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Maternal and neonatal characteristics that influence early neonatal deaths in a maternity teaching hospital

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Abstract

Background and objective: Low early neonatal death reflects health care progress in any country. We aimed to determine the prevalence of early neonatal deaths and the associated maternal and neonatal factors in a hospital-based study.

Methods: This audit study was conducted on all newborns in the labor ward and neonatal intensive care unit of a maternity teaching hospital in Erbil city, Kurdistan Region, Iraq, from January 1, 2020, to December 31, 2020. Fetal and maternal factors were determined and correlated with early neonatal deaths.

Results: The early neonatal death rate was 6.7%. All categories of preterm deliveries (extreme, very, and moderate preterm) were significantly associated with early neonatal deaths (odds ratios [ORs] = 45.1, 6.2, and 2.1, respectively). The primiparous and grand multiparous women had a higher risk of early neonatal deaths (ORs = 8.4 and 13.0, respectively). Obese women had a higher risk of early neonatal deaths (OR = 3.3). The risk of early neonatal deaths was significantly high when the number of antenatal care visits was less than four (OR = 8.1). Delivery by cesarean section was associated with high risk (OR = 3.8). Regarding the Apgar scores in the first and fifth minutes after birth, early neonatal death was significantly higher among those with severely depressed scores.

Conclusion: High parity, inadequate antenatal attendance, obesity, and mode of delivery, were contributing factors to early neonatal deaths. Early prenatal care can assist in the rapid identification and management of risk factors for early neonatal deaths.

Keywords: Early neonatal death; Parity; Low birth weight; Maternal characteristics; Overweight.

Introduction

Low neonatal death, early and late, is a sign of prosperity only happening in advanced health systems and educated societies.[1] Early neonatal death is neonatal death within seven days after birth, and it is sometimes difficult to differentiate between stillbirth and early neonatal death, especially in low-income countries.[2]

Three-quarters of neonatal deaths occur in the first week, and more than one-quarter occur in the first 24 h after birth.[3] According to the World Health Organization (WHO), there are approximately 7000 newborn deaths every day.[4] Internationally, the number of neonatal mortalities has decreased from approximately 5.0 million in 1990 to 2.5 million in 2018.[5]

There seems to be little information regarding the epidemiology of traditional sources and mortality in Iraq among neonates. In the Kurdistan region, the death rate of children was slightly lower than that in other regions of Iraq.[6] Approximately one-third of all infant deaths in the Kurdistan region are neonatal deaths.[7]

The etiology of early neonatal death varies according to the extent of evolution of various regions worldwide. Premature

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neonates and birth malformations contribute to the prevalence of early neonatal mortality.[8] Unexplained causes, such as congenital disorders, have been found to be responsible for a significant proportion of the early neonatal mortality rates.[9,10]

Earlier studies performed in both developed and developing countries have revealed a large number of risk factors for perinatal and neonatal mortality. Some of these risk factors are related to the mother and others to the baby. Perinatal deaths are largely the result of poor maternal health, adverse social conditions, and inadequate care during pregnancy, delivery, and the immediate postpartum period.[11]

In our region, the estimation of data on the frequency and predisposing factors of adverse birth outcomes is an essential step in promoting maternal and child healthcare services. This study aimed to determine the prevalence rate and maternal and neonatal characteristics that influence early neonatal deaths in a hospital-based environment.

Methods

Study Design and Sample

This cross-sectional audit study was conducted in the labor ward and neonatal intensive care unit of maternity teaching hospital, Erbil city, Kurdistan Region, Iraq, from January 1, 2020, to December 31, 2020, on all early neonatal deaths.

Maternity Teaching Hospital is the only public maternity hospital in Erbil city for all women from different backgrounds.

Early neonatal death was defined as death between 0 and 7 days of birth.[12]

Inclusion and exclusion criteria

All newborns up to the end of the first week after birth whose mothers agreed to participate in the research were included in the study.

The newborns of mothers who denied participating in the study were excluded.

Data collection

Data were collected in the labor ward and neonatal intensive care unit. The neonatal intensive care unit is a well-equipped unit in the hospital for managing newborn babies. During the year of the study, 4355 newborns were admitted to the neonatal intensive care unit.

