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Obesity and Underweight Diagnoses during Pregnancy using Two Standards

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Abstract

This observational study compared two maternal weight gain standards in their predictive capacity of low Birth Weight (BW), low Birth Length (BL) and macrosomic births. Those standards were the Rosso-Mardones (RM) chart and the Atalah et al (AEA) chart. Pregnant women were classified as underweight and obese in early and late gestation using the RM and AEA charts. These findings were then correlated with newborn's anthropometric characteristics. Surveillance data was provided by the Informatics Perinatal System (IPS) of the Uruguayan Ministry of Health, covering 94% of all national deliveries for the years 2010-2012. A group of 23832 women free of gestational complications, with a singleton and term delivery, were considered as healthy pregnancies and included in this study. Main results showed that the AEA chart diagnosed a lower percentage of both underweight and obese women at the beginning and at the end of the pregnancy than the RM chart. Proportions of BL < 50cm and both BW < 3000g and > 4250g were similar at each nutritional category of both charts either at the beginning or at the end of pregnancy. However, absolute figures for at risk newborns were much higher in the RM underweight and obese women in both moments of pregnancy. The RM chart showed higher sensitivity values than the AEA chart, both at the beginning and at the end of the pregnancy supporting its use in Uruguay.

Keywords: Maternal nutrition; Pregnancy; Body mass index; Birth weight; Birth length

Abbreviations

BMI: Body Mass Index; RM: Rosso-Mardones; AEA: Atalah et al; IPS: Informatics Perinatal System; CLAP: Centro Latinoamericano de Perinatología (Latin American Perinatology Center); PAHO/WHO: Pan American Health Organization/World Health Organization; BW: Birth Weight; BL: Birth Length; CI: Confidence Interval; PPV: Positive Predictive Value; NPV: Negative Predictive Value; SPSS: *Statistical Package for the Social Sciences;* USA: United States of America; *GA: Gestational age;* SD: Standard Deviation; PG-BMI: Pre Gestational Body Mass Index; MNS: Maternal Nutritional Status.

Introduction

Maternal BMI in early pregnancy and gestational weight gain are known to influence pregnancy outcome [1-3]. Underweight mothers who gain little weight during pregnancy have a higher risk of spontaneous preterm birth and small for gestational age infants. By contrast, overweight and obese women are at risk of gestational complications such as gestational diabetes and preeclampsia while the fetus is at risk for stillbirth and congenital anomalies. Obesity in pregnancy can also affect health later in life for both mother and child with a higher risk of diabetes, hypertension and cardiovascular disease.

During the mid-eighties, based on longitudinal studies conducted in a Chilean population of gravidas, we developed a chart to diagnose adequacy of maternal BMI during gestation [4]. This instrument -named after the authors "RM chart"- was adopted by the Chilean Public Health Services and used nation-wide for prenatal controls. Subsequently, the RM chart also was adopted by other Latin American countries [4,5].

In the late nineties Atalah et al. proposed a modification of the RM chart, defining new cut off points that meant a larger "normal" BMI area when compared with the original RM chart [6]. This resulted in a smaller proportion of pregnant women diagnosed as at risk due to either low or high BMI. In 2004 the modified RM chart ("AEA chart") became the "official chart" in Chile and later on also replaced the use of the RM chart in other countries of the Region [5]. For example, Uruguay used the RM chart between 1989 and 2013 and in 2014 switched to using the AEA chart [7].

Despite the obvious implications of using different criteria to assess adequacy of body weight for height for pregnant women, studies comparing the predictive capacity of the RM chart and the AEA chart to identify women at risk of either small or large for gestational age babies are lacking. This situation prompted us to conduct the present investigation where we studied the outcome of pregnancy in Uruguayan pregnant women diagnosed as obese and underweight at the beginning and at the end of pregnancy by the RM and AEA charts, respectively.

Methods

Information for this study was available at the IPS of Uruguay for the years 2010 -2012 [8]. The IPS was organized by the CLAP of the PAHO/WHO [9,10]. Since 1990, when registration of deliveries at

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Table 1: Categories of nutritional status of women at week 10 and 40 of pregnancy according to specific cut-off points of the RM chart and the AEA chart [4,6].

	RM chart (BMI)	AEA chart (BMI)
Beginning of pregnancy (week 10 GA)		
Underweight	<21.15	<20.20
Normal	21.15 – 24.49	20.20 – 25.20
Overweight	24.50 – 26.73	25.30 – 30.20
Obese	>26.73	>30.20
End of pregnancy (week 40 GA)		
Underweight	<26.55	<25.00
Normal	26.55 – 28.90	25.00 – 29.00
Overweight	28.91 – 30.03	29.10 – 33.10
Obese	>30.03	>33.10

Table 2: General characteristics of healthy pregnant women and their newborns (n: 23832). IPS, Uruguay, 2010-2012.

