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Effects of Essential Newborn Care Training on Fresh Stillbirths and Early Neonatal Deaths by Maternal Education

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Key Words

Education · Neonatal mortality · Developing countries · Low and mid resource countries

Abstract

Background: Infants of women with lower education levels are at higher risk for perinatal mortality. ***Objectives:*** We explored the impact of training birth attendants and pregnant women in the Essential Newborn Care (ENC) Program on fresh stillbirths (FSBs) and early (7-day) neonatal deaths (END) by maternal education level in developing countries. ***Methods:*** A train-the-trainer model was used with local instructors in rural communities in six countries (Argentina, Democratic Republic of the Congo, Guatemala, India, Pakistan, and Zambia). Data were collected using a pre-/post-active baseline controlled study design. ***Results:*** A total of 57,643 infants/mothers were enrolled. The follow-up rate at 7 days of age was 99.2%. The risk for FSB and END was higher for mothers with 0–7 years of education than for those with ≥8 years of education during both the pre- and post-ENC periods in unadjusted models and in models adjusted for confounding. The effect of ENC differed as a function of maternal education for FSB (interaction $p = 0.041$) without evidence that the effect of ENC differed as a function of maternal education for END. The model-based estimate of FSB risk was reduced among mothers with 0–7 years of education (19.7/1,000 live births pre-ENC, CI: 16.3, 23.0 vs. 12.2/1,000 live births post-ENC, CI: 16.3, 23.0, $p < 0.001$), but was not significantly different for mothers with ≥8 years of education, respectively. ***Conclusion:*** A low level of maternal education was associated with higher risk for FSB and END. ENC training was more effective in reducing FSB among mothers with low education levels.

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Introduction

An estimated 6.3 million deaths occur annually worldwide in children aged <5 years, and of these 44% occur during the first 4 weeks after birth, mostly during the first 7 days after birth [1]. Causes of early neonatal mortality [sometimes classified as fresh stillbirths (FSBs)] include birth asphyxia, complications of low birth weight/prematurity, and infection [2]. More than 50% of the <5 years and neonatal deaths occur in South Asia and Africa [1]. Many countries in these areas were on the priority list for the Millennium Development Goal 4 (MDG4), which aimed at reducing childhood mortality by two thirds between 1990 and 2015 [3]. In these priority countries, 50% or less of adult females are literate [4] and the poverty levels are high with most living on less than USD 1.00 per day [5].

Studies have suggested that maternal education is a predictor of neonatal outcomes with newborns of more educated women having better survival [6, 7]. In a recent study, brief antenatal education increased mothers' understanding of basic newborn care [8]. Mothers retained this knowledge until the early postpartum period and during early infancy. In a previous study by us, World Health Organization Essential Newborn Care (ENC) training of college-educated midwives working in low-risk health centers in large urban settings to practice and teach mothers basic care reduced early neonatal mortality in Zambia, and the reduction was largest among newborns of mothers with low education levels [9]. These results suggest that women with lower education levels may benefit most from a basic education intervention and led to the current secondary analysis of the First Breath Study [10] as the latter study was conducted in rural areas of multiple countries and included a diverse group of birth attendants and health care workers. We explored the role of maternal education and birth attendant training on birth outcomes. In the First Breath Study, we reported that a postnatal intervention based on ENC reduced stillbirths. Because it is difficult to distinguish between FSB and death soon after birth, many experts recommend analyzing FSB and early neonatal death (END) rates in low-resource settings. Thus, we hypothesized that training birth attendants in a simplified ENC program was associated with a larger reduction in FSBs and ENDs as well as the combination of the two denoted as perinatal mortality among women with lower compared to higher education levels.

Materials and Methods

Study Sites and Population

This study is a secondary analysis of the active baseline design pre- and post-ENC part of the First Breath Study [10]. The study was conducted in 96 rural communities at seven sites of the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) Global Network for Women's and Children's Health Research involving six countries [Argentina, Democratic Republic of the Congo, Guatemala, India (2 sites), Pakistan, and Zambia] between March 2005 and February 2007. Rural and geographically distinct communities with at least 300 births per year were selected. Most communities had high rates of home births assisted by traditional birth attendants. The sample size was determined based on enough power to identify a mortality effort [10]. Pre- and posttraining of birth attendants in ENC was done. The elements of ENC included neonatal resuscitation, thermoregulation, early and exclusive breast feeding, kangaroo (skin-to-skin) mother care, and care of the small baby. The birth attendants taught the mothers essential newborn care concepts. The study included collection of baseline data (pre-ENC) followed by data collection after training (post-ENC).

