain based on IOM (1992)[15] cut-offs of pre-gestational body mass index; **according to total gestational weight gain, considering the recommendation of weight gain based on IOM (2009)[13] cut-offs of pre-gestational body mass index; ***according to total gestational weight gain, considering the recommendation of weight gain based on Brazilian Ministry of Health (2006)[18] and WHO (2007)[16] cut-offs of pre-gestational body mass index, specific for adolescents.
SE: sensitivity; S: specificity; PPV: positive predictable value; NPV: negative predictable value; Low weight: children born less than 2,500 g; macrossomia: children born over 4,000 g - WHO (1995)[17].

The number of prenatal medical care exceeded the minimum recommended[18] and the average age of the adolescent mother was, favorably, closer to adulthood. However, data from the original research, not exposed in this article, show that, despite the broad prenatal care coverage among the interviewed mothers, the younger adolescents had fewer medical consultations and later care beginning[28]. The most immature teenagers, both chronologically and biologically, have also shown lower weight gain and higher incidence of unwanted outcomes, such as premature birth and low birth weight[29].

In this study, considering the application of methods, proper of pre-pregnancy diagnosis of adults and adolescents in the adequacy of gestational weight gain, according to what was proposed by the IOM[13,15] and the MOH[18], it was verified that all of them were significantly associated to the birth weight outcome.

In the comparison of the adopted classifications for the pre-pregnancy anthropometric nutritional diagnosis, the results of this study revealed that the recommendation by the WHO[16] presented a discrepancy of 40% in relation to the one by the IOM[15]. The discrepancy would be explained by the smaller proportion of adolescents classified as low weight and a higher proportion with adequate weight or overweight, according to what was proposed by the WHO[16]. Besides that, it was verified that, when applying the proposal by the IOM[15], there was a higher proportion of adolescents with pre-pregnancy low weight BMI ($< 19.8\ kg/m^2$), once this cutoff point was defined based on data of the adult American population.

Table 4. Results of simple and multiple logistic regression with birth weight as the response variable according to different methods of gestational weight gain adequacy. City of Rio de Janeiro, Brazil, 1999 – 2001.

| Birth weight situation | Model of regression by gestational weight gain adequacy | | | | | |
|---|---|---|---|---|---|---|
| | Model 1 - IOM (1992)* | | Model 2 - IOM (2009)** | | Model 3 - MOH (2006)*** | |
| | Raw OR | Adjusted OR | Raw OR | Adjusted OR | Raw OR | Adjusted OR |
| Low weight[1] | | | | | | |
| Low gestational weight gain | 3.84 (2.19 – 6.74) | 3.66 (2.22 – 6.05) | 2.85 (1.82 – 4.46) | 2.62 (1.76 – 3.90) | 2.88 (1.73 – 4.79) | 2.60 (1.62 – 4.16) |
| Up to 5 prenatal medical visits | 2.07 (1.35 – 3.16) | 1.69 (1.16 – 2.45) | | 1.76 (1.21 – 2.55) | | 1.74 (1.18 – 2.56) |
| Less than 6 years of school education | 0.60 (0.15 – 2.43) | 0.21 (0.22 – 2.10) | | 0.23 (0.23 – 2.16) | | 0.22 (0.23 – 2.13) |
| Macrosomia[2] | | | | | | |
| Over gestational weight gain | 1.56 (1.04 – 4.49) | 1.55 (1.04 – 4.45) | 1.59 (1.05 – 3.87) | 1.56 (1.03 – 3.87) | 2.42 (1.05 – 6.84) | 2.37 (1.03 – 6.80) |
| Up to 5 prenatal medical visits | 0.73 (0.30 – 1.78) | 0.92 (0.37 – 2.33) | | 0.91 (0.36 – 2.32) | | 0.93 (0.36 – 2.40) |
| Less than 6 years of school education | 1.76 (0.96 – 3.30) | 2.80 (1.46 – 5.37) | | 2.98 (1.49 – 5.94) | | 3.61 (1.67 – 7.80) |

