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Health facility structure and maternal characteristics related to essential newborn care in Brazil: a cross-sectional study

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ABSTRACT

Objectives To assess the use of the WHO's Essential Newborn Care (ENC) programme items and to investigate how the non-use of such technologies associates with the mothers' characteristics and hospital structure.

Design A cross-sectional observational health facility assessment.

Setting This is a secondary analysis of the 'Birth in Brazil' study, a national population-based survey on postnatal women/newborn babies and of 266 publicly and privately funded health facilities (secondary and tertiary level of care).

Participants Data on 23 894 postnatal women and their newborn babies were analysed.

Main outcome measures The facility structure was assessed by evaluating the availability of medicines and equipment for perinatal care, a paediatrician on call 24/7, a neonatal intensive care unit (NICU) and kangaroo mother care. The use of each ENC item was assessed according to the health facility structure and the mothers' sociodemographic characteristics.

Results The utilisation of ENC items is low in Brazil. The factors associated with failure in pregnant woman reference were: pregnant adolescents (OR_{adj} 1.17; 95% CI 1.06 to 1.29), ≤7 years of schooling (OR_{adj} 1.47; 95% CI 1.22 to 1.78), inadequate antenatal care (OR_{adj} 1.67; 95% CI 1.47 to 1.89). The non-use of corticosteroids was more frequently associated with the absence of an NICU (OR_{adj} 3.93; 95% CI 2.34 to 6,66), inadequate equipment and medicines (OR_{adj} 2.16; 95% CI 1.17 to 4.01). In caesarean deliveries, there was a less frequent use of a partograph (OR_{adj} 4,93; 95% CI 3.77 to 6.46), early skin-to-skin contact (OR_{adj} 3.07; 95% CI 3.37 to 4.90) and breast feeding in the first hour after birth (OR_{adj} 2.55; 95% CI 2.21 to 2.96).

Conclusions The coverage of ENC technologies use is low throughout Brazil and shows regional differences. We found a positive effect of adequate structure at health facilities on antenatal corticosteroids use and on partograph use during labour. We found a negative effect of caesarean section on early skin-to-skin contact and early breast feeding.

INTRODUCTION

The reduction of child mortality is a topic of the Sustainable Development Goal 3, that

is, to ensure healthy lives and promote well-being for all at all ages.[1] Neonatal mortality accounts for 45% of all under-five deaths worldwide[2] and reaches 64% in Brazil.[3]

Increased coverage and quality improvement of preconception, antenatal, intrapartum and postnatal interventions can avert 71% of neonatal deaths by 2025. Interventions around the labour period are the most effective in reducing neonatal mortality. The wider use of effective interventions will prevent 1 million neonatal deaths by 2020.[4]

Almost two decades ago, with a view to reducing neonatal mortality and morbidity, WHO recommended specific care practices outlined in the Essential Newborn Care (ENC) programme. These are strategic actions extended from preconception care through to the postnatal period.[5] Infant mortality tends to be lower in countries where the coverage of these essential interventions is high.[3]

In Brazil, antenatal care coverage is high (98% of pregnant women had at least one antenatal care visit and 66.9% of them had

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Strengths and limitations of this study

► Using primary data, we have conveyed a representative nationwide survey.
► Our data are representative for the entire country and reflect regional characteristics and disparities.
► The 'Birth in Brazil' study was conducted in hospitals with >500 deliveries per year, representing 80% of childbirths in the country.
► The study data was based on information provided by women shortly after delivery, by medical records and by managers, rather than on performance observations of the essential care items.
► The cross-sectional nature of the survey data limits our ability to assess causal relationships.

more than six antenatal care visits in 2015) and the hospital delivery rate is almost 100%. Nevertheless, neonatal mortality remains high (9.5 deaths per 1000 live births in 2015)[6] and deaths in first 24 hours of life account for nearly a quarter of all neonatal deaths.[7] The main reasons are preventable causes, such as complications from preterm birth, sepsis and intrapartum-related asphyxia.[8] This situation may be linked to economic, social and biological disparities, but may be also linked to the quality of antenatal care, labour and birth assistance.

However, only limited national data are available on public policies, such as antenatal corticosteroid use in managing preterm labour, and on the availability of the kangaroo mother care (KMC) for preterm or low birth weight newborns.[3] Thus, identifying shortcomings in perinatal care in Brazil is an essential stage in conducting interventions to allocate resources according to where they are needed most and where their effect will be maximised. This is a problem that may also affect other countries with a similar level of socioeconomic development, observable in different places and at different intensities.[9]

This study aims to evaluate the utilisation of certain core technologies for the care of mothers and newborns, as defined in the WHO's Essential Newborn Care programme, and the association between the non-use of these technologies and variables related to hospital structure and the mothers' characteristics.

METHODS
Design and setting
This is a cross-sectional observational health facility assessment.

This study is a secondary analysis of the 'Birth in Brazil' study,[10] a national population-based survey conducted between February 2011 and October 2012, including data on the mothers' pregnancy and delivery, their newborn babies and the structure of the health facilities where the deliveries occurred.

Participants and sample
The sample size has a power of 80% to detect adverse outcomes in the order of 3%, and differences of at least 1.5% among large geographic regions or types of hospital governance (public/private/mixed). Mixed healthcare facility describes care in private hospitals that was paid for by the government's unified healthcare system.[10] For this study, mixed and public hospitals were analysed together.