The total number of births in the Maternity Teaching Hospital during the period of the study was 21,732. All neonatal and maternal characteristics were recorded using data extraction sheets. Maternal information included maternal age, parity, educational level, mode of delivery (vaginal or cesarean), antenatal care visits, and information regarding pregnancy complications (hypertension disorder during pregnancy, diabetes mellitus in pregnancy, and antepartum hemorrhage).

For women whose pregnancies are progressing normally minimum of four antenatal care visits were recorded to be adequate, depending on a report from National Institute for Health and Care Excellence 2013.[13]

Body mass index (BMI) was defined for all women depending on the body weight before pregnancy or in the early first trimester in kilograms divided by the square of the height in meters (kg/m^2). The BMI was categorized as follows: normal weight 18.5–24.9, pre-obesity 25–29.9, obesity class 1 30–34.9, obesity class 2 35–39.9, and obesity class 3 >40.[14]

An expert neonatologist evaluated all neonates during the week following birth. Pregnancy outcomes, including gestational age in weeks, newborn weight in grams, sex of the neonate, presence of frank congenital anomalies, and Apgar score in the first minute and 5 minutes after delivery, were also recorded.

Extremely preterm labor was defined as <28 weeks, very preterm as 28 to <32 weeks, and late-preterm as 32 to <37 weeks of gestation.[15] Birth weight was categorized as high birth weight ≥4000 g, normal birth weight ≥2500–4000 g, low birth weight (LBW)=1500–2499 g, very LBW=1000–1499 g, and extremely LBW ≤999 g.[16]

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The Apgar score was classified as low (0–3), moderately abnormal (4–6), or reassuring (7–10).[17]

Statistical Analysis

Data were analyzed using the statistical package for the social sciences (SPSS, version 25). The Chi-square test of association was used to compare the proportions. Fisher's exact test was used when the expected count of more than 20% of the cells in the table was less than 5. Variables significantly associated with neonatal death (using the Chi-square test) were entered into a binary logistic regression model. Statistical significance was set at $P \leq 0.05$.

Ethical Considerations

The Ethics and Scientific Committee of the Kurdistan Board of Medical Specialties approved this study on July 15, 2019 (no. 1050). Written informed consent was obtained from each woman who agreed to participate in the study at the time of the first interview. All participants were assured that their information would be kept confidential and would be used for research purposes only. All interviews were conducted following the ethical standards of the Institutional Research Committee and the Declaration of Helsinki for Ethical Principles for Medical Research Involving Human Subjects.

Results

The total number of neonates admitted to the neonatal intensive care unit in the maternity teaching hospital and included in the study was 4355. The early neonatal death rate was 6.7% during the study.

The mean age of the mothers was 28.4 ± 6.7 years, with a median of 28 years and an age range of 16–47 years.

Table 1 shows that 5.4% of the women were aged less than 20 years, 6.1% were aged ≥40 years, and the highest proportion of women (27.3%) was aged 20–24. The other characteristics of the mothers are presented in Table 1.

The rate of early neonatal deaths in the entire sample was 6.7% (Table 2). It is evident in the table that there was a significant association ($P = 0.029$) between age and the outcome. The highest death rate (10.9%) was among women aged 40 years or older, and the lowest rate (5.7%) was in the 20-24 year age group.

The table shows that the higher the gestational age, the lower the early neonatal death rate ($P < 0.001$). The death rate was the lowest (4%) among the multiparous women, while it was 21.3% among the primiparous women and 21.7% among the grand multiparous women ($P < 0.001$). All neonates with a family history of congenital anomalies died, compared to the mortality rate of 6.2% among those with no such history ($P < 0.001$). No significant association was detected between smoking and early neonatal death ($P = 0.979$). The rate of early neonatal deaths was 27.9% when there was a history of miscarriage compared to 5.4% without a history of miscarriage ($P < 0.001$). Higher rates of deaths were detected among women with normal weight (12.7%) or those who were obese (9.1%) than among those who were overweight (6.2%) ($P = 0.001$). Finally, the death rate was significantly higher among women with fewer than four antenatal care visits (15.4%) compared to 3.2% among those with four or more visits ($P < 0.001$), as presented in Table 2.

