Original article

Socio-economic factors associated with increased neonatal mortality: A mixed-method study of Bangladesh and 20 other developing countries based on demographic and health survey data

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ABSTRACT

Background: Neonatal mortality is a significant pointer of a country's level of socio-economic development and quality of life. The neonatal mortality rate reduction is an important goal of Sustainable Development Goals (SDGs) as it is decreasing slowly but surely compare to under-five mortality in developing countries. This study desired to determine the prevalence of neonatal mortality and its associated risk factors in developing countries. **Methods:** This study used the latest DHS data of 21 different developing countries, including Bangladesh. Logistic regression model and Meta-Analysis techniques were used in this study.

Results: A logistic regression model reveals that, for Bangladesh mother's higher-level education (OR: 0.591; CI: 0.401–0.872) and father's higher-level education (OR: 0.352; CI: 0.135–0.915), better wealth status (OR: 0.467; CI: 0.275–0.795), being 2nd born and above order neonate (OR: 0.329; CI: 0.216–0.501), above 19 years for delivery (OR: 0.51; CI: 0.341–0.763), being female neonate (OR: 0.352; CI: 0.253–0.49), ANC visit, (OR: 0.206; CI: 0.144–0.296), media access (OR: 0.590; CI: 0.391–0.891) were statistically significant predictors of lowering neonatal death. While being twin birth (OR: 8.815; CI: 4.057–19.153) is revealed as a risk factor of neonatal mortality. These results were justified by meta-analyses for the developing countries as well.

Conclusion: In this study, mother's and father's lower education level, poor wealth status, being 1st born neonate, early maternal age, being male neonate, being twin birth, having no ANC visit, no media access was found to be statistically significant influencing factors of neonatal death in developing countries.

Key points

The number of fetus and the size of the child were positively associated with neonatal mortality but, utilization of ANC, maternal, and paternal education were negatively associated with neonatal mortality in 21 developing countries. This study recommends increasing ANC utilization, ensuring maternal and paternal education to raise awareness regarding neonatal mortality to achieve the targeted goal of reducing neonatal mortality by the Sustainable Development Goal by 2030.

What is new?

Using the DHS data of 21 developing countries, this study has revealed the socio-economic influencing factors and their consistency across the developing countries. This study also showed a mixed-method analysis and compared the logistic regression model results with meta-

analysis results to get more precise results.

1. Introduction

The most vulnerable time of human life for diseases is the neonatal period, which is defined as the duration of the first four weeks or 28 days from birth.^{1,2} In this period, the risk of dying of a child is almost 15 times greater than at any other time during the first year of life.³ Although the total annual deaths of children younger than five years are reducing, the relative magnitude of neonatal death is increasing, and the portion of neonatal death of total yearly deaths of children younger than five years is about 45%.⁴ Approximately 98% of total neonatal death occurs in low-income and middle-income countries, especially in sub-Saharan African and South Asian.^{4–6} Among ten countries with the highest neonatal mortality rate, eight sub-Saharan and 2 are south Asian. In sub-Saharan Africa, 1.2 million newborns died every year alone, which

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Flow Diagram of the process of identifying and including datasets

Fig. 1. Displays the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) flow diagram from which we get a clear illustration of the process of identifying and including DHS datasets for the random effect meta-analysis.

is equivalent to 13000 deaths per day or nine deaths every minute almost.⁷ This neonatal death is influenced by multiple factors and represents a complex interaction among these variables.⁸ Biological factors, socio-economic status, demographics factors, health care system, cultural practices, and technologies are essential determinants of neonatal death.^{9,10} Even a countries socio-economic condition efficiency and effectiveness of healthcare systems as well as achieving optimal education can be standardized by the neonatal morbidity and mortality rates.¹¹ Neonatal death is mostly preventable, and up to two-third of this death can be reduced with the provision of essential newborn care at birth and during the neonatal period.¹² In developed countries, the neonatal mortality rate has been reduced using develop health facility appropriate techniques and proper steps.^{13,14} However, the neonatal mortality rate is still unacceptably high at 37 per 1000 life birth exceeding the global estimate in low-income and middle-income countries.¹⁵

To improve the overall condition, the world introduced the sustainable development goals (SDGs) after millennium development goals (MDGs) in 2015, keeping the maternal, neonatal, child, and adolescent health issues in central.¹⁶ In SDGs, the first three targets of health goals are the continuations of MDGs. The important one is to reduce neonatal mortality to below 12 deaths per 1000 live births and under-five mortality to below 25 deaths per 1000 live births.^{1,17} To achieve the SDGs first, it is essential to explore the factors that contribute to neonatal death. Identifying the cause of neonatal death and triggering factors of neonatal mortality will help to select appropriate strategies to reduce the neonatal mortality rate.¹⁸ In our study, considering the vital facts related to neonatal mortality, we tried to find out the socio-economic and demographic influencing factors of neonatal mortality and their consistency across the 21 developing countries, including Bangladesh. We have introduced a mixed method that was designated to combine data from Bangladesh and 20 other countries, which we think would be more

effective to find out more precious summary results of the influencing factors of neonatal death than using a simple cross-sectional survey and meta-analysis.

2. Materials and methods

2.1. Design

We applied a mixed-method design to conduct the study comprising both binary logistic regression for the cross-sectional survey of Bangladesh and meta-analysis for 21 developing countries. Afterward, we made a comparison between the results of Logistic regression of Bangladesh and the findings of a meta-analysis of 21 developing countries. We could broadly explore the influential determinants of neonatal mortality by employing this approach. All the data were taken from the Demographic and Health Survey (DHS).

2.2. Data source and data extraction

Initially, for this cross-sectional study, we extracted relevant information for analysis from a nationwide representative secondary dataset, Bangladesh Demography and Health Survey 2014, for binary logistic regression.¹⁹ Besides, we conducted a meta-analysis utilizing the recently accessible datasets (accessed in July 2019) from MEASURE DHS (Monitoring and evaluating to Assess and Use Result, Demographic and Health Survey) (www.measuredhs.com). We adopted the recent available DHS data for the other 20 developing countries.²⁰ Which are Afghanistan (2015), Angola (2015–16), Benin (2017–18), Chad (2014–15), Cambodia (2014), Ethiopia (2016), Ghana (2014), Guinea (2018), India (2015–16), Indonesia (2017), Kenya (2014), Lesotho (2014), Myanmar (2015–16), Nepal (2016), Nigeria (2018), Pakistan (2017–18), Sierra Leone (2013), Timor-Leste (2016), Zambia (2013–14), Zimbabwe (2015). DHS program provides high-quality, accessible data for analysis in the form of a questionnaire, which was used as one of the elementary goals of the DHS program. The DHS database contains information from 91 countries (<http://dhsprogram.com/data/available-datasets.com>), but 70 countries were excluded due to excessive missing values, developing countries' checklist, and unavailability of information regarding independent variable in any of the selected countries. Finally, we have chosen Bangladesh along with 20 developing countries that are homogeneous in nature as similar probability sampling for data collection was applied to them (Fig. 1).