For the 'Birth in Brazil' study, we included 90 women who recently delivered (within the last 24 hours) from every health facility. The sample was selected using three-stage cluster sampling. The first encompassed hospitals with 500 or more deliveries per year, stratified according to Brazil's five geographical macro-regions (North, Northeast, Southeast, South and Mid-West), location (state capital or not) and type of funding (public and private), according to random sampling. In the second stage of sampling, an inverse sampling method was used

to select as many days as were necessary to interview 90 postnatal women in the hospital.[11] This method, originally proposed by Haldane[12] to estimate frequencies and proportions, can be defined as a technique to sample as many units (in this case, days) as are needed to observe a prespecified number of successes or, in this case, 90 interviews performed with postnatal women in the hospital. To account for the difference in the number of live births on weekends and on work days, a minimum of seven consecutive days was mandatory and the size of the field team was determined to ensure compliance with this rule.[11]

The number of postnatal women (third stage of the sample) to be selected per day and for every hospital depended on the number of live births, the number of interview shifts and the number of available interviewers per day in the hospital. To ensure a random selection of postnatal women, the survey central office prepared tables containing an ordered list of women to be interviewed according to the number of live births. The ordering of this list was defined by the order of the women's admittance to the hospital. Some additional women were selected to replace those who did not respond.[11]

Data collection
Data was obtained from two sources: i) interviews were conducted with health facility managers and with postnatal women during hospitalisation within the first 24 hours after birth; ii) the medical records of mothers and newborns were consulted after hospital discharge or death. In the case of prolonged postpartum hospital stays, records were analysed up to the 42nd day of hospitalisation for mothers and up to the 28th day for newborns. In the case of postnatal transfers of mothers and/or newborns, data were obtained from the hospital records of the transfer destination, even when the hospital was not part of the original sample of the study. In the case of refusal or early discharge, the participant was replaced by a new subject selected from the same hospital. A digital photograph of the antenatal notes was taken when available and the relevant data from the notes were converted into electronic form. All field work was conducted by healthcare professionals or healthcare students under the supervision of the research team. Further information about the sample design and data collection are detailed elsewhere.[10 13]

Variable definitions
Following WHO guidelines,[5] six essential neonatal care variables were investigated: adequate referral of pregnant woman during the antenatal period to a specific health facility for delivery; administration of antenatal corticosteroids when indicated[14] to women at risk of preterm birth between 24 and 34 weeks' gestation (gestational age was calculated using an algorithm that primarily relied on early ultrasound estimates)[15]; continuous social support (a companion at all times during the mother's hospital stay); use of a partograph during labour; early skin-to-skin

contact between mother and newborn, while still in the delivery room and breast feeding in the first hour after birth. These data were abstracted from medical records of mothers and newborns and from interviews with post-natal woman.

At the hospitals, the following structure-related variables were investigated, by interviewing the facilities managers: existence of a neonatal intensive care unit (NICU) and use of the KMC, a paediatrician on call 24 hours a day, availability of equipment for the emergency care of mothers (laryngoscope and endotracheal tube, self-inflating bag valve mask and mechanical ventilator) and newborns (laryngoscope and endotracheal tube, self-inflating bag valve mask, suction device, adapter for meconium aspirator, mechanical ventilator and warming device), availability of medicines for mothers and newborns (anti-hypertensives, anxiolytics/hypnotics, corticosteroids, oxytocics, inhibitors of uterine contractility, coagulants/haemostatics, magnesium sulfate, surfactant, eye drops for prophylaxis of gonococcal ophthalmia and anti-D immunoglobulin for Rh-negative women) as required by Brazilian law.[16] For the set of equipment and medicines, a degree of adequacy was calculated by taking affirmative responses as a percentage of the total items investigated. Health facilities were classified as adequate if 80% or more of the items were available and inadequate if <80% were available. Equal weights were attributed to all items studied.

Analytical approach
The study variables were compared according to the type of funding (public or private), macro-region (North, Northeast, Southeast, South and Mid-West), location (state capital or not), as well as by the mothers' characteristics, such as age (12–19, 20–34 and 35 or more years), schooling (7 or less, 8–10, 11–14 and 15 or more years in school), social class (A or B, C, D or E), sufficient number of antenatal care visits (4 or more visits=adequate; fewer than 4=inadequate) and delivery route (vaginal or caesarean section). Women who gave birth in public or mixed healthcare facilities and who were not covered by private health insurance plans were classified as receiving public healthcare at childbirth. Women covered by a private health insurance plan and women who gave birth in private hospitals, regardless of coverage by a health insurance plan, were classified as receiving private healthcare at childbirth.

