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TITLE PAGE

ESSENTIAL NEWBORN CARE IN BRAZIL: COVERAGE AND RELATION WITH HOSPITAL STRUCTURE AND MATERNAL CARACTERISTICS

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ABSTRACT

OBJECTIVES: To assess the availability of the Essential Newborn Care (ENC) program items, and how the non-use of such technologies associates with mothers´ characteristics and hospital structure.

SETTING: This is a complementary analysis of the "Birth in Brazil" study, a national hospital-based survey on postnatal women/newborn babies and of 266 public and private founding health facilities (secondary and tertiary level of care) of all macro regions in the country.

PARTICIPANTS: Data on 266 hospitals and 23.894 postnatal women and their newborn babies were analysed and that were representative of their macro-regions.

PRIMARY AND SECONDARY OUTCOME MEASURES: The assessment was performed using six ENC items, interviewing mothers in the first 24 hours after delivery, and health facility managers. The structure was evaluated by the availability of medicines and equipment for perinatal care, paediatrician on call 24/7, neonatal intensive care unit (NICU), and kangaroo mother care. Each ENC item was assessed according to the health facility structure and the mothers' socio-demographic characteristics.

RESULTS: The coverage in terms of the ENC items in Brazil varies depending on the characteristics of both the mother and the hospital. The factors associated with failures in pregnant woman reference were: pregnant adolescents (ORa 1.17; 95%CI 1.06-1.29), ≤ 7 years of schooling (ORa 1.47; 95%CI 1.22-1.78), inadequate antenatal care (ORa 1.67; 95%CI 1.47-1.89). The non-use of corticosteroids was more frequently associated to absence of NICU (ORa 3.93; 95%CI 2.34-6,66), inadequate equipment and medicines (ORa 2.16 95%CI 1.17-4.01). There was less partograph use (ORa 4,93; 95%CI 3.77-6.46), early skin-to-skin contact (ORa

3.07; 95%CI 3.37-4.90) and breast feeding in the first hour of birth (ORa 2.55; 95%CI 2.21-2.96) after caesarean deliveries.

CONCLUSIONS: The coverage of ENC technologies is low throughout Brazil with regional differences. The association found between hospital structure and perinatal care processes points to a need to prioritize interventions in less well-structured facilities.

Keywords: Essential Newborn Care, Brazil, structure, private health care, public health care.

ARTICLE SUMMARY

STRENGTHS AND LIMITATIONS OF THIS STUDY

Neonatal care is an international relevance issue. Many avoidable deaths related with prematurity still occur in high, but mostly in low and middle-income countries like Brazil.

This article presents significant information about neonatal care in Brazil, with representative data of public and private founding health services of all macro regions in the country.

The “Birth in Brazil” study was conducted in hospitals type where 80% of childbirths in the country are born. Smaller hospitals may be less structured, which would result in an underestimation of the inadequacy of health care.

The study data were based on information provided by women early after delivery and by managers, rather than on observation of performance of the essential care items.

INTRODUCTION

In Brazil, antenatal care coverage is high and the hospital delivery rate is almost 100%. [1] Nonetheless, neonatal mortality remains high and nearly one quarter of deaths occur in the first 24 hours of life. [2] The main reasons are avoidable causes like complications from preterm births, sepsis, and intrapartum-related asphyxia.[3] This situation reflects economics, socials and biologicals disparities, but may be also linked to the quality of antenatal care, labour, and birth assistance. Almost two decades ago, with a view to reducing neonatal mortality and morbidity, the World Health Organization (WHO) recommended specific care practices outlined in the Essential Newborn Care (ENC) program. These are strategic actions extended from preconception care through postnatal period. [4] Infant mortality tends to be lower in countries where the coverage of these essential interventions is high. [5]

However, no 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 birthweight newborns. [5] Thus, identifying shortcomings in perinatal care in Brazil is an essential stage in conducting interventions in underprivileged groups.

This is a problem that may reach most countries of similar socioeconomic development situation and is visible in different places and with different intensities.[6]

This study aims to evaluate the availability of certain core technologies in caring for mothers and newborns, as defined in the Essential Newborn Care program, as well as the association between the non-use of these technologies and variables relating to hospital structure and characteristics of the mothers.

METHODS

This study performed a complementary analysis of the "Birth in Brazil" study, [7] a national hospital-based survey conducted between February 2011 and October 2012, including data on mothers' pregnancy and delivery, their newborn babies, and the structure of health facilities. 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). The second included days (minimum of seven days of data collection at each hospital) and the third included postnatal women and their newborn babies. The sampling weights for the hospitals were based on the inverse of their probabilities of inclusion in the sample. To ensure that the total estimates were equivalent to the number of hospitals in the sample, a calibration process was used on each stratum of the selection. The results shown are the estimates for the universe of hospitals studied (1402) based on the sample of hospitals visited. In each of these, 90 postnatal women were interviewed. More information on the sample design is available in a prior publication.[8]

Data were collected by interviewing postnatal women in the first 24 hours after delivery and health facility managers, and by consulting the hospital records of the women and babies. In addition, antenatal record cards were photographed for subsequent data extraction. Detailed information on the data collection instruments is reported in Do Carmo Leal et al.[7] and Bittencourt et al. 2014.[9]

In line with WHO recommendations,[4] six essential neonatal care variables were investigated: adequate referral of the pregnant woman during the antenatal period to a specific health facility for delivery; administration of antenatal corticosteroids when indicated[10] to women at risk of preterm birth between 24 and 34 weeks' gestation (gestational age was calculated using an algorithm that primarily relied upon early ultrasound

estimates);[11] 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 her newborn whilst still in the delivery room; and breast feeding in the first hour of birth.

At the hospitals, the following structure-related variables were investigated: existence of a neonatal intensive care unit (NICU) and use of the KMC, a paediatrician on call round the clock, 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), and availability of medicines for the mothers and newborns (antihypertensives, anxiolytics/hypnotics, corticosteroids, oxytocics, inhibitors of uterine contractility, coagulants/haemostatics, magnesium sulphate, surfactant, eye drops for prophylaxis of gonococcal ophthalmia, and anti-D immunoglobulin for Rh-negative women) as required by Brazilian law.[12] For the set of equipment and medicines, a degree of adequacy was calculated by taking affirmative responses as a percentage of total items investigated. Health facilities were classified as adequate if 80% or more of the items were available and inadequate if less than 80% were available. Equal weights were attributed to all items studied.

The study variables were compared according to 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 to 19, 20 to 34 and 35 or more years old), schooling (7 or less, 8 to 10, 11 to 14 and 15 or more years in school), 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-funding hospitals, but who were not covered by private health insurance plans, were classified as receiving public health care at childbirth. Women whose birth was covered by a private

health insurance plan, and those who gave birth in private hospitals regardless of coverage by a health insurance plan, were classified as receiving private health care at childbirth.

For each ENC-related variable, the percentage use was calculated (95% Confidence Interval-CI) according to variables relating to the health facility structure and the mothers' socio-demographic characteristics. Simple regression models with robust variance were then developed to estimate the strength of the associations between the dependent variable (non-access to each item of essential newborn care – yes/no) and the independent variables listed above. Crude odds ratios with respective 95% CI were then estimated. In sequence, 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 odds ratios were adjusted and 95% CI were estimated. All results were obtained using IBM® SPSS - Statistical Package for the Social Sciences, for Windows, version 22.

The ethics committee of the Sergio Arouca National School of Public Health, Oswaldo Cruz Foundation (CEP/ENSP), approved this study under the research protocol CAAE:0096.0.031.000–10. All hospital directors and postnatal women gave written informed consent.

RESULTS

Data on 23.894 postnatal women and their newborn babies were analysed at 266 hospitals that provided childbirth care in Brazil and that were representative of their macro-regions and respective strata, about the type of funding and location.

Tables 1 and 2 show coverage of the ENC items investigated according to location, type of funding, health facility structural variables, and mothers' characteristics. Pregnant women were referred to a specific health facility during the antenatal period in 58.7% of cases; this increased to 70.8% in privately funded facilities. Antenatal corticosteroids were used in 41% of cases where this was indicated; this declined to 20% in the North and Mid-West and rose to 63.1% at private facilities. Labour monitoring using a partograph had been done in only 48.5% of the deliveries (65.8% in the Southeast region). Continuous social support during the hospital stay was provided to 19.9% of women; the percentage was higher (40.3%) in cases where the mother had 15 or more years of schooling. Early skin-to-skin contact occurred in 26.3% of births and in 39.7% of vaginal deliveries. 59.1% of all newborns were breastfed in their first hour of birth, increasing to 73.4% in the North region.

In the logistic regression analyses, the factors highly associated with failures in referring pregnant woman to health facilities during the antenatal period were: maternities located in the Northern region, pregnant adolescents, seven or less years of schooling, and inadequate antenatal care. Women hospitalised in private facilities and those who underwent caesarean delivery were more likely to have a prior reference to the health facility (Tables 3 to 5).

In cases where the use of corticosteroids was indicated, the factors most associated with their non-use were health facility in the Mid-West region, inadequate equipment and medicines, and lacking a NICU or paediatrician on call 24/7. The lack of NICU beds and inadequate equipment and medicines maintained the association in the adjusted analysis.

Private funding and caesarean delivery were protective factors even in the adjusted model (Tables 3 to 5).

Table 1 – Number and percentage (confidence interval) of Essential Newborn Care items according to geographical location, 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
Macro-region																		
North	1,132	49.4	[43.7,55.2]	34	24.2	[13.3,40.1]	325	22.4	[11.8,38.3]	277	12.1	[7.5,18.9]	589	25.7	[19.1,33.5]	1,511	73.4	[69.0,77.4]
Northeast	3,770	54.7	[51.4,58.0]	160	42.4	[28.4,57.8]	1,359	33.1	[24.7,42.7]	1,017	14.7	[10.5,20.3]	1,857	26.9	[22.3,32.0]	3,353	57.1	[52.8,61.4]
Southeast	6,271	61.8	[58.7,64.9]	196	47.6	[36.4,59.0]	3,631	65.8	[59.3,71.8]	2,517	24.8	[19.6,30.8]	2,561	25.2	[21.2,29.7]	4,868	54.6	[49.2,59.9]
South	1,906	64.0	[56.3,71.0]	55	47.8	[39.8,55.9]	880	55.1	[44.9,64.8]	684	22.9	[16.8,30.5]	910	30.5	[24.7,36.9]	1,719	64.1	[56.0,71.4]
Mid-West	925	59.7	[53.0,66.1]	13	20.0	[12.0,31.4]	329	42.0	[28.4,57.0]	261	16.8	[11.1,24.7]	376	24.2	[16.8,33.5]	923	65.6	[59.9,70.8]
Brazil	14,004	58.7	[56.7,60.7]	458	41.0	[34.2,48.0]	6,524	48.5	[43.8,53.1]	4,756	19.9	[17.0,23.1]	6,293	26.3	[23.9,29.0]	12,374	59.1	[56.3,61.9]
Location																		
Non-capital	8,661	57.9	[55.3,60.6]	190	36.5	[30.1,43.3]	3,514	42.5	[37.5,47.6]	2,290	15.3	[12.5,18.6]	3,388	22.6	[20.1,25.4]	7,795	58.9	[55.1,62.6]
Capital	5,342	60.0	[57.0,62.9]	268	45.6	[34.3,57.3]	3,010	58.1	[49.6,66.1]	2,466	27.7	[22.0,34.1]	2,905	32.6	[27.6,37.9]	4,579	59.5	[55.4,63.4]
Funding																		
Public	11,501	56.6	[54.5,58.7]	385	38.8	[31.3,46.8]	6,375	49.3	[44.5,54.2]	3,391	16.7	[13.7,20.2]	5,431	26.7	[23.9,29.6]	11,268	63.4	[60.4,66.4]
Private	2,502	70.8	[65.5,75.5]	73	63.1	[52.4,72.7]	149	27.6	[17.7,40.4]	1,365	38.7	[30.0,48.0]	862	24.3	[19.3,30.2]	1,106	34.9	[27.8,42.7]
Material resources > 80%																		
No	920	56.2	[48.7,63.4]	8	17.3	[10.1,28.0]	173	17.3	[7.4,35.2]	88	5.4	[3.5,8.1]	331	20.2	[11.8,32.5]	890	56.8	[43.1,69.5]

