Maternal Weight Gain during Pregnancy and Somatic Classification of Neonates According to Birth Weight and Duration of Pregnancy Taking Account of Maternal Body Weight and Height

Mütterliche Gewichtszunahme in der Schwangerschaft und somatische Klassifikation der Neugeborenen nach Geburtsgewicht und Schwangerschaftsdauer unter Berücksichtigung von Körpergewicht und Körperhöhe der Mütter

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Key words
- epidemiology
- pregnancy
- growth retardation

Schlüsselwörter
- Epidemiologie
- Schwangerschaft
- Wachstumsretardierung

received 21.12.2012
revised 11.3.2013
accepted 11.3.2013

Bibliography
DOI http://dx.doi.org/10.1055/s-0032-1328436
Geburtsh Frauenheilk 2013; 73: 318–323 © Georg Thieme Verlag KG Stuttgart · New York · ISSN 0016-5751

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Abstract

Background and Aim: The classification of weight gain during pregnancy and the somatic classification of neonates according to birth weight and duration of pregnancy can be done using percentile values. We aimed to compare such classifications using percentiles of the overall study population with classifications using percentiles that were calculated taking account of maternal height and weight.

Material and Methods: Using data from the German Perinatal Survey (1995–2000, over 2.2 million singleton pregnancies) we classified weight gain during pregnancy as low (< 10th percentile), high (> 90th percentile), or medium (10th–90th percentile). Neonates were classified by birth weight as small for gestational age (SGA, < 10th percentile), large for gestational age (LGA, > 90th percentile), or appropriate for gestational age (AGA, 10th–90th percentile). Classifications were performed for 12 groups of women and their neonates formed according to maternal height and weight, either with the percentiles calculated from the total study population or with group-specific percentiles.

Results: Using percentiles of the total study population there was large variability between the 12 groups in the proportions with low and high weight gain and in the proportions of SGA and LGA neonates. The variability was much lower when group-specific percentiles were used.

Conclusions: Classifications of maternal weight gain during pregnancy and birth weight differ substantially, depending on whether percentiles calculated from the total study population or group-specific percentiles are used. The impact of using percentiles that take account of maternal anthropometric parameters for the medical care and health of neonates needs to be elucidated in future research.

Zusammenfassung

Hintergrund und Fragestellung: Die Klassifikation der Gewichtszunahme während der Schwangerschaft und die somatische Klassifikation der Neugeborenen nach Geburtsgewicht und Schwangerschaftsdauer können mit Perzentilwerten durchgeführt werden. Unser Ziel war, solche Klassifikationen basierend auf Perzentilen der gesamten Studienpopulation mit Klassifikationen basierend auf Perzentilwerten, die mütterliche Größe und Gewicht berücksichtigen, zu vergleichen.

Material und Methodik: Anhand von Daten der Deutschen Perinatalerhebung (1995–2000, über 2,2 Mio. Einlingsschwangerschaften) klassifizierten wir die Gewichtszunahme während der Schwangerschaft als gering (< 10. Perzentile), groß (> 90. Perzentile) oder mittel (10.–90. Perzentile). Die Neugeborenen wurden nach dem Geburtsgewicht als „small for gestational age" (SGA, < 10. Perzentile), „large for gestational age" (LGA, > 90. Perzentile) oder „appropriate for gestational age" (AGA, 10.–90. Perzentile) klassifiziert. Diese Klassifikationen wurden für 12 Gruppen von Frauen und deren Neugeborenen, die aufgrund von mütterlicher Körpergröße und -gewicht gebildet wurden, durchgeführt, entweder mit den Perzentilen der gesamten Studienpopulation oder mit gruppenspezifischen Perzentilen.

Ergebnisse: Bei Gebrauch von Perzentilen der gesamten Studienpopulation ergab sich zwischen den 12 Gruppen eine große Variabilität in den Anteilen mit geringer und großer Gewichtszunahme und in den Anteilen von SGA- und LGA-Neugeborenen. Bei Gebrauch gruppenspezifischer Perzentilen war diese Variabilität deutlich kleiner.

Schlussfolgerungen: Die Klassifikationen der Gewichtszunahme während der Schwangerschaft und des Geburtsgewichts unterscheiden sich deutlich, je nachdem, ob Perzentilen der gesamten Studienpopulation oder gruppenspezifische

Perzentilen verwendet werden. Die Auswirkungen des Gebrauchs von Perzentilen, welche die mütterlichen Körpermaße berücksichtigen, auf die medizinische Versorgung und Gesundheit der Neugeborenen müssen noch untersucht werden.