In Brazil, the organisation responsible for the demographic census Instituto Brasileiro de Geografia e Estatística (IBGE) uses a particular indicator, which is a proxy wealth index. This index considers the schooling of the interviewee and the access to some specific public services and goods that the interviewee possesses at the time of the interview. The individual is classified according to socioeconomic criteria into the following classes: A—>45 points; B1—from 38 to 44 points; B2—from 29 to 37 points; C1—from 23 to 28 points; C2—from 17 to 27 points; D–E—from 0 to 16 points. For this work,

classes A, B1 and B2 were grouped as class A and B, and classes C1 and C2 were grouped as class C. Classes D and E remained as in the original.[17]

The deliveries included in this study had 'early skin-to-skin contact'; few missing cases were reported for 'reference to health facility', 'continuous social support' and 'breast feeding in first hour of birth'. The total 'antenatal corticosteroids used appropriately' were at risk of preterm birth between 24 and 34 weeks' gestation. Prelabour caesareans were excluded for 'partograph used'.

For each ENC-related variable, the percentage use was calculated (mean, 95% CI) according to variables relating to the health facility structure and the mothers' sociodemographic characteristics. Simple regression models were used to estimate the associations between the dependent variable (non-use to each item of essential newborn care) and the independent variables listed above. Crude ORs with respective 95% CI were then estimated. In sequence, by the backward method, multiple regression models were developed with each dependent variable and the independent variables that proved significant in the first analysis. Independent variables that proved significant (to a 5% level of significance) in explaining the use or the non-use of each of the essential care items were retained in the model. The ORs were adjusted, and the 95% CI were estimated. All inferential analyses were weighted and took the sampling design plan into account, which considers the stratification, the conglomerate and the probability of the individuals. The results were obtained using IBM SPSS (Statistical Package for the Social Sciences, for Windows, V.22).

All hospital directors and postnatal women gave written informed consent.

Patient involvement
No patients were involved in defining the research question or the outcome measures, nor were they involved in the design and implementation of the study. There are no plans to involve patients in the dissemination of the results.

RESULTS
The coverage of the ENC items investigated according to location, type of funding, health facility structural variables and the mothers' characteristics is shown in table 1. In Brazil, pregnant women were referred to a specific health facility during the antenatal period in 58.7% (95% CI 56.7% to 60.7%) of cases. According to the type of funding, this was higher in privately funded and for women with adequate antenatal care. Antenatal corticosteroids were used in 41.0% (95% CI 34.2% to 48.0%) of indicated pregnant women; it was less frequently used in publicly funded facilities, in the North and Mid-West regions, in facilities without paediatrician available 24 hours a day, with material resources <80% and without a NICU. Partograph labour monitoring occurred in 48.5% (95% CI 43.8% to 53.1%) of the deliveries around

Table 1 Number and percentage (95% CI) of essential newborn care items according to geographical location, mothers' socioeconomic variables, type of funding and structural variables (Brazil, 2011–2012)

