Family Medicine & Primary Care Review 2022; 24(3): 227–236, https://doi.org/10.5114/fmpcr.2022.118281

ORIGINAL PAPERS

© Copyright by Wydawnictwo Continuo

ISSN 1734-3402, eISSN 2449-8580

Exploring the influencing factors for infant mortality: a mixed-method study of 24 developing countries based on demographic and health survey data

MD. AKHTARUL ISLAM[1, A–C, E, F], TARANA TABASSUM[1, B, D, E], MOHAMMAD ALI MONI[2, E]
ORCID ID: 0000-0003-2396-2168

[1] Statistics Discipline, Science Engineering and Technology School, Khulna University, Khulna, Bangladesh
[2] Faculty of Medicine and Health, University of Sydney, Sydney, Australia

A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Infant mortality is a salient indicator for appraising the quality of the healthcare infrastructures of a country. To achieve the sustainable development goal, the infant mortality rate should be reduced to the indicated level. On account of this, it is requisite to point out the associated factors of infant mortality and provide action plans for monitoring them.
Objectives. This study aimed to discover the prevalence of infant mortality and assess how different factors influence infant mortality in 24 developing countries by utilising the latest Demographic and Health Survey (DHS) data.
Material and methods. This study used a mixed-method design to assemble cross-sectional studies to integrate data from 24 other countries due to the widening perspective of infant mortality. Descriptive analysis, binary logistic regression model, random-effect meta-analysis and forest plot have been used for the analyses.
Results. The binary logistic regression model for Bangladesh revealed that a higher education level of fathers (OR: 0.344, 95% CI: 0.147; 0.807), being 2nd born or above order infant (OR: 0.362, 95% CI: 0.248; 0.527), undergoing antenatal care (ANC) (OR: 0.271, 95% CI: 0.192; 0.382 for 1–4 visits) and undergoing postnatal care (PNC) (OR: 0.303, 95% CI: 0.216; 0.425) were statistically significant determinants of lowering infant death. While carrying multiple foetuses (OR: 6.634, 95% CI: 3.247; 13.555) was shown to be a risk factor of infant mortality. The most significant factors influencing infant mortality for developing countries were the number of foetuses (OR: 0.193, 95% CI: 0.176; 0.213), undergoing ANC (OR: 0.356, 95% CI: 0.311; 0.407), undergoing PNC (OR: 0.302, 95% CI: 0.243; 0.375) and the size of the children (OR: 0.653, 95% CI: 0.588; 0.726).
Conclusions. In this study, the number of the foetuses, undergoing ANC and PNC, mother's education, fathers' education and size of the children were the most significant factors affecting infant mortality in developing countries. Thusly, anticipation and control projects need to be taken considering the outcome of this study to reduce the infant mortality.
Key words: infant mortality, prenatal care, developing countries, meta-analysis.

Islam MA, Tabassum T, Moni MA. Exploring the influencing factors for infant mortality: a mixed-method study of 24 developing countries based on demographic and health survey data. *Fam Med Prim Care Rev* 2022; 24(3): 227–236, doi: https://doi.org/10.5114/fmpcr.2022.118281.

Background

The infant mortality rate (IMR), characterised as the number of deaths in children under one year of age for every 1,000 live births, has been viewed as a profoundly delicate measure of public health [1]. Infant mortality is found to be one of the most significant parts of under-five child mortality as a vulnerable age group for medicinal administrations, which is particularly necessary for the foundation of wellbeing, social prosperity and improvement of life standard [2–7]. The mortality rate of infants under one year is one of the most deciding indicators of a nation's advancement [8]. In 1990, 9 million children younger than one year died globally. Up until 2011, every year about 4,000,000 infants used to die during the initial month of life, and worldwide neonatal mortality made up 40% of the all child mortality [9]. About 99% of these deaths occurred in developing countries, particularly in sub-Saharan Africa and South Asia [10–13]. Decreasing this rate by 66% between 1990 and 2015 became the fourth Millennium Development Goal (MDG) of the United Nations (UN). Similarly, under sustainable improvement objectives (SDG), the countries expected to diminish the preventable deaths of infants to as low as 12 for every 1,000 live births and under-five child mortality to as low as 25 for every 1,000 live births [14–16]. As a result of the United Nations Millennium Development Goals (MDGs), where reduction of the infant mortality rate was a key challenge, the rate of infant mortality was reduced from 65 fatalities for every 1,000 live births to 29 deaths for every 1,000 by 2015 [17–20].