3. Variables

In this study, we considered *neonatal mortality* as the dependent variable. The outcome variable, "Neonatal mortality," was recorded as a binary variable. If the live-born infant dies within the first four weeks of its life, we recorded it as "Yes," otherwise "No." We included different relevant socio-economic and demographic factors as independent variables to execute the research and to discover the triggering factors of the neonatal mortality based on the previous literature.^{5,12,18,21,22} We used the standard covariates whose data were available for all selected countries. Commencing with the type of place of residence, sex of the child, and mother working status remained the same as the existing category of DHS datasets. The remaining covariates were subcategorized. We merged no education and primary to up to primary, secondary, and higher in terms of parent's education level for BDHS data. Again, for meta-analysis, we combined secondary and higher to above primary while another category was up to the primary. In the case of binary logistic regression, the wealth index has remained the same as the original data. Further, we changed the label of the variable to Living below the poverty line for the meta-analysis with two categories. We combined poorer and poorest and labeled them as 'yes', which means if the individuals are poor, they certainly live below the poverty line; on the other hand, we combined middle, richer, and richest with the label

Table 1

Frequency distribution of different variables with levels for BDHS data.

Variables	Categories	Frequencies	Percentages
Dependent variables			
Neonatal mortality	No	4586	973 (in 1000)
	Yes	127	27 (in 1000)
Explanatory variables			
Maternal age at delivery	Up to 19 years	1166	24.7
	Above 19 years	3547	75.3
Type of place of residence	Rural	3210	68.1
	Urban	1503	31.9
Mother's education level	Up to primary	1954	41.5
	Secondary	2219	47.1
	Higher	540	11.4
Mass media	No	1811	38.4
	Yes	2902	61.6
Wealth Index	Poorest	1009	21.4
	Poorer	897	19.0
	Middle	899	19.1
	Richer	987	20.8
	Richest	930	19.7
Father's education level	Up to primary	2522	53.5
	Secondary	1472	31.2
	Higher	719	15.3
Mother's working status	No	3682	78.1
	Yes	1031	21.9
Birth order number	1st born	1938	41.1
	2nd and above	2775	58.9
Number of fetus	Single	4651	98.7
	One of multiple	62	1.3
Sex of child	Male	2431	51.6
	Female	2282	48.4
Place of delivery	Home	2857	60.6
	Hospital	1856	39.4
Antenatal care utilization	No	1203	25.5
	Yes	3510	74.5
Size of child	Average	3173	67.3
	Larger than average	614	13.0
	Smaller than average	926	19.6

'no,' which represents the individuals who live above the poverty line. The variable birth order number was categorized as firstborn and 2nd and above born for both binary logistic regression and meta-analysis. Maternal age at delivery was converted into a nominal scale from the continuous form with the category less than or equal to 19 years (≤ 19) and above 19 years.⁹ Categories for the variable number of the fetus were single and multiple for both methods. For binary logistic regression, we subcategorized taking antenatal care (ANC) as no visits, 1–4 visits, more than four visits, whereas, in the meta-analysis, individuals who had at least one ANC visit were considered in the category yes, otherwise no. For the variable mass media, we categorized it as 'yes', which represents access to mass media, and 'no' represents no media access. Variable place of delivery was categorized as Home and Hospital for both logistic regression and meta-analysis. Finally, for the size of the child, we subcategorized the variable as average, larger than average (combined by very large and larger than average), and smaller than average (combined by very small and smaller than average) for the logistic regression analysis. We further recoded this variable for meta-analysis with two independent levels, such as average and larger or smaller than average.

3.1. Statistical analysis

We used statistical software SPSS V.23 (SPSS Inc. Chicago, USA) and R V.3.6.2 (Bell Laboratories, New Jersey, USA) to carry out the analysis. Binary logistic regression was practiced determining the key factors that have an impact on neonatal mortality in Bangladesh using BDHS data.²³ Besides, we applied meta-analysis on the DHS data from 21 developing countries. Heterogeneity was assessed by enumerating values from I^2 and p values among datasets.²⁴ We performed a random-effects model in the meta-analytical approach as significant heterogeneity was found by

Table 2

Different categories of variables and frequency distribution for 21 developing countries DHS data.