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Table 1 Basic characteristics of the mothers

Characteristic	No.	(%)
Age (years)		
<20	234	(5.4)
20–24	1188	(27.3)
25–29	1159	(26.6)
30–34	786	(18.0)
35–39	722	(16.6)
≥40	266	(6.1)
Gestational age (weeks)		
Extreme preterm (24–27)	110	(2.5)
Very preterm (28–31)	346	(7.9)
Moderate preterm (32–36)	1369	(31.4)
Term (≥37)	2530	(58.1)
Parity		
Primipara	315	(7.2)
Multipara	3676	(84.4)
Grand multipara	364	(8.4)
Educational level		
Illiterate and read and write	167	(3.8)
Primary	1459	(33.5)
Intermediate	1193	(27.4)
Secondary	1148	(26.4)
Higher	388	(8.9)
Family history of congenital anomalies		
Yes	25	(0.6)
No	2330	(99.4)
Smoking		
Yes	505	(11.6)
No	3850	(88.4)
Miscarriage		
No	4111	(94.4)
Yes	244	(5.6)
BMI (Kg/m^2)		
Below 18.5	0	0
18.5- 24.9	110	(2.5)
25–29	3673	(84.3)
≥30	572	(13.1)
Number of antenatal care visits		
<4 (Inadequate)	1263	(29.0)
≥4 (Adequate)	3092	(71.0)
Total	4355	(100.0)

BMI, body mass index

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Table 2 Neonatal outcome according to maternal characteristics

Characteristic	Alive		END		Total		
	No.	(%)	No.	(%)	No.	(%)	*P* value
Age (years)							
<20	216	(92.3)	18	(7.7)	234	(100.0)	
20–24	1120	(94.3)	68	(5.7)	1188	(100.0)	
25–29	1088	(93.9)	71	(6.1)	1159	(100.0)	
30–34	724	(92.1)	62	(7.9)	786	(100.0)	
35–39	678	(93.9)	44	(6.1)	722	(100.0)	
≥40	237	(89.1)	29	(10.9)	266	(100.0)	0.029
Gestational age (weeks)							
Extreme preterm	64	(58.2)	46	(41.8)	110	(100.0)	
Very preterm	255	(73.7)	91	(26.3)	346	(100.0)	
Moderate preterm	1279	(93.4)	90	(6.6)	1369	(100.0)	
Term	2465	(97.4)	65	(2.6)	2530	(100.0)	<0.001
Parity							
Primipara	248	(78.7)	67	(21.3)	315	(100.0)	
Multipara	3530	(96.0)	146	(4.0)	3676	(100.0)	
Grand multipara	285	(78.3)	79	(21.7)	364	(100.0)	<0.001
Family history of congenital anomalies							
Yes	0	(0.0)	25	(100.0)	25	(100.0)	
No	4063	(93.8)	267	(6.2)	4330	(100.0)	<0.001*
Smoking							
Yes	471	(93.3)	34	(6.7)	505	(100.0)	
No	3592	(93.3)	258	(6.7)	3850	(100.0)	0.979
Miscarriage							
No	3887	(94.6)	224	(5.4)	4111	(100.0)	
Yes	176	(72.1)	68	(27.9)	244	(100.0)	<0.001
BMI (Kg/m^2)							
18.5-24.9	96	(87.3)	14	(12.7)	110	(100.0)	
25–29	3447	(93.8)	226	(6.2)	3673	(100.0)	
≥30	520	(90.9)	52	(9.1)	572	(100.0)	0.001
Number of antenatal care visits							
<4	1069	(84.6)	194	(15.4)	1263	(100.0)	
≥4	2994	(96.8)	98	(3.2)	3092	(100.0)	<0.001
Total	4063	(93.3)	292	(6.7)	4355	(100.0)	

* Fisher's exact test

END: Early neonatal deaths, BMI: Body mass index

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Table 3 shows that there was no significant association between the sex of the baby and the rate of early neonatal death (*P* = 0.676). The association was significant with the mode of delivery, where it is evident that the death rate was 7.6% among cesarean section deliveries compared to 6% among vaginal deliveries (*P* = 0.041). The early neonatal death rate was 5.5% when there were no complications during pregnancy. However, it was as follows with the following complications: antepartum hemorrhage (100%), hypertension disorder in pregnancy (42%), diabetes (28.3%), and hypertension and diabetes (100%) (*P* <0.001). All neonates with congenital anomalies died compared to the early neonatal death rate of 5.6% among those with no anomalies (*P* <0.001). A significant association was detected between LBW and high rates of early neonatal deaths (*P* <0.001). Regarding the Apgar scores in the first and fifth minutes, higher death rates were associated with low Apgar scores in the two mentioned periods (*P* <0.001).