Nevertheless, an estimate showed that 6.3 million children died in 2017, in most cases from preventable causes. About 1.6 million of these deaths occurred between the age of 1–11 months, with 2.5 million deaths occurring in the very first month of life. African countries have higher IMR rather than developed countries like European countries (53 infant deaths per 1,000 live births in sub-Saharan Africa compared to 3 infant deaths per 1,000 live births in the European Union in 2018) [19–21]. Although this mortality rate has steadily decrease in recent years, this rate is still disappointingly high in many developing countries. The primary reasons may be the unavailability of primary healthcare facilities and several disparities with the socio-economic condition [22, 23].

Bangladesh is a small South Asian country that is still underdeveloped. Bangladesh has gained improvement gradually

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0). License (http://creativecommons.org/licenses/by-nc-sa/4.0/).

towards infant mortality in the previous decade [23]. Despite this decrease in new-born child mortality, the level of the infant death rate is not optimal in Bangladesh compared to the other developing countries [24]. The infant mortality rate in Bangladesh was 38 for every 1,000 live births in 2014, though it was 43 and 52 in 2011 and 2007, respectively [25]. Like other low and middle-income countries, in Bangladesh, child survival and physical condition have improved in recent years [26, 27]. However, there are still various significant triggering factors influencing infant mortality in Bangladesh to keep it above average. Among these factors, socio-economic inequalities are the primary cause of this high rate in Bangladesh [27, 28]. Along with this, in developing countries, socio-economic condition and health-related factors such as place of residence, education level of parents, wealth index, maternal age at delivery, birth order number, child's size, antenatal care utilisation, birth weight, type of infant nutrition, status of breastfeeding, delivery assistance and many more factors are found to be responsible for the likelihood of infant death [8, 29–35].

In this study, considering the vital facts related to infant mortality, we attempted to discover the influencing factors of infant mortality in 24 developing countries, including Bangladesh. We presented a mixed method [36, 37] that was designated to combine data from 24 developing countries, which we think would be more effective in giving more insight into the prevalence and associated factors of infant death than using a simple cross-sectional survey and meta-analysis.

Material and method

Design

We applied a mixed-method design to conduct the study [37]. Binary logistic regression (BLR) was performed for the cross-sectional analysis of Bangladesh. Afterward, we made a comparison between the results from Bangladesh and the findings of a meta-analysis of 24 developing countries to find out the consistency of the influencing factors on infant mortality across the developing countries. We could broadly explore the influential determinants of infant mortality by employing this approach. All the data was taken from the Demographic and Health Survey (DHS).

Data source and data extraction

Demographic and Health Survey (DHS) data is collected using a cross-sectional study design for a large, nationally representative sample for every country. Similar questionnaires and the same measures are used to gather information from the respondent. A two-stage cluster sampling design with households in urban and rural strata has been utilised to select the study respondents in most of these surveys. Detailed information about the sampling and data collection methodology is available on the DHS websites [38]. For this cross-sectional study, we initially extracted relevant information for analysis from a nationwide representative secondary dataset, the Bangladesh Demography and Health Survey 2014, for binary logistic regression [24]. Besides this, we conducted a meta-analysis utilising the recently accessible datasets (accessed in January 2020) from MEASURE DHS. We adopted the recent available DHS data for the 24 developing countries [18]: Afghanistan (2015), Angola (2015–2016), Benin (2017–2018), Chad (2014–2015), Cambodia (2014), Egypt (2014), Ethiopia (2016), Guinea (2018), India (2015–2016), Indonesia (2017), Kenya (2014), Lesotho (2014), Malawi (2015–2016), Myanmar (2015–2016), Nepal (2016), Nigeria (2018), Pakistan (2017–2018), Sierra Leone (2013), South Africa (2016), Tanzania Timor-Leste (2016), Zambia (2013–2014), Zimbabwe (2015). The DHS database contains information from 91 countries (http://dhsprogram.com/data/available-datasets.com); 67 countries were excluded due to excessive missing values and unavailability of information regarding dependent and independent variables in any of the selected countries. Finally, we chose 24 developing countries, including Bangladesh, where similar probability sampling was applied for data collection [39, 40] (Figure 1).