Introduction

The weight gain of women during pregnancy is a key perinatal parameter; it is easily measured and there is now a wealth of evidence showing that weight gain has an impact on a number of important maternal and neonatal outcomes, including the preterm birth rate and the duration of pregnancy [1–15], the birth weight [7–13, 15–20], and the somatic classification of neonates [7–9, 15, 21–24]. For this somatic classification neonates are typically classified using the 10th and 90th birth weight percentiles, calculated according to gestational age; neonates below the 10th birth weight percentile are "small for gestational age" (SGA), those above the 90th birth weight percentile are "large for gestational age" (LGA), and all those in-between are "appropriate for gestational age" (AGA).

We previously investigated weight gain in pregnancy in relation to maternal anthropometric measurements, finding an increase in the weight gained during pregnancy with increasing maternal height and, for women weighing more than about 63 kg at the first obstetric consultation (for the pregnancy in question), an inverse relationship between maternal weight at the first consultation and the weight gained during pregnancy [25]. Maternal anthropometric measurements of course also influence neonatal anthropometric measurements and therefore the somatic classification of neonates, when this is performed using percentiles of the total study population [26, 27].

The classification of weight gain during pregnancy and the somatic classification of neonates can therefore be expected to be more accurate when maternal body height and weight are taken into account, rather than when percentiles calculated from the total study population are used, irrespective of maternal anthropometric measurements. As body height and weight can be combined into a single measure such as the body mass index (BMI), the question arises whether the classification of maternal weight gain and the neonatal somatic classification should be undertaken according to maternal BMI, e.g. whether the ranges for weight gain should be specified for different BMI ranges. Indeed, the Institute of Medicine recommends assessing weight gain during pregnancy by maternal BMI [28]. However, we have shown that both maternal weight gain [25] and the somatic classification of neonates [29] can differ substantially between women who have the same BMI but different body heights and weights.

An alternative approach, i.e. taking account of maternal anthropometric measurements by grouping women according to their height and weight, therefore deserves investigation. We previously presented norm values for weight gain during pregnancy for different maternal height and weight groups [30]. In the present analysis, we investigate the classification of weight gain during pregnancy and the somatic classification of neonates: we compare classifications based on weight gain and birth weight percentiles that were calculated from the total study population with classifications based on percentiles that were calculated separately for the different maternal height and weight groups.

The question we wanted to answer was whether these classifications differ substantially, because if they do not, it would be hard to see any advantage of using classification systems that take maternal height and weight into account.

Material and Methods

The data on which this analysis is based were taken from the routine data collection of the German Perinatal Survey that is done throughout Germany. Data were kindly made available to Dr. Voigt by the Chambers of Physicians of the States of Germany. The data were collected in the years 1995 to 2000. For the years 1995–1997 all States of Germany except Baden-Württemberg provided data; thereafter only Bavaria, Brandenburg, Hamburg, Mecklenburg-Western Pomerania, Lower Saxony, Saxony, Saxony-Anhalt, and Thuringia provided data, not necessarily for all years. Overall, our database contains datasets from more than 2.2 million singleton pregnancies; this is our total study population. Because not all datasets were complete with regard to all maternal and neonatal parameters collected, the sample sizes vary between analyses. The figures presented in this paper and the supplemental online figures contain information on the case numbers included in individual analyses.

We calculated weight gain during pregnancy from the weights recorded at the first obstetric consultation and at the end of pregnancy; weight gain was classified using the 10th and 90th weight gain percentiles; "low weight gain" was defined as a weight gain below the 10th percentile, "high weight gain" as above the 90th percentile, and "medium weight gain" was between the 10th and 90th percentiles.

As described in the introduction, the neonatal somatic classification was based on birth weight percentiles specified according to gestational age, using the 10th and 90th percentiles; neonates with a birth weight below the 10th percentile were SGA, those with a birth weight greater than the 90th percentile were LGA, and those in-between were AGA.