Yes	13,083	58.9	[56.8,61]	453	42	[35.1,49.3]	6,351	51	[46.2,55.8]	4,668	21	[17.9,24.4]	5,962	26.8	[24.2,29.5]	11,484	53.8	[50.8,56.7]
Paediatrician on call 24/7																		
No	3,737	58.9	[55,62.8]	64	27.9	[20.1,37.4]	1,252	35.3	[26.9,44.7]	895	14.1	[10.6,18.5]	1,733	27.3	[23.1,31.9]	3,603	58.8	[53.3,64.1]
Yes	10,266	58.6	[56.2,61.1]	398	44.3	[36.2,52.7]	5,272	53.2	[47.6,58.7]	3,861	22	[18.4,26.1]	4,560	26	[23,29.2]	8,771	52.2	[48.7,55.8]
Neonatal ICU																		
No	5,015	56.7	[52.8,60.5]	29	14.8	[10.2,20.8]	1,284	33.3	[26.5,40.9]	1,135	12.9	[9.4,17.1]	2,038	23.0	[19.4,27.0]	4,997	58.9	[53.9,63.7]
Yes	8,987	59.9	[57.5,62.2]	433	46.4	[38.7,54.4]	4,699	58.9	[52.7,64.9]	3,621	24.1	[20.1,28.7]	4, 255	28.3	[25.0,31.9]	7,377	51.1	[47.4,54.8]
Kangaroo mother care																		
No	9,739	58.3	[55.8,60.8]	203	33.8	[28.1,40]	3,785	41.9	[36.5,47.6]	3,051	18.3	[15.6,21.3]	3,991	23.9	[21.2,26.8]	8,447	52.8	[49.3,56.3]
Yes	4,263	59.5	[55.8,63.2]	259	49.1	[36.9,61.5]	2,739	61.8	[52.5,70.3]	1,705	23.8	[17.5,31.5]	2,302	32.1	[27.3-37.2]	3,927	56.8	[51.1,62.3]

Table 2 – Number and percentage (confidence interval) of Essential Newborn Care items, according to the mothers' socio-economic 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 during 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
Mother's age (years)																		
12 to 19	2,385	52.3	[49.5,55.1]	88	31.8	[22.5,42.9]	1,656	49.5	[44,54.9]	813	17.8	[14.7,21.3]	1,212	26.5	[23.4,29.9]	2,593	59.8	[56.5,63]
20 to 34	10,065	60	[57.9,62]	301	42.8	[35.9,50]	4,417	48.6	[44.1,53.3]	3,315	19.7	[16.8,23.1]	4,434	26.4	[23.9,29.1]	8,739	54	[51.1,57]
35 or more	1,549	61.9	[58.6,65.1]	73	50.7	[40.4,60.8]	448	43.6	[37.9,49.5]	624	24.9	[20.9,29.3]	645	25.7	[22.6,29.1]	1,042	43.4	[39.5,47.4]
Mother's years' schooling																		
≤ 7	3,285	52.1	[49.3,54.9]	135	37.9	[28.2,48.6]	1,939	43.2	[37.9,48.6]	868	13.7	[11.2,16.7]	1,826	28.9	[25.6,32.4]	3,552	60	[56.9,63.1]
8 to 10	3,421	56.3	[53.4,59.1]	91	33.7	[25.1,43.6]	2,047	52	[47,57]	1,016	16.7	[13.3,20.7]	1,614	26.5	[23.4,29.9]	3,464	59.3	[56,62.5]
11 to 14	5,751	62.2	[59.8,64.5]	190	45.9	[37.6,54.5]	2,355	51.8	[46.3,57.2]	1,993	21.5	[18,25.5]	2,261	24.4	[22.1,26.9]	4,525	50.4	[46.9,53.8]
15 or more	1,490	70.8	[66.7,74.6]	44	53.1	[40,65.7]	167	38.7	[31.7,46.1]	848	40.3	[34.2,46.8]	565	26.8	[21.1,33.4]	774	37.4	[33.1,41.8]
Antenatal care																		
Adequate	1,876	45.5	[42.4,48.7]	165	35.1	[26.2,45.3]	1,261	42.8	[36.9,49.1]	538	13	[10.7,15.8]	1,119	27.1	[23.5,31]	2,257	57.7	[53.6,61.6]
Inadequate	11,849	61.5	[59.4,63.6]	283	44.9	[37.6,52.3]	5,148	50.2	[45.7,54.8]	4,141	21.5	[18.3,25]	5,067	26.3	[23.8,28.9]	9,874	53.2	[50.2,56.1]
Type of delivery																		
Vaginal/forceps	6,215	54.1	[51.7,56.5]	158	30.4	[23.6,38.2]	6,142	53.4	[48.4,58.4]	2,382	20.7	[16.8,25.3]	4,564	39.7	[36.1,43.4]	7,478	67.6	[64.6,70.5]
Caesarean	7,788	63	[60.7,65.1]	303	50	[41.4,58.5]	382	19.5	[16,23.5]	2,374	19.2	[16.3,22.4]	1,729	13.9	[12,16.2]	4,896	41.3	[38,44.6]

Table 3 – Simple odds ratios (confidence interval) 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 [1.27,2.16]	2.85 [1.21,6.72]	6.66 [2.95,15.02]	2.40 [1.30,4.41]	0.98 [0.63,1.52]	0.44 [0.32,0.59]
Northeast	1.34 [1.11,1.61]	1.23 [0.57,2.63]	3.90 [2.38,6.40]	1.91 [1.17,3.11]	0.92 [0.66,1.28]	0.90 [0.68,1.19]
South	0.91 [0.64,1.29]	0.97 [0.56,1.68]	1.57 [0.97,2.54]	1.11 [0.68,1.80]	0.77 [0.53,1.11]	0.67 [0.45,1.01]
Mid-West	1.09 [0.81,1.47]	3.63 [1.75,7.52]	2.65 [1.35,5.21]	1.63 [0.92,2.90]	1.06 [0.63,1.76]	0.63 [0.46,0.88]
Southeast	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Location						
Not capital	1.09 [0.92,1.28]	1.45 [0.84,2.49]	1.88 [1.26,2.79]	2.12 [1.45,3.10]	1.65 ([.25,2.18]	1.02 [0.82,1.28]
Capital	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Type of funding						
Private	0.54 [0.42,0.70]	0.38 [0.22,0.65]	2.55 [1.39,4.68]	0.32 [0.20,0.50]	1.13 [0.81,1.57]	3.24 [2.28,4.60]
Public	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Material resources > 80%						

Adequate	1.12 [0.81,1.54]	3.46 [1.76,6.82]	4.99 [1.85,13.45]	4.69 [2.87,7.67]	1.44 [0.75,2.79]	0.93 [0.52,1.66]
Inadequate	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Paediatrician on call 24/7						
No	0.99 [0.81,1.21]	2.06 [1.16,3.64]	2.09 [1.31,3.32]	1.72 [1.16,2.56]	0.94 [0.71,1.24]	0.81 [0.60,1.09]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Kangaroo mother care						
No	1.05 [0.86,1.28]	1.89 [1.08,3.32]	2.24 [1.39,3.59]	1.40 [0.92,2.12]	1.51 [1.15,1.97]	1.35 [0.99,1.83]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Neonatal ICU beds						
No	1.14 [0.94,1.38]	5.00 [2.97,8.43]	2.88 [1.88,4.41]	2.17 [1.43,3.27]	1.32 [1.01,1.74]	0.82 [0.62,1.08]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 4 – Simple odds ratios (confidence interval) of non-use of Essential Newborn Care items, according to the mothers' socio-economic 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 to 19	1.37 [1.23,1.52]	1.60 [1.08,2.38]	0.97 [0.86,1.09]	1.14 [0.96,1.34]	0.99 {0.89,1.11]	0.76 [0.68,0.86]
20 to 34	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
35 or more	0.92 [0.82,1.04]	0.73 [0.50,1.05]	1.23 [1.03,1.45]	0.74 [0.65,0.85]	1.04 [0.91,1.18]	1.45 [1.28,1.64]
Mother's years' schooling						
≤ 7	2.23 [1.81,2.75]	1.85 [0.99-3.48]	0.83 [0.60,1.16]	4.24 [3.05,5.89]	0.90 [0.64,1.27]	0.34 [0.27,0.42]
8 to 10	1.89 [1.53,2.32]	2.22 [1.14,4.31]	0.58 [0.41,0.81]	3.37 [2.40,4.73]	1.01 [0.73,1.42]	0.38 [0.30,0.47]
11 to 14	1.48 [1.23,1.77]	1.33 [0.71,2.48]	0.59 [0.42,0.81]	2.46 [1.88,3.24]	1.13 [0.84,1.54]	0.54 [0.46,0.65]
15 or more	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Antenatal care						
Adequate	1.91 [1.68,2.18]	1.50 [1.00,2.26]	1.34 [1.13,1.60]	1.83 [1.51,2.21]	0.96 [0.82,1.13]	0.68 [0.5,0.78]
Inadequate	1 (-)	1 (-)	1	1 (-)	1 (-)	1 (-)
Type of delivery						

Caesarean	0.69 [0.63,0.77]	0.44 [0.29,0.65]	4.74 [3.59,6.25]	1.10 [0.85,1.42]	4.06 [3.38,4.88]	3.04 [2.62,3.53]
Vaginal	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 5 – Adjusted odds ratios (confidence interval) for non-use of Essential Newborn Care items, according to geographical location, type of funding, structural variables and mothers' socio-economic 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
	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)
Macro-region						
North	X	X	6.94 [2.89,16.82]	2.14 [1.14,4.02]	X	0.48 [0.35,0.65]
Northeast	X	X	3.58 [2.15,5.95]	1.97 [1.17,3.31]	X	0.92 [0.69,1.23]
South	X	X	1.42 [0.83,2.45]	1.06 [0.64,1.76]	X	0.64 [0.42,0.97]
Mid-West	X	X	2.82 [1.52,5.22]	2.27 [1.21,4.29]	X	0.56 [0.37,0.84]
Southeast	X	X	1	1	X	1
Location						
No capital	X	X	1.62 [1.01,2.60]	2.25 [1.47,3.46]	1.66 [1.23,2.22]	X
Capital	X	X	1	1	1	X
Type of funding						
Private	0.71 [0.55,0.93]	0.55 [0.31,0.97]	3.36 [1.75,6.49]	0.42 [0.26,0.67]	X	1.87 [1.28,2.74]
Public	1	1	1	1	X	1
Material resources ≥ 80%						
Adequate	X	2.16 [1.17,4.01]	X	3.77 [2.13,6.68]	X	X
Inadequate	X	1	X	1	X	X

Neonatal ICU beds						
No	X	3.93 [2.34,6.66]	2.08 [1.24,3.48]	x	X	X
Yes	X	1	1	x	X	X
Mother's age (years)						
12 to 19	1.17 [1.06,1.29]		0.85 [0.74,0.97]	0.76 [0.65,0.90]		1.07 [0.95,1.20]
20 to 34	1	X	1	1	X	1
35 or more	1.00 [0.88,1.13]	X	1.30 [1.07,1.58]	0.94 [0.81,1.08]	x	1.20 [1.05,1.36]
Mother's years' schooling						
≤ 7	1.47 [1.22,1.78]	X	X	2.34 [1.81,3.02]	x	0.76 [0.62,0.95]
8 to 10	1.32 [1.10,1.60]	X	X	2.33 [1.81,3.00]	x	0.79 [0.64,0.97]
11 to 14	1.20 [1.01,1.42}	X	X	1.89 [1.54,2.32]	x	0.90 [0.75,1.08]
15 or more	1	X	X	1	x	1
Antenatal care						
Adequate	1.67 [1.47,1.89]	X	1.25 [1.04,1.49]	1.42 [1.16,1.73]	x	0.96 [0.84,1.09]
Inadequate	1	X	1	1	x	1
Type of delivery						
Caesarean	0.84 [0.77,0.91]	0.55 [0.36,0.84]	4.93 [3.77,6.46]	X	3.07 [3.37,4.90]	2.55 [2.21,2.96]
Vaginal	1	1	1	X	1	1

Items filled with x are variables excluded from the model.

Factors associated with the non-use of a partograph in the adjusted analysis were private funding, a caesarean delivery, and an absence of NICU beds (Tables 3 to 5).

The factors most involved in the absence of continuous social support were: health facilities outside of a state capital, having less than 7 years of schooling, and inadequate antenatal care, while private funding was a protective factor (Tables 3 to 5).

The absence of early skin-to-skin contact was most associated with a caesarean delivery and health facilities without KMC or NICU beds; the association with a caesarean delivery persisted, even after an adjusted analysis (Tables 3 to 5).

Breast feeding in the first hour of birth was less frequent in private maternities, maternal age ≥ 35 years, and a caesarean delivery; these factors continued to be associated in the adjusted analysis. Mothers having less schooling breastfed more, even in the adjusted analysis (Tables 3 to 5).

DISCUSSION

In Brazil, neonatal morbidity and mortality remains high despite universal antenatal care availability and hospital delivery, highlighting a possible low quality in delivery and birth assistances. The widespread availability of ENC items can contribute effectively to change this scenario.

This is not the case, because our study has pointed out that coverage of the ENC items in Brazil is low and 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.[13] However, the percentage of pregnant women informed of the referral maternity, where they will be admitted to give birth is still small, indicating insufficient integration between antenatal services and childbirth care facilities. This may lead pregnant women in labour to peregrinate in search of a bed for admission and 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.[14] Such situations certainly place women's health at risk, in addition to increasing the likelihood of neonatal death.[2]

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 reducible if women receive adequate care during pregnancy.[15],[10]. Corticosteroid use can avert 20 to 40% of neonatal deaths related to complications from preterm birth.[16] The fact that hospitals with private funding were more likely to use antenatal corticosteroids could be explained by mothers having access to better quality

antenatal care and by a more formal link between antenatal and childbirth care than in publicly funded hospitals.