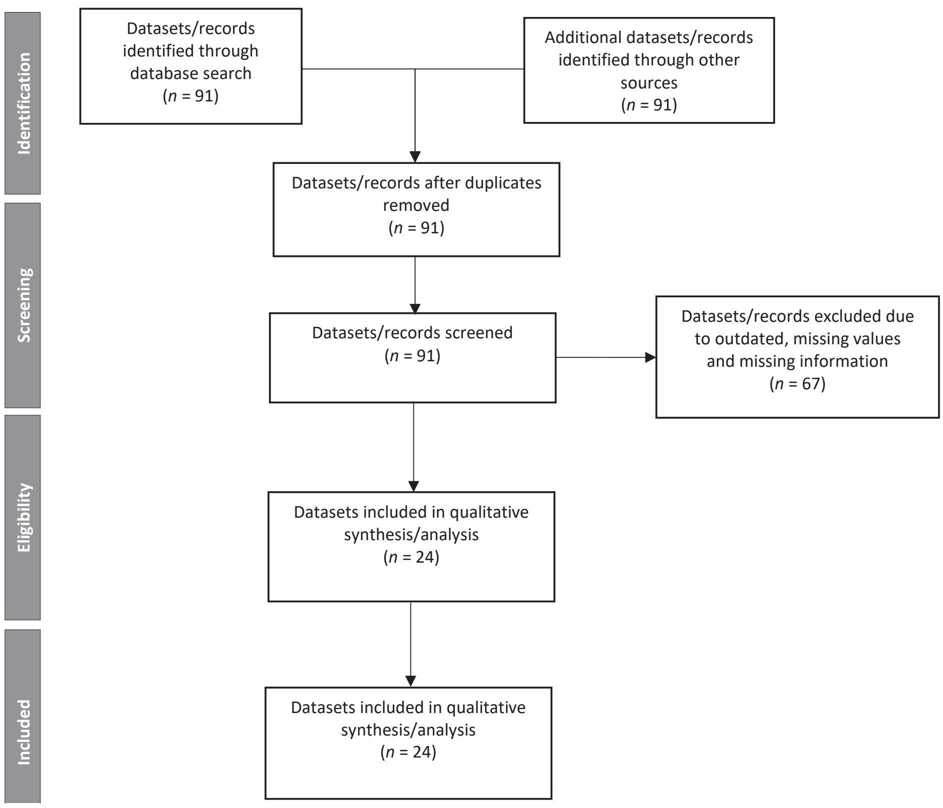

Figure 1. PRISMA (preferred reporting items for systematic reviews and meta-analysis) flow diagram illustrating the process of identifying and including DHS datasets for the random effect meta-analysis

Variables

In this study, we considered *infant mortality* as the dependent variable. We measured this as a two-category dummy variable, and the two distinct levels are "*yes*" if infant death occurs and "*no*" if death does not occur. We included a group of relevant socio-economic and demographic factors as an independent variable to carry out the research and to discover the impacting determinants that are presumed to influence infant mortality based on previous literature. Firstly, the categories of the variable type of place of residence have remained the same as the existing category of the DHS datasets. Similarly, the category of *mother's current working* status remained the same as the original datasets. The remaining covariates were subcategorised. We merged *no education* and *primary* to *up to primary* for BDHS data, whereas the other categories were *secondary* and *higher* in terms of parent's education level. For meta-analysis, we combined *secondary* and *higher* to *above primary*, while another category was *up to primary*. In the case of binary logistic regression, the *wealth index* remained the same as the original data. Furthermore, 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 labelled them as '*yes*', which means if the individuals are poor, they live below the poverty line. On the other hand, we combined *middle, richer* and *richest* with the label '*no*', which represents individuals who live above the poverty line. The variable *birth order number* was categorised as *firstborn* and *2^nd^ and above born* for both binary logistic regression and meta-analysis. *Mother's 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* [30]. Categories for the variable *number of foetuses* were *single* and *multiple* for both methods. For binary logistic regression, we subcategorised *undergoing antenatal care (ANC)* as *no visits*, *1–4 visits*, *more than 4 visits*, whereas in the meta-analysis, individuals who had at least one *ANC visit* were placed in the category *yes*, otherwise *no*. We used the original variable *undergoing postnatal care (PNC)*, which was categorised into two levels of *yes* and *no* for both logistic regression and meta-analysis. Finally, for the *child's size,* we subcategorised the variable into *average, larger than average* (combining very large and larger than average) and *smaller than average* (combining very small and smaller than average) for logistic regression analysis. We further recoded this variable for meta-analysis with two independent levels, i.e. *average* and *larger or smaller than average*.