Characteristics	Mean	SD	%
Maternal age (years)	28.47	5.68	
PG-BMI	24.09	4.28	
Gestational age at birth (weeks)	40	0.64	
Maternal height (cm)	162.05	6.29	
First pregnancy (n)	10174		43
Cesarean section (n)	10035		42
Male (n)	12089		51
Birth weight (g)	3494.52	406.9	
Height at birth (cm)	49.51	2.49	

Table 3: MNS according to the RM and the AEA charts at the beginning and at the end of pregnancy. Healthy pregnant women (n: 23832) surveyed by the IPS from Uruguay, 2010-2012.

MNS	RM chart (%)	CI (95%)	AEA chart n (%)	CI (95%)
Beginning of pregnancy (week 10 GA)				
Underweight	5090 (21.4)	20.2 – 22.5	2939 (12.3)	11.1 – 13.4
Normal	9017 (37.8)	36.8 – 38.8	12870 (54.0)	53.1 – 54.8
Overweight	4111 (17.2)	16.0 – 18.3	5776 (24.2)	23.1 – 25.3
Obese	5614 (23.6)	22.4 – 24.7	2247 (9.4)	8.1 – 10.6
End of pregnancy (week 40 GA)				
Underweight	6469 (27.1)	26.0 – 28.1	3278 (13.8)	12.6 – 14.9
Normal	5813 (24.4)	23.3 – 25.5	9455 (39.7)	38.7 – 40.6
Overweight	2476 (10.4)	9.2 – 11.6	7136 (29.9)	28.8 – 30.9
Obese	9074 (38.1)	37.1 – 39.1	3963 (16.6)	15.4 – 17.7

the IPS became mandatory for all public and private health services, approximately 94% of all deliveries are registered in this data base with complete information on prenatal visits and pregnancy outcomes.

The present study was carried out using data from 51420 women, representing nearly one third of all deliveries that took place in Uruguay in 2010-2012 [11]. Only women that met the following criteria were considered: eighteen years of age or older; height over 130 cm and under 200cm; gestational weight gain less than 35kg or weight loss less than 5kg; six or more prenatal visits; pre-delivery maternal weight was recorded at least one week before delivery; live baby and singleton delivery.

A sub-sample of 23832 healthy pregnant women was used. This selection would allow controlling for the effect of factors others than maternal nutritional status on the newborns anthropometry. Inclusion criteria for this group were the following: 1) free of medical and obstetrical conditions affecting fetal growth; 2) term delivery (39-41 weeks of gestation) [12]; and 3) not consumers of alcohol or drugs.

All subjects were classified at the beginning and at the end of pregnancy using both the RM and AEA charts. Table 1 presents the weight/height areas for the two charts at weeks 10 and 40 of gestation. Weight gain recommendations of the two charts are proportional to maternal height. Figures for both standards have gestational age on the horizontal axis and maternal body weight, expressed as BMI, on the vertical axis [4,6]. Areas of different colors are used to classify adequacy of weight for height for underweight, normal weight, overweight and obese mothers.

Indicators of inadequate fetal growth were: A) BW at term less than 3000g, a category which has been described as having the highest infant mortality risk in Latin America by Puffer and Serrano [13]. B) BW higher than 4250g which is a proxy for macrosomy at birth as suggested by recent Pan American Health Organization guidelines [12]. C) BL less than 50cm which was considered as proxy for shortness at birth. The prevalence of obesity, abnormally high blood pressure, insulin resistance and lower school achievement scores have been inversely associated with BL using Chilean data [14-16]. The birth length <50cm category has been shown to be at risk in those recent Chilean analyses.

Maternal weight was measured by trained personnel using beam scales at the health clinics and the maternity hospital [7,9,10]. The most frequently used beam scales were Cam®, *model P1001 (Buenos Aires, Argentina) and Seca®, model 713 (Hamburg, Germany)* [7]. Pre-pregnancy weight was collected via maternal report during the first visit to the clinics. Maternal height was also determined by trained personnel in the health clinics [7,9,10]. Subjects reported their pre-pregnancy weight during their first prenatal visit.

Both the RM and AEA charts allow diagnosing adequacy of BMI from week 10 of gestation. Since during the first 12 weeks of gestation maternal weight gain is minimal, the reported pre-pregnancy weight was used as a proxy for "weight at 10 weeks of gestation" data.

