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Agreement between information recorded during antenatal care and in the MINA-Brazil study

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Abstract *This article aims to examine agreement of pre-pregnancy weight, pregnancy weight, height and systolic (SBP) and diastolic (DBP) blood pressure measurements recorded on antenatal record cards with the same information obtained in the MINA-Brazil longitudinal study. 428 pregnant women who participated in the MINA-Brazil study and had an antenatal card at time of childbirth were selected. Concordance analysis of the data used Lin's correlation coefficient and Bland-Altman analysis. There was moderate agreement on self-reported pre-pregnancy weight (0.935) and height (0.913) information, and substantial agreement on the pregnant women's weight in the second (0.993) and third (0.988) trimesters of pregnancy. Little agreement was found on SBP and DBP measured in the second (SBP = 0.447; DBP = 0.409) and third (SBP = 0.436; DBP = 0.332) trimesters of pregnancy. Anthropometric measurements showed strong agreement. There was weak agreement between blood pressure measurements, which may relate both to the variability and the standardisation of these measurements, suggesting the need for continued training of antenatal teams in primary health care.*

Key words *Anthropometry, Antenatal care, Pregnancy, Maternal health*

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Introduction

With proper antenatal care, it is possible to prevent, diagnose and treat disorders of pregnancy, childbirth and puerperium. Studies using information on care during pregnancy have been essential to guiding the actions of health services[1,2].

In Brazil, the expectant mother's antenatal booklet is a record of care that should contain information on all management and procedures performed during pregnancy monitoring. The Ministry of Health recommends the booklet be filled in since the first antenatal appointment. The information should include data on pre-pregnancy weight and height, as well as pregnancy monitoring information from all antenatal appointments, such as the pregnant woman's weight and blood pressure, and other information necessary to prevent and treat unfavourable pregnancy outcomes, so that the baby can be born healthy and with no adverse effects on the mother's health[3].

Proper records of comprehensive antenatal care offer a good indicator of the quality of care. Accordingly, research to investigate agreement between data entered in expectant mothers' antenatal care booklets and from other information sources is fundamental to assessing pregnancy monitoring services and their concepts, given that the lack or inappropriate provision of antenatal care has been associated with higher rates of maternal and neonatal morbi-mortality[4,5]. Also, as the data entered by the various health services in expectant mothers' antenatal care records are easy to access, they have been used for conducting epidemiological studies.

Some Brazilian studies have found good agreement between anthropometric measurements recorded in expectant mothers' antenatal care records and the values obtained in surveys[6] or information reported by pregnant women[7]. It is important to ascertain whether there are differences between the data recorded on antenatal record cards and data obtained by other methods, so as to identify variability of measurements. The literature search found no studies to date evaluating to what extent anthropometric and blood pressure measurements taken during antenatal monitoring agree with measurements obtained in longitudinal studies.

Information from antenatal monitoring can differ depending on the method, standardisation and instruments used and it is important to know the magnitude of error involved in measuring such information. Accordingly, this study examined to what extent data on pre-pregnancy weight, and gestational weight, height and systolic (SBP) and diastolic (DBP) blood pressure entered on antenatal record cards during routine antenatal appointments agreed with the same information obtained by researchers in the MINA-Brazil longitudinal study of maternal and child health in Cruzeiro do Sul, Acre, Brazil.

Methods

Study design and population

The MINA-Brazil study: Maternal and Child Health in Cruzeiro do Sul, Acre, is a prospective cohort designed mainly to investigate factors associated with the health and nutrition of mothers and their babies through pregnancy up to two years of age. For the study reported here, a subsample of participants was selected in order to assess agreement between the data obtained by the MINA-Brazil study team and the same data entered on antenatal record cards during routine antenatal monitoring.

The pregnant women who participated in the MINA-Brazil study were identified by their having enrolled in the antenatal programme at primary health care facilities in the urban zone of the Cruzeiro do Sul municipality in the period between February 2015 and February 2016, as described in a previous publication[8], and whose antenatal record cards had entries from at least one antenatal appointment.