Variables	Reference to health facility (n=23,851)			Antenatal corticosteroids used appropriately (n=1,126)			Partograph used (n=13,458)			Continuous social support (n=23,879)			Early skin-to-skin contact (n=23,894)			Breast feeding in first hour of birth (n=22,919)		
	N	%	95% CI	N	%	95% CI	n	%	95% CI	n	%	95% CI	N	%	95% CI	n	%	95% CI
Total	14004	58.7	56.7 to 60.7	458	41	34.2 to 48.0	6524	48.5	43.8 to 53.1	4756	19.9	17.0 to 23.1	6293	26.3	23.9 to 29.0	12374	59.1	56.3 to 61.9
Macro-region																		
North	1132	49.4	43.7 to 55.2	34	24.2	13.3= to 40.1	325	22.4	11.8 to 38.3	277	12.1	7.5 to 18.9	589	25.7	19.1 to 33.5	1511	73.4	69.0 to 77.4
Northeast	3770	54.7	51.4 to 58.0	160	42.4	28.4 to 57.8	1359	33.1	24.7 to 42.7	1017	14.7	10.5 to 20.3	1857	26.9	22.3 to 32.0	3353	57.1	52.8 to 61.4
Southeast	6271	61.8	58.7 to 64.9	196	47.6	36.4 to 59.0	3631	65.8	59.3 to 71.8	2517	24.8	19.6 to 30.8	2561	25.2	21.2 to 29.7	4868	54.6	49.2 to 59.9
South	1906	64	56.3 to 71.0	55	47.8	39.8 to 55.9	880	55.1	44.9 to 64.8	684	22.9	16.8 to 30.5	910	30.5	24.7 to 36.9	1719	64.1	56.0 to 71.4
Mid-West	925	59.7	53.0 to 66.1	13	20	12.0 to 31.4	329	42	28.4 to 57.0	261	16.8	11.1 to 24.7	376	24.2	16.8 to 33.5	923	65.6	59.9 to 70.8
Location																		
Not capital	8661	57.9	55.3 to 60.6	190	36.5	30.1 to 43.3	3514	42.5	37.5 to 47.6	2290	15.3	12.5 to 18.6	3388	22.6	20.1 to 25.4	7795	58.9	55.1 to 62.6
Capital	5342	60	57.0 to 62.9	268	45.6	34.3 to 57.3	3010	58.1	49.6 to 66.1	2466	27.7	22.0 to 34.1	2905	32.6	27.6 to 37.9	4579	59.5	55.4 to 63.4
Funding																		
Public	11501	56.6	54.5 to 58.7	385	38.8	31.3 to 46.8	6375	49.3	44.5 to 54.2	3391	16.7	13.7 to 20.2	5431	26.7	23.9 to 29.6	11268	63.4	60.4 to 66.4
Private	2502	70.8	65.5 to 75.5	73	63.1	52.4 to 72.7	149	27.6	17.7 to 40.4	1365	38.7	30.0 to 48.0	862	24.3	19.3 to 30.2	1106	34.9	27.8 to 42.7
Mother's age (years)																		
12–19	2385	52.3	49.5 to 55.1	88	31.8	22.5 to 42.9	1656	49.5	44.0 to 54.9	813	17.8	14.7 to 21.3	1212	26.5	23.4 to 29.9	2593	59.8	56.5 to 63.0
20–34	10065	60	57.9 to 62.0	301	42.8	35.9 to 50.0	4417	48.6	44.1 to 53.3	3315	19.7	16.8 to 23.1	4434	26.4	23.9 to 29.1	8739	54	51.1 to 57.0
35 or more	1549	61.9	58.6 to 65.1	73	50.7	40.4 to 60.8	448	43.6	37.9 to 49.5	624	24.9	20.9 to 29.3	645	25.7	22.6 to 29.1	1042	43.4	39.5 to 47.4
Mother's years of schooling																		
≤7	3285	52.1	49.3 to 54.9	135	37.9	28.2 to 48.6	1939	43.2	37.9 to 48.6	868	13.7	11.2 to 16.7	1826	28.9	25.6 to 32.4	3552	60	56.9 to 63.1
8–10	3421	56.3	53.4 to 59.1	91	33.7	25.1 to 43.6	2047	52	47.0 to 57.0	1016	16.7	13.3 to 20.7	1614	26.5	23.4 to 29.9	3464	59.3	56.0 to 62.5
11–14	5751	62.2	59.8 to 64.5	190	45.9	37.6 to 54.5	2355	51.8	46.3 to 57.2	1993	21.5	18.0 to 25.5	2261	24.4	22.1 to 26.9	4525	50.4	46.9 to 53.8
15 or more	1490	70.8	66.7 to 74.6	44	53.1	40.0 to 65.7	167	38.7	31.7 to 46.1	848	40.3	34.2 to 46.8	565	26.8	21.1 to 33.4	774	37.4	33.1 to 41.8
Social class																		
D+E	2898	51.8	48.7 to 54.8	107	34.3	22.5 to 48.4	1572	38.5	32.6 to 44.8	598	10.7	8.5 to 13.3	1520	27.1	23.7 to 30.8	3253	67.7	64.5 to 70.8
C	7184	58.4	55.9 to 60.8	239	42.3	34.7 to 50.3	3816	52.7	48.1 to 57.3	2244	18.2	15.0 to 22.0	3252	26.4	23.6 to 29.4	6479	60	56.8 to 63.1
A+B	3804	66.2	62.9 to 69.4	108	45.6	36.0 to 55.4	1094	54	48.8 to 59.2	1860	32.3	27.8 to 37.2	1452	25.2	21.9 to 28.9	2529	49.1	45.0 to 53.2
Antenatal care																		
Inadequate	1876	45.5	42.4 to 48.7	165	35.1	26.2 to 45.3	1261	42.8	36.9 to 49.1	538	13	10.7 to 15.8	1119	27.1	23.5 to 31.0	2257	57.7	53.6 to 61.6
Adequate	11849	61.5	59.4 to 63.6	283	44.9	37.6 to 52.3	5148	50.2	45.7 to 54.8	4141	21.5	18.3 to 25.0	5067	26.3	23.8 to 28.9	9874	53.2	50.2 to 56.1
Type of delivery																		
Vaginal/forceps	6215	54.1	51.7 to 56.5	158	30.4	23.6 to 38.2	6142	53.4	48.4 to 58.4	2382	20.7	16.8 to 25.3	4564	39.7	36.1 to 43.4	7478	67.6	64.6 to 70.5
Caesarean	7788	63	60.7 to 65.1	303	50	41.4 to 58.5	382	19.5	16.0 to 23.5	2374	19.2	16.3 to 22.4	1729	13.9	12.0 to 16.2	4896	41.3	38.0 to 44.6