Variable														
Country Name	Neonatal mortality (in 1000)		Maternal Age at Delivery n (%)		Residence n (%)		Mother's Education n (%)		Media Access n (%)		Living below Poverty Line n (%)		Father's Education n (%)	
	No	Yes	≤19 years	>19 years	Rural	Urban	Up to primary	Above primary	No	Yes	No	Yes	Up to primary	Above primary
Sierra Leone	9836	328	1143	9021	7377	2787	8828	1336	4287	5877	4613	5551	7616	2548
2013	(968)	(32)	(11.2)	(88.8)	(72.6)	(27.4)	(86.9)	(13.1)	(42.2)	(57.8)	(45.4)	(54.6)	(74.9)	(25.1)
Zambia	11318	263	1231	10350	7389	4192	8026	3555	3836	7745	5607	5974	5719	5862
2013-14	(977)	(23)	(10.6)	(89.4)	(63.8)	(36.2)	(69.3)	(30.7)	(33.1)	(66.9)	(48.4)	(51.6)	(49.4)	(59.6)
Bangladesh	4586	127	1166	3547	3210	1503	1954	2759	1811	2902	1906	2807	2522	2191
2014	(973)	(27)	(24.7)	(75.3)	(68.1)	(31.9)	(41.5)	(58.5)	(38.4)	(61.6)	(40.4)	(59.6)	(53.5)	(46.5)
Cambodia	6981	94	491	6584	5147	1928	4503	2572	1459	5616	3005	4070	3731	3344
2014	(987)	(13)	(6.9)	(93.1)	(72.7)	(27.3)	(63.6)	(36.4)	(20.6)	(79.4)	(42.5)	(57.5)	(52.7)	(47.3)
Ghana 2014	5240	144	260	5124	3269	2115	3078	2306	726	4658	2962	2422	2310	3074
	(973)	(27)	(4.8)	(95.2)	(60.7)	(39.3)	(57.2)	(42.8)	(13.5)	(86.5)	(55.0)	(45.0)	(42.9)	(57.1)
Kenya 2014	9007	184	780	8411	6168	3023	6973	2218	2380	6811	5056	4135	6137	3054
	(980)	(20)	(8.5)	(91.5)	(67.1)	(32.9)	(75.9)	(24.1)	(25.9)	(74.1)	(55.0)	(45.0)	(66.8)	(33.2)
Lesotho 2014	2635	94	314	2415	2071	658	1408	1321	762	1967	1303	1426	1784	945
	(966)	(34)	(11.5)	(88.5)	(75.9)	(24.1)	(51.6)	(48.4)	(27.9)	(72.1)	(47.7)	(52.3)	(65.4)	(34.6)
Chad	16290	454	2575	14169	13274	3470	15393	1351	12598	4146	6560	10184	13746	2998
2014-15	(973)	(27)	(15.4)	(84.6)	(79.3)	(20.7)	(91.9)	(8.1)	(75.2)	(24.8)	(39.2)	(60.8)	(82.1)	(17.9)
Afghanistan	30087	705	2813	27979	23384	7408	28524	2268	12263	18529	12637	18155	21862	8930
2015	(977)	(23)	(9.1)	(90.9)	(75.9)	(24.1)	(92.6)	(7.4)	(39.8)	(60.2)	(41.0)	(59.0)	(71.0)	(29.0)
Zimbabwe	5002	125	509	4618	3218	1909	1554	3573	1268	3859	1982	3145	1137	3990
2015	(976)	(24)	(9.9)	(90.1)	(62.8)	(37.2)	(30.3)	(69.7)	(24.7)	(75.3)	(38.7)	(61.3)	(22.2)	(77.8)
Angola	9028	183	1214	7997	4081	5130	6666	2545	3285	5926	4617	4594	4532	4679
2015-16	(980)	(20)	(13.2)	(86.8)	(44.3)	(55.7)	(72.4)	(27.6)	(35.7)	(64.3)	(50.1)	(49.9)	(49.2)	(50.8)
India	42623	1234	2832	41025	32883	10974	19010	24847	11483	32374	20798	23059	14102	29755
2015-16	(972)	(28)	(6.5)	(93.5)	(75.0)	(25.0)	(43.3)	(56.7)	(26.2)	(73.8)	(47.4)	(52.6)	(32.2)	(67.8)
Myanmar	4420	120	218	4322	3564	976	2791	1749	874	3666	2384	2156	2603	1937
2015-16	(974)	(26)	(4.8)	(95.2)	(78.5)	(21.5)	(61.5)	(38.5)	(19.3)	(80.7)	(52.5)	(47.5)	(57.3)	(42.7)
Ethiopia	9537	290	866	8961	8099	1728	8811	1016	6643	3184	5363	4464	8053	1774
2016	(970)	(30)	(8.8)	(91.2)	(82.4)	(17.6)	(89.7)	(10.3)	(67.6)	(32.4)	(54.6)	(45.4)	(81.9)	(18.1)
Nepal	4874	102	760	4216	2145	2831	2642	2334	1123	3853	2380	2596	1815	3161
2016	(980)	(20)	(15.3)	(84.7)	(43.1)	(56.9)	(53.1)	(46.9)	(22.6)	(77.4)	(47.8)	(52.2)	(36.5)	(63.5)
Timor-Leste	52640	94	275	5459	3801	1933	2229	3505	1935	3799	2037	3697	2290	3444
2016	(984)	(16)	(4.8)	(95.2)	(66.3)	(33.7)	(38.9)	(61.1)	(33.7)	(66.3)	(35.5)	(64.5)	(39.9)	(60.1)
Indonesia	16561	216	801	15976	8415	8362	4294	12483	675	16102	7736	9041	4564	12213
2017	(987)	(13)	(4.8)	(95.2)	(50.2)	(49.8)	(25.6)	(74.4)	(4.0)	(96.0)	(46.1)	(53.9)	(27.2)	(72.8)
Benin 2017-18	11632	296	940	10988	7326	4602	10066	1862	4736	7192	5212	6716	9110	2818
	(975)	(25)	(7.9)	(92.1)	(61.4)	(38.6)	(84.4)	(15.6)	(39.7)	(60.3)	(43.7)	(56.3)	(76.4)	(23.6)
Pakistan	12093	430	794	11729	6994	5529	8127	4396	4990	7533	5731	6792	5234	7289
2017-18	(966)	(34)	(6.3)	(93.7)	(55.8)	(44.2)	(64.9)	(35.1)	(39.8)	(60.2)	(45.8)	(54.2)	(41.8)	(58.2)
Guinea	7072	96.7	995	6321	5374	1942	6518	798	2536	4780	3499	3817	5931	1385
2018	(967)	(33)	(13.6)	(86.4)	(73.5)	(26.5)	(89.1)	(10.9)	(34.7)	(65.3)	(47.8)	(52.2)	(81.1)	(18.9)
Nigeria	30169	1140	2922	28387	20664	10645	19339	11970	12659	18650	14701	16608	15963	15346
2018	(964)	(36)	(9.3)	(90.7)	(66.0)	(34.0)	(61.8)	(38.2)	(40.4)	(59.6)	(47.0)	(53.0)	(51.0)	(49.0)