Pregnant women with fewer than 20 weeks gestational age, as based on the date of their last menstruation, were contacted by telephone by the research team to invite them to take part in the study. On accepting, home visits were scheduled to interview them on sociodemographic and health history information. Two clinical assessments were then scheduled in order to monitor the study participants: the first, during the second trimester of pregnancy and the second in the third trimester, using the best estimate of gestational age (date of the last menstruation or ultrasound performed at the first evaluation).

All the pregnant women monitored by the MINA-Brazil study at any of the assessments conducted during the period of pregnancy were selected, providing their antenatal record card, at the moment of childbirth, with at least one antenatal appointment recorded. The antenatal cards were previously digitised and the data were double-entered by the research team.

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The agreement analysis in this study first identified the self-reported pre-pregnancy weight and height measurements recorded in the antenatal record card and in the MINA-Brazil study. Agreement was then evaluated between the records of self-reported pre-pregnancy weight in the MINA-Brazil study and the pregnant women's weight measured up to 13 weeks of pregnancy recorded in the antenatal card, with a view to observing differences possibly related to memory bias. Agreement for weight during pregnancy and for SBP and DBP was examined at two points, in the second and third trimesters of pregnancy, allowing a maximum tolerance period of seven days earlier or later between the measurements taken by health personnel and recorded in the antenatal record card and those in the MINA-Brazil study evaluations (Figure 1).

The study used the MINA-Brazil research protocol submitted to and approved by the research ethics committee of the Public Health Faculty of the Universidade de São Paulo (Projeto MINA approval protocol No. 872.613, of 13 November 2014).

Data collection

Information on the pregnant women's demographic and socioeconomic characteristics was obtained by interview, as follows: age (< 19, 19 to < 35 and ≥ 35 years), schooling (≤ 9, 10 to 12 and >12 years), self-reported skin colour (white, non-white), woman head of family (Yes, No), has paid occupation (Yes, No), receives *Bolsa Família* conditional cash transfer programme benefit (Yes, No), marital status (lives with partner, does not live with partner) and first pregnancy (Yes, No).

The measurements used in the MINA-Brazil study as regards the variables of interest to the agreement analysis in this study (weight prior to