Continued

Table 1 Continued

Variables	Reference to health facility (n=23.851)			Antenatal corticosteroids used appropriately (n=1.126)			Partograph used (n=13.458)			Continuous social support (n=23.879)			Early skin-to-skin contact (n=23.894)			Breast feeding in first hour of birth (n=22.919)		
	N	%	95% CI	N	%	95% CI	n	%	95% CI	n	%	95% CI	N	%	95% CI	n	%	95% CI
Material resources >80%																		
No	920	56.2	48.7 to 63.4	8	17.3	10.1 to 28.0	173	17.3	7.4 to 35.2	88	5.4	3.5 to 8.1	331	20.2	11.8 to 32.5	890	56.8	43.1 to 69.5
Yes	13 083	58.9	56.8 to 61.0	453	42	35.1 to 49.3	6351	51	46.2 to 55.8	4668	21	17.9 to 24.4	5962	26.8	24.2 to 29.5	11 484	53.8	50.8 to 56.7
Paediatrician on call 24/7																		
No	3737	58.9	55.0 to 62.8	64	27.9	20.1 to 37.4	1252	35.3	26.9 to 44.7	895	14.1	10.6 to 18.5	1733	27.3	23.1 to 31.9	3603	58.8	53.3 to 64.1
Yes	10 266	58.6	56.2 to 61.1	398	44.3	36.2 to 52.7	5272	53.2	47.6 to 58.7	3861	22	18.4 to 26.1	4560	26	23.0 to 29.2	8771	52.2	48.7 to 55.8
Neonatal intensive care unit																		
No	5015	56.7	52.8 to 60.5	29	14.8	10.2 to 20.8	1284	33.3	26.5 to 40.9	1135	12.9	9.4 to 17.1	2038	23	19.4 to 27.0	4997	58.9	53.9 to 63.7
Yes	8987	59.9	57.5 to 62.2	433	46.4	38.7 to 54.4	4699	58.9	52.7 to 64.9	3621	24.1	20.1 to 28.7	4255	28.3	25.0 to 31.9	7377	51.1	47.4 to 54.8
Kangaroo mother care																		
No	9739	58.3	55.8 to 60.8	203	33.8	28.1 to 40.0	3785	41.9	36.5 to 47.6	3051	18.3	15.6 to 21.3	3991	23.9	21.2 to 26.8	8447	52.8	49.3 to 56.3
Yes	4263	59.5	55.8 to 63.2	259	49.1	36.9 to 61.5	2739	61.8	52.5 to 70.3	1705	23.8	17.5 to 31.5	2302	32.1	27.3 to 37.2	3927	56.8	51.1 to 62.3

the country, with a distribution similar to antenatal corticosteroid use. Continuous social support during the hospital stay was provided to 19.9% (95% CI 17.0% to 23.1%) of the entire sample; it was higher in cases where the mother had 15 or more years of schooling, in facilities with a NICU, with material resources >80%, and with paediatrician available 24 hours a day. Early skin-to-skin contact occurred in 26.3% (95% CI 23.9.0% to 29.0%) of cases and only in 13.9% (95% CI 12.0% to 16.2%) of women undergoing caesarean section. The rate of breast feeding in the first hour after birth was 59.1% (95% CI 56.3 to 61.9); this was lower in privately funded facilities, for older women, for women with higher schooling and income and for women delivering by caesarean section.

The simple regression analysis (tables 2 and 3) identified health facilities with inadequate material resources (OR 3.46; 95% CI 1.76 to 6.82) and an absence of NICU beds (OR 5.0; 95% CI 2.97 to 8.43) as risk factors to the non-use of antenatal corticosteroids. Pregnant women in lower social classes were more likely to not receive continuous social support (social classes D+E: OR 4.0; 95% CI 2.96 to 5.41).

The adjusted logistic regression analysis (table 4) showed that privately funded women were more likely to not use a partograph (OR_{adj} 3.36; 95% CI 1.75 to 6.49) and to not breast feed in the first hour after birth (OR_{adj} 1.87; 95% CI 1.28 to 2.74). The use of a partograph varies according to the region of residence; it is lower in the North (OR_{adj} 6.94; 95% CI 2.89 to 16.82), Northeast (OR_{adj} 3.58; 95% CI 2.15 to 5.95) and Mid-West (OR_{adj} 2.82; 95% CI 1.52 to 5.22).

Lower social class was related to lower continuous social support (social class C: OR_{adj} 1.40; 95% CI 1.19 to 1.65; social class D and E: OR_{adj} 1.77; 95% CI 1.28 to 2.44).

Caesarean section was associated with an absence of early skin-to-skin contact (OR_{adj} 3.07; 95% CI 3.37 to 4.90) and breast feeding in first hour after birth (OR_{adj} 2.55; 95% CI 2.21 to 2.96), regardless of the maternal characteristics and the hospital structure.

DISCUSSION

In Brazil, neonatal morbidity and mortality remains high despite the availability of universal antenatal care and hospital delivery, highlighting the low quality in delivery and birth assistance. A widespread use of ENC items can effectively contribute to improving this situation.

However, our study has confirmed that the coverage of the ENC items in Brazil is low and that it varies, depending on the characteristics of both the mother and the health facility, where the delivery occurs.

The requirement for pregnant women to be enrolled with a referral health facility during the antenatal period has been regulated in Brazil since 2007.[18] However, the percentage of pregnant women informed of the referral maternity, where they will be admitted to give birth, is still small. Pregnant women in labour may have to visit more than one hospital in order to be admitted for delivery

Table 2 Simple ORs (95% CI) for non-use of essential newborn care items, according to geographical location, type of funding and structural variables (Brazil, 2011–2012)