The classification of weight gain during pregnancy and the somatic classification of neonates were done using either the 10th and 90th percentiles calculated from the total study population or the 10th and 90th percentiles calculated specifically for the groups of mothers and neonates compiled based on maternal height and weight. We compiled 12 such groups based on a division of maternal height into three groups (≤ 161 cm, 162–171 cm, ≥ 172 cm) and a division of maternal weight into four groups within the height groups, as described previously [30]. In addition to presenting the classification of maternal weight gain during pregnancy and the somatic classification of neonates separately, we also show combined classifications: neonatal somatic classifications are presented separately for low, medium, and high weight gain.

The chi-squared test was used to establish the statistical significance of differences between neonatal somatic classifications of different maternal weight gain groups. Data analysis was performed using the computer programme SPSS (version 20) in the computing centre of the University of Rostock, Germany.

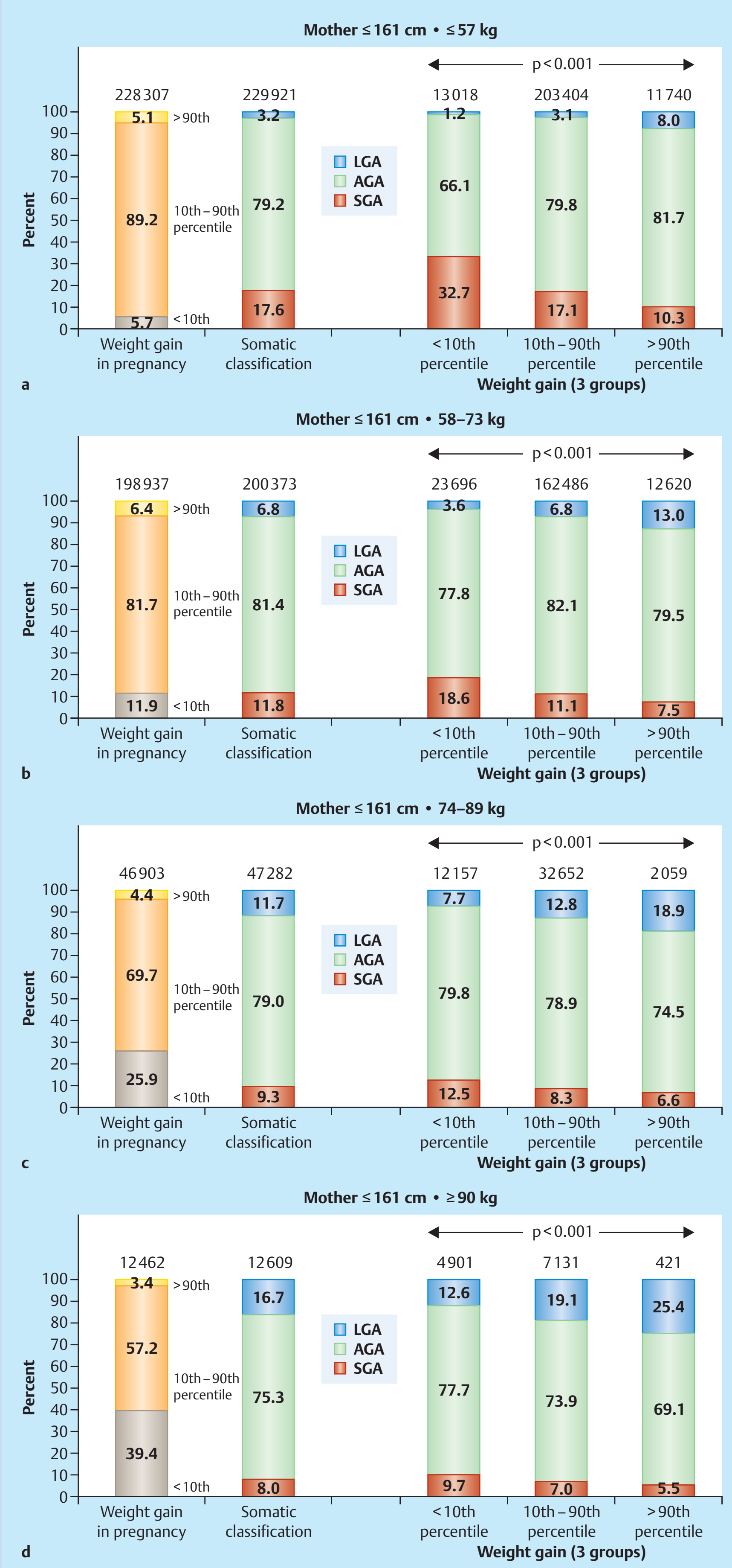