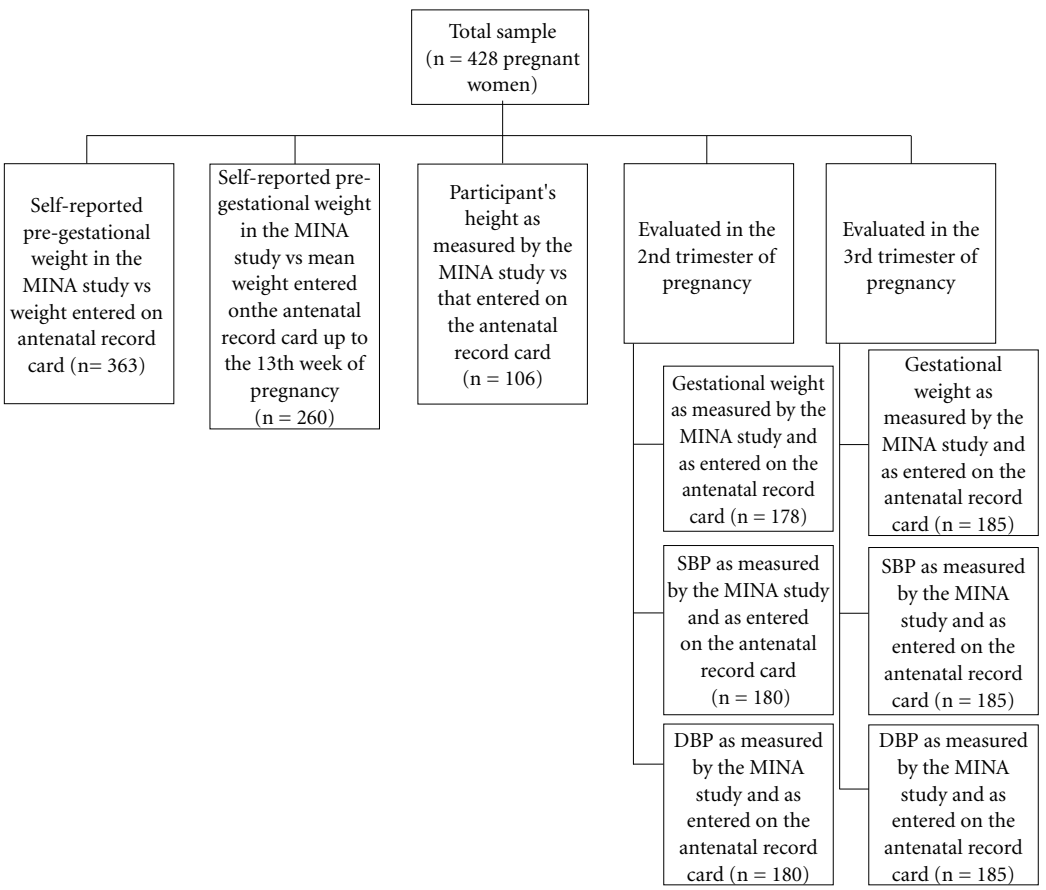

Figure 1. Flow diagram for measurements taken of the study population.

Source: Authors.

and during pregnancy, height and blood pressure) were standardised and taken by a trained research team. The pregnant women's bodyweight was measured using a Tanita Corporation® (Tokyo, Japan), portable scales model UM061, with 150 kg capacity and 0.1 kg graduation, which was regularly calibrated by the team. Weight was measured with the participant barefoot and in light clothing, standing upright, arms at her side and feet together; that position was held while the measurement was read and recorded. Height was measured using a portable Alturaexata® stadiometer (Belo Horizonte, Brazil) precise to 0.1 cm and with capacity of 213 cm. Height was measured with the participant barefoot and bareheaded, with no ornaments (hair clips, hair stick and so on) or hairstyles (ponytail, plaits and so on), positioned at the centre of the equipment, upright, arms at her sides, head upright, looking at a fixed point at eye level, and that position was held while the measurement was read and recorded. All measurements were taken twice, following the recommendations of the World Health Organisation (WHO)[9]. The mean of the measurements was then calculated and the exact value of the mean was used for analysis. Blood pressure was measured using an OMRON HEM-705CPINT digital apparatus. Measurement was standardised for all the pregnant women who participated in the study, following the recommendations of the Ministry of Health low-risk antenatal care manual[3]. Blood pressure measurements were taken on the right arm using a cuff of appropriate size, with the participant seated, her feet on the floor and arm at heart level, after resting for at least five minutes. Three measurements were taken, at one-minute intervals, and the mean was calculated for SBP and DBP. High blood pressure in pregnancy was defined by identifying absolute values of SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg[10].

Statistical analysis

Means and their respective 95% confidence intervals (95% CI) were calculated for the continuous variables. The categorical variables were described by absolute and relative frequencies.

Bland-Altman analysis[11,12] was performed to identify the Limits of Agreement (LoA) intervals with 95% confidence, making it possible to analyse the overall distribution of agreement values by dimension of the measurements in question. The Bland-Altman technique produces a graph displaying bias (how far the differences are from zero, i.e., the mean difference), error (the dispersion of difference points around the mean) and outliers.

Lin's Concordance Correlation Coefficient (CCC)[13] was used to complement the analysis of agreement by ascertaining the magnitude of deviation from the line of perfect agreement. In order to assess the degree of agreement by CCC, the following classification was used: near perfect (> 0.99), substantial (0.95 to 0.99), moderate (0.90 to 0.95) and low (< 0.90)[14].

A 5% level of significance was used. Data were processed with the aid of the Stata statistical package, version 12.0 (Stata Corp, College Station, TX, USA).