Maternal and neonatal data were collected for all births (including FSB) with a birth weight of ≥1,500 g. Fetuses and neonates with birth weight <1,500 g were excluded from the analyses because advanced medical care for very-low-birth-weight infants was not available in most of the participating communities. In cases in which the birth weight was not measured, infants were included if the weight was estimated by the birth attendant to be ≥1,500 g.

Data Management and Statistical Analysis

Data edits, including inter- and intraform consistency checks, were performed upon data entry locally and by the data coordinating center (RTI International, Research Triangle Park, N.C., USA). Multivariable logistic and proportional odds regression models with generalized estimating equations adjusting for cluster were used to determine differences in maternal and neonatal characteristics between the pre-ENC training and post-ENC training for mothers with 0–7 years of education and mothers with ≥8 years of education. Logistic models were used for binary data, proportional odds models with cumulative logit were used for ordered multinomial variables, and proportional odds models with generalized logit were used for non-ordered multinomial variables. Estimates of risk and associated adjusted relative risk (RR) and 95% CI from generalized estimating equation extensions of robust Poisson regression models adjusting for clustering are reported for FSB and END as a function of the ENC training period, maternal education, the interaction of ENC and education, controlling for cluster prenatal care, birth attendant type, gestational age, and birth weight. The data were analyzed using SAS software version 9.2 (Cary, N.C., USA).

Results

A total of 57,819 pregnant women (pre-ENC 22,745 and post-ENC 35,074) were screened and 57,642 (99.7%) were enrolled (pre-ENC 22,625 and post-ENC 35,017) as

Table 1. Maternal and neonatal demographic characteristics

Characteristic	Pre-ENC	Post-ENC	Total
Screened	22,745	35,074	57,819
Enrolled	22,625 (99.5)	35,017 (99.8)	57,642 (99.7)
Region	22,625	35,017	57,642
Africa	4,075 (18.0)	10,492 (30.0)	14,567 (25.3)
Asia	13,595 (60.1)	17,877 (51.1)	31,472 (54.6)
Latin America	4,955 (21.9)	6,648 (19.0)	11,603 (20.1)
Maternal education	22,576	34,936	57,512
0–7 years	19,280 (85.4)	30,342 (86.9)	49,622 (86.3)
≥8 years	3,296 (14.6)	4,594 (13.1)	7,890 (13.7)
Maternal age	22,576	34,937	57,513
<20 years	2,656 (11.8)	4,219 (12.1)	6,875 (12.0)
20–35 years	18,483 (81.9)	28,245 (80.8)	46,728 (81.2)
≥36 years	1,437 (6.4)	2,473 (7.1)	3,910 (6.8)
Received prenatal care	22,571	34,913	57,484
Yes	19,345 (85.7)	32,410 (92.8)	51,755 (90.0)
No	3,226 (14.3)	2,503 (7.2)	5,729 (10.0)
Birth location	22,625	35,000	57,625
Home/other	14,933 (66.0)	22,915 (65.5)	37,848 (65.7)
Clinic	1,712 (7.6)	3,704 (10.6)	5,416 (9.4)
Hospital	5,980 (26.4)	8,381 (23.9)	14,361 (24.9)
Birth attendant	22,623	34,978	57,601
Physician	4,061 (18.0)	5,311 (15.2)	9,372 (16.3)
Nurse/midwife/LHW	7,326 (32.4)	8,531 (24.4)	15,857 (27.5)
Trained TBA	7,521 (33.2)	13,718 (39.2)	21,239 (36.9)
Untrained/family/other	3,715 (16.4)	7,418 (21.2)	11,133 (19.3)
Gestational age	22,566	34,911	57,477
Term	21,788 (96.6)	33,843 (96.9)	55,631 (96.8)
Preterm	778 (3.4)	1,068 (3.1)	1,846 (3.2)
Gender	22,567	34,937	57,504
Male	11,781 (52.2)	18,262 (52.3)	30,043 (52.2)
Female	10,786 (47.8)	16,675 (47.7)	27,461 (47.8)
Birth weight (measured)	22,625	35,017	57,642
1,500–2,000 g	929 (4.1)	1,560 (4.5)	2,489 (4.3)
2,001–2,500 g	4,477 (19.8)	7,420 (21.2)	11,897 (20.6)
≥2,501 g	13,679 (60.5)	24,820 (70.9)	38,499 (66.8)
Unknown	3,540 (15.6)	1,217 (3.5)	4,757 (8.3)
Mean (SD)	2,886.9 (522.8)	2,907.3 (516.2)	2,900.0 (518.7)
Resuscitated	22,572	34,938	57,510
Yes	1,313 (5.8)	1,492 (4.3)	2,805 (4.9)
No	21,259 (94.2)	33,446 (95.7)	54,705 (95.1)