	No reference to health facility	Antenatal corticosteroids not used	Partograph not used	No continuous social support	No early skin-to-skin contact	No breast feeding in first hour of birth
	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)
Macro-region						
North	1.65 (1.27 to 2.16)	2.85 (1.21 to 6.72)	6.66 (2.95 to 15.02)	2.40 (1.30 to 4.41)	0.98 (0.63 to 1.52)	0.44 (0.32 to 0.59)
Northeast	1.34 (1.11 to 1.61)	1.23 (0.57 to 2.63)	3.90 (2.38 to 6.40)	1.91 (1.17 to 3.11)	0.92 (0.66 to 1.28)	0.90 (0.68 to 1.19)
South	0.91 (0.64 to 1.29)	0.97 (0.56 to 1.68)	1.57 (0.97 to 2.54)	1.11 (0.68 to 1.80)	0.77 (0.53 to 1.11)	0.67 (0.45 to 1.01)
Mid-West	1.09 (0.81 to 1.47)	3.63 (1.75 to 7.52)	2.65 (1.35 to 5.21)	1.63 (0.92 to 2.90)	1.06 (0.63 to 1.76)	0.63 (0.46 to 0.88)
Southeast	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Location						
Not capital	1.09 (0.92 to 1.28)	1.45 (0.84 to 2.49)	1.88 (1.26 to 2.79)	2.12 (1.45 to 3.10)	1.65 (.25 to 2.18)	1.02 (0.82 to 1.28)
Capital	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Type of funding						
Private	0.54 (0.42 to 0.70)	0.38 (0.22 to 0.65)	2.55 (1.39 to 4.68)	0.32 (0.20 to 0.50)	1.13 (0.81 to 1.57)	3.24 (2.28 to 4.60)
Public	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Material resources>80%						
Inadequate	1.12 (0.81 to 1.54)	3.46 (1.76 to 6.82)	4.99 (1.85 to 13.45)	4.69 (2.87 to 7.67)	1.44 (0.75 to 2.79)	0.93 (0.52 to 1.66)
Adequate	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Paediatrician on call 24/7						
No	0.99 (0.81 to 1.21)	2.06 (1.16 to 3.64)	2.09 (1.31 to 3.32)	1.72 (1.16 to 2.56)	0.94 (0.71 to 1.24)	0.81 (0.60 to 1.09)
Yes	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Kangaroo mother care						
No	1.05 (0.86 to 1.28)	1.89 (1.08 to 3.32)	2.24 (1.39 to 3.59)	1.40 (0.92 to 2.12)	1.51 (1.15 to 1.97)	1.35 (0.99 to 1.83)
Yes	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Neonatal intensive care unit beds						
No	1.14 (0.94 to 1.38)	5.00 (2.97 to 8.43)	2.88 (1.88 to 4.41)	2.17 (1.43 to 3.27)	1.32 (1.01 to 1.74)	0.82 (0.62 to 1.08)
Yes	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)

Table 3 Simple ORs (95% CI) of non-use of essential newborn care items, according to the mothers' socioeconomic variables (Brazil, 2011–2012)

	No reference to health facility	Antenatal corticosteroids not used	Partograph not used	No continuous social support	No early skin-to-skin contact	No breast feeding in first hour of birth
	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)	Simple OR (95% CI)
Mother's age (years)						
12–19	1.37 (1.23 to 1.52)	1.60 (1.08 to 2.38)	0.97 (0.86 to 1.09)	1.14 (0.96 to 1.34)	0.99 (0.89 to 1.11)	0.76 (0.68 to 0.86)
20–34	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
35 or more	0.92 (0.82 to 1.04)	0.73 (0.50 to 1.05)	1.23 (1.03 to 1.45)	0.74 (0.65 to 0.85)	1.04 (0.91 to 1.18)	1.45 (1.28 to 1.64)
Mother's years of schooling						
≤7	2.23 (1.81 to 2.75)	1.85 (0.99 to 3.48)	0.83 (0.60 to 1.16)	4.24 (3.05 to 5.89)	0.90 (0.64 to 1.27)	0.34 (0.27 to 0.42)
8–10	1.89 (1.53 to 2.32)	2.22 (1.14 to 4.31)	0.58 (0.41 to 0.81)	3.37 (2.40 to 4.73)	1.01 (0.73 to 1.42)	0.38 (0.30 to 0.47)
11–14	1.48 (1.23 to 1.77)	1.33 (0.71 to 2.48)	0.59 (0.42 to 0.81)	2.46 (1.88 to 3.24)	1.13 (0.84 to 1.54)	0.54 (0.46 to 0.65)
15 or more	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
Social class						
A+B	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)
C	1.40 (1.22 to 1.60)	1.14 (0.73 to 1.78)	1.06 (0.89 to 1.25)	2.15 (1.78 to 2.58)	0.94 (0.78 to 1.13)	0.64 (0.55 to 0.74)
D+E	1.82 (1.48 to 2.24)	1.60 (0.84 to 3.06)	1.88 (1.46 to 2.42)	4.00 (2.96 to 5.41)	0.91 (0.73 to 1.14)	0.46 (0.38 to 0.55)
Antenatal care						
Inadequate	1.91 (1.68 to 2.18)	1.50 (1.00 to 2.26)	1.34 (1.13 to 1.60)	1.83 (1.51 to 2.21)	0.96 (0.82 to 1.13)	0.68 (0.59 to 0.78)
Adequate	1 (–)	1 (–)	1	1 (–)	1 (–)	1 (–)
Type of delivery						
Caesarean	0.69 (0.63 to 0.77)	0.44 (0.29 to 0.65)	4.74 (3.59 to 6.25)	1.10 (0.85 to 1.42)	4.06 (3.38 to 4.88)	3.04 (2.62 to 3.53)
Vaginal	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)	1 (–)

Table 4 Adjusted ORs (95% CI) for non-use of essential newborn care items, according to geographical location, type of funding, structural variables and mothers' socioeconomic variables (Brazil, 2011–2012)