Results

A total of 428 pregnant women for whom information was available on their antenatal record cards and in the MINA-Brazil study were included in this study. From these, pairs of measurements were obtained, as follows: 363 for self-reported pre-pregnancy weight, 260 for pre-pregnancy weight entered on the antenatal record card up to the 13th week of pregnancy, 106 for height, 178 for second-trimester gestational weight and 185 for third-trimester gestational weight, 180 for second-trimester SBP and DBP and 185 for third-trimester SBP and DBP.

From data on the antenatal record cards, the prevalence of systemic arterial hypertension was 2.2% in the second trimester of pregnancy and 1.6% in the third trimester. From the MINA-Brazil study data, there were no cases of arterial hypertension in the second trimester and prevalence in the third trimester was 0.5%.

The pregnant women who participated in the study were, on average, between 19 and 34 years old (71%), 85% considered themselves non-white, 58% had completed from 10 to 12 years' schooling and 79% reported living with a partner. Most participants did not have a paid occupation (64%) and were not heads of household (85%), 38% received benefits from the *Bolsa Família* conditional cash transfer programme, 11% belonged to the first household wealth quintile and 44% were in their first pregnancy (Table 1).

Table 2 shows mean values and 95% CIs for the measurements taken in the MINA-Brazil study and from the antenatal record cards, with a sample total for each variable and CCC values and mean differences with their respective Bland-Altman limits of agreement.

Table 1. Sociodemographic, economic and reproductive characteristics of the pregnant women seen in the antenatal service, Cruzeiro do Sul, Acre. 2015-2016. N = 428.

Variables	N	%
Age (complete years)		
< 19	84	19.6
19 to < 35	304	71.0
≥ 35	40	9.4
Self-reported skin colour		
White	65	15.2
Non-white	363	84.8
Schooling		
≤ 9 years	120	28.0
10 to 12 years	246	57.5
> 12 years	62	14.5
Marital status		
Not living with partner	90	21.0
Living with partner	338	79.0
Paid occupation		
No	275	64.3
Yes	153	35.7
Head of family		
No	364	85.1
Yes	64	14.9
Receiving Bolsa Família benefit		
No	265	61.9
Yes	163	38.1
First pregnancy		
No	239	55.8
Yes	189	44.2

Source: Authors.

The Bland-Altman analysis showed that the expectant mothers' second- and third-trimester weights measured and recorded in the antenatal record card were, on average, very close to those in the MINA-Brazil study (mean differences of -0.278 and -0.186, respectively). The SBP measurements taken at antenatal appointments and entered on the antenatal record card in the second and third trimesters of pregnancy were underestimated in comparison with those of the MINA-Brazil study (-5.443 and -4.638, respectively). The measurements of self-reported pre-pregnancy weight and height in the antenatal record cards were, on average, greater than those in the MINA-Brazil study (0.809 and 0.223, respectively). The mean difference was greater (0.960) when considering pre-pregnancy weight measured at up to the 13th week of pregnancy and entered on the antenatal record card (Table 2).

In limit of agreement assessment, smaller variations were observed in pre-pregnancy weight (LoA = -6.689; 8.306) (Figure 2A), height (-5.148; 5.595) (Figure 2B) and weight assessed in the two trimesters: (-2.660; 2.104 at the second trimester and -3.192; 2.821 in the third trimester) (Figure 2C and 2D). Greater variation in limits of agreement were observed in all blood pressure measurements: second-trimester SBP returned LoA = -26.185; 15.299 and third-trimester SBP returned LoA= -24.798; 15.522 (Figure 2E and 2F), while LoA for second-trimester DBP was -18.624; 18.994 and, for third-trimester DBP, -17.368; 20.665 (Figure 2G and 2H). Limits of agreement values are shown in Table 2.

CCC returned moderate agreement between the information on the antenatal cards and those recorded by the MINA-Brazil study for pre-pregnancy weight (0.935), pre-pregnancy weight measured at up to the 13th week of pregnancy (0.920) and height (0.913). Agreement for weight in the second and third trimesters of pregnancy was substantial, at 0.993 and 0.988, respectively. Blood pressure measured in the second and third trimesters of pregnancy returned low agreement: respectively, SBP = 0.447; DBP = 0.409 and SBP = 0.436; DBP = 0.332 (Table 2).