*According to total gestational weight gain adequacy, considering the recommendation of weight gain based on IOM (1992)[15] cut-offs of pre-gestational body mass index; **according to total gestational weight gain adequacy, considering the recommendation of weight gain based on IOM (2009)[13] cut-offs of pre-gestational body mass index specific for adolescents; ***according to total gestational weight gain adequacy, considering the recommendation of weight gain based on Brazilian Ministry of Health (2006)[18] and WHO (2007)[16] cut-offs of pre-gestational body mass index and, specific for adolescents.
1: dependent variable: low birth weight (reference category: no); model: Intercept; weight gain adequacy: adequate (adequate + above); 2: dependent variable: macrosomia (reference category: no); model: Intercept; weight gain adequacy: adequate (below + adequate); antenatal care: 6 or more visits; schooling degree: 7 years or more.

With the same recommendation from the IOM[13], this discrepancy is reduced to 5%, being considered as more adequate. Despite that, the adjustments proposed by the IOM are still not ideal for pregnant teenagers, since the cutoff points for the pre-pregnancy BMI classification are adopted by the WHO[17] for grow ups. The discrepancy between the different methods applied ratifies the need of choosing the one which uses adequate cutoff points for adolescents[30-32].

In the last few years, an increasing number of studies have been developed in order to guide the choice of anthropometric nutritional evaluation for pregnant women, particularly concerning the cutoff points adopted for the initial nutritional assessment, especially for teenagers[30-33].

The choice of the method to be adopted must be accurate enough to guide the best gestational weight gain range[32]. The appropriate pre-pregnancy diagnosis ensures a healthy weight gain, with favorable impacts in the maternal outcome and in the future life of both mother and child[30,34,35].

The gestational weight gain adequacy, proposed by the IOM[15] was the one which presented best Se in predicting LBW. On the other hand, in order to predict macrosomia, the proposal by the MOH[18], which considered the pre-pregnancy nutritional diagnosis according to the WHO[16] criteria, proved to be the best option.

The Se, the Sp and the PPV depend on the association between a risk factor and determined result[17]. In the prediction of LBW, the low values of Se for the adaptations of the MOH[18] and of the IOM (2009)[13] for weight gain adequacy, in relation to the adequacy of the IOM (1992)[15], may be justified by the fact that the indicators were built from data obtained in studies with adult women.

Groth[31] highlights two matters which differentiate the BMI categories in adult and adolescent pregnant women: (1) the BMI variation in adolescents depends on their age; and (2) there are different cutoff points for low and adequate weight, overweight and obesity. These differences may lead the professional into classifying the same adolescent as low weighted in the beginning of the pregnancy, by the proposal of IOM (1992)[15] and as adequate weight by the proposal of the MOH[18], affecting, thus, the also differentiated application of weight gain range during pregnancy.

The low predictive values found for LBW may be attributed to the low prevalence of outcome and justified by the recognized interference that the prevalence of an event has on the PPV result[26]. On the other hand, the accuracy results were satisfactory for the LBW, making rather acceptable the effect of both possible positive and negative classifications in the analysis. In order for an indicator to be good, it is desirable that it has a high predictive ability and a narrow confidence interval, to be appropriate, sensible and specific for screening, in addition to being efficient, with low number of false classifications[26].

The recommendation with the best statistical performance in order to explain low birth weight was the proposed adequacy of weight gain by the IOM (1992)[15], a result which may seem controversial and, at the same time, may indicate it as the best recommendation. The best sensibility of this method allows the identification of a greater proportion of pregnant teenagers in the low pre-pregnancy weight category, with higher chance of becoming mothers of LBW newborns. However, this ability has to be counterbalanced by the method to classifying those with adequate weight or overweight.