Gestational age was estimated according to the date of the last menstrual period and confirmed by trans abdominal ultrasound fetal biometry performed before 20 weeks of gestation.

Infants were dried and weighed on an electronic self-calibrating scale immediately after delivery with a Seca® model 345, electronic scale accurate to 20g (Hamburg, Germany) [7]. Crown-heel length was measured in most hospitals on an aluminum made neonatometer with inextensible millimeter [17]; in some small hospitals a custom-made wooden neonatometer was used [7].

Statistical analyses

Percentage values with 95% CI were calculated for women falling in each category of nutritional status defined by each chart. Possible statistical differences in the proportions of the three target events, i.e.

Table 4: Newborn anthropometry according to MNS as diagnosed at the beginning and at the end of pregnancy by the RM chart and the AEA chart; P values of a χ^2 test are included. Healthy pregnant women and their single newborns (n: 23832) surveyed by the IPS from Uruguay, 2010-2012.

MNS	Chart	BL <50cm n (%)	P value	BW <3000g n (%)	P value	BW >4250g n (%)	P value	Women in each category of MNS
Beginning of pregnancy (week 10 GA)								
Underweight	RM	2714 (53.3)	0.44	735 (14.4)	0.09	82 (1.6)	0.29	5090
	AEA	1594 (54.2)		464 (15.8)		37 (1.3)		2939
Normal	RM	4289 (47.6)	0.56	862 (9.6)	0.46	298 (3.3)	0.4	9017
	AEA	6179 (48.0)		1278 (9.9)		415 (3.2)		12870
Overweight	RM	1841 (44.8)	0.28	316 (7.7)	0.85	192 (4.7)	0.05	4111
	AEA	2523 (43.7)		439 (7.6)		326 (5.6)		5776
Obese	RM	2437 (43.3)	0.69	419 (7.5)	0.22	369 (6.6)	0.03	5614
	AEA	985 (43.8)		151 (6.7)		163 (7.3)		2247
Total		11281 (47.3)		2332 (9.8)		941 (3.9)		23832
End of pregnancy (week 40 GA)								
Underweight	RM	3480 (53.8)	0.09	936 (14.5)	<0.001	84 (1.3)	0.198	6469
	AEA	1822 (55.6)		555 (16.9)		33 (1.0)		3278
Normal	RM	2744 (47.2)	0.04	556 (9.6)	0.16	166 (2.9)	0.13	5813
	AEA	4619 (48.9)		972 (10.3)		240 (2.5)		9455
Overweight	RM	1129 (45.6)	0.34	188 (7.6)	0.75	94 (3.8)	0.01	2476
	AEA	3173 (44.5)		556 (7.8)		362 (5.1)		7136
Obese	RM	3928 (43.3)	0.2	652 (7.2)	0.06	597 (6.6)	0.02	9074
	AEA	1667 (42.1)		249 (6.3)		306 (7.7)		3963
Total		11281 (47.3)		2332 (9.8)		941 (3.9)		23832

BL <50cm, BW <3000g and BW > 4250g, at each maternal nutritional category of the RM and AEA charts, were tested using a χ^2 test for two independent proportions. Sensitivity and specificity values were obtained using underweight pregnant women for variables BL <50cm and BW<3000g. The same values were obtained in obese pregnant women for BW >4250g. Statistical differences of sensitivity and specificity values between the RM and AEA charts were tested using a McNemar's χ^2 test. All tests were two-tailed and significance was defined with a p value of less than 0.05. PPV and NPV were also calculated in all cases. All analyses used SPSS Statistics version 23.

Ethical standards disclosure

This study was approved by the Ethics committee of the School of Medicine, Pontificia Universidad Católica de Chile, Chile.

Result

General characteristics of women and newborns from the sub-sample of healthy women are presented in Table 2. Most women were 22-34 years old and their BMI ranged between 20 and 28 kg/m^2. Vaginal deliveries were 58 percent of total and male and female newborns were nearly 50 percent each.

As expected, the AEA chart diagnosed a lower percentage of both underweight and obese women at the beginning and at the end of the pregnancy than the RM chart (Table 3).

Comparisons of the proportions of newborns presenting inadequate fetal growth in each category of maternal nutritional status, at the beginning and at the end of pregnancy, showed rather similar values for the RM and AEA charts, with differences reaching statistical significance in only a few categories (Table 4). However, the absolute number of newborns at risk in both the underweight and obese women was almost double when diagnosed by the RM chart as compared with the AEA chart.