Variable														
Country Name	Mother's Working Status n (%)		Birth Order n (%)		Number of Fetus n (%)		Sex of Child n (%)		Place of Delivery n (%)		ANC Visit n (%)		Size of Child n (%)	
	Not working	Working	1st born	2nd & above	Single	One of multiple	Male	Female	Home	Hospital	No	Yes	Average	> or < average
Sierra Leone	2397	7767	1710	8454	9710	454	5088	5076	4490	5674	4224	5940	4152	6012
2013	(23.6)	(76.4)	(16.8)	(83.2)	(95.5)	(4.5)	(50.1)	(49.9)	(44.2)	(55.8)	(41.6)	(58.4)	(40.9)	(59.1)
Zambia 2013-14	4752	6829	1877	9704	11186	395	5892	5689	3586	7995	3896	7685	6891	4690
	(41.0)	(59.0)	(16.2)	(83.8)	(96.6)	(3.4)	(50.9)	(49.1)	(31.0)	(69.0)	(33.6)	(66.4)	(59.5)	(40.5)
Bangladesh	3682	1031	1938	2775	4651	62	2431	2282	2857	1856	1203	3510	3173	1540
2014	(78.1)	(21.9)	(41.1)	(58.9)	(98.7)	(1.3)	(51.6)	(48.4)	(60.6)	(39.4)	(25.5)	(74.5)	(67.3)	(32.7)
Cambodia	2360	4715	2744	4331	6943	132	3558	3517	1230	5845	1562	5513	3755	3320
2014	(33.4)	(66.6)	(38.8)	(61.2)	(98.1)	(1.9)	(50.3)	(49.7)	(17.4)	(82.6)	(22.1)	(77.9)	(53.1)	(46.9)
Ghana	1033	4351	1026	4358	5111	273	2796	2588	1685	3699	1664	3720	1789	3595
2014	(19.2)	(80.8)	(19.1)	(80.9)	(94.9)	(5.1)	(51.9)	(48.1)	(31.3)	(68.7)	(30.9)	(69.1)	(33.2)	(66.8)
Kenya	3791	5400	1777	7414	8956	235	4626	4565	4192	4999	3097	6094	5449	3742
2014	(41.2)	(58.8)	(19.3)	(80.7)	(97.4)	(2.6)	(50.3)	(49.7)	(45.6)	(54.4)	(33.7)	(66.3)	(59.3)	(40.7)
Lesotho 2014	1913	816	953	1776	2656	73	1342	1387	693	2036	607	2122	1810	919
	(70.1)	(29.9)	(34.9)	(65.1)	(97.3)	(2.7)	(49.2)	(50.8)	(25.4)	(74.6)	(22.2)	(77.8)	(66.3)	(33.7)
Chad	10182	6562	2425	14319	16292	452	8497	8247	13583	3161	10995	5749	4727	12017
2014-15	(60.8)	(39.2)	(14.5)	(85.5)	(97.3)	(2.7)	(50.7)	(49.3)	(81.1)	(18.9)	(65.7)	(34.3)	(28.2)	(71.8)
Afghanistan	27575	3217	5685	25107	30230	562	15988	14804	16378	14414	20344	10448	19346	11446
2015	(89.6)	(10.4)	(18.5)	(81.5)	(98.2)	(1.8)	(51.9)	(48.1)	(53.2)	(46.8)	(66.1)	(33.9)	(62.8)	(37.2)
Zimbabwe	3073	2054	1250	3877	4940	187	2516	2611	897	4248	1378	3749	2499	2628
2015	(59.9)	(40.1)	(24.4)	(75.6)	(96.4)	(3.6)	(49.1)	(50.9)	(17.1)	(82.9)	(26.9)	(73.1)	(48.7)	(51.3)

(continued on next page)

Table 2 (continued)

Variable															
Angola 2015-16	2489 (27.0)	6722 (73.0)	1488 (16.2)	7723 (83.8)	8939 (97.0)	272 (3.0)	4626 (50.2)	4585 (49.8)	5109 (55.5)	4102 (44.5)	4877 (52.9)	4334 (47.1)	5387 (58.5)	3824 (41.5)	
India 2015–16	36328 (82.8)	7529 (17.2)	16449 (37.5)	27408 (62.5)	43093 (98.3)	764 (1.7)	22814 (52.0)	21043 (48.0)	9630 (22.0)	34227 (78.0)	17232 (39.3)	26625 (60.7)	30896 (70.4)	12961 (29.6)	
Myanmar 2015-16	2133 (47.0)	2407 (53.0)	1475 (32.5)	3065 (67.5)	4455 (98.1)	85 (1.9)	2384 (52.5)	2156 (47.5)	2951 (65.0)	1589 (35.0)	1408 (31.0)	3132 (69.0)	2811 (61.9)	1729 (38.1)	
Ethiopia 2016	7246 (73.7)	2581 (26.3)	1874 (19.1)	7953 (80.9)	9563 (97.3)	264 (2.7)	5071 (51.6)	4756 (48.4)	6689 (68.1)	3138 (31.9)	5569 (56.7)	4258 (43.3)	4129 (42.0)	5698 (58.0)	
Nepal 2016	2399 (48.2)	2577 (51.8)	1958 (39.3)	3018 (60.7)	4909 (98.7)	67 (1.3)	2623 (52.7)	2353 (47.3)	2049 (41.2)	2927 (58.8)	1263 (25.4)	3713 (74.6)	3307 (66.5)	1669 (33.5)	
Timor-Leste 2016	3604 (62.9)	2130 (37.1)	1453 (25.3)	4281 (74.7)	5624 (98.1)	110 (1.9)	2973 (51.8)	2761 (48.2)	2427 (42.3)	3307 (57.7)	2178 (38.0)	3556 (62.0)	3988 (69.6)	1746 (30.4)	
Indonesia 2017	9025 (53.8)	7752 (46.2)	5459 (32.5)	11318 (67.5)	16541 (98.6)	236 (1.4)	8663 (51.6)	8114 (48.4)	4144 (24.7)	12633 (75.3)	2802 (16.7)	13975 (83.3)	9020 (53.8)	7757 (46.2)	
Benin 2017-18	2292 (19.2)	9636 (80.8)	2387 (20.0)	9541 (80.0)	11343 (95.1)	585 (4.9)	6035 (50.6)	5893 (49.4)	1837 (15.4)	10091 (84.6)	5203 (43.6)	6725 (56.4)	6869 (57.6)	5059 (42.4)	
Pakistan 2017-18	11083 (88.5)	1440 (11.5)	2971 (23.7)	9552 (76.3)	12204 (97.5)	319 (2.5)	6125 (48.9)	6398 (51.1)	4365 (34.9)	8158 (65.1)	5635 (45.0)	6888 (55.0)	9284 (74.1)	3239 (25.9)	
Guinea 2018	2340 (32.0)	4976 (68.0)	6049 (82.7)	1267 (17.3)	6983 (95.4)	333 (4.6)	3771 (51.5)	3545 (48.5)	3701 (50.6)	3615 (49.4)	3199 (43.7)	4117 (56.3)	2702 (36.9)	4614 (63.1)	
Nigeria 2018	10278 (32.8)	21031 (67.2)	5625 (18.0)	25684 (82.0)	30138 (96.3)	1171 (3.7)	15946 (50.9)	15363 (49.1)	18551 (59.3)	12758 (40.7)	16628 (53.1)	14681 (46.9)	16411 (52.4)	14898 (47.6)	

which we estimated DerSimonian and Laird's pooled effect.²⁵ Forest plots were used to display 95% CI, summary measure, and weight of each study for the most significant determinants.²⁶ As a summary measure, we used the Odds Ratio (OR), and all findings were weighted to handle bias due to undersampling and oversampling.