Discussion

In this study, the data for pre-pregnancy weight, height and weight during pregnancy entered on antenatal record cards returned good agreement with the measurements taken by the MINA-Brazil study. However, the systolic and diastolic arterial pressure data obtained in routine antenatal care showed greater error than the corresponding information obtained by the MINA-Brazil research team.

The Ministry of Health stresses that taking these measurements is indispensable to proper physical examination of pregnant women and, given their importance, they should be assessed starting at the first antenatal appointment. It also standardises the procedures for taking all these measurements, so as to ensure better healthy service quality[3,10].

Pre-pregnancy nutrition assessment is of prime importance to monitoring weight gain during pregnancy and indispensable to identifying women at nutritional risk[15]. The pre-pregnancy weight entered on antenatal record cards may be self-reported or measured up to the 13th complete week of pregnancy[16]. Self-reported

Table 2. Means, CCC, differences in means and Limits of Agreement between values of pre-pregnancy weight, height, weight in pregnancy and systolic and diastolic arterial pressure on the antenatal record card and in the MINA-Brazil study, Cruzeiro do Sul, Acre. 2015-2016.

Variables compared	N	MINA-Brasil study	Antenatal record card	Bland-Altman		
		Mean (95%CI)	Mean (95%CI)	CCC[a]	Difference in means	Limits of Agreement
Pre-pregnancy weight (kg)	363	57,9 (56,8-59,1)	58,7 (57,6-59,8)	0,935	0,809	-6,689; 8,306
Pre-pregnancy weight on antenatal record card up to 13th week of pregnancy*	260	58,2 (56,9-59,5)	59,2 (57,8-60,5)	0,920	0,963	-7,294; 9,220
Height (cm)	106	157,6 (156,4-158,9)	157,8 (156,5-159,1)	0,913	0,223	-5,148; 5,595
Second Trimester						
Weight (kg)	178	62,4 (60,8-64,0)	62,2 (60,6-63,7)	0,993	-0,278	-2,660; 2,104
Systolic arterial pressure (mmHg)	180	109,3 (107,8-110,8)	103, 8 (102,2-105,5)	0,447	-5,443	-26,185; 15,299
Diastolic arterial pressure (mmHg)	180	65,7 (64,5-66,8)	65,9 (64,4-67,3)	0,409	0,185	-18,624; 18,994
Third Trimester						
Weight (kg)	185	65,6 (64,2-67,1)	65,4 (64,0-66,9)	0,988	-0,186	-3,192; 2,821
Systolic arterial pressure (mmHg)	185	109,8 (108,3-111,2)	105,1 (103,6-106,6)	0,436	-4,638	-24,798; 15,522
Diastolic arterial pressure (mmHg)	185	65,9 (64,8-67,0)	67,6 (66,3-68,9)	0,332	1,649	-17,368; 20,665

Comparison between self-reported pre-pregnancy weight on the antenatal record card up to 13th week of pregnancy and self-reported pre-pregnancy weight in the MINA-Brazil study. [a] CCC = Lin's Concordance Correlation Coefficient.

Source: Authors.

measurements have been used for pre-pregnancy nutritional monitoring, mainly because they are difficult to take before pregnancy. In this study, there was moderate agreement between self-reported pre-pregnancy weights. The mean difference increased in the pregnant women's weight measured at up to the 13th week of pregnancy as entered on the antenatal record card.

Shin *et al.*[17], in a study performed in the United States which assessed agreement between self-reported weight and weight measured in the first trimester, found a mean difference of 2.3 kg. The difference found in a study by Natamba *et al.*[18] in Lima, Peru, was greater (0.27 kg). Both studies concluded that there was good agreement between the measurements and that self-reported pre-pregnancy weights are generally valid and reliable for proper evaluation of, and guidance on, gestational weight gain and also for purposes of research and population-based surveillance[17,18]. In the study reported here, the mean difference observed in self-reported pre-pregnancy weight was 0.81 kg.