Statistical analysis

We used SPSS V.23 (SPSS Inc. Chicago, USA) statistical software and R V.3.6.2 (Bell Laboratories, New Jersey, USA) to carry out the analysis. Binary logistic regression was used to determine the key factors that have an impact on infant mortality in Bangladesh using BDHS data [41, 42]. Besides this, we carried out a meta-analysis on the DHS data from Bangladesh and 23 other developing countries [43]. Heterogeneity was assessed by enumerating values from I^2 and p values among the datasets [44]. We used a random-effects model in the meta-analytical approach as significant heterogeneity was found, by which we estimated DerSimonian and Laird's pooled effect [45, 46]. Forest plots were used to display 95% CI, summary measure and weight of each study for the most significant determinants [47]. As a summary measure, we used the Odds Ratio (OR), and all findings were weighted to handle bias due to undersampling and oversampling [48].

Ethical approval

We used a secondary dataset from the Demographic and Health Surveys (DHS) Programme website (https://dhsprogram.com/data/). No ethics approval is required for this dataset.

Results

Table 1 shows the baseline characteristics of the selected covariates for BDHS data. Most of the respondents were from rural areas (about 68.2%). Up to primary education was seen for 41.5% of women and 53.5% of men, and only 11.5% of the women and 15.2% of the men had higher education. We also found that about 78.1% of women were not employed at that time, and 75.3% of the women were above 19 years of age at delivery time. Most of the respondents (98.7%) included in the analysis carry a single foetus. 67.4% of the children were average in size, and 19.6% were smaller than average, while 61.6% were taken for postnatal check-ups. About 54.5% of the respondents visited 1–4 times for antenatal care, and 25.5% of the respondents did not go for the check-ups.

Table 1. Baseline characteristics of different variables with levels for BDHS data

Variable	Levels of the variables with code	Frequency	Percentage
Dependent variable			
Infant mortality	No [0]	4,561	96.5
	Yes [1]	163	3.5
Covariates			
Type of place of residence	Rural [0]	3,220	68.2
	Urban [1]	1,504	31.8
Mother's education	Up to primary [0]	1,959	41.5
	Secondary [1]	2,224	47.0
	Higher [2]	541	11.5
Father's education	Up to primary [0]	2,526	53.5
	Secondary [1]	1,478	31.3
	Higher [2]	720	15.2
Wealth index	Poorest [0]	1,011	21.4
	Poorer [1]	902	19.1
	Middle [2]	901	19.1
	Richer [3]	980	20.7
	Richest [4]	930	19.7
Mother's current working status	No [0]	3,689	78.1
	Yes [1]	1,035	21.9
Birth order number	First born [0]	1,943	41.1
	Second and above [1]	2,781	58.9
Mother's age at delivery	≤ 19 [0]	1,168	24.7
	Above 19 [1]	3,556	75.3
Number of foetuses	Single [0]	4,662	98.7
	Multiple [1]	62	1.3
Undergoing ANC	No [0]	1,204	25.5
	1–4 visits [1]	2,573	54.5
	More than 4 visits [2]	947	20.0
Undergoing PNC	No [0]	1,816	38.4
	Yes [1]	2,908	61.6
Size of child	Average [0]	3,181	67.4
	Larger than average [1]	616	13.0
	Smaller than average [2]	927	19.6

The baseline characteristics of the selected factors for 24 developing countries are displayed in Table 2. We calculated the prevalence of all 24 countries separately with the DHS's sampling weights. Table 3 demonstrates the different influential socio-economic and demographic determinants of infant mortality in Bangladesh. Infant mortality is associated with mother's education with an adjusted OR of 0.537 (95% CI: 0.380 to 0.759; $p \leq 0.001$) for the secondary level of education. The number of individuals from poorer and middle-class households showed a significant influence on infant mortality, where the ORs were 0.448 (95% CI: 0.303 to 0.663; $p \leq 0.001$) and 0.408 (95% CI:

Table 2. Baseline characteristics of selected covariates for 24 developing countries