4. Results

Table 1 illustrates that according to the analytical evidence, the neonatal mortality rate for Bangladesh in 2014 was 27 deaths per 1000 live births. About 24.7% of women gave birth to their children as teenagers. The respondents included in the study for the analysis were mostly from rural areas (about 68.1%) and about 21.9% of women belonged to the poorest family, while another 19.0% belonged to a poor family. About 41.5% of mothers ended up with up to primary level education, 47.1% completed their secondary level education, and the rest 11.4% managed to complete their education at a higher level. About 38.4% of mothers were deprived of having the facility of mass media, while the rest 61.6% had the facility. About 53.5% of women's partner completed up to primary level education, while only 15.3% of women's partner managed to complete their higher level. About 41.1% of women had one child and about 1.3% of women gave birth to a twin child, while the rest gave birth to a single child. About 51.6% of women gave birth to a male child and among the mother, only 21.9% are working. Place of delivery was home for about 60.6% of women, and the rest 39.4% gave birth to their children at the hospital. 74.5% of women took antenatal care visits during their pregnancy while the rest 25.5% did not. About 67.3% of women gave birth to averaged sized child, while the rest 13% and 19.6% of women gave birth to larger than average and smaller than average children.

The frequency and percentages of the selected factors for 21 developing countries are displayed in Table 2. Table 3 demonstrated the different influential socio-economic determinants of neonatal mortality in Bangladesh. Neonatal mortality was associated with maternal education with an aOR of 0.591 ($p \leq 0.001$) for the secondary level of education. Neonate with higher educated father was 0.35 times less likely ($p \leq 0.032$) to die than the neonate with lower educated father. Individuals from poorer and middle-class households showed a significant influence on neonatal mortality. Neonatal mortality for children from were 0.427 ($p \leq 0.001$) and 0.467 ($p \leq 0.001$) times less likely for poorer and middle-class household, respectively compare to children from poorest family. Similarly, birth order number had a noticeable impact on neonatal mortality with an adjusted OR of 0.329 ($p \leq 0.001$) with respect

Table 3

Results of the binary logistic regression model affecting socio-economic and demographic factors for neonatal mortality in Bangladesh.

Variables	B	aOR	P – value	95% C.I. for EXP(B)	
				Lower	Upper
Maternal age at delivery					
Up to 19 years (ref)					
Above 19 years	–0.67	0.51	0.001	0.34	0.76
Type of place of resident					
Rural (ref)					
Urban	–0.21	0.81	0.353	0.53	1.26
Mother's education level					
Up to primary (ref)			0.025		
Secondary	–0.53	0.59	0.008	0.40	0.87
Higher	–0.71	0.49	0.172	0.18	1.36
Mass media					
No (ref)					
Yes	–0.53	0.59	0.012	0.39	0.89
Wealth Index					
Poorest(ref)			0.000		
Poorer	–0.85	0.43	0.000	0.28	0.66
Middle	–0.76	0.47	0.005	0.28	0.80
Richer	–0.04	0.96	0.888	0.55	1.68
Richest	–0.068	0.93	0.856	0.45	1.95
Father's education					
Up to primary (ref)			0.060		
Secondary	–0.34	0.71	0.119	0.46	1.09
Higher	–1.04	0.35	0.032	0.14	0.92
Mother's working status					
Working (ref)					
Not working	–0.11	0.90	0.601	0.61	1.34
Birth order number					
1st born (ref)					
2nd and above	–1.11	0.33	0.000	0.22	0.50
Number of fetus					
Single (ref)					
One of multiple	2.18	8.82	0.000	4.06	19.15
Sex of child					
Male (ref)					
Female	–1.04	0.35	0.000	0.25	0.49
Place of delivery					
Home (ref)					
Hospital	0.24	1.27	0.23	0.86	1.90
Antenatal care utilization					
No (ref)					
Yes	–1.58	0.21	0.000	0.14	0.30
Size of child					
Average (ref)					
Larger than average	0.37	1.45	0.097	0.94	2.24
Smaller than average	–0.53	0.59	0.010	0.39	0.88

*B = β ; CI=Confidence Interval; aOR = Adjusted Odds Ratio; ref = Reference Category.

Table 4

Random-effects model estimation of OR for Bangladesh and 20 other developing countries.

Country Name	Maternal Age at Delivery	Place of Residence	Mother's Education	Media Access	Wealth Index	Father's Education	Mother's Working Status	Birth Order	Number of Fetus	Sex of Child	Place of Delivery	ANC Visits	Size of Child
	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
Afghanistan	0.82	0.68	0.98	0.86	0.93	0.88	1.99	1.10	0.15	1.18	0.66	0.57	0.49
Angola	0.59	0.63	0.61	0.74	0.65	0.73	1.29	0.66	0.23	1.41	1.13	0.57	0.64
Bangladesh	0.98	0.95	0.67	0.71	0.78	0.62	1.37	0.85	0.11	1.41	1.11	0.33	0.45
Benin	0.65	0.81	0.79	1.04	0.94	0.89	1.12	0.91	0.16	1.38	1.09	0.39	0.82
Cambodia	0.93	0.54	0.90	0.90	0.54	0.75	1.75	1.17	0.33	1.23	0.65	0.29	0.57
Chad	0.57	1.01	0.98	1.21	0.94	0.98	1.21	0.60	0.18	1.57	1.24	0.53	1.29
Ethiopia	0.70	0.51	0.85	0.68	0.73	0.66	0.99	0.94	0.17	1.90	0.85	0.33	0.65
Ghana	1.42	1.01	1.04	1.91	0.95	1.12	1.03	0.93	0.17	1.27	1.23	0.24	0.88
Guinea	0.91	0.60	0.60	1.09	0.75	0.76	1.11	0.77	0.15	1.09	0.79	0.48	0.99
India	0.64	0.75	0.59	0.69	0.60	0.63	1.13	0.97	0.12	1.30	0.73	0.38	0.62
Indonesia	0.62	1.09	0.87	0.86	0.90	0.85	1.26	1.17	10.05	2.01	0.96	0.24	0.55
Kenya	0.71	1.01	0.96	1.15	1.01	0.95	1.20	1.06	0.15	1.26	0.85	0.32	0.41
Lesotho	1.10	0.69	1.02	0.82	0.99	0.93	0.44	0.82	0.24	1.24	0.72	0.37	0.41
Myanmar	0.96	0.82	0.92	0.95	0.97	1.07	1.39	1.33	0.07	1.23	0.73	0.24	0.48
Nepal	0.47	0.70	0.70	1.06	0.49	0.82	0.93	0.82	0.32	1.14	0.57	0.18	0.36
Nigeria	0.59	0.82	0.81	0.85	0.84	0.79	0.99	0.76	0.170	1.23	1.03	0.53	0.93
Pakistan	0.87	0.80	0.70	0.94	0.75	0.75	1.58	0.91	0.25	1.33	0.88	0.51	0.59
Sierra Leone	0.71	1.39	1.17	1.04	0.23	1.12	0.80	0.67	0.19	1.16	0.95	0.67	0.69
Timor-Leste	0.62	0.67	0.82	0.90	0.97	0.79	1.00	0.89	0.09	1.44	0.67	0.56	0.45
Zambia	0.39	0.90	1.02	0.87	0.92	1.03	0.95	0.55	0.14	1.03	0.82	0.28	0.62
Zimbabwe	0.68	0.55	0.65	0.88	0.70	0.67	0.96	0.76	0.18	1.33	0.78	0.22	0.5
I ²	46.2	64.6	61.3	57.7	70.7	55.1	73.0	61.1	95.8	36.0	65.0	86.3	82.8
τ ²	0.026	0.032	0.031	0.021	0.033	0.019	0.047	0.028	0.728	0.008	0.028	0.094	0.067