Proper evaluation of nutritional status during pregnancy and related practical interventions have positive impact during pregnancy and after childbirth. In addition to preventing adverse health outcomes for the *conceptus*, appropriate nutritional status in pregnancy contributes to a favourable prognosis for the child's health status in the early years of life[9,15,19]. In this study, there was good intrapair agreement in height measurements, as indicated by the CCCs and narrow LoAs. Some Brazilian studies that have evaluated agreement between self-reported height and the values entered on antenatal record cards have found that height was overestimated[6,7]. Another study that examined the reliability of using self-reported values for pregnant women observed that women pregnant for the first time tended to underestimate their height and weight, which affected calculations of BMI[20]. The find-

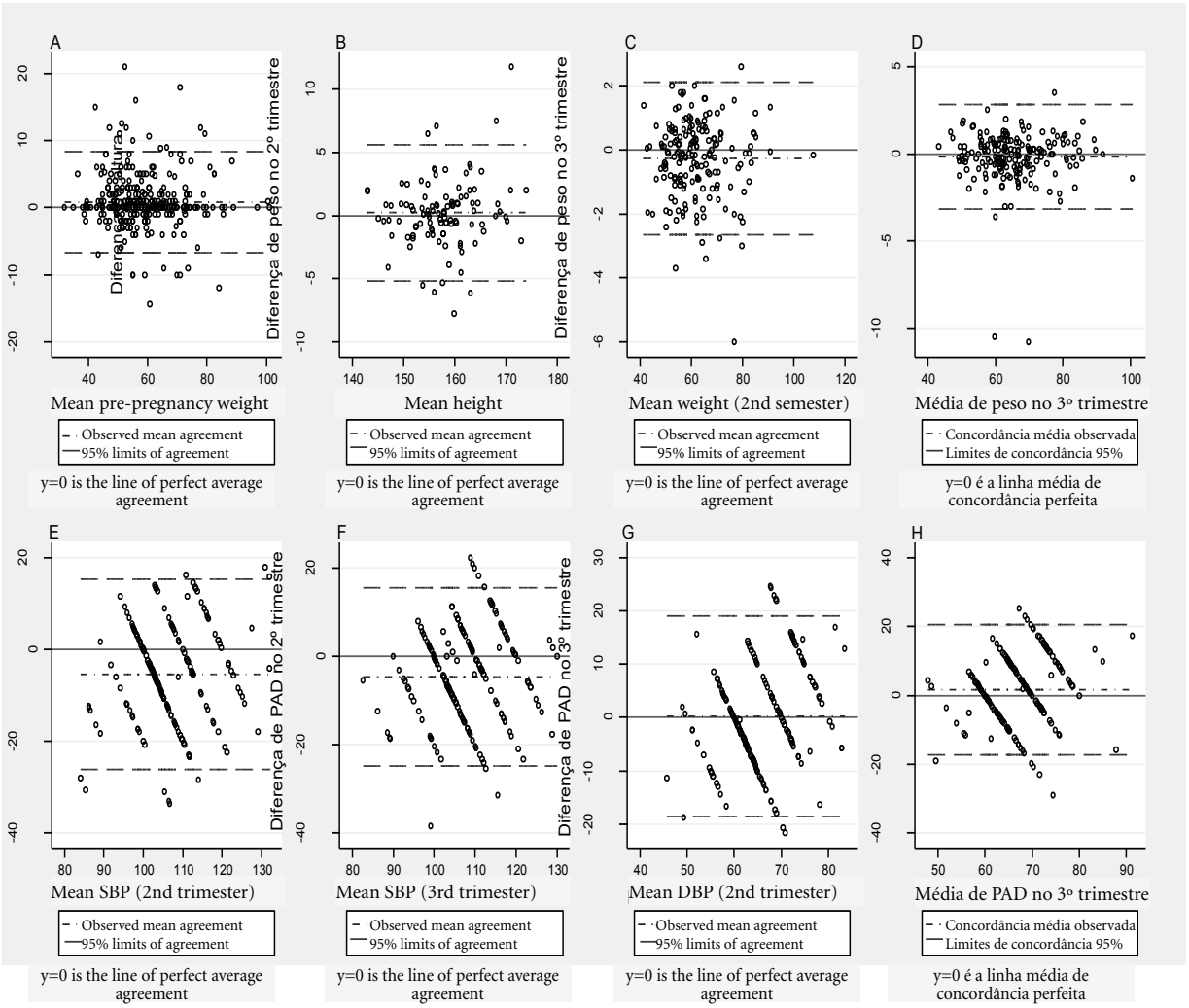

Figure 2. Bland-Altman plots showing mean differences and Limits of Agreement at 95% for pre-pregnancy weight (A), height (B), weight in second trimester of pregnancy (C), weight in third trimester of pregnancy (D), second trimester systolic arterial pressure (E), third trimester systolic arterial pressure (F), second trimester diastolic arterial pressure (G) and third trimester diastolic arterial pressure (H), as entered on the antenatal record card and in the MINA-Brazil study in Cruzeiro do Sul, Acre, 2015-2016.

Source: Authors.

ings of those studies underline the importance of measuring the height of pregnant women and of that procedure's being performed appropriately.

In this study, the information that returned best agreement between the variables investigated was gestational weight in the second and third trimesters of pregnancy. That high degree of agreement may be related to the use of suitable digital scales in antenatal care services, and to health personnel's following procedures appropriately. On the other hand, Niquini et al.[7] found that, despite strong agreement between data, certain criteria were not properly met when pregnant women were weighed in antenatal appointments at Rio de Janeiro's municipal primary care facilities and publics hospitals. This undermined the validity of those measurements and pointed to a need to train health personnel in taking weight measurements.

It is of paramount importance to measure pregnant women's blood pressure during antenatal appointments in order to identify hyperten-