Table 3 Neonatal outcome according to fetal and neonatal characteristics

Characteristic	Alive		END		Total		
	No.	(%)	No.	(%)	No.	(%)	*P* value
Sex of neonate							
Male	2189	(93.1)	161	(6.9)	2350	(100.0)	
Female	1874	(93.5)	131	(6.5)	2005	(100.0)	0.676
Mode of delivery							
Vaginal	2309	(94.0)	148	(6.0)	2457	(100.0)	
Cesarean	1754	(92.4)	144	(7.6)	1898	(100.0)	0.041
Complications during pregnancy							
APH	0	(0.0)	12	(100.0)	12	(100.0)	
HTD	40	(58.0)	29	(42.0)	69	(100.0)	
DM	38	(71.7)	15	(28.3)	53	(100.0)	
None	3985	(94.5)	230	(5.5)	4215	(100.0)	
HTD and DM	0	(0.0)	6	(100.0)	6	(100.0)	<0.001
Congenital anomalies							
Yes	0	(0.0)	51	(100.0)	51	(100.0)	
No.	4063	(94.4)	241	(5.6)	4304	(100.0)	<0.001*
Neonatal weight							
Extremely LBW	0	(0.0)	29	(100.0)	29	(100.0)	
Very LBW	264	(81.0)	62	(19.0)	326	(100.0)	
LBW	727	(88.1)	98	(11.9)	825	(100.0)	
Normal BW	2864	(96.7)	98	(3.3)	2962	(100.0)	
High BW	208	(97.7)	5	(2.3)	213	(100.0)	<0.001
Apgar 1 min							
Severely depressed	400	(73.0)	148	(27.0)	548	(100.0)	
Moderately depressed	1254	(92.3)	105	(7.7)	1359	(100.0)	
Normal	2409	(98.4)	39	(1.6)	2448	(100.0)	<0.001
Apgar 5 min							
Severely depressed	192	(76.5)	59	(23.5)	251	(100.0)	
Moderately depressed	319	(69.7)	139	(30.3)	458	(100.0)	
Normal	3552	(97.4)	94	(2.6)	3646	(100.0)	<0.001
Total	4063	(93.3)	292	(6.7)	4355	(100.0)	

*By Fisher's exact test
APH: Antepartum hemorrhage, HTD: Hypertension disorders in pregnancy, DM: Diabetes mellitus in pregnancy, LBW: Low birth weight

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The main causes of death were prematurity (43.8%), birth asphyxia (21.2%), and congenital anomalies (16.1%), in addition to the other causes mentioned in Table 4.

Table 5 shows that all the categories of preterm deliveries (extreme, very, and moderate preterm) are significantly associated with early neonatal deaths (odds ratio [ORs] = 45.1, 6.2, and 2.1, respectively) with term deliveries as reference. The primiparous and grand multiparous women had a higher risk for early neonatal deaths than the multiparous women (ORs = 8.4 and 13.0, respectively). Obese women had a higher risk for early neonatal deaths than overweight women (OR = 3.3). When the number of antenatal care visits was less than four, the risk for early neonatal deaths was significantly high (OR = 8.1). The risk was also high when the delivery was by a cesarean section (OR = 3.8). Regarding the Apgar score in the first minute, the risk for early neonatal death was significantly high among those with severely depressed score (OR = 10.1). Finally, the severely and moderately depressed Apgar scores in the fifth minute were significant predictors for early neonatal death compared to the normal Apgar score (ORs = 1.9 and 9.7, respectively). No significant association was detected with the other factors.