τ²: Estimate of between-study variance.

to 2nd and above. Mothers aged above 19 years had a significant influence on neonatal mortality with an aOR 0.510 ($p \leq 0.001$). The variable number of the fetus showed a significant association with neonatal mortality, where the OR for the category 'multiple fetuses' is 8.815 ($p \leq 0.000$). Likewise, taking ANC had a significant influence on neonatal mortality, with an OR of 0.206 ($p \leq 0.000$) for the category '1–4 visits'. The sizes of children had a significant impact on neonatal mortality with an adjusted OR 1.44 ($p = 0.097$) with regards to the category 'larger than average'.

In our study, we intended to use the random-effects model as the study showed a high between-study variation. In Table 4 shows the results of the random effect model estimation results of 21 developing countries, and Table 5 shows the summary effect of different explanatory variables.

About 64.6% of the variation has been observed for the type of place of residence and the overall OR indicates that individuals residing in

urban areas have a 20% lower chance of experiencing neonatal deaths than their rural counterparts. About 61.3% of the variation has been found for maternal education and its overall OR demonstrates that, the mothers who have above primary level education are 18.0% less likely to confront neonatal death compared to the mothers who have up to primary education. Similarly, father's education shows about 55.1% of the variation with overall OR indicates, with an increment in education level, fathers have 0.830 times or 17% lower chance of experiencing neonatal death. For living below the poverty line, I² has been found to be 70.7% where the overall OR reveals the odds of neonatal mortality is 0.823 times lower to the individuals who do not live below the poverty line compared to those who live below the poverty line. About 73.0% of the variation has been observed for maternal current working status and the overall OR revealed the odds of neonatal mortality is 1.1388 times higher in the women who are currently working compared to those who are not working currently. For birth order number I² has been found to

Table 5

Random-effects model estimation (summary effect) for different independent variables in Bangladesh and 21 other developing countries.

Variables	Random effects model			
	Odds Ratio (OR)	P-Value	Confidence Interval (CI)	
			Lower Bound	Upper Bound
Maternal age at delivery	0.68	0.0111	0.62	0.75
Type of Place of Residence	0.80	0.0319	0.73	0.89
Mother's Education Level	0.82	0.0306	0.74	0.91
Media Access	0.91	0.0005	0.83	0.99
Wealth Index	0.82	0.0001	0.75	0.91
Father's Education Level	0.83	0.0013	0.76	0.91
Mother's Working Status	1.14	0.0001	1.02	1.28
Birth Order	0.86	0.0001	0.78	0.95
Number of Fetus	0.20	0.0001	0.14	0.29
Sex of Child	1.32	0.0518	1.23	1.41
Place of Delivery	0.86	0.0001	0.79	0.95
ANC Visits	0.37	0.0001	0.32	0.43
Size of Child	0.61	0.0001	0.54	0.70

Fig. 2. Forest plot for the sex of the child showing the weight of the study by the size of each box while each crossed line indicates 95% CI.

be 61.1% with overall OR 0.862, indicating 13.8% lower chance of neonatal mortality in the second and above born child than those who are the firstborn child. The overall OR for maternal age at delivery with a 46.2% variation. This suggests that with the increment of the mother's age, the risk of neonatal death decreases. Again, the overall OR for the number of the fetus is 0.200 with 72.8% variation which indicates that neonatal death occurs 0.200 times less likely in the women who carry a single fetus than those women who carry multiple fetuses. About 86.3% of the variation has been found for taking ANC and the overall OR demonstrates that, the neonatal death occurs 0.374 times less likely in the women who took antenatal care compared to those women who do not take it. Size of child shows 82.8% variation with overall OR of 0.612 which indicates that neonatal death occurs 0.612 times less likely in the average-sized child compared to those children who are larger or smaller than average. The overall OR of the sex of the child indicates that neonatal death occurs 1.319 times more likely in the male child compared to female children. Media access shows 57.7% variation with overall OR of 0.908. This indicates that neonatal death occurs 0.908 times less likely in the family with media access compare to the family with no media access. Place of delivery shows 65% variation with overall OR of 0.864. This indicates that neonatal death occurs 0.864 times less for hospital delivery compares to home delivery.

Fig. 2 illustrates that the women of Indonesia have the highest chance of confronting neonatal deaths of male children compare to female children among all the countries, as the OR is 2.01. On the other hand, women of Zambia face an almost equal chance of neonatal death between male and female children. The overall estimate is statistically significant, with a p -value ≤ 0.05 at a 5% level of significance.

5. Discussion

The third SDG was — “ensure healthy lives and promote well-being for all at all ages.” For neonatal death, the target was set as 12 deaths per 1000 live births. To achieve this goal by 2030, we need to give more focus on developing countries. Although there exists global progress, in sub-Saharan Africa and Southern Asia, child death, especially neonatal death, is increasing comparatively. Out of every five deaths of children under age five four death occurs in these regions.²¹ Our study focused on finding out the socio-economic and demographic factors that affect neonatal death in developing countries. Through the logistic regression model's outcome, maternal education, birth order number, maternal age at delivery, number of fetuses, taking ANC, and child's size, media access was found to have a significant influence on neonatal death for Bangladesh. In this study, the odds of neonatal death is lower among births to mothers who have above primary level education than the mothers with up to primary level education for BDHS data. For instance, mothers who had secondary level education are 0.591 times less likely to confront neonatal death compared to the mothers who had up to primary education. Finding from the meta-analysis for 21 developing countries also supports the fact the maternal education reduces neonatal death. Our study's outcomes are similar to the previous study, and the positive influence of maternal education on neonate survivals is supported worldwide.^{5,27} Both logistic regression models for BDHS data and meta-analysis for 21 developing countries revealed that, like maternal education, the father's higher education reduces the risk of neonatal mortality. Previous studies show an association with paternal education to reduce neonatal mortality, which supports this study's findings.^{28,29} Education increases knowledge about child health and healthcare