It is estimated that the use of a partograph can reduce early neonatal deaths from asphyxia by 40%. [16] In Brazil, the use of partographs is more frequent (48,5%) than in Uganda (29%),[17] but the use of partographs is still very far from the recommended 90%.[16] It's worrying that those women who underwent caesarean delivery were less likely to have their labour monitored and, consequently, they were more likely to suffer undesirable maternal and/or neonatal outcomes.

In Brazil, all women are entitled to a companion during their hospital stay for delivery.[18] This was the item with the lowest coverage (< 20%). A previous study, based on the "Birth in Brazil" project,[19] focussing on the implementation of the requirement of a continuous social support during a hospital stay for childbirth, found that the main reason for not having companion during delivery was prohibition by the hospital and that only 1.4% of women did not wish to be accompanied. This study showed an association between inadequate hospital structure and less accomplishment of ENC recommendations.

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%).[20] Newborns by vaginal delivery in health facilities in capital cities 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. [21] It is estimated that proper prevention and management of hypothermia could avert 40% of neonatal mortality.[22]

Early breast feeding within the first hour of birth is a factor associated with lower neonatal mortality,[23] averting around 10% of neonatal deaths.[22] 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.[5] for the 75 countries responsible for 95% of neonatal deaths. Brazil's coverage, classified as good according to the WHO,[24] is lower than the one found in Zambia (92%)[20] and is higher than India (36.4%), Bangladesh (24%), or Pakistan (8.5%).[25]

A study in India,[26] which examined more than 12,000 births, reported that, after training in the ENC program, coverage of breast feeding in the first hour of birth increased from 73.1% to 88.4% and early skin-to-skin contact increased from 50.2% to 81.7%, whilst neonatal mortality decreased.

Data from a meta-analysis,[27] 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 post-partum surgical procedures.[28] As the frequency of caesarean delivery in Brazil has reached high levels of around 56%,[29] the situation calls for interventions to evaluate more judiciously the options available for this kind of delivery. 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. [27] Lassi et al. describe a 44% reduction in neonatal mortality when breast feeding began in the first 24 hours of birth.[30] In another study of more than 10,000 newborns in Brazil,[28] the delivery location was described as a pivotal factor for breast feeding, which was not found in this study.

Limitations of the study: The "Birth in Brazil" study was conducted in hospitals with more than 500 deliveries per year, and 80% of childbirths in the country are in these hospitals. Smaller hospitals should have worst structures, which would result in an underestimation of the inadequacy of health care. The study data were based on information provided by women early after delivery and by managers, rather than on observation of 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 program. Nonetheless, the items investigated are described worldwide as evidence-based interventions that are cost-effective in reducing neonatal mortality and morbidity.[16],[30]

The relationships identified in this study, between inadequate structures at health facilities and lesser coverage of items, such as the use of antenatal corticosteroids and partographs during labour, points to a need for interventions mostly in facilities with less adequate structure.

The finding that caesarean delivery is a risk factor for not having early skin-to-skin contact and breast feeding in the first hour of birth – which are linked to the reduction of neonatal morbidity and mortality – highlights the importance of the prevention of hypothermia, and of facilitating breast feeding in caesarean deliveries. Moreover, it also shows the need to implement strategies to reduce the rate of caesarean deliveries in Brazil, which was almost 56% in this study,[29] and is identified as a hindering factor for the mother and child early bonding, a crucial period involving a great many changes.

In Brazil, South and Southeast regions have the lowest rate of neonatal mortality,[2] and have more reference hospitals for the care of high-risk pregnancies and neonates.[9] North and Northeast regions have the highest rate of neonatal mortality,[2] have less reference hospitals,[9] have less access to antenatal care services and to these hospitals, the majority located in state capitals.[31]

The regional differences, as in other countries,[32] reveal inequities in the distribution of health funding and exemplify the phenomenon described as the Inverse Care Law,[33] where individuals with lesser financial means and greater need receive worse and less-qualified health care.

The essential interventions here investigated are simple and inexpensive and should be integrated into existing programs. The low and uneven coverage of such simple health technologies indicates the necessity for widespread intervention to improve perinatal outcomes. Related coverage data should also be collected frequently in routine national surveys.

CONFLICT OF INTERESTS

There are no conflicts of interest.

CONTRIBUTORSHIP STATEMENT

MASM, RQG and SDA participated in the design, analysis, and data interpretation, and in the drafting and final approval of the manuscript; VEP collaborated in the database organization and statistical analysis; MCL participated in the design of the article, oversaw the analysis, and made the final revision of the article. All co-authors contributed to the improvement of the article.

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NO ADDITIONAL DATA AVAILABLE.

KEY MESSAGES

WHAT IS ALREADY KNOW ON THIS SUBJECT?

Neonatal mortality is yet high in low and middle income countries.

Health technologies like Essential Newborn Care can reduce neonatal mortality.

WHAT THIS STUDY ADDS?

In Brazil, Essential Newborn Care items coverage is low. Less adequate structure facilities must be prioritized in interventions to scale up Essential Newborn care practices, included in a policy health.

LIST OF REFERENCES

1 Brasil. Ministério da Saúde. DATASUS. Dep. Informática do SUS. 2015.http://tabnet.datasus.gov.br/cgi/tabcgi.exe?idb2012/f07.def

2 Lansky S, Friche AA de L, Silva AAM da, *et al.* Pesquisa nascer no Brasil : perfil da mortalidade neonatal e avaliação da assistência à gestante e ao recém-nascido. *Cad Saúde Pública* 2014;**30**:192–207. doi:10.1590/0102-311X00133213

3 Black RE, Cousens S, Johnson HL, *et al.* Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet* 2010;**375**:1969–87. doi:10.1016/S0140-6736(10)60549-1

4 Narayanan I, Rose M, Cordero D, *et al.* The Components of Essential Newborn Care. 2004.

5 Requejo JH, Bryce J, Barros AJD, *et al.* Countdown to 2015 and beyond: fulfilling the health agenda for women and children. *Lancet (London, England)* Published Online First: 2015. doi:10.1016/S0140-6736(14)60925-9

6 Danzhen You, Lucia Hug, Simon Ejdemyr, Jan Beise PI, World. Child Mortality 2015. *UNICEF WHO World Bank Gr United Nations* 2015;:74.www.childmortality.org

7 Leal M do C, Moura Da Silva AA, Dias MAB, *et al.* Birth in Brazil: national survey into labour and birth. *Reprod Health* 2012;**9**. doi:10.1186/1742-4755-9-15

8 Vasconcellos MTL, Silva PL do N, Pereira APE, *et al.* Sampling design for the Birth in Brazil : National Survey into Labor and Birth Desenho da amostra Nascer no Brasil : Pesquisa Nacional sobre Parto e Nascimento Diseño de la muestra Nacer en Brasil :

Encuesta Nacional sobre Partos y Nascimientos en Brasil. *Cad Saude Publica* 2014;**30**:S49–58. doi:10.1590/0102-311X00176013

9 Bittencourt SDA, Reis LGC, Ramos MM, *et al.* Structure in Brazilian maternity hospitals: key characteristics for quality of obstetric and neonatal care. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00176913

10 Roberts D, Brown J, Medley N, *et al.* Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. Cochrane Database Syst. Rev. 2017;**2017**. doi:10.1002/14651858.CD004454.pub3

11 Pereira APE, Leal M do C, da Gama SGN, *et al.* Determining gestational age based on information from the Birth in Brazil study. *Cad saúde pública* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00160313

12 Ministério da Saúde. Portaria n° 1071, de 04 de julho de 2005. Institui a Política Nacional de Atenção ao Paciente Crítico. *Diário Of da União* 2005.

13 BRASIL. Lei n° 11.634, de 27 de dezembro de 2007. Dispõe sobre o direito da gestante ao conhecimento e a vinculação à maternidade onde receberá assistência, no âmbito do Sistema Único de Saúde-SUS. 2007.

14 Bittencourt SDA, Gurgel RQ, Menezes MAS, *et al.* Neonatal care in Brazil: hospital structure and adequacy according to newborn obstetric risk. *Paediatr Int Child Health* 2015;**35**:206–12. doi:10.1179/2046905515Y.0000000028

15 Malta DC, França E, Abreu DX De, *et al.* Atualização da lista de causas de mortes evitáveis (5 a 74 anos de idade) por intervenções do Sistema Único de Saúde do Brasil. *Epidemiol e Serviços Saúde* 2010;**20**:409–12. doi:10.5123/S1679-49742011000300016

16 Darmstadt GL, Bhutta ZA, Cousens S, *et al.* Evidence-based, cost-effective interventions: How many newborn babies can we save? *Lancet* 2005;**365**:977–88. doi:10.1016/S0140-

6736(05)71088-6

17 Wilunda C, Oyerinde K, Putoto G, *et al.* Availability, utilisation and quality of maternal and neonatal health care services in Karamoja region, Uganda: a health facility-based survey. *Reprod Health* 2015;**12**. doi:10.1186/s12978-015-0018-7

18 Brasil. Lei n° 11.108, de 07 de abril de 2005. Dispõe sobre o direito da parturiente à presença de acompanhante durante o trabalho de parto, parto e pós-parto imediato, no âmbito do Sistema Único de Saúde-SUS. *Diário Of da União* 2005.

19 Diniz CSG, D'Orsi E, Domingues RMSM, *et al.* Implementação da presença de acompanhantes durante a internação para o parto : dados da pesquisa nacional Nascer no Brasil. *Cad Saude Publica* 2014;**30**:S140–53. doi:10.1590/0102-311X00127013

20 Dhaded SM, Somannavar MS, Vernekar SS, *et al.* Neonatal mortality and coverage of essential newborn interventions 2010 - 2013: a prospective, population-based study from low-middle income countries. *Reprod Health* 2015;**12**:S6. doi:10.1186/1742-4755-12-S2-S6

21 Lyu Y, Shah PS, Ye XY, *et al.* Association Between Admission Temperature and Mortality and Major Morbidity in Preterm Infants Born at Fewer Than 33 Weeks' Gestation. *JAMA Pediatr* 2015;**169**:e150277. doi:10.1001/jamapediatrics.2015.0277

22 Darmstadt GL, Walker N, Lawn JE, *et al.* Saving newborn lives in Asia and Africa: Cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008;**23**:101–17. doi:10.1093/heapol/czn001

23 Khan J, Vesel L, Bahl R, *et al.* Timing of Breastfeeding Initiation and Exclusivity of Breastfeeding During the First Month of Life: Effects on Neonatal Mortality and Morbidity—A Systematic Review and Meta-analysis. *Matern Child Health J* 2015;**19**:468–79.

24 WHO (World Health Organization), UNICEF (United Nations Children's Fund). Global Strategy for Infant and Young Child Feeding. *World Heal Organ* 2003;:1–30. doi:ISBN 92 4 156221 8

25 Adhikari M, Khanal V, Karkee R, *et al.* Factors associated with early initiation of breastfeeding among Nepalese mothers: further analysis of Nepal Demographic and Health Survey, 2011. *Int Breastfeed J* 2014;**9**:21. doi:10.1186/1746-4358-7-1

26 Goudar SS, Dhaded SM, Mcclure EM, *et al.* ENC training reduces perinatal mortality in Karnataka, India. *J Matern Neonatal Med* 2012;**25**:568–74. doi:10.3109/14767058.2011.584088

27 Prior E, Santhakumaran S, Gale C, *et al.* Breastfeeding after cesarean delivery: A systematic review and meta-analysis of world literature. *Am J Clin Nutr* 2012;**95**:1113–35. doi:10.3945/ajcn.111.030254

28 Boccolini CS, Carvalho ML, Oliveira MIC, *et al.* Fatores associados à amamentação na primeira hora de vida. *Rev Saude Publica* 2011;**45**:69–78.www.scielo.br/rsp

29 Domingues RMSM, Dias MAB, Nakamura-Pereira M, *et al.* Processo de decisão pelo tipo de parto no Brasil : da preferência inicial das mulheres à via de parto final. *Cad Saude Publica* 2014;**30**:1–16. doi:S0102-311X2014001300017 [pii]

30 Lassi ZS, Middleton PF, Crowther C, *et al.* Interventions to Improve Neonatal Health and Later Survival: An Overview of Systematic Reviews. *EBioMedicine* Published Online First: 2015. doi:10.1016/j.ebiom.2015.05.023

31 Viellas EF, Domingues RMSM, Dias MAB, *et al.* Prenatal care in Brazil. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-15. doi:S0102-311X2014001300016 [pii]

32 Lassi ZS, Salam RA, Das JK, *et al.* Essential interventions for maternal, newborn and child health: background and methodology. *Reprod Health* 2014;**11**:S1. doi:10.1186/1742-

4755-11-S1-S1

33 Tudor Hart J. THE INVERSE CARE LAW. *Lancet* 1971;**297**:405–12. doi:10.1016/S0140-6736(71)92410-X

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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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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 availability of the WHO´s Essential Newborn Care (ENC) program 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 analyzed.