Values represent n (%) unless otherwise indicated. LHW = Lady health worker (Pakistan); TBA = traditional birth attendant.

shown in table 1. Most of the women had 0–7 years of education (86.3%) and were 20–35 years old (81.2%). About 90% of the women received prenatal care and 65.7% of the women delivered at home. The follow-up rate at 7 days of age was 99.2% and did not vary by group.

During both the pre- and post-ENC periods, women with 0–7 years of education were older, had a lower rate of antenatal care, and delivered more often at home with traditional birth attendants rather than in facilities with physicians compared to women with ≥8 years of education (table 2). During the post-ENC training period, the crude rate of FSB was lower than during the pre-ENC period among mothers with 0–7 years of education (FSB was 21.6/1,000 live births pre-ENC vs. 13.5/1,000 live

Table 2. Characteristics by maternal education

Characteristic	0–7 years of education			≥8 years of education		
	Pre-ENC	Post-ENC	p	Pre-ENC	Post-ENC	p
Total	19,280	30,342		3,296	4,594	
Maternal age	19,280	30,338	0.3923	3,296	4,594	0.3664
<20 years	2,080 (10.8)	3,436 (11.3)		576 (17.5)	783 (17.0)	
20–35 years	15,863 (82.3)	24,589 (81.1)		2,620 (79.5)	3,652 (79.5)	
≥36 years	1,337 (6.9)	2,313 (7.6)		100 (3.0)	159 (3.5)	
Prenatal care	19,275	30,320	0.0006	3,296	4,588	0.0551
Yes	16,230 (84.2)	27,986 (92.3)		3,115 (94.5)	4,421 (96.4)	
No	3,045 (15.8)	2,334 (7.7)		181 (5.5)	167 (3.6)	
Birth location	19,280	30,327	0.0650	3,296	4,592	0.5757
Home/other	13,715 (71.1)	21,300 (70.2)		1,192 (36.2)	1,592 (34.7)	
Clinic	1,344 (7.0)	3,056 (10.1)		364 (11.0)	639 (13.9)	
Hospital	4,221 (21.9)	5,971 (19.7)		1,740 (52.8)	2,361 (51.4)	
Birth attendant	19,279	30,311	0.0003	3,296	4,586	0.0002
Physician	2,774 (14.4)	3,716 (12.3)		1,271 (38.6)	1,562 (34.1)	
Nurse/midwife/LHW	6,253 (32.4)	6,865 (22.6)		1,067 (32.4)	1,641 (35.8)	
TBA trained	6,882 (35.7)	12,714 (41.9)		623 (18.9)	995 (21.7)	
Untrained/family/other	3,370 (17.5)	7,016 (23.1)		335 (10.2)	388 (8.5)	
Gestational age	19,250	30,287	0.1518	3,293	4,584	0.9411
Term	18,626 (96.8)	29,429 (97.2)		3,141 (95.4)	4,377 (95.5)	
Preterm	624 (3.2)	858 (2.8)		152 (4.6)	207 (4.5)	
Gender	19,250	30,310	0.8812	3,294	4,586	0.4350
Male	10,028 (52.1)	15,775 (52.0)		1,741 (52.9)	2,466 (53.8)	
Female	9,222 (47.9)	14,535 (48.0)		1,553 (47.1)	2,120 (46.2)	
Birth weight (measured)	16,189	29,286	0.9400	2,878	4,475	0.6149
1,500–2,000 g	795 (4.9)	1,370 (4.7)		129 (4.5)	179 (4.0)	
2,001–2,500 g	3,929 (24.3)	6,656 (22.7)		541 (18.8)	750 (16.8)	
≥2,501 g	11,465 (70.8)	21,260 (72.6)		2,208 (76.7)	3,546 (79.2)	
Resuscitated	19,254	30,310	0.0006	3,295	4,587	0.0649
Yes	1,067 (5.5)	1,224 (4.0)		238 (7.2)	259 (5.6)	
No	18,187 (94.5)	29,086 (96.0)		3,057 (92.8)	4,328 (94.4)	
FSB, n/n (rate/1,000)	415/19,213 (21.6)	409/30,250 (13.5)	0.0008	21/3,283 (6.4)	33/4,574 (7.2)	0.7072
Early neonatal deaths, n/n (rate/1,000)	454/18,734 (24.2)	721/29,630 (24.3)	0.9099	55/3,241 (17.0)	65/4,461 (14.6)	0.4091
Fresh SB + END, n/n (rate/1,000)	869/19,149 (45.4)	1,130/30,039 (37.6)	0.0059	76/3,262 (23.3)	98/4,494 (21.8)	0.6208