services and improves the healthcare-seeking behaviors for children and themselves. In our society, the father is the main pay worker and chief of the family. His education assumes a job with a significant salary and good earning. Education tends them to live in a rich community with better access to health care services with a short distance.^{30,31} From the outcome of BDHS data, we come to know that the women whose ages were above 19 are 0.510 times less likely to experience neonatal mortality compared to the women whose ages were less or equal to 19. The meta-analysis also showed a similar association. This result is supported by other study findings, which showed that teenage mothers are more likely to have neonatal death.^{32–34} Lack of childbearing knowledge, awareness, and premature age with different complicity might be responsible for the higher risk of neonatal mortality to the younger mother.³⁵ Binary logistic regression and meta-analysis showed that male children were at higher risk than female children for neonatal mortality. Existing literature and studies confirm these results that male children were more affected by neonatal mortality.^{5,16,36,37} Neonatal mortality is greatly influenced by ANC utilization in developing countries. Results of this study uncovered that neonatal death occurs less likely in the women who took antenatal care compared to those women who did not take it. This result is supported by other studies showing a significant association of ANC with neonatal mortality.^{16,17} Because ANC utilization improves pregnancy outcomes and provides an opportunity for prompt detection of complications and early inception of breastfeeding. With the identification of complications, they get a better chance to resolve the problem, and at the same time, this follow-up with ANC usually leads them to have quality essential newborn cares, which increase survival.^{38–40} Our study showed that children larger than average size were more likely to die in the neonatal period compared to average size children. The result of our study was consistent with previous studies where size of the children influences the rate of neonatal mortality.^{41,42} Logistic regression showed that the second or more birth ordered children were 0.329 times less likely to neonatal death were meta-analysis suggested 0.862 times. The findings of our study were justified by the other studies' results.⁴³ The number of fetuses shows a highly significant impact on neonatal mortality. From the outcome of binary logistic regression and meta-analysis estimate, neonatal death occurs likely in the women who carried a single fetus than those women who carried multiple fetuses. Thus, the odds of neonatal death were higher among twin births compared with singleton births.^{43,44} The possible explanation for this finding could be pregnancy with twin fetuses usually lead to prematurity, underweight, which is the most common cause of neonatal death. Additionally, twins' babies create complicity, which requires emergency and leads to death.⁴⁵

5.1. Limitation and strength

We confronted several limitations while conducting the research. We could only collect data from 21 of the 91 countries from the DHS database for missing data, developing countries list, variable availability, etc. For estimating OR from random-effects meta-analysis, we had to create a 2 × 2 cross-tabulation for which each variable was categorized into two categories only like maternal age (> or <19 years) and size of the child etc. Moreover, a wide number of factors that could influence neonatal mortality could not be included in our study because of the unavailability of those variables in some DHS data.

The study has some strengths despite these constraints. We combined two methods: binary logistic regression of BDHS data and meta-analysis of 21 DHS data. The integrated findings enlarged the validity of the outcome of the research. We have compared the results of logistic regression analysis and meta-analysis of 21 DHS data. We have used a mixed-method design to generate better knowledge and insights.

6. Conclusion

Undoubtedly neonatal mortality is the essential part of under-five

child mortality, which reflects social, monetary, and ecological conditions of nations. This study acknowledged the most significant influential factors of neonatal mortality. The number of the fetus, taking ANC and sex of the children, birth order are the dominating factors of neonatal mortality. The utilization of ANC services needs to be ensured and increased across developing countries. Maternal age needs to more than 19, and Parental education needs to be secured to reduce neonatal mortality. Mothers with multiple fetuses should take under proper surveillance. Besides, modernized health care services should be provided mostly to rural areas with free medical facilities for unprivileged counterparts.

Ethical approval

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Declaration of competing interest

The authors have no conflicts of interest to declare.

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References

- 1 You D, Hug L, Ejdemyr S, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *Lancet*. 2015;386(10010):2275–2286.
- 2 Yego F, D'Este C, Byles J, Nyongesa P, Williams JS. A case-control study of risk factors for fetal and early neonatal deaths in a tertiary hospital in Kenya. *BMC Pregnancy Childbirth*. 2014;14(1):1–9.
- 3 Organization WH. *Newborn Death and Illness*. vol. 4. Millennium Development goal (mdg); 2011.
- 4 Liu L, Oza S, Hogan D, et al. Global, regional, and national causes of under-5 mortality in 2000–15: an updated systematic analysis with implications for the Sustainable Development Goals. *Lancet*. 2016;388(10063):3027–3035.
- 5 Titaley CR, Dibley MJ, Agho K, Roberts CL, Hall J. Determinants of neonatal mortality in Indonesia. *BMC Publ Health*. 2008;8(1):1–15.
- 6 Målqvist M. Neonatal mortality: an invisible and marginalised trauma. *Glob Health Action*. 2011;4(1):5724.
- 7 Devine S, Taylor G, UNICEF. *Every Child Alive: The Urgent Need to End Newborn Deaths*. Unicef; 2018.
- 8 de Souza S, Duim E, Nampo FK. Determinants of neonatal mortality in the largest international border of Brazil: a case-control study. *BMC Publ Health*. 2019;19(1):1–9.
- 9 Jahan S. Poverty and infant mortality in the Eastern Mediterranean region: a meta-analysis. *J Epidemiol Community Health*. 2008;62(8):745–751.
- 10 Rahman S, Salameh K, Bener A, El Ansari W. Socioeconomic associations of improved maternal, neonatal, and perinatal survival in Qatar. *Int J Wom Health*. 2010;2:311.
- 11 Bhutta ZA, Qadir M. Addressing maternal nutrition and risks of birth asphyxia in developing countries. *Arch Pediatr Adolesc Med*. 2009;163(7):671–672.
- 12 Gopalan SS, Das A, Howard N. Maternal and neonatal service usage and determinants in fragile and conflict-affected situations: a systematic review of Asia and the Middle-East. *BMC Wom Health*. 2017;17(1):1–12.
- 13 Castro MPd, Rugolo LMSS, Margotto PR. Survival and morbidity of premature babies with less than 32 weeks of gestation in the central region of Brazil. *Rev Bras Ginecol Obstet*. 2012;34(5):235–242.
- 14 Choi YY, Song ES, Kim YH, Song TB. Analysis of high-risk infant births and their mortality: ten years' data from chonnam national university hospital. *Chonnam J. Med. Sci*. 2011;47(1):31.
- 15 Unicef U. *Levels and Trends in Child Mortality*. New York: UNICEF; 2015.
- 16 Bhutta ZA. Community-based primary health care: a core strategy for achieving sustainable development Goals for health. *J global health*. 2017;7(1).
- 17 Kumar S, Kumar N, Vivekadhish S. Millennium development goals (MDGs) to sustainable development goals (SDGs): addressing unfinished agenda and