One may assume that, as a greater proportion of pregnant teenagers was classified with low weight pre-pregnancy BMI, the statistical results obtained when applying the method of the IOM (1992)[15] may bring a false interpretation of the method in increasing the chance of identifying LBW risk. At the same time, it is observed that it does not identify the risk of overweight, with consequences for future macrosomic babies and postpartum weight retention and obesity of the mother[30,33].

As opposed to that, the MOH recommendations[18] showed a greater chance of identifying future newborns with macrosomia, especially for new mothers with less than one year of school education.

Given the current nutritional situation, this result suggests that these may be useful, with contribution potential as for reducing cases of postpartum weight retention and obesity, events which present a rapid growth over the past recent times, particularly in younger and socially underprivileged classes[27,30].

In a recent study[35], the method of the IOM (2009)[13] presented better specificity ADN sensitivity for the outcomes most related to insufficient weight gain (low birth weight and small for gestational age newborns – SGA) in grown women. The results also indicate the need for further investigation regarding the ranges of weight gain proposed by the IOM (2009)[13], for age groups, and its applicability for pregnant adolescents, especially Brazilian ones.

Finally, it is recognized that the pre-pregnancy nutritional status, according to the BMI values, interferes with gestational weight gain, with consequences to the obstetric outcome[33]. Therefore, the judicious choice of a method for such an assessment is essential for the definition of gestational weight gain ranges, aimed at improving birth weight.

It is noteworthy that, from the total of adolescent mothers interviewed in the original study, about 42% of them meet the inclusion criteria of possessing anthropometric information. Thus, it is assumed that the association between the anthropometric variables — pre-pregnancy BMI and weight gain — and the occurrence of adverse outcomes evidence in the study could have been potentialized if the anthropometric information of all the interviewed adolescent mothers were available.

However, a comparative analysis of the groups revealed significant differences, showing that the lack of anthropometric information was higher in adolescent pregnant women with worse sociodemographic and health conditions and obstetric results[24]. Given this, the difference between the groups was controlled in multinomial logistic regression, in an attempt of minimizing the effect of possible selection bias.

Thus, as the poverty conditions of the adolescent mothers in this study associated to the weight gain above the expected, and not with lower gain, one may assume that the presence of the ones who did not have their anthropometric information could strengthen the choice of the method recommended by the MOH[18], which considers the pre-pregnancy BMI classification by the[16].

It is noteworthy that the study reflects the anthropometric profile of Brazilian pregnant adolescents, and the scientific production in this Field is still scarce in both national and international studies. Also noteworthy is the importance of the sampling universe studied, despite the losses, and the scientific findings which may support the reflection on the choice of method to be used in clinical practice of pregnant adolescents' prenatal care.

It is worth being stressed that, up to this date, there is no reference proposal based on national studies and validated for use with Brazilian pregnant adolescent prenatal care. Thus, the validation and performance studies of the proposed methods with international data are of great value.

The early identification of the inadequate pregnant nutritional status contributes to timely interventions during pregnancy, reflecting on the birth conditions of the child, especially among pregnant adolescents[22]. Studies which were devoted to the nutritional assessment indicated decrease in mortality rates and preterm births, as well as macrosomic prevention and weight retention after birth labor, being these last two considered a risk to future occurrence of cardiovascular diseases[30,35].

## CONCLUSION

The study demonstrated that the choice of specific methods for adolescent in determining their pre-pregnancy anthropometric nutritional assessment, as proposed by the MOH[18], which considers the pre-pregnancy nutritional diagnosis according to the WHO criteria[16], seems to be an adequate option for the current nutritional situation of Brazilian pregnant women. Besides that, the proposal by the MOH[18] overcomes the one by the IOM (2009)[13] in rick identification for the birth of macrosomic children among adolescent, ensuring, at the same time, the identification of those with risk of low birth weight, adapting its use to the outcome we intend to prevent. Either way, it is worth mentioning the importance of investments in national research focused on the definition of population-specific methods, based on the pregnant Brazilian adolescent anthropometric data for clinical practice.

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