Country Name	Variables: Infant mortality n (%)		Type of place of residence n (%)		Mother's education n (%)		Father's education n (%)		Living below poverty line n (%)		Mother's current working status n (%)		Birth order number n (%)		Mother's age at delivery n (%)		Number of foetuses n (%)		Undergoing ANC n (%)		Undergoing PNC		Size of child n (%)	
	No	Yes	Rural	Urban	Up to primary	Above primary	Up to primary	Above primary	No	Yes	Not working	Working	1st born	2nd & above	≤ 19 years	Above 19	Single	Multiple	No	Yes	No	Yes	Average	> or < than average
Sierra Leone 2013	9,453 (92.4)	778 (7.6)	7,424 (72.6)	2,807 (27.4)	8,879 (86.8)	1,352 (13.2)	7,659 (74.9)	2,572 (25.1)	5,590 (54.6)	4,641 (45.4)	2,416 (23.6)	7,815 (976.4)	1,720 (16.8)	8,511 (83.2)	1,150 (11.2)	9,081 (88.8)	9,777 (95.6)	454 (4.4)	4,009 (39.2)	6,222 (60.8)	5,388 (52.7)	4,843 947.3)	4,175 (40.8)	6,056 (59.2)
Zambia 2013–2014	11,164 (96.0)	469 (4.0)	7,425 (63.8)	4,208 (36.2)	8,061 (69.3)	3,572 (30.7)	5,748 (49.4)	5,885 (50.6)	5,997 (51.6)	5,636 (48.4)	4,761 (40.9)	6,872 (59.1)	1,880 (16.2)	9,753 (83.8)	1,233 (10.6)	10,400 (89.4)	11,238 (96.6)	395 (3.4)	3,912 (33.6)	7,721 (66.4)	6,983 (60.0)	4,650 (40.0)	6,923 (59.5)	4,710 (40.5)
Bangladesh 2014	4,561 (96.5)	163 (3.5)	3,220 (68.2)	1,504 (31.8)	1,959 (41.5)	2,765 (58.5)	2,526 (53.5)	2,198 (46.5)	2,811 (59.5)	1,913 (40.5)	3,689 (78.1)	1,035 (21.9)	1,943 (41.1)	2,781 (58.9)	1,168 (24.7)	3,556 (75.3)	4,662 (98.7)	62 (1.3)	2,204 (25.5)	3520 (74.5)	1,816 (38.4)	2,908 (61.6)	3,181 (67.3)	1,543 (32.7)
Cambodia 2014	6,913 (97.7)	164 (2.3)	5,148 (72.7)	1,929 (27.3)	4,504 (63.6)	2,573 (36.4)	3,732 (52.7)	3,345 (47.3)	4,072 (57.5)	3,005 (42.5)	2,360 (33.3)	4,717 (66.7)	2,744 (38.8)	4,333 (61.2)	491 (6.9)	6,586 (93.1)	6,945 (98.1)	132 (1.9)	1,562 (22.1)	5,515 (77.9)	2,526 (35.7)	4,551 (64.3)	3,756 (53.1)	3,321 (46.9)
Egypt 2014	15,432 (97.9)	335 (2.1)	9,411 (59.7)	6,356 (40.3)	4,030 (25.6)	11,737 (74.4)	3,975 (25.2)	11,792 (74.8)	9,851 (62.5)	5,916 (37.5)	13,802 (87.5)	1,965 (12.5)	4,872 (30.9)	10,895 (69.1)	783 (5.0)	14,984 (95.0)	15,153 (96.1)	614 (3.9)	1,657 (10.5)	14,110 (89.5)	11,906 (75.5)	3,861 (24.5)	12,928 (82.0)	2,839 (18.0)
Kenya 2014	8,886 (96.6)	311 (3.4)	6,169 (67.1)	3,028 (32.9)	6,978 (75.9)	2,219 (24.1)	6,141 (66.8)	3,056 (33.2)	4,140 (45.0)	5,057 (55.0)	3,794 (41.3)	5,403 (58.7)	1,777 (19.3)	7,420 (80.7)	780 (8.5)	8,417 (91.5)	8,960 (97.4)	237 (2.6)	3,099 (33.7)	6,098 (66.3)	5,139 (55.9)	4,058 (44.1)	5,455 (59.3)	3,742 (40.7)
Lesotho 2014	2,565 (94.0)	164 (6.0)	2,071 (75.9)	658 (24.1)	1,408 (51.6)	1,321 (48.4)	1,784 (65.4)	945 (34.6)	1,426 (52.3)	1,303 (47.7)	1,913 (70.1)	816 (29.9)	953 (34.9)	1,776 (65.1)	314 (11.5)	2,415 (88.5)	2,656 (97.3)	73 (2.7)	607 (22.2)	2,122 (77.8)	963 (35.3)	1,766 (64.7)	1,810 (66.3)	919 (33.7)