Fig. 1 Classifications based on weight gain and birth weight percentiles calculated from the total study population for women with a height ≤ 161 cm and their neonates. The classification of maternal weight gain during pregnancy for women with a height ≤ 161 cm and a weight of ≤ 57 kg, 58–73 kg, 74–89 kg, or ≥ 90 kg (Figs. **1 a–d**, respectively) and the somatic classification of infants born to them are shown in the two columns on the left of each figure. The right side of each figure shows a combination of the two: the somatic classification of neonates within the three weight gain groups (< 10th, 10–90th and > 90th weight gain percentile). Neonates were classified as small for gestational age (SGA, < 10th birth weight percentile), appropriate for gestational age (AGA, 10–90th birth weight percentile), or large for gestational age (LGA, > 90th weight gain percentile). Contributing case numbers are shown on top of the columns. The p-values were calculated using the chi-squared test.

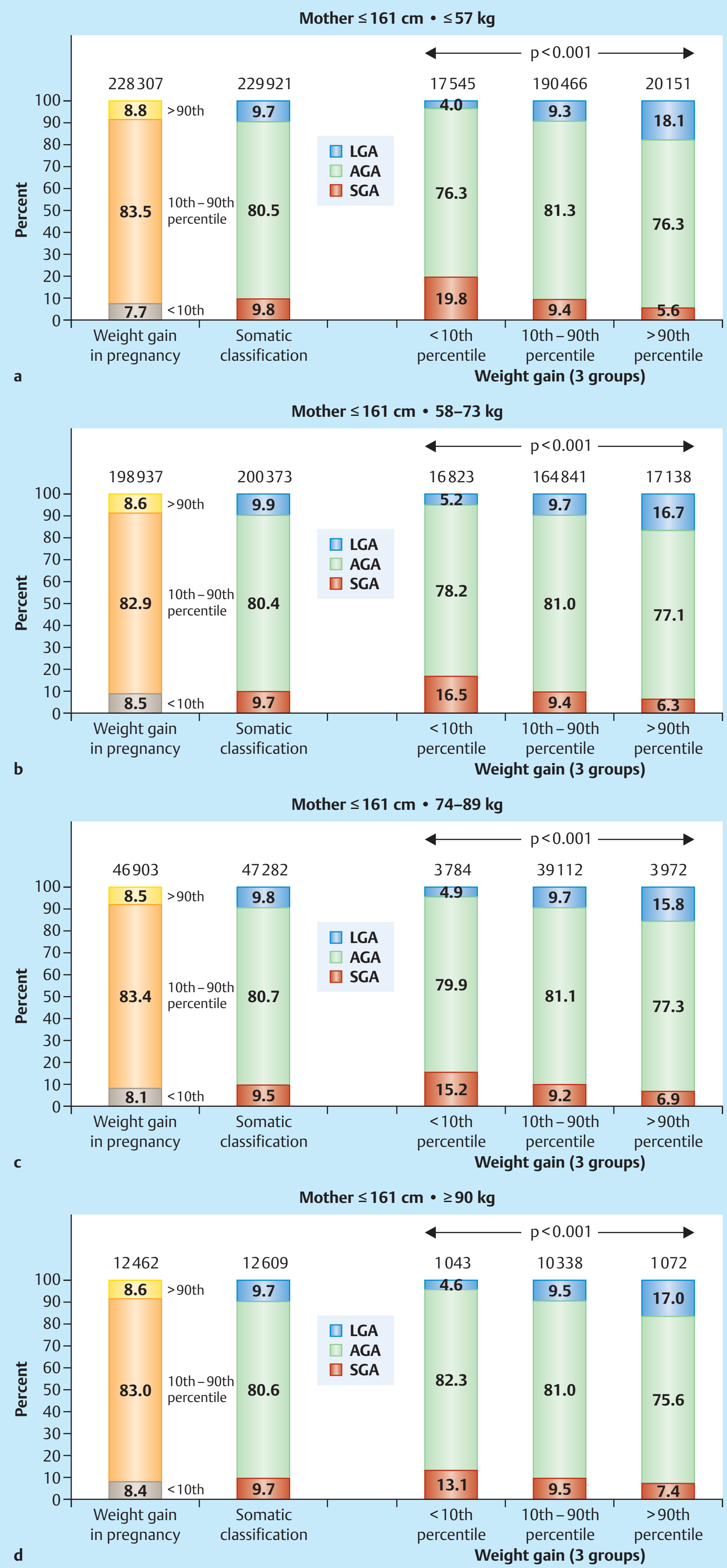

Fig. 2 Classifications based on weight gain and birth weight percentiles calculated specifically for the maternal height and weight groups in question for women with a height ≤ 161 cm and their neonates. Details are analogous to the description in the legend to **Fig. 1**.