Table 4 Causes of death in the newborns

Causes of death	No.	(%)
Prematurity	128	(43.8)
Birth asphyxia	62	(21.2)
Congenital anomalies	47	(16.1)
Respiratory distress	23	(7.9)
Sepsis	17	(5.8)
Hydrops	8	(2.7)
Pulmonary hypertension	7	(2.4)
Total	292	(100.0)

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Table 5 Logistic regression analysis of factors associated with neonatal death

Covariates	B	*P* value	OR	95% CI for OR	
				Lower	Upper
Age ≥40	-0.646	0.074	0.524	0.258	1.064
Gestational age		**<0.001**			
Extreme preterm	3.810	<0.001	45.146	18.341	111.130
Very preterm	1.840	<0.001	6.297	3.034	13.070
Moderate preterm	0.740	0.003	2.096	1.284	3.424
Term (reference)					
Parity		**<0.001**			
Primi-parous	2.135	<0.001	8.459	5.253	13.622
Grand multiparous	2.567	<0.001	13.022	7.679	22.084
Multi-parous (reference)					
BMI (Kg/m^2)		**<0.001**			
<25	0.617	0.167	1.854	0.772	4.453
≥30	1.205	<0.001	3.337	2.106	5.288
25-29 (reference)					
Number of antenatal care visits (<4)	2.087	**<0.001**	8.059	5.647	11.502
≥4 (reference)					
Mode of delivery (Cesarean)	1.354	**<0.001**	3.873	2.710	5.534
Neonatal weight	-0.560	0.061	0.571	0.318	1.025
Apgar score first minute		**<0.001**			
Severely depressed	2.313	<0.001	10.101	5.975	17.076
Moderately depressed	0.160	0.577	1.174	0.668	2.062
Normal (reference)					
Apgar score in the fifth minute		**<0.001**			
Severely depressed	0.648	0.047	1.912	1.008	3.627
Moderately depressed	2.277	<0.001	9.744	5.803	16.361
Normal (reference)					
Constant	-7.019	<0.001	0.001		

OR, Odds ratio; CI, Confidence intervals; BMI, body mass index

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Discussion

Several factors are associated with an increased risk of early neonatal death. In our study, the rate of early neonatal death in the whole sample was 6.7%, which was lower than that reported in the Felege Hiwot Referral Hospital (13.29%),[18] in northern Gonder,[19] and Jimma zone Ethiopia in previous studies.[20]

The variations may be because of methodological differences among studies and dissimilarity in sociocultural, health service utilization, and variations among study participants in the study areas, in addition to the quality of care delivered by the hospital.

We found a significant association between advanced maternal age and early neonatal mortality. In addition, similar findings in other studies revealed that advanced maternal age had a significantly higher rate of fetal death than their younger counterparts did.[21,22]

Regarding parity, we found lower rates of early neonatal death among multiparas compared to high risks associated with prior miscarriage, stillbirth, and premature live births among nulliparous. However, a previous study found no significant differences in adverse perinatal outcomes (including early neonatal death) between multiparas and nulliparous after adjusting for other risk factors.[23] Another study found that the first pregnancies were at a significantly higher risk than the second pregnancies.[22]

Interestingly, we found higher rates of early neonatal death among obese mothers and the lowest rates in overweight and normal weight mothers. This finding was incomparable to Rai et al., who found that overweight mothers had higher odds of early neonatal mortality than mothers with the optimum weight, but an insignificant association was registered for obese mothers.[24] However, this was a survey data from nine Asian countries where the authors concluded that preconception counseling for women with abnormal BMI should be devised, and they must be encouraged for the setting of the delivery at an institution well equipped with an emergency obstetric and neonatal care unit.