Chad 2014–2015	16,027 (94.1)	1,003 (5.9)	13,495 (79.2)	3,535 (20.8)	15,627 (91.8)	1,403 (8.2)	13,975 (82.1)	3,055 (17.9)	10,366 (60.9)	6,664 (39.1)	10,340 (60.7)	6,690 (39.3)	2,476 (14.5)	14,554 (85.5)	2,610 (15.3)	14,420 (84.7)	16,568 (97.3)	462 (2.7)	11,186 (65.7)	5,844 (34.3)	15,508 (91.1)	1522 (8.9)	4811 (28.3)	12219 (71.7)
Afghanistan 2015	29,618 (95.8)	1,313 (4.2)	23,501 (76.0)	7,430 (24.0)	28,632 (92.6)	2,299 (7.4)	21,959 (71.0)	8,972 (29.0)	18,238 (59.0)	12,693 (41.0)	27,695 (89.5)	3,236 (10.5)	25,215 (81.5)	5,716 (18.5)	2,831 (9.2)	28,100 (90.8)	30,369 (98.2)	562 (1.8)	20,434 (66.1)	10,497 (33.9)	26,604 (86.0)	4,327 (14.0)	19,426 (62.8)	11,505 (37.2)
Zimbabwe 2015	4,914 (95.8)	213 (4.2)	3,218 (62.8)	1,909 (37.2)	1,554 (30.3)	3,573 (69.7)	1,137 (22.2)	3,990 (77.8)	3,145 (61.3)	1,982 (38.7)	3,073 (59.9)	2,054 (40.1)	1,250 (24.4)	3,877 (75.6)	509 (9.9)	4,618 (90.1)	4,940 (96.4)	187 (3.6)	1,378 (26.9)	3,749 (73.1)	1,743 (34.0)	3,384 (66.0)	2,499 (48.7)	2,628 (51.3)
Angola 2015–2016	8,788 (95.4)	423 (4.6)	4,081 (44.3)	5,130 (55.7)	6,666 (72.4)	2,545 (27.6)	4,532 (49.2)	4,679 (50.8)	4,594 (49.9)	4,617 (50.1)	2,489 (27.0)	6,722 (73.0)	1,488 (16.2)	7,723 (83.8)	1,214 (13.2)	7,997 (86.8)	8,939 (97.0)	272 (3.0)	4,887 (52.9)	4,334 (47.1)	8,101 (87.9)	1,110 (12.1)	5,387 (58.5)	3,824 (41.5)
Malawi 2015–2016	13,603 (96.3)	522 (3.7)	11,892 (84.2)	2,233 (15.8)	11,176 (79.1)	2,949 (20.9)	9,132 (64.7)	4,993 (35.3)	8,115 (57.5)	6,010 (42.5)	4,878 (34.5)	9,247 (65.5)	3,330 (23.6)	10,795 (76.4)	1,891 (13.4)	12,234 (86.6)	13,595 (96.2)	530 (3.8)	3,498 (24.8)	10,627 (75.2)	9,303 (65.9)	4,822 (34.1)	7,119 (50.4)	7,006 (49.6)
Tanzania 2015–2016	8,191 (96.3)	319 (3.7)	6,668 (78.4)	1,842 (21.6)	7,033 (82.6)	1,477 (17.4)	6,798 (79.9)	1,712 (20.1)	4,707 (55.3)	3,803 (44.7)	1,962 (23.1)	6,548 (76.9)	1,733 (20.4)	6,777 (79.6)	843 (9.9)	7,667 (90.1)	8,211 (96.5)	299 (3.5)	2,949 (34.7)	5,561 (65.3)	6,505 (76.4)	2,005 (23.6)	5,989 (70.4)	2,521 (29.6)
India 2015–2016	42,170 (96.2)	1,687 (3.8)	32,883 (75.0)	10,974 (25.0)	19,010 (43.3)	24,847 (56.7)	14,102 (32.2)	29,755 (67.8)	23,059 (52.6)	20798 (47.4)	36,328 (82.8)	7,529 (17.2)	16,449 (37.5)	27,408 (62.5)	2,832 (6.5)	41,025 (93.5)	43,093 (98.3)	764 (1.7)	16,704 (38.1)	27,153 (61.9)	32,068 (73.1)	11,789 (26.9)	30,896 (70.4)	12,961 (29.6)
Myanmar 2015–2016	4,353 (95.9)	187 (4.1)	3,564 (78.5)	976 (21.5)	2,791 (61.5)	1,749 (38.5)	2,603 (57.3)	1,937 (42.7)	2,156 (47.5)	2,384 (52.5)	2,133 (47.0)	2,407 (53.0)	1,475 (32.5)	3,065 (67.5)	218 (4.8)	4,322 (95.2)	4,455 (98.1)	85 (1.9)	1,408 (31.0)	3,132 (69.0)	2,797 (61.6)	1,743 (38.4)	2,811 (61.9)	1,729 (38.1)