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 access to each ENC item was assessed according to the health facility structure and the mothers' socio-demographic characteristics.

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

CONCLUSIONS: The coverage of ENC technologies 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.

Keywords: Essential Newborn Care, Brazil, structure, private health care, public health care.

STRENGTHS AND LIMITATIONS OF THIS STUDY

The strength of this study is that we have used a representative nationwide survey, with primary data collected from medical records. This allowed, for the first time, a description of the Essential Newborn Care and variables related to hospital structure and characteristics of the mothers.

As limitation, the "Birth in Brazil" study was conducted in hospitals with more than 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 health care.

The study data was based on information provided by women early after delivery, medical records and by managers, rather than on observation of performance of the essential care items.

The cross-sectional nature of these survey data limits our ability to assess causal relationships.

INTRODUCTION

The reduction of child mortality is a topic of the Sustainable Development Goal 3, i.e., 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 one million neonatal deaths by 2020 [4].

Almost two decades ago, with a view to reducing neonatal mortality and morbidity, the World Health Organization (WHO) recommended specific care practices outlined in the Essential Newborn Care (ENC) program. 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 more than 6 antenatal care visits in 2015) and the hospital delivery rate is almost 100%. Nevertheless, neonatal mortality remains high (9.5 deaths per 1,000 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 birthweight 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 socio-economic development, observable in different places and at different intensities [9].

This study aims to evaluate the availability of certain core technologies for the care of mothers and newborns, as defined in the WHO´s Essential Newborn Care program, 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.

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). 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. This method, originally

proposed by Haldane [11] 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 pre-specified 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 [12].

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 [12].

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 analyzed 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 was 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 was 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 upon 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, whilst still in the delivery room; and breast feeding in the first hour after birth.

At the hospitals, the following structure-related variables were investigated: 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 (antihypertensives, anxiolytics/hypnotics, corticosteroids, oxytocics, inhibitors of uterine contractility, coagulants/haemostatics, magnesium sulphate, 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 less than 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 to 19, 20 to 34 and 35 or more years old), schooling (7 or less, 8 to 10, 11 to 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 health care facilities and who were not covered by private health insurance plans were classified as receiving public health care 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 health care at childbirth. Mixed health care facility is a care in private hospitals that was paid by government unified health care system.

In Brazil, the organisation responsible for the demographic census (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 socio-economic criteria into the following classes: A – more than 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].

For each ENC-related variable, the percentage use was calculated (mean, 95% Confidence Interval-CI) according to variables relating to the health facility structure and the

mothers' socio-demographic characteristics. Simple regression models were used to estimate the associations between the dependent variable (non-access to each item of essential newborn care) and the independent variables listed above. Crude odds ratios 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 odds ratios 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, version 22).

The ethics committee of the Sergio Arouca National School of Public Health, Oswaldo Cruz Foundation (CEP/ENSP), approved this study under the research protocol CAAE:0096.0.031.000–10. 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%-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%-48.0%) of 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 less than 80% and without a NICU. Partograph labour monitoring occurred in 48.5% (95% CI 43.8%-53.1%) of the deliveries around 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%-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 greater than 80%, and with paediatrician available 24 hours a day. Early skin-to-skin contact occurred in 26.3% (95% CI 23.9.0%-29.0%) of cases and only in 13.9% (95% CI 12.0%-16.2%) of women undergoing caesarean section. The rate of breast feeding in the first hour after birth was 59.1% (95% CI 56.3-61.9); 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) found health facilities with inadequate material resources (OR 3.46; IC95% 1.76-6.82) and absence of NICU beds (OR 5.0; IC95% 2.97-8.43) as risk factors to the not use of antenatal corticosteroids. Pregnant women in lower social classes were more likely to not have continuous social support (social classes D+ E: OR 4.0; IC 95% 2.96-5.41).

The adjusted logistic regression analysis (Table 4) showed that privately funded women were more likely to not use a partograph (OR_{adj} 3.36; IC95% 1.75-6.49) and to not breast feed in the first hour after birth (OR_{adj} 1.87; IC 95% 1.28-2.74). The use of a partograph

varies according to the region of residence; it is lower in the North (OR_{adj} 6.94; IC95% 2.89-16.82), Northeast (OR_{adj}: 3.58; IC95% 2.15-5.95) and Mid-West (OR_{adj}: 2.82; IC95% 1.52-5.22).

Lower social class was related to lower continuous social support (social class C: OR_{adj} 1.40; IC95% 1.19-1.65; social class D and E: OR_{adj}: 1.77; IC95% 1.28-2.44).

Caesarean section was associated with an absence of early skin-to-skin contact (OR_{adj} 3.07; IC95% 3.37-4.90) and breast feeding in first hour after birth (OR_{adj} 2.55; IC95% 2.21-2.96), regardless of the maternal characteristics and the hospital structure.

Table 1 – Number and percentage (confidence interval) of Essential Newborn Care items according to geographical location, mothers´socio-economic variables, type of funding and structural variables (Brazil, 2011-2012)

	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)			Breastfeeding in first hour of birth (n=22.919)		
Variables	**N**	**%**	**95%CI**	**N**	**%**	**95%CI**	**n**	**%**	**95%CI**	**n**	**%**	**95%CI**	**N**	**%**	**95%CI**	**n**	**%**	**95%CI**
Total	14,004	58.7	56.7-60.7	458	41.0	34.2-48.0	6,524	48.5	43.8-53.1	4,756	19.9	17.0-23.1	6,293	26.3	23.9-29.0	12,374	59.1	56.3-61.9
Macro-region																		
North	1,132	49.4	43.7-55.2	34	24.2	13.3-40.1	325	22.4	11.8-38.3	277	12.1	7.5-18.9	589	25.7	19.1-33.5	1,511	73.4	69.0-77.4
Northeast	3,770	54.7	51.4-58.0	160	42.4	28.4-57.8	1,359	33.1	24.7-42.7	1,017	14.7	10.5-20.3	1,857	26.9	22.3-32.0	3,353	57.1	52.8-61.4
Southeast	6,271	61.8	58.7-64.9	196	47.6	36.4-59.0	3,631	65.8	59.3-71.8	2,517	24.8	19.6-30.8	2,561	25.2	21.2-29.7	4,868	54.6	49.2-59.9
South	1,906	64.0	56.3-71.0	55	47.8	39.8-55.9	880	55.1	44.9-64.8	684	22.9	16.8-30.5	910	30.5	24.7-36.9	1,719	64.1	56.0-71.4
Mid-West	925	59.7	53.0-66.1	13	20.0	12.0-31.4	329	42.0	28.4-57.0	261	16.8	11.1-24.7	376	24.2	16.8-33.5	923	65.6	59.9-70.8
Location																		
Non-capital	8,661	57.9	55.3-60.6	190	36.5	30.1-43.3	3,514	42.5	37.5-47.6	2,290	15.3	12.5-18.6	3,388	22.6	20.1-25.4	7,795	58.9	55.1-62.6
Capital	5,342	60.0	57.0-62.9	268	45.6	34.3-57.3	3,010	58.1	49.6-66.1	2,466	27.7	22.0-34.1	2,905	32.6	27.6-37.9	4,579	59.5	55.4-63.4
Funding																		
Public	11,501	56.6	54.5-58.7	385	38.8	31.3-46.8	6,375	49.3	44.5-54.2	3,391	16.7	13.7-20.2	5,431	26.7	23.9-29.6	11,268	63.4	60.4-66.4
Private	2,502	70.8	65.5-75.5	73	63.1	52.4-72.7	149	27.6	17.7-40.4	1,365	38.7	30.0-48.0	862	24.3	19.3-30.2	1,106	34.9	27.8-42.7
Mother's age (years)																		
12 to 19	2,385	52.3	49.5-55.1	88	31.8	22.5-42.9	1,656	49.5	44.0-54.9	813	17.8	14.7-21.3	1,212	26.5	23.4-29.9	2,593	59.8	56.5-63.0
20 to 34	10,065	60.0	57.9-62.0	301	42.8	35.9-50.0	4,417	48.6	44.1-53.3	3,315	19.7	16.8-23.1	4,434	26.4	23.9-29.1	8,739	54.0	51.1-57.0
35 or more	1,549	61.9	58.6-65.1	73	50.7	40.4-60.8	448	43.6	37.9-49.5	624	24.9	20.9-29.3	645	25.7	22.6-29.1	1,042	43.4	39.5-47.4
Mother's years' schooling																		
≤ 7	3,285	52.1	49.3-54.9	135	37.9	28.2-48.6	1,939	43.2	37.9-48.6	868	13.7	11.2-16.7	1,826	28.9	25.6-32.4	3,552	60.0	56.9-63.1
8 to 10	3,421	56.3	53.4-59.1	91	33.7	25.1-43.6	2,047	52.0	47.0-57.0	1,016	16.7	13.3-20.7	1,614	26.5	23.4-29.9	3,464	59.3	56.0-62.5
11 to 14	5,751	62.2	59.8-64.5	190	45.9	37.6-54.5	2,355	51.8	46.3-57.2	1,993	21.5	18.0-25.5	2,261	24.4	22.1-26.9	4,525	50.4	46.9-53.8
15 or more	1,490	70.8	66.7-74.6	44	53.1	40.0-65.7	167	38.7	31.7-46.1	848	40.3	34.2-46.8	565	26.8	21.1-33.4	774	37.4	33.1-41.8

Social class																	
D+E	2,898	51.8	48.7-54.8	107	34.3	22.5-48.4	1,572	38.5	32.6-44.8	598	10.7	8.5-13.3	1,520	27.1	23.7-30.8	3,253	67.7	64.5-70.8
C	7,184	58.4	55.9-60.8	239	42.3	34.7-50.3	3,816	52.7	48.1-57.3	2,244	18.2	15.0-22.0	3,252	26.4	23.6-29.4	6,479	60.0	56.8-63.1
A+B	3,804	66.2	62.9-69.4	108	45.6	36.0-55.4	1,094	54.0	48.8-59.2	1,860	32.3	27.8-37.2	1,452	25.2	21.9-28.9	2,529	49.1	45.0-53.2
Antenatal care																		
Inadequate	1,876	45.5	42.4-48.7	165	35.1	26.2-45.3	1,261	42.8	36.9-49.1	538	13.0	10.7-15.8	1,119	27.1	23.5-31.0	2,257	57.7	53.6-61.6
Adequate	11,849	61.5	59.4-63.6	283	44.9	37.6-52.3	5,148	50.2	45.7-54.8	4,141	21.5	18.3-25.0	5,067	26.3	23.8-28.9	9,874	53.2	50.2-56.1
Type of delivery																		
Vaginal/forceps	6,215	54.1	51.7-56.5	158	30.4	23.6-38.2	6,142	53.4	48.4-58.4	2,382	20.7	16.8-25.3	4,564	39.7	36.1-43.4	7,478	67.6	64.6-70.5
Caesarean	7,788	63.0	60.7-65.1	303	50.0	41.4-58.5	382	19.5	16.0-23.5	2,374	19.2	16.3-22.4	1,729	13.9	12.0-16.2	4,896	41.3	38.0-44.6
Material resources > 80%																		
No	920	56.2	48.7-63.4	8	17.3	10.1-28.0	173	17.3	7.4-35.2	88	5.4	3.5-8.1	331	20.2	11.8-32.5	890	56.8	43.1-69.5
Yes	13,083	58.9	56.8-61.0	453	42.0	35.1-49.3	6,351	51.0	46.2-55.8	4,668	21.0	17.9-24.4	5,962	26.8	24.2-29.5	11,484	53.8	50.8-56.7
Paediatrician on call 24/7																		
No	3,737	58.9	55.0-62.8	64	27.9	20.1-37.4	1,252	35.3	26.9-44.7	895	14.1	10.6-18.5	1,733	27.3	23.1-31.9	3,603	58.8	53.3-64.1
Yes	10,266	58.6	56.2-61.1	398	44.3	36.2-52.7	5,272	53.2	47.6-58.7	3,861	22.0	18.4-26.1	4,560	26.0	23.0-29.2	8,771	52.2	48.7-55.8
Neonatal ICU																		
No	5,015	56.7	52.8-60.5	29	14.8	10.2-20.8	1,284	33.3	26.5-40.9	1,135	12.9	9.4-17.1	2,038	23.0	19.4-27.0	4,997	58.9	53.9-63.7
Yes	8,987	59.9	57.5-62.2	433	46.4	38.7-54.4	4,699	58.9	52.7-64.9	3,621	24.1	20.1-28.7	4, 255	28.3	25.0-31.9	7,377	51.1	47.4-54.8
Kangaroo mother care																		
No	9,739	58.3	55.8-60.8	203	33.8	28.1-40.0	3,785	41.9	36.5-47.6	3,051	18.3	15.6-21.3	3,991	23.9	21.2-26.8	8,447	52.8	49.3-56.3
Yes	4,263	59.5	55.8-63.2	259	49.1	36.9-61.5	2,739	61.8	52.5-70.3	1,705	23.8	17.5-31.5	2,302	32.1	27.3-37.2	3,927	56.8	51.1-62.3