	No reference to health facility Adjusted OR (95% CI)	Antenatal corticosteroids not used Adjusted OR (95% CI)	Partograph not used Adjusted OR (95% CI)	No continuous social support Adjusted OR (95% CI)	No early skin-to-skin contact Adjusted OR (95% CI)	No breast feeding in first hour of birth Adjusted OR (95% CI)
Macro-region						
North	x	x	6.94 (2.89 to 16.82)	2.01 (1.06 to 3.8)	X	0.48 (0.35 to 0.65)
Northeast	x	x	3.58 (2.15 to 5.95)	1.81 (1.08 to 3.03)	X	0.92 (0.69 to 1.23)
South	x	x	1.42 (0.83 to 2.45)	1.11 (0.66 to 1.86)	X	0.64 (0.42 to 0.97)
Mid-West	x	x	2.82 (1.52 to 5.22)	2.25 (1.2 to 4.24)	X	0.56 (0.37 to 0.84)
Southeast	x	x	1 (–)	1 (–)	X	1
Location						
No capital	x	x	1.62 (1.01 to 2.60)	2.24 (1.46 to 3.46)	1.66 (1.23 to 2.22)	X
Capital	x	x	1 (–)	1 (–)	1	X
Type of funding						
Private	0.71 (0.55 to 0.93)	0.55 (0.31 to 0.97)	3.36 (1.75 to 6.49)	0.47 (0.29 to 0.77)	X	1.87 (1.28 to 2.74)
Public	1 (–)	1 (–)	1 (–)	1 (–)	X	1 (–)
Mother's age (years)						
12–19	1.17 (1.06 to 1.29)		0.85 (0.74 to 0.97)	0.75 (0.64 to 0.88)		1.07 (0.95 to 1.20)
20–34	1 (–)	x	1 (–)	1 (–)	X	1 (–)
35 or more	1.00 (0.88 to 1.13)	x	1.30 (1.07 to 1.58)	0.97 (0.84 to 1.11)	x	1.20 (1.05 to 1.36)
Mother's years of schooling						
≤7	1.47 (1.22 to 1.78)	x	x	1.76 (1.36 to 2.27)	x	0.76 (0.62 to 0.95)
8–10	1.32 (1.10 to 1.60)	x	x	1.88 (1.46 to 2.42)	x	0.79 (0.64 to 0.97)
11–14	1.20 (1.01 to 1.42)	x	x	1.65 (1.34 to 2.03)	x	0.90 (0.75 to 1.08)
15 or more	1 (–)	x	x	1 (–)	x	1 (–)
Social class						
A+B	x	x	x	1 (–)	X	X
C	x	x	x	1.40 (1.19 to 1.65)	X	X
D+E	x	x	x	1.77 (1.28 to 2.44)	X	X
Antenatal care						
Inadequate	1.67 (1.47 to 1.89)	x	1.25 (1.04 to 1.49)	1.38 (1.13 to 1.68)	x	0.96 (0.84 to 1.09)
Adequate	1 (–)	x	1 (–)	1 (–)	x	1 (–)

Continued

Table 4 Continued

	No reference to health facility	Antenatal corticosteroids not used	Partograph not used	No continuous social support	No early skin-to-skin contact	No breast feeding in first hour of birth
	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (95% CI)
Type of delivery						
Caesarean	0.84 (0.77 to 0.91)	0.55 (0.36 to 0.84)	4.93 (3.77 to 6.46)	x	3.07 (3.37 to 4.90)	2.55 (2.21 to 2.96)
Vaginal	1 (–)	1 (–)	1 (–)	x	1 (–)	1 (–)
Material resources≥80%						
Inadequate	x	2.16 (1.17 to 4.01)	x	3.70 (2.08 to 6.61)	x	x
Adequate	x	1 (–)	x	1 (–)	x	x
Neonatal intensive care unit beds						
No	x	3.93 (2.34 to 6.66)	2.08 (1.24 to 3.48)	x	x	x
Yes	x	1 (–)	1 (–)	x	x	x

Items filled with x are variables excluded from the model.

and this may contribute to the fact that only 10% of high-risk births occur in public maternities considered adequate for neonatal care in Brazil. This situation was highlighted by a prior study using data from the 'Birth in Brazil' survey.[19] Such situations certainly put the health of women at risk, in addition to increasing the likelihood of neonatal death,[7] and point to a failure in the integration between antenatal services and childbirth care.

Antenatal corticosteroids were used in only 41% of indicated cases and is another marked deficiency in the quality of antenatal care offered in Brazil. Every year, thousands of preterm babies are exposed to neonatal respiratory distress syndrome and to the risk of death from causes considered preventable if women received adequate care during pregnancy.[14 20] Corticosteroid use can avert 20%–40% of neonatal deaths related to complications from preterm birth.[21] The fact that hospitals with private funding were more likely to use antenatal corticosteroids could be explained by mothers having greater access to antenatal care and by a more formal link between antenatal and childbirth care compared with publicly funded hospitals. The rate of corticosteroid antenatal use in our study was lower than those previously reported in other countries, for example, Japan (58%), Peru (75%)[22] and the USA (87%).[23] Intensive efforts are needed to scale up the use of antenatal corticosteroids in facilities across Brazil.