South Africa 2016	1,351 (96.7)	46 (3.3)	556 (39.8)	841 (60.2)	178 (12.7)	1,219 (87.3)	225 (16.1)	1,172 (83.9)	783 (56.0)	614 (44.0)	913 (65.4)	484 (34.6)	297 (21.3)	1,100 (78.7)	58 (4.2)	1,339 (95.8)	1,358 (97.2)	39 (2.8)	335 (24.0)	1,062 (76.0)	409 (29.3)	988 (70.7)	846 (60.6)	551 (39.4)
Ethiopia 2016	9,372 (95.4)	455 (4.6)	8,099 (82.4)	1,728 (17.6)	8,811 (89.7)	1,016 (10.3)	8,053 (81.9)	1,774 (18.1)	4,464 (45.4)	5,363 (54.6)	7,246 (73.7)	2,581 (26.3)	1,874 (19.1)	7,953 (80.9)	866 (8.8)	8,961 (91.2)	9,563 (97.3)	264 (2.7)	5,569 (56.7)	4,258 (43.3)	9,239 (94.0)	588 (6.0)	4,129 (42.0)	5,698 (58.0)
Nepal 2016	4,821 (96.9)	155 (3.1)	2,145 (43.1)	2,831 (56.9)	2,642 (53.1)	2,334 (46.9)	1,815 (36.5)	3,161 (63.5)	2,596 (52.2)	2,380 (47.8)	2,399 (48.2)	2,577 (51.8)	1,958 (39.3)	3,018 (60.7)	760 (15.3)	4,216 (84.7)	4,909 (98.7)	67 (1.3)	1,263 (25.4)	3,713 (74.6)	3,551 (71.4)	1,425 (28.6)	3,307 (66.5)	1,669 (33.5)
Timor-Leste 2016	5,580 (97.3)	154 (2.7)	3,801 (66.3)	1,933 (33.7)	2,229 (38.9)	3,505 (61.1)	2,290 (39.9)	3,444 (60.1)	3,697 (64.5)	2,037 (35.5)	3,604 (62.9)	2,130 (37.1)	1,453 (25.3)	4,281 (74.7)	275 (4.8)	5,459 (95.2)	5,624 (98.1)	110 (1.9)	2,178 (38.0)	3,556 (62.0)	4,909 (85.6)	825 (14.4)	3,988 (69.6)	1,746 (30.4)
Indonesia 2017	16,487 (97.9)	347 (2.1)	8,452 (50.2)	8,382 (49.8)	4,330 (25.7)	12,504 (74.3)	4,587 (27.2)	12,247 (72.8)	9,054 (53.8)	7,780 (46.2)	9,059 (53.8)	7,775 (46.2)	5,468 (32.5)	11,366 (67.5)	803 (4.8)	16,031 (95.2)	16,598 (98.6)	236 (1.4)	2,746 (16.3)	14,088 (83.7)	7,017 (41.7)	9,817 (58.3)	9,049 (53.8)	7,785 (46.2)
Benin 2017–2018	11,379 (95.4)	549 (4.6)	7,326 (61.4)	4,602 (38.6)	10,066 (84.4)	1,862 (16.6)	9,110 (76.4)	2,818 (23.6)	6,716 (56.3)	5,212 (43.7)	2,292 (19.2)	9,636 (80.8)	2,387 (20.0)	9,541 (80.0)	940 (7.9)	10,988 (92.1)	11,343 (95.1)	585 (4.9)	5,203 (43.6)	6,725 (56.4)	10,360 (86.9)	1,568 (13.1)	6,869 (57.6)	5,059 (42.4)
Pakistan 2017–2018	11,845 (94.9)	638 (5.1)	6,960 (55.8)	5,523 (44.2)	8,086 (64.8)	4,397 (35.2)	5,204 (41.7)	7,279 (58.3)	6,785 (54.4)	5,698 (45.6)	11,046 (88.5)	1,437 (11.5)	2,964 (23.7)	9,519 (76.3)	786 (6.3)	11,697 (93.7)	12,164 (97.4)	319 (2.6)	5,607 (44.9)	6,876 (55.1)	10,287 (82.4)	2,196 (17.6)	9,291 (74.4)	3,192 (25.6)
Guinea 2018	6,854 (93.7)	462 (6.3)	5,374 (73.5)	1,942 (26.5)	6,518 (89.1)	798 (10.9)	5,931 (81.1)	1,385 (18.9)	3,817 (52.2)	3,499 (47.8)	2,340 (32.0)	4,976 (68.0)	1,267 (17.3)	6,049 (82.7)	995 (13.6)	6,321 (86.40	6,983 (95.4)	333 (4.6)	3,199 (43.7)	4,117 (56.3)	5,669 (77.5)	1,647 (22.5)	2,702 (36.9)	4,614 (63.1)
Nigeria 2018	29,359 (93.8)	1,950 (6.2)	20,664 (66.0)	10,645 (34.0)	19,339 (61.8)	11,970 (38.2)	15,963 (51.0)	15,346 (49.0)	16,608 (53.0)	14,701 (47.0)	10,278 (32.8)	21,031 (67.2)	5,625 (18.0)	25,684 (82.0)	2,922 (9.3)	28,387 (90.7)	30,138 (96.3)	1171 (3.7)	16,628 (53.1)	14,681 (46.9)	27,207 (86.9)	4,102 (13.1)	16,411 (52.4)	14,898 (47.6)