Table 2 – Simple odds ratios (confidence interval) 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 Corticos-teroids 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 [1.27,2.16]	2.85 [1.21,6.72]	6.66 [2.95,15.02]	2.40 [1.30,4.41]	0.98 [0.63,1.52]	0.44 [0.32,0.59]
Northeast	1.34 [1.11,1.61]	1.23 [0.57,2.63]	3.90 [2.38,6.40]	1.91 [1.17,3.11]	0.92 [0.66,1.28]	0.90 [0.68,1.19]
South	0.91 [0.64,1.29]	0.97 [0.56,1.68]	1.57 [0.97,2.54]	1.11 [0.68,1.80]	0.77 [0.53,1.11]	0.67 [0.45,1.01]
Mid-West	1.09 [0.81,1.47]	3.63 [1.75,7.52]	2.65 [1.35,5.21]	1.63 [0.92,2.90]	1.06 [0.63,1.76]	0.63 [0.46,0.88]
Southeast	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Location						
Not capital	1.09 [0.92,1.28]	1.45 [0.84,2.49]	1.88 [1.26,2.79]	2.12 [1.45,3.10]	1.65 [.25,2.18]	1.02 [0.82,1.28]
Capital	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Type of funding						
Private	0.54 [0.42,0.70]	0.38 [0.22,0.65]	2.55 [1.39,4.68]	0.32 [0.20,0.50]	1.13 [0.81,1.57]	3.24 [2.28,4.60]
Public	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Material resources > 80%						
Inadequate	1.12 [0.81,1.54]	3.46 [1.76,6.82]	4.99 [1.85,13.45]	4.69 [2.87,7.67]	1.44 [0.75,2.79]	0.93 [0.52,1.66]
Adequate	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Paediatrician on call 24/7						
No	0.99 [0.81,1.21]	2.06 [1.16,3.64]	2.09 [1.31,3.32]	1.72 [1.16,2.56]	0.94 [0.71,1.24]	0.81 [0.60,1.09]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Kangaroo mother care						
No	1.05 [0.86,1.28]	1.89 [1.08,3.32]	2.24 [1.39,3.59]	1.40 [0.92,2.12]	1.51 [1.15,1.97]	1.35 [0.99,1.83]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Neonatal ICU beds						
No	1.14 [0.94,1.38]	5.00 [2.97,8.43]	2.88 [1.88,4.41]	2.17 [1.43,3.27]	1.32 [1.01,1.74]	0.82 [0.62,1.08]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 3 – Simple odds ratios (confidence interval) of non-use of Essential Newborn Care items, according to the mothers' socio-economic 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 breastfeeding 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 to 19	1.37 (1.23-1.52)	1.60 (1.08-2.38)	0.97 (0.86-1.09)	1.14 (0.96-1.34)	0.99 (0.89-1.11)	0.76 (0.68-0.86)
20 to 34	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
35 or more	0.92 (0.82-1.04)	0.73 (0.50-1.05)	1.23 (1.03-1.45)	0.74 (0.65-0.85)	1.04 (0.91-1.18)	1.45 (1.28-1.64)
Mother's years' schooling						
≤ 7	2.23 (1.81-2.75)	1.85 (0.99-3.48)	0.83 (0.60-1.16)	4.24 (3.05-5.89)	0.90 (0.64-1.27)	0.34 (0.27-0.42)
8 to 10	1.89 (1.53-2.32)	2.22 (1.14-4.31)	0.58 (0.41-0.81)	3.37 (2.40-4.73)	1.01 (0.73-1.42)	0.38 (0.30-0.47)
11 to 14	1.48 (1.23-1.77)	1.33 (0.71-2.48)	0.59 (0.42-0.81)	2.46 (1.88-3.24)	1.13 (0.84-1.54)	0.54 (0.46-0.65)
15 or more	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Social Class						
A + B	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
C	1.40 (1.22-1.60)	1.14 (0.73-1.78)	1.06 (0.89-1.25)	2.15 (1.78-2.58)	0.94 (0.78-1.13)	0.64 (0.55-0.74)
D + E	1.82 (1.48-2.24)	1.60 (0.84-3.06)	1.88 (1.46-2.42)	4.00(2.96-5.41)	0.91 (0.73-1.14)	0.46 (0.38-0.55)
Antenatal care						
Inadequate	1.91 (1.68-2.18)	1.50 (1.00-2.26)	1.34 (1.13-1.60)	1.83 (1.51-2.21)	0.96 ()0.82-1.13)	0.68 (0.59-0.78)
Adequate	1 (-)	1 (-)	1	1 (-)	1 (-)	1 (-)
Type of delivery						
Caesarean	0.69 (0.63-0.77)	0.44 (0.29-0.65)	4.74 (3.59-6.25)	1.10 (0.85-1.42)	4.06 (3.38-4.88)	3.04 (2.62-3.53)
Vaginal	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 4 – Adjusted odds ratios (confidence interval) for non-use of Essential Newborn Care items, according to geographical location, type of funding, structural variables and mothers' socio-economic 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
	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)
Macro-region						
North	X	x	6.94 (2.89-16.82)	2.01 (1.06-3.8)	X	0.48 (0.35-0.65)
Northeast	X	x	3.58 (2.15-5.95)	1.81 (1.08-3.03)	X	0.92 (0.69-1.23)
South	X	x	1.42 (0.83-2.45)	1.11 (0.66-1.86)	X	0.64 (0.42-0.97)
Mid-West	X	x	2.82 (1.52-5.22)	2.25 (1.2-4.24)	X	0.56 (0.37-0.84)
Southeast	X	x	1 (-)	1 (-)	X	1
Location						
No capital	X	x	1.62 (1.01-2.60)	2.24 (1.46-3.46)	1.66 (1.23-2.22)	X
Capital	X	x	1 (-)	1 (-)	1	X
Type of funding						
Private	0.71 (0.55-0.93)	0.55 (0.31-0.97)	3.36 (1.75-6.49)	0.47 (0.29-0.77)	X	1.87 (1.28-2.74)
Public	1 (-)	1 (-)	1 (-)	1 (-)	X	1 (-)
Mother's age (years)						
12 to 19	1.17 (1.06-1.29)		0.85 (0.74-0.97)	0.75 (0.64-0.88)		1.07 (0.95-1.20)
20 to 34	1 (-)	X	1 (-)	1 (-)	X	1 (-)
35 or more	1.00 (0.88-1.13)	X	1.30 (1.07-1.58)	0.97 (0.84-1.11)	x	1.20 (1.05-1.36)
Mother's years' schooling						
≤ 7	1.47 (1.22-1.78)	X	X	1.76 (1.36-2.27)	x	0.76 (0.62-0.95)
8 to 10	1.32 (1.10-1.60)	X	X	1.88 (1.46-2.42)	x	0.79 (0.64-0.97)
11 to 14	1.20 (1.01-1.42)	X	X	1.65 (1.34-2.03)	x	0.90 (0.75-1.08)
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 (1.19-1.65)	X	X
D + E	X	X	X	1.77 (1.28-2.44)	X	X
Antenatal care						
Inadequate	1.67 (1.47-1.89)	X	1.25 (1.04-1.49)	1.38 (1.13-1.68)	x	0.96 (0.84-1.09)
Adequate	1 (-)	X	1 (-)	1 (-)	x	1 (-)
Type of delivery						
Caesarean	0.84 (0.77-0.91)	0.55 (0.36-0.84)	4.93 (3.77-6.46)	X	3.07 (3.37-4.90)	2.55 (2.21-2.96)
Vaginal	1 (-)	1 (-)	1 (-)	X	1 (-)	1 (-)
Material resources ≥ 80%						
Inadequate	X	2.16 (1.17-4.01)	X	3.70 (2.08-6.61)	X	X
Adequate	X	1 (-)	X	1 (-)	X	X
Neonatal ICU beds						
No	X	3.93 (2.34-6.66)	2.08 (1.24-3.48)	x	X	X
Yes	X	1 (-)	1 (-)	x	X	X

Items filled with x are variables excluded from the model.

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 availability 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 search for more than one hospital for delivery 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 women's health 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 [20][14]. Corticosteroid use can avert 20 to 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, e.g., 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 their labour monitored 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 in those facilities prelabour caesarean section is frequent (78,3%) [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 the 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 program, 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%, whilst 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 post-partum 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 neonatal ICU, 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 more than 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 more than 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 health care. 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 program. 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 health care.

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.

CONFLICT OF INTERESTS

There are no conflicts of interest.

CONTRIBUTORSHIP STATEMENT

MASM, RQG, RC and SDA participated in the design, analysis, and data interpretation, and in the drafting and final approval of the manuscript; VEP collaborated in the database organization and statistical analysis; MCL participated in the design of the article, oversaw the analysis, and made the final revision of the article. All co-authors contributed to the improvement of the article.

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DATA SHARING STATEMENT

No additional data available.

LIST OF REFERENCES

1 NATIONS U. Sustainable Development. https://sustainabledevelopment.un.org/sdg3. 2017.https://sustainabledevelopment.un.org/sdg3

2 UNICEF. Committing to Child Survival : A Promise Renewed. Progress Report. *WwwApromiserenewedOrg* 2014;:104. doi:978-92-806-4706-8

3 Requejo JH, Bryce J, Barros AJD, *et al.* Countdown to 2015 and beyond: fulfilling the health agenda for women and children. *Lancet (London, England)* Published Online First: 2015. doi:10.1016/S0140-6736(14)60925-9

4 Bhutta ZA, Das JK, Bahl R, *et al.* Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *Lancet* 2014;**384**. doi:10.1016/S0140-6736(14)60792-3

5 Narayanan I, Rose M, Cordero D, *et al.* The Components of Essential Newborn Care. *Basics Support Institutionalizing Child Surviv Proj (BASICS II) United States Agency Int Dev* 2004.

6 Leal MDC, Szwarcwald CL, Almeida PVB, *et al.* Reproductive , maternal , neonatal and child health in the 30 years since the creation of the Unified Health System (SUS). *Ciência e Saúde Coletiva* 2018;**23**:1915–28. doi:10.1590/1413-81232018236.03942018

7 Lansky S, Friche AA de L, Silva AAM da, *et al.* Birth in Brazil survey : neonatal mortality

profile, and maternal and child care. *Cad Saúde Pública* 2014;**30**:192–207. doi:10.1590/0102-311X00133213

8 Black RE, Cousens S, Johnson HL, *et al.* Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet* 2010;**375**:1969–87. doi:10.1016/S0140-6736(10)60549-1

9 Danzhen You, Lucia Hug, Simon Ejdemyr, Jan Beise PI, World. Child Mortality 2015. *UNICEF WHO World Bank Gr United Nations* 2015;:74.www.childmortality.org

10 Leal MDC, Da Silva AA, Dias MA, *et al.* Birth in Brazil: national survey into labour and birth. *Reprod Health* 2012;**9**. doi:10.1186/1742-4755-9-15

11 Haldane JBS. On a Method of Estimating Frequencies. *Biometrika* 1945;**33**:222–5. doi:10.2307/2332299

12 Vasconcellos MTL, Silva PL do N, Pereira APE, *et al.* Sampling design for the Birth in Brazil : National Survey into Labor and Birth. *Cad Saude Publica* 2014;**30**:S49–58. doi:10.1590/0102-311X00176013

13 Bittencourt SDA, Reis LGC, Ramos MM, *et al.* Structure in Brazilian maternity hospitals: key characteristics for quality of obstetric and neonatal care. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00176913

14 Roberts D, Brown J, Medley N, *et al.* Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. Cochrane Database Syst. Rev. 2017;**2017**. doi:10.1002/14651858.CD004454.pub3

15 Pereira APE, Leal M do C, da Gama SGN, *et al.* Determining gestational age based on information from the Birth in Brazil study. *Cad saúde pública* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00160313

16 Ministério da Saúde. Portaria n° 1071, de 04 de julho de 2005. Institui a Política Nacional de Atenção ao Paciente Crítico. *Diário Of da União* 2005.

17 ABEP. Brazilian Criteria 2015 and social class distribution update for 2016. www.abep.org. 2016;:1–6.

18 BRASIL. Lei n° 11.634, de 27 de dezembro de 2007. Dispõe sobre o direito da gestante ao conhecimento e a vinculação à maternidade onde receberá assistência, no âmbito do Sistema Único de Saúde-SUS. 2007.