Sensitivity values were always higher for the RM chart than the AEA chart, especially at the end of pregnancy (Table 5). By contrast, specificity values were higher for the AEA chart. Differences of sensitivity and specificity values between the RM and the AEA chart were significant in all cases with p<0.001. PPV and NPV were similar for the two charts at the beginning and at the end of pregnancy.

Discussion

Results indicate that the AEA chart is less sensitive than the RM chart to identify, both in early and late gestation, gravidas at a higher risk of delivering babies with BW under 3000g, BL under 50cm or weighing over 4250g. This reflects the larger area of "normal" BMI in the AEA chart than the RM chart. Thus, by not diagnosing a percentage of gravidas at risk, the use of the AEA chart would prevent interventions that would benefit those women and their babies. Considering the well-known association between low BW and BL and higher morbidity and mortality during the first year of life, the reduced sensitivity of the AEA chart might have serious undesirable public health consequences if projected to the entire population of Uruguayan pregnant women. In addition, low BW infants are at a greater risk of developing coronary heart disease, stroke, diabetes and hypertension later in life [3,16]. A study in a Uruguayan population has also found a significant association between low BW and postnatal conditions such as stunting, delayed psychomotor development and

Table 5: Sensitivity, Specificity, positive and negative predictive values corresponding to each target event in specific maternal nutrition categories as diagnosed at the beginning and at the end of pregnancy by the RM and AEA charts. Values for underweight women were for BL < 50cm and BW < 3000g. Values for obese women were for BW > 4250g. Sample of healthy pregnant women and their newborns (n: 23832). IPS from Uruguay, 2010-2012.

	Chart	Sensitivity	Specificity	PPV	NPV
Beginning of pregnancy (week 10 GA)					
BL < 50cm	RM*	0.24	0.81	0.53	0.54
	AEA†	0.14	0.89	0.54	0.54
BW < 3000g	RM*	0.31	0.8	0.14	0.91
	AEA†	0.2	0.88	0.16	0.91
BW > 4250g	RM*	0.39	0.77	0.06	0.97
	AEA†	0.17	0.91	0.07	0.96
End of pregnancy (week 40 GA††)					
BL < 50cm	RM*	0.31	0.76	0.54	0.55
	AEA†	0.16	0.88	0.55	0.54
BW < 3000g	RM*	0.4	0.74	0.14	0.92
	AEA†	0.24	0.87	0.17	0.91
BW > 4250g	RM*	0.63	0.63	0.06	0.97
	AEA†	0.32	0.84	0.07	0.96

being overweight [18]. With respect to babies with BW>4250g, they are at high risk of complicated deliveries, including fetal distress and cesarean section, and of chronic diseases later in life such as diabetes and hypertension [3].

One of the limitations of the present study is its observational and retrospective nature. However, the large subsample of women used should help to minimize potential errors. With respect to this aspect, it is important to mention that the PAHO/WHO has recognized the high reliability of health surveillance data from Uruguay [19]. This fact is mostly due to the fact that CLAP, appointed by PAHO/WHO as a prestigious center providing technical guidance on perinatology to the Latin American Ministries of Health, has designed the IPS and has been providing advice to the IPS in the following aspects [9,10]: a) the norms for measuring anthropometric indexes; b) the detailed forms used to register the individual information; and c) the personnel training for performing those tasks.

The study design that considered a subsample of healthy mothers allowed for a better assessment of maternal nutritional influences on BL and BW. Misclassification errors were similar for both references. Self-reported pre-pregnancy weight was found to be a reliable indicator in a Spanish population [20]. On the other hand, average maternal weight increment during the first ten weeks of gestation has been reported as less than 1kg [21]. Thus, the use of reported pre-pregnancy weight as a proxy for weight at ten weeks of gestation seems well supported.

Sensitivity values of both charts were low, a fact that implies a rather low diagnostic efficiency of both the AEA and RM charts, although the latter performed significantly better. Similar results were recently found for a Chilean sample population [22].

The USA institute of Medicine has developed weight gain guidelines for the USA population that are being used in some developing countries, despite indications that they may not be suitable for populations with a lower average maternal height [2]. Considering the importance of weight gains proportional to maternal height, two recent publications have recommended the use of the RM chart in developing countries [3,23].

Conclusion

There are clear short and long term implications of not recognizing the undetected cases in the primary health care by the AEA chart and it would be advisable to start using again the RM chart in the health services of Uruguay.