- strengthening sustainable development and partnership. *Indian J Community Med: off publ Indian Assoc Preventive & Soc Med*. 2016;41(1):1.
- 18 Tekelab T, Akibu M, Tagesse N, Tilhaun T, Yohanes Y, Nepal S. Neonatal mortality in Ethiopia: a protocol for systematic review and meta-analysis. *Syst Rev*. 2019;8(1): 1–4.
 - 19 National Institute of Population Research and Training, Mitra and Associates, ICF International. *Bangladesh Demographic and Health Survey 2014: Key Indicators*. Dhaka, Bangladesh, and Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2015.
 - 20 bank W. *Countries and Economies*; 2019. Available from: <https://data.worldbank.org/country>.
 - 21 Hussein J, Hirose A, Owolabi O, Imamura M, Kanguru L, Okonofua F. Maternal death and obstetric care audits in Nigeria: a systematic review of barriers and enabling factors in the provision of emergency care. *Reprod Health*. 2016;13(1):1–11.
 - 22 Ezeh OK, Agho KE, Dibley MJ, Hall J, Page AN. Determinants of neonatal mortality in Nigeria: evidence from the 2008 demographic and health survey. *BMC Publ Health*. 2014;14(1):1–10.
 - 23 Cramer JS. *The Origins of Logistic Regression*. 2002.
 - 24 Huedo-Medina TB, Sánchez-Meca J, Marín-Martínez F, Botella J. Assessing heterogeneity in meta-analysis: Q statistic or I² index? *Psychol Methods*. 2006;11(2): 193.
 - 25 DerSimonian R, Laird N. Meta-analysis in clinical trials. *Contr Clin Trials*. 1986;7(3): 177–188.
 - 26 Verhagen A, Ferreira ML. Forest plots. *J Physiother*. 2014;60(3):170–173.
 - 27 Bhutta ZA, Darmstadt GL, Hasan BS, Haws RA. Community-based interventions for improving perinatal and neonatal health outcomes in developing countries: a review of the evidence. *Pediatrics*. 2005;115(Supplement 2):519–617.
 - 28 Chowdhury QH, Islam R, Hossain K. Socio-economic determinants of neonatal, post neonatal, infant and child mortality. *Int J Sociol Anthropol*. 2010;2(6):118–125.
 - 29 Singh A, Kumar A, Kumar A. Determinants of neonatal mortality in rural India. *PeerJ*. 2013;1, e75, 2007–2008.
 - 30 Macassa G, Hallqvist J, Lynch JW. Inequalities in child mortality in sub-Saharan Africa: a social epidemiologic framework. *Afr J Health Sci*. 2011;18(1-2):14–26.
 - 31 Abuqamar M, Coomans D, Louckx F. The impact of parental education on infant mortality in Gaza strip, Palestine. *J Publ Health Epidemiol*. 2011;3(1):28–33.
 - 32 Huda TM, Tahsina T, Arifeen SE, Dibley MJ. The importance of intersectoral factors in promoting equity-oriented universal health coverage: a multilevel analysis of social determinants affecting neonatal infant and under-five mortality in Bangladesh. *Glob Health Action*. 2016;9(1), 29741.
 - 33 Jehan I, Harris H, Salat S, et al. Neonatal mortality, risk factors and causes: a prospective population-based cohort study in urban Pakistan. *Bull World Health Organ*. 2009;87:130–138.
 - 34 Chen X-K, Wen SW, Fleming N, Yang Q, Walker MC. Increased risks of neonatal and postneonatal mortality associated with teenage pregnancy had different explanations. *J Clin Epidemiol*. 2008;61(7):688–694.
 - 35 Schell CO, Reilly M, Rosling H, Peterson S, Mia Ekström A. Socioeconomic determinants of infant mortality: a worldwide study of 152 low-, middle-, and high-income countries. *Scand J Publ Health*. 2007;35(3):288–297.
 - 36 Shakya K, McMURRAY C. Neonatal mortality and maternal health care in Nepal: searching for patterns of association. *J Biosoc Sci*. 2001;33(1):87.
 - 37 Alonso V, Fuster V, Luna F. Causes of neonatal mortality in Spain (1975-98): influence of sex, rural-urban residence and age at death. *J Biosoc Sci*. 2006;38(4):537.
 - 38 Bale J, St oll BJ, Lucas AO. *Improving Birth Outcomes Meeting the Challenges in the Developing World*. Washington, DC: National Academies Press; 2003.
 - 39 Phukan D, Ranjan M, Dwivedi L. Impact of timing of breastfeeding initiation on neonatal mortality in India. *Int Breastfeed J*. 2018;13(1):1–10.
 - 40 Rarani MA, Rashidian A, Khosravi A, Arab M, Abbasian E, Morasae EK. Changes in socio-economic inequality in neonatal mortality in Iran between 1995-2000 and 2005-2010: an Oaxaca decomposition analysis. *Int J Health Pol Manag*. 2017;6(4): 219.
 - 41 Akinyemi JO, Bamgboye EA, Ayeni O. Trends in neonatal mortality in Nigeria and effects of bio-demographic and maternal characteristics. *BMC Pediatr*. 2015;15(1): 1–12.
 - 42 Kozuki N, Lee AC, Silveira MF, et al. The associations of parity and maternal age with small-for-gestational-age, preterm, and neonatal and infant mortality: a meta-analysis. *BMC Publ Health*. 2013;13(3):1–10.
 - 43 Kamal SM, Ashrafuzzaman M, Nasreen S. Risk factors of neonatal mortality in Bangladesh. *J Nepal Paediatr Soc*. 2012;32(1):37–46.
 - 44 Alam N, Van Ginneken JK, Bosch AM. Infant mortality among twins and triplets in rural Bangladesh in 1975–2002. *Trop Med Int Health*. 2007;12(12):1506–1514.
 - 45 Justesen A, Kunst A. Postneonatal and child mortality among twins in Southern and Eastern Africa. *Int J Epidemiol*. 2000;29(4):678–683.