19 Bittencourt SDA, Gurgel RQ, Menezes MAS, *et al.* Neonatal care in Brazil: hospital structure and adequacy according to newborn obstetric risk. *Paediatr Int Child Health* 2015;**35**:206–12. doi:10.1179/2046905515Y.0000000028

20 Malta DC, França E, Abreu DX De, *et al.* Update of avoidable causes of death due to interventions at the Brazilian Health System. *Epidemiol e Serviços Saúde* 2010;**20**:409–12. doi:10.5123/S1679-49742011000300016

21 Darmstadt GL, Bhutta ZA, Cousens S, *et al.* Evidence-based, cost-effective interventions: How many newborn babies can we save? *Lancet* 2005;**365**:977–88. doi:10.1016/S0140-6736(05)71088-6

22 Vogel JP, Souza JP, Gülmezoglu AM, *et al.* Use of antenatal corticosteroids and tocolytic drugs in preterm births in 29 countries: An analysis of the WHO Multicountry Survey on Maternal and Newborn Health. *Lancet* 2014;**384**:1869–77. doi:10.1016/S0140-6736(14)60580-8

23 Stoll BJ, Hansen NI, Bell EF, *et al.* Trends in care practices, morbidity, and mortality of extremely preterm Neonates, 1993-2012. *JAMA - J Am Med Assoc* 2015;**314**:1039–51. doi:10.1001/jama.2015.10244

24 Domingues RMSM, Dias MAB, Nakamura-Pereira M, *et al.* Process of decision-making

regarding the mode of birth in Brazil: from the initial preference of women to the final mode of birth. *Cad Saude Publica* 2014;**30**:1–16. doi:S0102-311X2014001300017 [pii]

25 Brasil. Lei n° 11.108, de 07 de abril de 2005. Dispõe sobre o direito da parturiente à presença de acompanhante durante o trabalho de parto, parto e pós-parto imediato, no âmbito do Sistema Único de Saúde-SUS. *Diário Of da União* 2005.

26 Diniz CSG, D'Orsi E, Domingues RMSM, *et al.* Implementation of the presence of companions during hospital admission for childbirth: data from the Birth in Brazil national survey. *Cad Saude Publica* 2014;**30**:S140–53. doi:10.1590/0102-311X00127013

27 Dhaded SM, Somannavar MS, Vernekar SS, *et al.* Neonatal mortality and coverage of essential newborn interventions 2010 - 2013: a prospective, population-based study from low-middle income countries. *Reprod Health* 2015;**12**:S6. doi:10.1186/1742-4755-12-S2-S6

28 Prevention C for DC and. Breastfeeding: Report Card. https://www.cdc.gov/breastfeeding/data/mpinc/data/2015/tables2_1a-2_4a.htm. 2015.https://www.cdc.gov/breastfeeding/data/mpinc/data/2015/tables2_1a-2_4a.htm

29 Lyu Y, Shah PS, Ye XY, *et al.* Association Between Admission Temperature and Mortality and Major Morbidity in Preterm Infants Born at Fewer Than 33 Weeks' Gestation. *JAMA Pediatr* 2015;**169**:e150277. doi:10.1001/jamapediatrics.2015.0277

30 Darmstadt GL, Walker N, Lawn JE, *et al.* Saving newborn lives in Asia and Africa: Cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008;**23**:101–17. doi:10.1093/heapol/czn001

31 Khan J, Vesel L, Bahl R, *et al.* Timing of Breastfeeding Initiation and Exclusivity of Breastfeeding During the First Month of Life: Effects on Neonatal Mortality and Morbidity—A Systematic Review and Meta-analysis. *Matern Child Health J*

2015;**19**:468–79.

32 WHO (World Health Organization), UNICEF (United Nations Children's Fund). Global Strategy for Infant and Young Child Feeding. *World Heal Organ* 2003;:1–30. doi:ISBN 92 4 156221 8

33 Adhikari M, Khanal V, Karkee R, *et al.* Factors associated with early initiation of breastfeeding among Nepalese mothers: further analysis of Nepal Demographic and Health Survey, 2011. *Int Breastfeed J* 2014;**9**:21. doi:10.1186/1746-4358-7-1

34 Goudar SS, Dhaded SM, Mcclure EM, *et al.* ENC training reduces perinatal mortality in Karnataka, India. *J Matern Neonatal Med* 2012;**25**:568–74. doi:10.3109/14767058.2011.584088

35 Prior E, Santhakumaran S, Gale C, *et al.* Breastfeeding after cesarean delivery: A systematic review and meta-analysis of world literature. *Am J Clin Nutr* 2012;**95**:1113–35. doi:10.3945/ajcn.111.030254

36 Boccolini CS, Carvalho ML, Oliveira MIC, *et al.* Factors associated with breastfeeding in the first hour of life. *Rev Saude Publica* 2011;**45**:69–78.www.scielo.br/rsp

37 Leal MDC, Esteves-Pereira AP, Nakamura-Pereira M, *et al.* Burden of early-term birth on adverse infant outcomes: a population-based cohort study in Brazil. *BMJ Open* 2017;**7**:e017789. doi:10.1136/bmjopen-2017-017789

38 Leal MDC, Esteves-Pereira AP, Nakamura-Pereira M, *et al.* Prevalence and risk factors related to preterm birth in Brazil. *Reprod Health* 2016;**13**. doi:10.1186/s12978-016-0230-0

39 Lassi ZS, Middleton PF, Crowther C, *et al.* Interventions to Improve Neonatal Health and Later Survival: An Overview of Systematic Reviews. *EBioMedicine* Published Online First: 2015. doi:10.1016/j.ebiom.2015.05.023

40 Viellas EF, Domingues RMSM, Dias MAB, *et al.* Prenatal care in Brazil. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-15. doi:S0102-311X2014001300016 [pii]

41 Lassi ZS, Salam RA, Das JK, *et al.* Essential interventions for maternal, newborn and child health: background and methodology. *Reprod Health* 2014;**11**:S1. doi:10.1186/1742-4755-11-S1-S1

42 Tudor Hart J. THE INVERSE CARE LAW. *Lancet* 1971;**297**:405–12. doi:10.1016/S0140-6736(71)92410-X

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, lines 3-4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 5
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 6, lines 12-18
Methods			
Study design	4	Present key elements of study design early in the paper	Page 6, lines 29-38
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 6, line 34; page 7, lines 42-43
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 6, line 44 to page 7, line 29
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8, line 13 to page 9, line 5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7, line 34 to page 8, line 5
Bias	9	Describe any efforts to address potential sources of bias	*Page 10, line 9-22*
Study size	10	Explain how the study size was arrived at	Page 6, line 44
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 9, lines 11-21
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 9, line 54 to page 10, line 22
		(*b*) Describe any methods used to examine subgroups and interactions	Page 9, line 11 to page 10, line 22
		(*c*) Explain how missing data were addressed	Page 7, line 27-28
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Page 10, lines 18-22

		(*e*) Describe any sensitivity analyses	Page 10, lines 3-18
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 10, line 54 to page 11, line 35
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 10, line 54 to page 11, line 35
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Pages 10, line 54 to page 18
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Pages 11, lines 37-46; pages 15-16
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 11, line 48 to page 12, line 17
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 19, lines 15-19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 22, lines 18-35
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 19, line 22 to page 22, line 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 19, line 22 to page 22, line 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 24, line 3-11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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

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.

Keywords: Essential Newborn Care, Brazil, structure, private health care, public health care.

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 more than 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.

INTRODUCTION

The reduction of child mortality is a topic of the Sustainable Development Goal 3, i.e., 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 one million neonatal deaths by 2020 [4].

Almost two decades ago, with a view to reducing neonatal mortality and morbidity, the World Health Organization (WHO) recommended specific care practices outlined in the Essential Newborn Care (ENC) program. 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 more than 6 antenatal care visits in 2015) and the hospital delivery rate is almost 100%. Nevertheless, neonatal mortality remains high (9.5 deaths per 1,000 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 birthweight 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 socio-economic 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 program, 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 health care facility describes care in private hospitals that was paid for by the government's unified health care 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 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 pre-specified 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 was 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 was 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 upon 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, whilst 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 postnatal 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 (antihypertensives, anxiolytics/hypnotics, corticosteroids, oxytocics, inhibitors of uterine contractility, coagulants/haemostatics, magnesium sulphate, 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 less than 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 to 19, 20 to 34 and 35 or more years old), schooling (7 or less, 8 to 10, 11 to 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 health care facilities and who were not covered by private health insurance plans were classified as receiving public health care 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 health care at childbirth.

In Brazil, the organisation responsible for the demographic census (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 socio-economic

criteria into the following classes: A – more than 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% Confidence Interval-CI) according to variables relating to the health facility structure and the mothers' socio-demographic 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 odds ratios 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 odds ratios 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, version 22).

The ethics committee of the Sergio Arouca National School of Public Health, Oswaldo Cruz Foundation (CEP/ENSP), approved this study under the research protocol

CAAE:0096.0.031.000–10. 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%-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%-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 less than 80% and without a NICU. Partograph labour monitoring occurred in 48.5% (95% CI 43.8%-53.1%) of the deliveries around 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%-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 greater than 80%, and with paediatrician available 24 hours a day. Early skin-to-skin contact occurred in 26.3% (95% CI 23.9.0%-29.0%) of cases and only in 13.9% (95% CI 12.0%-16.2%) of women undergoing caesarean section. The rate of breast feeding in the first hour after birth was 59.1% (95% CI 56.3-61.9); 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; IC95% 1.76-6.82) and an absence of NICU beds (OR 5.0; IC95% 2.97-8.43) 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; IC 95% 2.96-5.41).

The adjusted logistic regression analysis (Table 4) showed that privately funded women were more likely to not use a partograph (OR_{adj} 3.36; IC95% 1.75-6.49) and to not breast feed in the first hour after birth (OR_{adj} 1.87; IC 95% 1.28-2.74). The use of a partograph varies according to the region of residence; it is lower in the North (OR_{adj} 6.94; IC95% 2.89-16.82), Northeast (OR_{adj}: 3.58; IC95% 2.15-5.95) and Mid-West (OR_{adj}: 2.82; IC95% 1.52-5.22).

Lower social class was related to lower continuous social support (social class C: OR_{adj} 1.40; IC95% 1.19-1.65; social class D and E: OR_{adj}: 1.77; IC95% 1.28-2.44).

Caesarean section was associated with an absence of early skin-to-skin contact (OR_{adj} 3.07; IC95% 3.37-4.90) and breast feeding in first hour after birth (OR_{adj} 2.55; IC95% 2.21-2.96), regardless of the maternal characteristics and the hospital structure.

Table 1 – Number and percentage (confidence interval) of Essential Newborn Care items according to geographical location, mothers´socio-economic variables, type of funding and structural variables (Brazil, 2011-2012)

	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)			Breastfeeding in first hour of birth (n=22.919)		
Variables	**N**	**%**	**95%CI**	**N**	**%**	**95%CI**	**n**	**%**	**95%CI**	**n**	**%**	**95%CI**	**N**	**%**	**95%CI**	**n**	**%**	**95%CI**
Total	14,004	58.7	56.7-60.7	458	41.0	34.2-48.0	6,524	48.5	43.8-53.1	4,756	19.9	17.0-23.1	6,293	26.3	23.9-29.0	12,374	59.1	56.3-61.9
Macro-region																		
North	1,132	49.4	43.7-55.2	34	24.2	13.3-40.1	325	22.4	11.8-38.3	277	12.1	7.5-18.9	589	25.7	19.1-33.5	1,511	73.4	69.0-77.4
Northeast	3,770	54.7	51.4-58.0	160	42.4	28.4-57.8	1,359	33.1	24.7-42.7	1,017	14.7	10.5-20.3	1,857	26.9	22.3-32.0	3,353	57.1	52.8-61.4
Southeast	6,271	61.8	58.7-64.9	196	47.6	36.4-59.0	3,631	65.8	59.3-71.8	2,517	24.8	19.6-30.8	2,561	25.2	21.2-29.7	4,868	54.6	49.2-59.9
South	1,906	64.0	56.3-71.0	55	47.8	39.8-55.9	880	55.1	44.9-64.8	684	22.9	16.8-30.5	910	30.5	24.7-36.9	1,719	64.1	56.0-71.4
Mid-West	925	59.7	53.0-66.1	13	20.0	12.0-31.4	329	42.0	28.4-57.0	261	16.8	11.1-24.7	376	24.2	16.8-33.5	923	65.6	59.9-70.8
Location																		
Non-capital	8,661	57.9	55.3-60.6	190	36.5	30.1-43.3	3,514	42.5	37.5-47.6	2,290	15.3	12.5-18.6	3,388	22.6	20.1-25.4	7,795	58.9	55.1-62.6
Capital	5,342	60.0	57.0-62.9	268	45.6	34.3-57.3	3,010	58.1	49.6-66.1	2,466	27.7	22.0-34.1	2,905	32.6	27.6-37.9	4,579	59.5	55.4-63.4
Funding																		
Public	11,501	56.6	54.5-58.7	385	38.8	31.3-46.8	6,375	49.3	44.5-54.2	3,391	16.7	13.7-20.2	5,431	26.7	23.9-29.6	11,268	63.4	60.4-66.4
Private	2,502	70.8	65.5-75.5	73	63.1	52.4-72.7	149	27.6	17.7-40.4	1,365	38.7	30.0-48.0	862	24.3	19.3-30.2	1,106	34.9	27.8-42.7
Mother's age (years)																		
12 to 19	2,385	52.3	49.5-55.1	88	31.8	22.5-42.9	1,656	49.5	44.0-54.9	813	17.8	14.7-21.3	1,212	26.5	23.4-29.9	2,593	59.8	56.5-63.0
20 to 34	10,065	60.0	57.9-62.0	301	42.8	35.9-50.0	4,417	48.6	44.1-53.3	3,315	19.7	16.8-23.1	4,434	26.4	23.9-29.1	8,739	54.0	51.1-57.0
35 or more	1,549	61.9	58.6-65.1	73	50.7	40.4-60.8	448	43.6	37.9-49.5	624	24.9	20.9-29.3	645	25.7	22.6-29.1	1,042	43.4	39.5-47.4
Mother's years' schooling																		
≤ 7	3,285	52.1	49.3-54.9	135	37.9	28.2-48.6	1,939	43.2	37.9-48.6	868	13.7	11.2-16.7	1,826	28.9	25.6-32.4	3,552	60.0	56.9-63.1
8 to 10	3,421	56.3	53.4-59.1	91	33.7	25.1-43.6	2,047	52.0	47.0-57.0	1,016	16.7	13.3-20.7	1,614	26.5	23.4-29.9	3,464	59.3	56.0-62.5
11 to 14	5,751	62.2	59.8-64.5	190	45.9	37.6-54.5	2,355	51.8	46.3-57.2	1,993	21.5	18.0-25.5	2,261	24.4	22.1-26.9	4,525	50.4	46.9-53.8
15 or more	1,490	70.8	66.7-74.6	44	53.1	40.0-65.7	167	38.7	31.7-46.1	848	40.3	34.2-46.8	565	26.8	21.1-33.4	774	37.4	33.1-41.8