Results

Using percentile values for maternal weight gain and birth weight calculated from the total study population

In the printed version of this article we show data for women with a height ≤ 161 cm and their neonates. Similar findings were obtained for the other maternal height groups: 162–171 cm and ≥ 172 cm (see supplemental online figures). **Fig. 1** and supplemental online **Figs. 1S** and **2S** illustrate the classification of maternal weight gain during pregnancy and the neonatal somatic classification as well as the combination of these classification systems (neonatal somatic classifications presented separately for low, medium, and high weight gain, as described above) when the percentiles used for the classification of weight gain and the somatic classification of neonates (i.e. the 10th and 90th percentiles) were calculated from the total study population of women or neonates, respectively.

Using percentile values for maternal weight gain and birth weight calculated separately for the 12 groups of women compiled according to height and weight

Fig. 2 and supplemental online **Figs. 3S** and **4S** show the classification of maternal weight gain during pregnancy and the neonatal somatic classification as well as the combination of these classification systems (as above) but this time using group-specific percentiles for weight gain during pregnancy and also group-specific percentiles of birth weight for gestational age calculated separately for the 12 groups of women and their neonates formed according to maternal height and weight.

When percentiles based on the total study population were used, there was a large variability in the percentages of women with low and high weight gain and in the percentages of SGA and LGA neonates. When group-specific percentiles were used, this variability was much lower. For example, for percentiles calculated from the total study population the percentage of women with a low weight gain (below the 10th weight gain percentile) ranged between 5.7 and 39.4% in women with a height ≤ 161 cm, depending on their weight group (**Fig. 1**). Using group-specific percentiles the variation was considerably lower and ranged between 7.7 and 8.5% (**Fig. 2**).

The proportion of SGA neonates born to women with a height ≤ 161 cm varied between 8.0 and 17.6%, depending on maternal weight, when percentiles calculated from the total study population were used for the somatic classification of neonates; when group-specific percentiles were used, the variation was between 9.5 and 9.8%, again substantially lower. The same pattern was observed for the other maternal height and weight groups.

When the combined classifications of weight gain during pregnancy and birth weight for gestational age were examined, considerable differences were also found between classifications using percentiles calculated from the total study population and those using group-specific percentiles. When percentiles calculated from the total study population were used, there was considerable variability between maternal weight groups with regard to the influence of maternal weight gain on the somatic classification of neonates. Using group-specific percentiles there was less variability between the maternal weight groups in this regard.

Discussion

We were fortunate to have a large amount of data available which permitted reliable calculations of percentiles for weight gain during pregnancy and birth weight for gestational age even in subpopulations of our total study population, i.e. in the groups of women and neonates compiled according to maternal height and weight. Our key finding is that the classifications of maternal weight gain during pregnancy by weight gain percentiles and the somatic classifications of neonates as SGA, AGA, or LGA differ substantially depending on whether these classifications were done using percentiles calculated from the total study population or using group-specific percentiles calculated specifically for the groups of women and neonates compiled based on maternal height and weight. The impact of using classification systems that take account of maternal height and weight on the medical care and health of neonates still needs to be investigated and this remains a task for future research.

Limitations of our study include a degree of uncertainty with regard to the calculation of weight gain during pregnancy: weight at the first obstetric consultation depends on when the first consultation occurs and weight at the end of pregnancy varies depending on the length of gestation. Moreover, the grouping of women by maternal height and weight was arbitrary and different cut-off points and different numbers of groups would also have been possible.

Because the classification of neonates as small, appropriate, or large for gestational age may well have consequences for the care of these neonates and with regard to the use of resources, it is important to use as accurate a classification system as possible. A classification system that takes account of maternal anthropometric measurements should more accurately identify small or large neonates due to abnormal intrauterine growth as compared to constitutionally small or large neonates.

Acknowledgements

We would like to thank the Chambers of Physicians of the States of Germany for contributing data to our database. We also thank Christel Fernow for her help with preparing the figures.

Conflict of Interest

None.

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