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References

1. Rosso P. Nutrition and metabolism in pregnancy. New York. Oxford University Press. 1990.
2. Institute of Medicine. Weight gain during pregnancy: Reexamining the guidelines. Washington DC. National Academy Press. 2009.
3. Hanson MA, Bardsley A, De-Regil LM, Moore SE, Oken E, Poston L, et al. The International Federation of Gynecology and Obstetrics (FIGO) recommendations on adolescent, preconception, and maternal nutrition. "Think Nutrition First." Int J Gynaecol Obstet. 2015; 131: S213-253.
4. Mardones F, Rosso P. A weight gain chart for pregnant women designed in Chile. Matern Child Nutr. 2005; 1: 77-90.
5. Scott C, Andersen CT, Valdez N, Mardones F, Nohr EA, Poston L, et al. No global consensus: a cross-sectional survey of maternal weight policies. BMC Pregnancy Childbirth. 2014; 14: 167-177.
6. Atalah E, Castillo C, Castro R, Aldea. Proposal of a new standard for the nutritional assessment of pregnant women. Rev Med Chile. 1997; 125: 1429-1436.
7. Bove I, Mardones F, Burgueño L, Klaps L, Dominguez A. Maternal anthropometry and intrauterine growth in Chile and Uruguay. Mardones F, Arnaiz P, Barja S and Rosso P, editors. In: Obesidad (Obesity). 2nd ed. Santiago (Chile). Ediciones Universidad Católica. 2018.
8. Bove I, Mardones F, Klaps L, Dominguez A. Asociaciones entre el crecimiento prenatal y la antropometríamaterna en el Uruguay (Associations between prenatal growth and maternal anthropometry in Uruguay). Nutr Hosp. 2014; 30: 643-649.
9. Fescina RH, De Mucio B, Martínez G, Alemán A, Sosa C, Mainero L, et al. Monitoring fetal growth. 2nd edition. Pan American Health Organization. Scientific Publication CLAP/WR No. 1586.02. Montevideo, Uruguay. Latin American Center for Perinatology. 2011.
10. Fescina RH, De Mucio B, Martínez G. Sistema informático perinatal (Informatics Perinatal System). Pan American Health Organization. Scientific Publication CLAP/SMR No. 1584. Montevideo, Uruguay. Latin American Center for Perinatology. 2011.
11. National Institute of Statistics. Uruguay: Vital statistics, national live births 2011-2015. 2012.
12. Pan American Health Organization/World Health Organization. AIEPI Neonatal Interventions Based on Evidence. 2nd ed. Washington DC. Pan American Health Organization. 2010.
13. Puffer RR, Serrano CV. Patterns of Birth Weight. Washington DC. Pan American Health Organization. 1987; 504: 9-43.
14. Mardones F, Villarroel L, Karzulovic L, Barja S, Arnaiz P, Taibo M. Association of perinatal factors and obesity in 6-8 years old Chilean children. Int J Epidemiol. 2008; 37: 902-910.

15. Villarroel L, Karzulovic L, Manzi J, Erikson JG, Mardones F. Association of perinatal factors and school performance in primary school Chilean children. J DevelOrig Health Dis. 2013; 4: 232-238.

16. Mardones F, Arnaiz P, Pacheco P, Dominguez A, Villarroel L, Eriksson JG, et al. Associations of prenatal growth with metabolic ssyndrome, insulin resistance and nutritional status in Chilean children. Biomed Res Int. 2014; 472017.

17. Morales M, Sosa C, Gonzalez G, Umpierrez E, Berta S, Borbonet D. Relación entre el consumo de mate en el embarazo con el peso al nacer. Arch Pediatr Urug. 2014; 85: 18-24.

18. Bove I, Miranda T, Campoy C, Uauy R, Napol M. Stunting, overweight and child development impairment go hand in hand as key problems of early infancy: Uruguayan case. Early Hum Dev. 2012; 88: 747-751.

19. Pan American Health Organization/World Health Organization. Health in the Americas. 2012.

20. Basterra-Gortari FJ, Bes-Rastrollo M, Forga LL, Martínez JA, Martínez-González MA. Validity of self-reported body mass index in the National Health Survey. AnSistSanitNavar. 2007; 30: 373-381.

21. Hytten FE, Leitch I. The physiology of human pregnancy, 2nd ed. Oxford: Blackwell scientific publications. 1971.

22. Mardones F, Rosso P, Villarroel L, Bacallao J, Dominguez A, Passi A, et al. Pregnancy outcomes and the use of two standards to assess adequacy of maternal body mass index in early gestation. J DevelOrig Health Dis. 2016; 7: 83-89.

23. Gluckman PD, Hanson MA, Seng CY Bardsley A. Pre-conception maternal body composition and gestational weight gain. Gluckman PD, Hanson MA, Seng CY and Bardsley A, editors. In: Nutrition and Lifestyle for Pregnancy and Breastfeeding. Oxford: Oxford University Press. 2014; 215-220.

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