Social class																	
D+E	2,898	51.8	48.7-54.8	107	34.3	22.5-48.4	1,572	38.5	32.6-44.8	598	10.7	8.5-13.3	1,520	27.1	23.7-30.8	3,253	67.7	64.5-70.8
C	7,184	58.4	55.9-60.8	239	42.3	34.7-50.3	3,816	52.7	48.1-57.3	2,244	18.2	15.0-22.0	3,252	26.4	23.6-29.4	6,479	60.0	56.8-63.1
A+B	3,804	66.2	62.9-69.4	108	45.6	36.0-55.4	1,094	54.0	48.8-59.2	1,860	32.3	27.8-37.2	1,452	25.2	21.9-28.9	2,529	49.1	45.0-53.2
Antenatal care																		
Inadequate	1,876	45.5	42.4-48.7	165	35.1	26.2-45.3	1,261	42.8	36.9-49.1	538	13.0	10.7-15.8	1,119	27.1	23.5-31.0	2,257	57.7	53.6-61.6
Adequate	11,849	61.5	59.4-63.6	283	44.9	37.6-52.3	5,148	50.2	45.7-54.8	4,141	21.5	18.3-25.0	5,067	26.3	23.8-28.9	9,874	53.2	50.2-56.1
Type of delivery																		
Vaginal/forceps	6,215	54.1	51.7-56.5	158	30.4	23.6-38.2	6,142	53.4	48.4-58.4	2,382	20.7	16.8-25.3	4,564	39.7	36.1-43.4	7,478	67.6	64.6-70.5
Caesarean	7,788	63.0	60.7-65.1	303	50.0	41.4-58.5	382	19.5	16.0-23.5	2,374	19.2	16.3-22.4	1,729	13.9	12.0-16.2	4,896	41.3	38.0-44.6
Material resources > 80%																		
No	920	56.2	48.7-63.4	8	17.3	10.1-28.0	173	17.3	7.4-35.2	88	5.4	3.5-8.1	331	20.2	11.8-32.5	890	56.8	43.1-69.5
Yes	13,083	58.9	56.8-61.0	453	42.0	35.1-49.3	6,351	51.0	46.2-55.8	4,668	21.0	17.9-24.4	5,962	26.8	24.2-29.5	11,484	53.8	50.8-56.7
Paediatrician on call 24/7																		
No	3,737	58.9	55.0-62.8	64	27.9	20.1-37.4	1,252	35.3	26.9-44.7	895	14.1	10.6-18.5	1,733	27.3	23.1-31.9	3,603	58.8	53.3-64.1
Yes	10,266	58.6	56.2-61.1	398	44.3	36.2-52.7	5,272	53.2	47.6-58.7	3,861	22.0	18.4-26.1	4,560	26.0	23.0-29.2	8,771	52.2	48.7-55.8
Neonatal ICU																		
No	5,015	56.7	52.8-60.5	29	14.8	10.2-20.8	1,284	33.3	26.5-40.9	1,135	12.9	9.4-17.1	2,038	23.0	19.4-27.0	4,997	58.9	53.9-63.7
Yes	8,987	59.9	57.5-62.2	433	46.4	38.7-54.4	4,699	58.9	52.7-64.9	3,621	24.1	20.1-28.7	4, 255	28.3	25.0-31.9	7,377	51.1	47.4-54.8
Kangaroo mother care																		
No	9,739	58.3	55.8-60.8	203	33.8	28.1-40.0	3,785	41.9	36.5-47.6	3,051	18.3	15.6-21.3	3,991	23.9	21.2-26.8	8,447	52.8	49.3-56.3
Yes	4,263	59.5	55.8-63.2	259	49.1	36.9-61.5	2,739	61.8	52.5-70.3	1,705	23.8	17.5-31.5	2,302	32.1	27.3-37.2	3,927	56.8	51.1-62.3

Table 2 – Simple odds ratios (confidence interval) 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 Corticos-teroids 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 [1.27,2.16]	2.85 [1.21,6.72]	6.66 [2.95,15.02]	2.40 [1.30,4.41]	0.98 [0.63,1.52]	0.44 [0.32,0.59]
Northeast	1.34 [1.11,1.61]	1.23 [0.57,2.63]	3.90 [2.38,6.40]	1.91 [1.17,3.11]	0.92 [0.66,1.28]	0.90 [0.68,1.19]
South	0.91 [0.64,1.29]	0.97 [0.56,1.68]	1.57 [0.97,2.54]	1.11 [0.68,1.80]	0.77 [0.53,1.11]	0.67 [0.45,1.01]
Mid-West	1.09 [0.81,1.47]	3.63 [1.75,7.52]	2.65 [1.35,5.21]	1.63 [0.92,2.90]	1.06 [0.63,1.76]	0.63 [0.46,0.88]
Southeast	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Location						
Not capital	1.09 [0.92,1.28]	1.45 [0.84,2.49]	1.88 [1.26,2.79]	2.12 [1.45,3.10]	1.65 [.25,2.18]	1.02 [0.82,1.28]
Capital	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Type of funding						
Private	0.54 [0.42,0.70]	0.38 [0.22,0.65]	2.55 [1.39,4.68]	0.32 [0.20,0.50]	1.13 [0.81,1.57]	3.24 [2.28,4.60]
Public	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Material resources > 80%						
Inadequate	1.12 [0.81,1.54]	3.46 [1.76,6.82]	4.99 [1.85,13.45]	4.69 [2.87,7.67]	1.44 [0.75,2.79]	0.93 [0.52,1.66]
Adequate	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Paediatrician on call 24/7						
No	0.99 [0.81,1.21]	2.06 [1.16,3.64]	2.09 [1.31,3.32]	1.72 [1.16,2.56]	0.94 [0.71,1.24]	0.81 [0.60,1.09]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Kangaroo mother care						
No	1.05 [0.86,1.28]	1.89 [1.08,3.32]	2.24 [1.39,3.59]	1.40 [0.92,2.12]	1.51 [1.15,1.97]	1.35 [0.99,1.83]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Neonatal ICU beds						
No	1.14 [0.94,1.38]	5.00 [2.97,8.43]	2.88 [1.88,4.41]	2.17 [1.43,3.27]	1.32 [1.01,1.74]	0.82 [0.62,1.08]
Yes	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 3 – Simple odds ratios (confidence interval) of non-use of Essential Newborn Care items, according to the mothers' socio-economic 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 breastfeeding 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 to 19	1.37 (1.23-1.52)	1.60 (1.08-2.38)	0.97 (0.86-1.09)	1.14 (0.96-1.34)	0.99 (0.89-1.11)	0.76 (0.68-0.86)
20 to 34	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
35 or more	0.92 (0.82-1.04)	0.73 (0.50-1.05)	1.23 (1.03-1.45)	0.74 (0.65-0.85)	1.04 (0.91-1.18)	1.45 (1.28-1.64)
Mother's years' schooling						
≤ 7	2.23 (1.81-2.75)	1.85 (0.99-3.48)	0.83 (0.60-1.16)	4.24 (3.05-5.89)	0.90 (0.64-1.27)	0.34 (0.27-0.42)
8 to 10	1.89 (1.53-2.32)	2.22 (1.14-4.31)	0.58 (0.41-0.81)	3.37 (2.40-4.73)	1.01 (0.73-1.42)	0.38 (0.30-0.47)
11 to 14	1.48 (1.23-1.77)	1.33 (0.71-2.48)	0.59 (0.42-0.81)	2.46 (1.88-3.24)	1.13 (0.84-1.54)	0.54 (0.46-0.65)
15 or more	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
Social Class						
A + B	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)
C	1.40 (1.22-1.60)	1.14 (0.73-1.78)	1.06 (0.89-1.25)	2.15 (1.78-2.58)	0.94 (0.78-1.13)	0.64 (0.55-0.74)
D + E	1.82 (1.48-2.24)	1.60 (0.84-3.06)	1.88 (1.46-2.42)	4.00(2.96-5.41)	0.91 (0.73-1.14)	0.46 (0.38-0.55)
Antenatal care						
Inadequate	1.91 (1.68-2.18)	1.50 (1.00-2.26)	1.34 (1.13-1.60)	1.83 (1.51-2.21)	0.96 ()0.82-1.13)	0.68 (0.59-0.78)
Adequate	1 (-)	1 (-)	1	1 (-)	1 (-)	1 (-)
Type of delivery						
Caesarean	0.69 (0.63-0.77)	0.44 (0.29-0.65)	4.74 (3.59-6.25)	1.10 (0.85-1.42)	4.06 (3.38-4.88)	3.04 (2.62-3.53)
Vaginal	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)	1 (-)

Table 4 – Adjusted odds ratios (confidence interval) for non-use of Essential Newborn Care items, according to geographical location, type of funding, structural variables and mothers' socio-economic 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
	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)	Adjusted OR (95%CI)
Macro-region						
North	X	x	6.94 (2.89-16.82)	2.01 (1.06-3.8)	X	0.48 (0.35-0.65)
Northeast	X	x	3.58 (2.15-5.95)	1.81 (1.08-3.03)	X	0.92 (0.69-1.23)
South	X	x	1.42 (0.83-2.45)	1.11 (0.66-1.86)	X	0.64 (0.42-0.97)
Mid-West	X	x	2.82 (1.52-5.22)	2.25 (1.2-4.24)	X	0.56 (0.37-0.84)
Southeast	X	x	1 (-)	1 (-)	X	1
Location						
No capital	X	x	1.62 (1.01-2.60)	2.24 (1.46-3.46)	1.66 (1.23-2.22)	X
Capital	X	x	1 (-)	1 (-)	1	X
Type of funding						
Private	0.71 (0.55-0.93)	0.55 (0.31-0.97)	3.36 (1.75-6.49)	0.47 (0.29-0.77)	X	1.87 (1.28-2.74)
Public	1 (-)	1 (-)	1 (-)	1 (-)	X	1 (-)
Mother's age (years)						
12 to 19	1.17 (1.06-1.29)		0.85 (0.74-0.97)	0.75 (0.64-0.88)		1.07 (0.95-1.20)
20 to 34	1 (-)	X	1 (-)	1 (-)	X	1 (-)
35 or more	1.00 (0.88-1.13)	X	1.30 (1.07-1.58)	0.97 (0.84-1.11)	x	1.20 (1.05-1.36)
Mother's years' schooling						
≤ 7	1.47 (1.22-1.78)	X	X	1.76 (1.36-2.27)	x	0.76 (0.62-0.95)
8 to 10	1.32 (1.10-1.60)	X	X	1.88 (1.46-2.42)	x	0.79 (0.64-0.97)
11 to 14	1.20 (1.01-1.42)	X	X	1.65 (1.34-2.03)	x	0.90 (0.75-1.08)
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 (1.19-1.65)	X	X
D + E	X	X	X	1.77 (1.28-2.44)	X	X
Antenatal care						
Inadequate	1.67 (1.47-1.89)	X	1.25 (1.04-1.49)	1.38 (1.13-1.68)	x	0.96 (0.84-1.09)
Adequate	1 (-)	X	1 (-)	1 (-)	x	1 (-)
Type of delivery						
Caesarean	0.84 (0.77-0.91)	0.55 (0.36-0.84)	4.93 (3.77-6.46)	X	3.07 (3.37-4.90)	2.55 (2.21-2.96)
Vaginal	1 (-)	1 (-)	1 (-)	X	1 (-)	1 (-)
Material resources ≥ 80%						
Inadequate	X	2.16 (1.17-4.01)	X	3.70 (2.08-6.61)	X	X
Adequate	X	1 (-)	X	1 (-)	X	X
Neonatal ICU beds						
No	X	3.93 (2.34-6.66)	2.08 (1.24-3.48)	x	X	X
Yes	X	1 (-)	1 (-)	x	X	X

Items filled with x are variables excluded from the model.