It is estimated that the use of a partograph can reduce early neonatal deaths from asphyxia by 40%.[21] We found the use of partographs is still very far from the recommended level of 90%.[21] Worryingly, women who underwent caesarean delivery were less likely to have been monitored during labour and were consequently more likely to suffer undesirable maternal and/or neonatal outcomes. We found that births in privately funded facilities were a risk factor for not using a partograph, probably due to the fact that prelabour caesarean section is frequent (78.3%) in those facilities.[24]

In Brazil, all women are entitled to a companion during their hospital stay for delivery.[25] However, this item had the lowest coverage (<20%). A previous study,[26] based on the 'Birth in Brazil' project and focussing on the implementation of the requirement of continuous social support during hospital stays for childbirth, found that the main reason for not having a companion present during delivery was due to prohibition by the hospital and that only 1.4% of women did not wish to be accompanied. Our results demonstrate the positive effect of adequate structures at facilities on ECN practices. These facilities have probably more physical capacity and material resources to support a companion.

The coverage of early skin-to-skin contact in Brazil is lower than in Argentina (83%), similar to Nagpur (32%) and Kenya (25.1%), and is higher than Pakistan (2%).[27] In the USA, early skin-to-skin rates were 83% in vaginal deliveries and 69.9% in uncomplicated caesarean births.[28] Our results show that in health facilities in capital cities, newborns by vaginal delivery were more likely to

experience skin-to-skin contact and protection from hypothermia, which reduces the risk of infection, coagulation disorders, neonatal respiratory distress syndrome and cerebroventricular haemorrhage, directly influencing neonatal mortality and morbidity.[29] It is estimated that proper prevention and management of hypothermia could avert 40% of neonatal mortality.[30]

Early breast feeding within the first hour of birth is an important factor associated with lower neonatal mortality,[31] averting around 10% of neonatal deaths.[30] This study found the coverage to be around 59% in Brazil, which is slightly higher than the mean of 50% found by Requejo et al[3] for the 75 countries responsible for 95% of all neonatal deaths. The coverage in Brazil is classified as good according to WHO,[32] lower than the coverage in Zambia (92%)[27] and higher than in India (36.4%), Bangladesh (24%) or Pakistan (8.5%).[33]

A study in India,[34] examining over 12 000 births after training in the ENC programme, reported that the coverage of breast feeding in the first hour after birth increased from 73.1% to 88.4% and early skin-to-skin contact increased from 50.2% to 81.7%, while neonatal mortality decreased.

Our results demonstrate the negative effect of caesarean sections on early breast feeding. Data from a meta-analysis,[35] covering more than half a million women in 31 countries, suggested an inverse association between caesarean delivery and early breast feeding, corroborating the association found in this study. This fact may be related to anaesthesia and postpartum surgical procedures.[36] As the frequency of caesarean delivery in Brazil has reached high levels of around 56%,[6] the situation calls for interventions to evaluate more judiciously the options available for this kind of delivery. In Brazil, it was verified that caesarean section was associated with the birth of preterm and early term babies and these babies are more likely to be admitted to NICU, hindering early lactation.[37 38] To reduce neonatal mortality in Brazil, all mothers, regardless of mode of delivery, should be encouraged to breastfeed early. Caesarean delivery can delay the onset of lactation, disrupt mother-infant interaction or inhibit infant suckling.[35] Lassi et al describe a 44% reduction in neonatal mortality when breast feeding began in the first 24 hours after birth.[39] In another study of >10 000 newborns in Brazil,[36] the delivery location was described as a pivotal factor for breast feeding, which was not found in this study.

LIMITATIONS

The 'Birth in Brazil' study was conducted in hospitals with >500 deliveries per year and 80% of childbirths in the country are in these hospitals. Smaller hospitals are likely to have worse structures, which would result in an underestimation of the inadequacies of healthcare. The study data were based on information provided by women early after delivery, by managers and from medical records, rather than from observation of the performance of

the essential care items. This study was not originally designed to examine the ENC and thus did not include all the items of the programme. Nonetheless, the items investigated here are described worldwide as evidence-based cost-effective interventions in reducing neonatal mortality and morbidity.[21 39]

CONCLUSION AND RECOMMENDATIONS

We found a positive effect of adequate structure at health facilities on the use of antenatal corticosteroids and partographs during labour. We found a negative effect of caesarean section on early skin-to-skin contact and early breast feeding.

In Brazil, the South and Southeast regions have the lowest rate of neonatal mortality[7] and these regions have more reference hospitals for the care of high-risk pregnancies and neonates.[13] The North and Northeast regions have the highest rate of neonatal mortality,[7] have fewer reference hospitals,[13] have less access to antenatal care services and, in these regions, the majority of hospitals are located in state capitals.[40] The regional differences, as observed in other countries,[41] reveal inequalities in the distribution of health funding and exemplify the phenomenon described as the Inverse Care Law,[42] where individuals with fewer financial resources and with greater need receive worse and lower quality healthcare.

The essential interventions investigated here are simple and inexpensive and should be integrated into existing health policies. The low and uneven coverage of such simple health technologies indicates the necessity for more widespread interventions to improve perinatal outcomes. Related coverage data should also be collected frequently in routine national surveys to guide the allocation of funding in priority areas, such as health facilities without NICU and with inadequate material resources.

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