Values represent n (%) unless otherwise indicated.

births post-ENC training, $p < 0.001$), but was not significantly different for mothers with ≥8 years of education (FSB was 6.4/1,000 live births pre-ENC vs. 7.2/1,000 live births post-ENC training, $p = 0.70$). END did not differ between the two periods for mothers with 0–7 or ≥8 years of education. FSB and END were higher for the mothers with 0–7 vs. ≥8 years of education during both the pre-ENC and post-ENC periods.

We evaluated the interaction between years of maternal education and ENC with and without adjusting for potentially confounding variables (birth weight and gestational age), prenatal care, and birth attendant type. Detailed results from these models are shown in table 3. The models that did not adjust for covariates suggested that the effect of ENC differed as a function of maternal education for FSB (interaction $p = 0.041$), but showed no evidence that the effect of ENC differed as a function of maternal education for END ($p = 0.47$ for the interaction). The unadjusted RR of FSB post-ENC compared to pre-ENC was 0.62 (95% CI: 0.49, 0.78) for mothers with 0–7 years of education while the unadjusted RR of FSB post-ENC compared to pre-ENC was 1.12 (95% CI: 0.70, 18.2) for mothers with ≥8 years of education. The adjusted results are included in table 3. While the p value for the interaction is attenuated somewhat for the adjusted models, the magnitudes of the adjusted RR estimates are quite comparable, suggesting that this effect is not mediated through either birth attendant or prenatal care.

Because the model for END showed no evidence of an interaction between education and ENC, we fit reduced models that included main effects for ENC and maternal education both with and without adjustment for the po-

Table 3. Model-based estimates of outcomes as a function of ENC and maternal education

	Outcome	
	FSBs	7-day neonatal mortality
Rates per 1,000 by ENC and maternal education, rate (95% CI)		
Pre-ENC, <7 years[a]	25.2 (20.4, 31.1)	27.9 (23.1, 33.6)
Pre-ENC, ≥8 years[a]	9.8 (6.6, 14.8)	23.0 (17.2, 30.)
Post-ENC, <7 years[a]	16.5 (13.1, 20.9)	27.6 (23.3, 32.7)
Post-ENC, ≥8 years[a]	11.0 (7.7, 15.7)	20.0 (15.0, 26.7)
Interaction p value[a]	0.0617	0.4347
ENC p value, maternal education <7 years[a]	0.0005	0.9267
ENC p value, maternal education ≥8 years[a]	0.6272	0.3959
Maternal education RR, <7 vs. ≥8 (95% CI)[b]		1.30 (1.07, 1.59)
ENC RR, post vs. pre (95% CI)[b]		0.98 (0.81, 1.18))
ENC RR, post vs. pre for education <7 years (95% CI)[a]	0.66 (0.52, 0.83)	
ENC RR, post vs. pre for education ≥8 years (95% CI)[b]	1.11 (0.72, 1.72)	

[a] Based on a model that contains interaction terms for ENC and maternal education, adjusted for cluster, prenatal care, and birth attendant type. [b] Based on a model that contains only the main effect terms for ENC and maternal education, adjusted for cluster, prenatal care, and birth attendant type.

tential confounders (table 3). The unadjusted models for END did not show an effect of ENC (RR = 0.97, 95% CI: 0.81, 1.18; p = 07.9), but showed a strong effect of maternal education averaged across both periods (RR = 1.33, 95% CI: 1.10, 1.66; p = 0.0038). The change in the magnitude of the RR for both ENC and maternal education was minimal after adjustment for the potential confounders, prenatal care, and birth attendant, both individually and in combination.