Women with a previous history of miscarriage and/or stillbirth had higher rates of early neonatal death. Similarly, Kassar et al. reported that neonatal deaths were significantly and independently associated with prior miscarriage.[25]

We also found a significant reduction in early neonatal death rates in women who had four or more antenatal care visits. Similarly, a previous meta-analysis revealed that antenatal care visits were significantly associated with lower rates of early neonatal death, and the risk of early neonatal death was significantly reduced by 34% among newborns delivered to mothers who had antenatal care visits compared to those with no or reduced visits.[26]

The reduced visit of antenatal care package has been implemented in several countries. A re-analysis found a significantly increased perinatal mortality rate, and this finding persisted after adjustment for potential confounding factors.[27] Accordingly, WHO's 2016 antenatal care model recommended a minimum of eight visits: five in the third trimester, one in the first trimester, and two in the second trimester.[28]

In our study, the association of early neonatal mortality was significantly associated with the mode of delivery, as the death rate was 7.6% among cesarean-section deliveries compared to 6% among vaginal deliveries. However, Ye et al. reported a reduction in neonatal mortality with cesarean sections when they were indicated based on restricted obstetric criteria.[29]

Regarding the presence of obstetric complications, we found increasing rates of early neonatal death with the following factors: combined hypertension disorders in pregnancy/diabetes in pregnancy and antepartum hemorrhage (100%), diabetes alone (28.3%), and hypertension disorder

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in pregnancy (42%). Similarly, a previous study showed increasing perinatal mortality rates (23%) among cases of antepartum hemorrhage and more frequently with abruption placentae (36.3%), while it was 17.4% in placenta previa, particularly premature, LBW babies, and those who were born vaginally.[30] On the other hand, Ananth et al. concluded that the substantial burden of stillbirth and neonatal mortality is associated with pregnancy-induced hypertension, especially among multiparas women, which may be because of more severe disease in women or a higher burden of underlying disease.[31]

Being born preterm increases a baby's risk of dying due to other causes, especially neonatal infections. Most newborn deaths among this group are caused by a lack of simple, essential care, such as warmth and feeding support.[11] We found that all the categories of preterm deliveries (extreme, very, and moderate preterm) were significantly associated with early neonatal death, as complications were more frequent in preterm newborn babies, which is consistent with the results of previous studies.[32,33]

A study in Ethiopia found that 11% of neonates with LBW died before completing their first month of life, mainly during the first week.[34] The risk of dying from LBW during the neonatal period is almost fourfold that of the current estimated national neonatal mortality rates. Maternal obstetric characteristics and fetal maturity (higher rates in preterm infants) were predictors of mortality. Our study detected a significant association between LBW and high rates of early neonatal deaths.

We found that low Apgar scores in the first and fifth minutes were associated with increased rates of early neonatal death and these findings are consistent with those of Mu et al., who observed that neonatal mortality rate with a low Apgar score at 5 min was 28.72%, which was higher than that for births with an intermediate (8.28%) or with a normal Apgar score (0.06%) and that the risk for early neonatal death increased by over 200-fold in groups with scores of 3 or lower.[35] Although all neonates with gross congenital malformations died in our study, Ajao et al.[36] concluded that the mortality rate among neonates with congenital anomalies (mainly cardiac and digestive tract) was 10.4%. Although congenital anomalies were associated with a reduced risk of neonatal mortality compared to those with other acute conditions, this was not statistically significant.

Finally, we found the probably associated factors of early neonatal mortality according to the frequency in the current study: prematurity (43.8%), birth asphyxia (21.2%), and congenital anomalies (16.1%). The findings of a Jordanian study were somewhat close to ours, as the main causes of neonatal deaths that occurred before discharge were respiratory and cardiovascular disorders (43%) and LBW and preterm birth (33%).[37]

However, this study also has some limitations. First, we did not include placental and umbilical cord anomalies in relation to early neonatal deaths. Second, we evaluated only associated factors in relation to early neonatal deaths, but the analysis did not provide a definite cause for the deaths; for instance, in a previous study, a proportion of neonatal deaths from asphyxia were shown to be associated with pre-existing brain injury, which precedes the onset of labor.[38]

Conclusion

The main risk factors for early neonatal deaths were mainly related to maternal, fetal, and birth complications .early prenatal care can assist in the rapid identification and management of risk factors for neonatal deaths to reduce subsequent mortality and morbidity. Furthermore, there is a serious need to establish a clear plan to prevent preterm deliveries, to offer early fetal diagnosis of congenital malformations by providing better antenatal care services with good interaction between obstetricians and

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pediatricians, and to improve the educational status of the community and ensure better family planning.

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Competing interests

The authors declare that they have no competing interests.

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