sive disorders early[21]. In this study, the measurements of systolic and diastolic arterial pressure in the second and third trimesters were highly discrepant in all the analyses of agreement. Silva *et al.*[22] reported similar findings in the general population, where values measured by what they considered to be the "gold standard" were discrepant from those measured in a public emergency facility in São Paulo. In another study of antenatal care at primary care facilities in Campinas[23], considerable variations were found in arterial pressure measured by sphygmomanometer (an aneroid apparatus more used in Brazil) and by oscillometer (an electronic apparatus). The oscillometer returned systolic arterial pressure values similar to those of the cuff method, but underestimated diastolic arterial pressure. In both methods, using the standard width cuff, rather than the correct wide cuff, resulted in underestimation of blood pressure.

Note that this is the first study in Brazil's North region to examine agreement between data recorded on antenatal record cards and the standardised measurements of a longitudinal study. However, certain limitations should be noted. The findings as regards arterial pressure measurements should be treated with caution, because the values may vary; even over small time intervals. The measurements in this study were taken over periods ranging from zero to seven days, rather than in quick succession, which may preclude any more substantial analysis of the agreement estimates. Some studies corroborate this, pointing out that even at normal levels, arterial pressure can show a pattern of variation over the course of pregnancy[24-26].

Conclusion

The findings warrant the conclusion that there was good agreement between the anthropometric measurements as entered on antenatal record cards in routine antenatal care and the measurements obtained by a research team. Note also that weak agreement between blood pressure measurements may be related to the intra-individual variability of such measurements and to the use of different equipment and unsuitable cuffs. Nonetheless, even though there may be such variation, our findings suggest a need to use appropriate, duly calibrated equipment and for continued capacity-building and training for antenatal teams in primary health care.

Collaborations

AAA Damasceno: collection, analysis and interpretation of data, writing and revision of the manuscript. PS Mosquera: data processing and analysis, manuscript review. MB Malta: supervision of data collection, processing and analysis and manuscript review. AM: conception, data interpretation and critical manuscript review. MA Cardoso: design, analysis and interpretation of data, manuscript review, approval of the final version, public responsibility for the content of the article.

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