Conclusions

The current analysis shows that the impact of reduced FSB rates was larger among mothers who had little or no formal education (0–7 years) than among those with more education. In spite of the reduction in FSB rates following ENC training, the risk for FSB remained significantly higher among those with a lower education level compared to those with a higher education level. The reason for the effect on FSB rather than on END may be due to the common misclassification in low-resource settings of identifying deaths soon after birth as FSB rather than END [10]. Thus, the reductions of FSBs can be in large part interpreted as a reduction of deaths at birth. It is likely that access to better trained birth attendants for the less educated mothers led to the reduction in stillbirths.

The strengths of this study include the use of large multicountry community-based data with high (99%) completeness of outcome information assessed prospectively by birth attendants trained in distinction between causes and timing on perinatal deaths. Even though demographic and medical data were collected, data on many socioeconomic variables which may be associated with adverse perinatal outcomes were not collected. Nonetheless, maternal education is a pragmatic proxy of adverse perinatal outcomes that may be used to identify women and settings in which perinatal education programs may be most effective.

Maternal education has been observed to be inversely associated with perinatal, neonatal, and/or infant mortality in low- and middle- [6–8, 11–14] as well as high-resource settings [15]. In a large study of data in Indonesia spanning over a decade, lower neonatal mortality was observed when the mother had a higher education level [14]. In the United States, infant mortality decreases were found to be associated with higher levels of maternal education rather than birth weight [16], which is one of the best predictors on infant mortality. In Nepal, mortality at 5 years was 93 per 1,000 live births among children born to mothers with no education and more than seven times higher than that of children born to a mother with a school certificate (13 per 1,000 live birth) [17]. Even high mortality rates in children <5 years have been associated in part with mothers having no or only primary education [18]. Improved maternal education has been associated with reduced perinatal and neonatal mortality [19, 20]. Mothers with more advanced education are more

likely to use good neonatal practices such as clean cord care and early breastfeeding [21]. Limited education may be a marker of poor health-seeking behavior and lifestyle as well as social disadvantage [22–24]. A brief maternal education program increased mothers' basic newborn care knowledge [8]. The current study contributes new information as brief essential newborn care training program directed at birth attendants and mothers resulted in a large reduction in adverse perinatal outcomes even after adjustment for baseline risks. In a more recent cohort of the Global Network, maternal mortality was higher in mothers with less education [25].

Because women in many rural communities have limited or no access to health care facilities but rely on home birth with midwives and traditional birth attendants, efforts have been made to improve outcomes through community-based interventions. In a study in Iraq, having the delivery supervised by a traditional birth attendant was associated with young maternal age, low education, and being poor [18]. In a cluster randomized controlled trial of training traditional birth attendants in the Safe Motherhood modules, there was a 30% reduction in perinatal mortality [23]. In the First Breath Study on which the current study is based, ENC training reduced stillbirth rates in community-based deliveries [10]. A simplified educational program for birth attendants and mothers based on ENC reduced neonatal mortality in a large study in first-level facilities in Zambia [26], but the benefits were more pronounced in the infants of mothers with less education [9]. Simplified ENC programs (Essential Care for Every Baby and Essential Care for Small Babies) [27], which also include teaching the mothers, are being implemented worldwide.

Although community enhancement is one approach, improving mothers' level of education and socioeconomic status is fundamental to long-term improvements in perinatal and childhood survival [24]. Expansion of maternal health services utilization may be accelerated with primary maternal education [28]. Efforts to improve maternal and newborn health must go hand in hand with improving women's education. Training in ENC is very cost-effective so it should be provided even in low-resource settings [29]. It has been estimated that training in neonatal care may save between 244,000 to >1 million lives per year [30].

In summary, low levels of maternal education is a risk for increased perinatal mortality. Maternal education was significantly associated with higher risk for FSB and END. ENC training of birth attendants reduced the FSB risk among mothers with 0–7 years of education but not in mothers with higher education. Focusing perinatal education training programs on birth attendants who deliver women with low levels of education may have a large impact on perinatal outcomes and increase equity.

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