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 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 [20][14]. Corticosteroid use can avert 20 to 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, e.g., 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 the 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 program, 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%, whilst 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 post-partum 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 neonatal ICU, 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 more than 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 more than 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 health care. 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 program. 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 health care.

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.

CONFLICT OF INTERESTS

There are no conflicts of interest.

CONTRIBUTORSHIP STATEMENT

MASM, RQG, RC and SDA participated in the design, analysis, data interpretation, and in the drafting and final approval of the manuscript; VEP collaborated in the database organisation and statistical analysis; MCL participated in the design of the article, oversaw the analysis, and made the final revision of the article. All co-authors contributed to the improvement of the article.

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DATA SHARING STATEMENT

No additional data available.

LIST OF REFERENCES

1 NATIONS U. Sustainable Development. https://sustainabledevelopment.un.org/sdg3. 2017.https://sustainabledevelopment.un.org/sdg3

2 UNICEF. Committing to Child Survival : A Promise Renewed. Progress Report. *WwwApromiserenewedOrg* 2014;:104. doi:978-92-806-4706-8

3 Requejo JH, Bryce J, Barros AJD, *et al.* Countdown to 2015 and beyond: fulfilling the health agenda for women and children. *Lancet (London, England)* Published Online First: 2015. doi:10.1016/S0140-6736(14)60925-9

4 Bhutta ZA, Das JK, Bahl R, *et al.* Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? *Lancet* 2014;**384**. doi:10.1016/S0140-6736(14)60792-3

5 Narayanan I, Rose M, Cordero D, *et al.* The Components of Essential Newborn Care. *Basics Support Institutionalizing Child Surviv Proj (BASICS II) United States Agency Int Dev* 2004.

6 Leal MDC, Szwarcwald CL, Almeida PVB, *et al.* Reproductive , maternal , neonatal and child health in the 30 years since the creation of the Unified Health System (SUS). *Ciência e Saúde Coletiva* 2018;**23**:1915–28. doi:10.1590/1413-81232018236.03942018

7 Lansky S, Friche AA de L, Silva AAM da, *et al.* Birth in Brazil survey : neonatal mortality profile, and maternal and child care. *Cad Saúde Pública* 2014;**30**:192–207. doi:10.1590/0102-311X00133213

8 Black RE, Cousens S, Johnson HL, *et al.* Global, regional, and national causes of child mortality in 2008: a systematic analysis. *Lancet* 2010;**375**:1969–87. doi:10.1016/S0140-6736(10)60549-1

9 Danzhen You, Lucia Hug, Simon Ejdemyr, Jan Beise PI, World. Child Mortality 2015. *UNICEF WHO World Bank Gr United Nations* 2015;:74.www.childmortality.org

10 Leal MDC, Da Silva AA, Dias MA, *et al.* Birth in Brazil: national survey into labour and birth. *Reprod Health* 2012;**9**. doi:10.1186/1742-4755-9-15

11 Vasconcellos MTL, Silva PL do N, Pereira APE, *et al.* Sampling design for the Birth in Brazil : National Survey into Labor and Birth. *Cad Saude Publica* 2014;**30**:S49–58. doi:10.1590/0102-311X00176013

12 Haldane JBS. On a Method of Estimating Frequencies. *Biometrika* 1945;**33**:222–5. doi:10.2307/2332299

13 Bittencourt SDA, Reis LGC, Ramos MM, *et al.* Structure in Brazilian maternity hospitals: key characteristics for quality of obstetric and neonatal care. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00176913

14 Roberts D, Brown J, Medley N, *et al.* Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. Cochrane Database Syst. Rev. 2017;**2017**. doi:10.1002/14651858.CD004454.pub3

15 Pereira APE, Leal M do C, da Gama SGN, *et al.* Determining gestational age based on information from the Birth in Brazil study. *Cad saúde pública* 2014;**30 Suppl 1**:S1-12. doi:10.1590/0102-311X00160313

16 Ministério da Saúde. Portaria n^{o} 1071, de 04 de julho de 2005. Institui a Política Nacional de Atenção ao Paciente Crítico. *Diário Of da União* 2005.

17 ABEP. Brazilian Criteria 2015 and social class distribution update for 2016. www.abep.org. 2016;:1–6.

18 BRASIL. Lei nº 11.634, de 27 de dezembro de 2007. Dispõe sobre o direito da gestante ao conhecimento e a vinculação à maternidade onde receberá assistência, no âmbito do Sistema Único de Saúde-SUS. 2007.

19 Bittencourt SDA, Gurgel RQ, Menezes MAS, *et al.* Neonatal care in Brazil: hospital structure and adequacy according to newborn obstetric risk. *Paediatr Int Child Health* 2015;**35**:206–12. doi:10.1179/2046905515Y.0000000028

20 Malta DC, França E, Abreu DX De, *et al.* Update of avoidable causes of death due to interventions at the Brazilian Health System. *Epidemiol e Serviços Saúde* 2010;**20**:409–12. doi:10.5123/S1679-49742011000300016

21 Darmstadt GL, Bhutta ZA, Cousens S, *et al.* Evidence-based, cost-effective interventions: How many newborn babies can we save? *Lancet* 2005;**365**:977–88. doi:10.1016/S0140-6736(05)71088-6

22 Vogel JP, Souza JP, Gülmezoglu AM, *et al.* Use of antenatal corticosteroids and tocolytic drugs in preterm births in 29 countries: An analysis of the WHO Multicountry Survey on Maternal and Newborn Health. *Lancet* 2014;**384**:1869–77. doi:10.1016/S0140-6736(14)60580-8

23 Stoll BJ, Hansen NI, Bell EF, *et al.* Trends in care practices, morbidity, and mortality of extremely preterm Neonates, 1993-2012. *JAMA - J Am Med Assoc* 2015;**314**:1039–51. doi:10.1001/jama.2015.10244

24 Domingues RMSM, Dias MAB, Nakamura-Pereira M, *et al.* Process of decision-making regarding the mode of birth in Brazil: from the initial preference of women to the final mode of birth. *Cad Saude Publica* 2014;**30**:1–16. doi:S0102-311X2014001300017 [pii]

25 Brasil. Lei n° 11.108, de 07 de abril de 2005. Dispõe sobre o direito da parturiente à presença de acompanhante durante o trabalho de parto, parto e pós-parto imediato, no âmbito do Sistema Único de Saúde-SUS. *Diário Of da União* 2005.

26 Diniz CSG, D'Orsi E, Domingues RMSM, *et al.* Implementation of the presence of companions during hospital admission for childbirth: data from the Birth in Brazil national survey. *Cad Saude Publica* 2014;**30**:S140–53. doi:10.1590/0102-311X00127013

27 Dhaded SM, Somannavar MS, Vernekar SS, *et al.* Neonatal mortality and coverage of essential newborn interventions 2010 - 2013: a prospective, population-based study from low-middle income countries. *Reprod Health* 2015;**12**:S6. doi:10.1186/1742-4755-12-S2-S6

28 Prevention C for DC and. Breastfeeding: Report Card. https://www.cdc.gov/breastfeeding/data/mpinc/data/2015/tables2_1a-2_4a.htm. 2015.https://www.cdc.gov/breastfeeding/data/mpinc/data/2015/tables2_1a-2_4a.htm

29 Lyu Y, Shah PS, Ye XY, *et al.* Association Between Admission Temperature and Mortality and Major Morbidity in Preterm Infants Born at Fewer Than 33 Weeks' Gestation. *JAMA Pediatr* 2015;**169**:e150277. doi:10.1001/jamapediatrics.2015.0277

30 Darmstadt GL, Walker N, Lawn JE, *et al.* Saving newborn lives in Asia and Africa: Cost and impact of phased scale-up of interventions within the continuum of care. *Health Policy Plan* 2008;**23**:101–17. doi:10.1093/heapol/czn001

31 Khan J, Vesel L, Bahl R, *et al.* Timing of Breastfeeding Initiation and Exclusivity of Breastfeeding During the First Month of Life: Effects on Neonatal Mortality and Morbidity—A Systematic Review and Meta-analysis. *Matern Child Health J* 2015;**19**:468–79.

32 WHO (World Health Organization), UNICEF (United Nations Children's Fund). Global

Strategy for Infant and Young Child Feeding. *World Heal Organ* 2003;:1–30. doi:ISBN 92 4 156221 8

33 Adhikari M, Khanal V, Karkee R, *et al.* Factors associated with early initiation of breastfeeding among Nepalese mothers: further analysis of Nepal Demographic and Health Survey, 2011. *Int Breastfeed J* 2014;**9**:21. doi:10.1186/1746-4358-7-1

34 Goudar SS, Dhaded SM, Mcclure EM, *et al.* ENC training reduces perinatal mortality in Karnataka, India. *J Matern Neonatal Med* 2012;**25**:568–74. doi:10.3109/14767058.2011.584088

35 Prior E, Santhakumaran S, Gale C, *et al.* Breastfeeding after cesarean delivery: A systematic review and meta-analysis of world literature. *Am J Clin Nutr* 2012;**95**:1113–35. doi:10.3945/ajcn.111.030254

36 Boccolini CS, Carvalho ML, Oliveira MIC, *et al.* Factors associated with breastfeeding in the first hour of life. *Rev Saude Publica* 2011;**45**:69–78.www.scielo.br/rsp

37 Leal MDC, Esteves-Pereira AP, Nakamura-Pereira M, *et al.* Burden of early-term birth on adverse infant outcomes: a population-based cohort study in Brazil. *BMJ Open* 2017;**7**:e017789. doi:10.1136/bmjopen-2017-017789

38 Leal MDC, Esteves-Pereira AP, Nakamura-Pereira M, *et al.* Prevalence and risk factors related to preterm birth in Brazil. *Reprod Health* 2016;**13**. doi:10.1186/s12978-016-0230-0

39 Lassi ZS, Middleton PF, Crowther C, *et al.* Interventions to Improve Neonatal Health and Later Survival: An Overview of Systematic Reviews. *EBioMedicine* Published Online First: 2015. doi:10.1016/j.ebiom.2015.05.023

40 Viellas EF, Domingues RMSM, Dias MAB, *et al.* Prenatal care in Brazil. *Cad Saude Publica* 2014;**30 Suppl 1**:S1-15. doi:S0102-311X2014001300016 [pii]

41 Lassi ZS, Salam RA, Das JK, *et al.* Essential interventions for maternal, newborn and child health: background and methodology. *Reprod Health* 2014;**11**:S1. doi:10.1186/1742-4755-11-S1-S1

42 Tudor Hart J. THE INVERSE CARE LAW. *Lancet* 1971;**297**:405–12. doi:10.1016/S0140-6736(71)92410-X

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	Page 1, lines 3-4
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 5
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 6, lines 12-18
Methods			
Study design	4	Present key elements of study design early in the paper	Page 6, lines 29-38
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 6, line 34; page 7, lines 42-43
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	Page 6, line 44 to page 7, line 29
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 8, line 13 to page 9, line 5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 7, line 34 to page 8, line 5
Bias	9	Describe any efforts to address potential sources of bias	*Page 10, line 9-22*
Study size	10	Explain how the study size was arrived at	Page 6, line 44
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 9, lines 11-21
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Page 9, line 54 to page 10, line 22
		(*b*) Describe any methods used to examine subgroups and interactions	Page 9, line 11 to page 10, line 22
		(*c*) Explain how missing data were addressed	Page 7, line 27-28
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Page 10, lines 18-22

		(*e*) Describe any sensitivity analyses	Page 10, lines 3-18
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Page 10, line 54 to page 11, line 35
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 10, line 54 to page 11, line 35
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	Pages 10, line 54 to page 18
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Pages 11, lines 37-46; pages 15-16
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Page 11, line 48 to page 12, line 17
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 19, lines 15-19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 22, lines 18-35
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 19, line 22 to page 22, line 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 19, line 22 to page 22, line 9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Page 24, line 3-11

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.