0.254 to 0.654; $p \leq 0.001$) for poorer and middle-class household, respectively. Similarly, birth order number had a noticeable impact on infant mortality, with an adjusted OR of 0.362 (95% CI 0.248 to 0.527: $p \leq 0.001$) with respect to 2nd and above born infants. Mothers over 19 years of age significantly influenced infant mortality, with an adjusted OR 0.477 (95% CI 0.333 to 0.682: $p \leq 0.001$). The variable number of foetused showed a significant association with infant mortality, where the OR for the category 'multiple foetuses' was 6.634 (95% CI 3.247 to 13.555: $p \leq 0.001$). Likewise, undergoing ANC has a significant influence on infant mortality, with an OR of 0.271 (95% CI 0.192 to 0.382: $p \leq 0.001$) for the category '1–4 visits'. The OR of undergoing PNC was 0.303 (95% CI 0.216 to 0.425; $p \leq 0.001$), which exhibits an association between infant mortality and undergoing PNC services. The sizes of children had a significant impact on infant mortality, with an adjusted OR of 0.578 (95% CI 0.400 to 0.834; $p = 0.003$) regarding the category 'smaller than average'.

Table 3. Results of the binary logistic regression model affecting socio-economic and demographic factors for infant mortality in Bangladesh

	B*	Odds Ratio	*p*	95% CI for OR
Type of place of residence				
Rural (Ref. Category)				
Urban	-0.101	0.904	0.606	[0.616; 1.326]
Mother's education				
Up to Primary (Ref. Category)			0.002	
Secondary	-0.622	0.537	0.000	[0.380; 0.759]
Higher	-0.723	0.485	0.116	[0.197; 1.196]
Father's education				
Up to Primary (Ref. Category)			0.017	
Secondary	-0.413	0.662	0.040	[0.447; 0.980]
Higher	-1.067	0.344	0.014	[0.147; 0.807]
Wealth Index				
Poorest (Ref. Category)			0.000	
Poorer	-0.802	0.448	0.000	[0.303; 0.663]
Middle	-0.897	0.408	0.000	[0.254; 0.654]
Richer	-0.209	0.812	0.389	[0.505; 1.305]
Richest	-0.049	0.952	0.874	[0.521; 1.741]
Mother's current working status				
Not Working (Ref. Category)				
Working	0.027	1.027	0.883	[0.716; 1.475]
Birth order number				
First born (Ref. Category)				
Second and above	-1.016	0.362	0.000	[0.248; 0.527]
Mother's age at delivery				
≤ 19 (Ref. Category)				
Above 19	-0.741	0.477	0.000	[0.333; 0.682]
Number of foetuses				
Single (Ref. Category)				
Multiple	1.892	6.634	0.000	[3.247; 13.555]
Undergoing antenatal care				
No (Ref. Category)			0.000	
1–4 Visits	-1.306	0.271	0.000	[0.192; 0.382]
More than 4 Visits	-0.758	0.468	0.003	[0.286; 0.768]
Undergoing postnatal care				
No (Ref. Category)				
Yes	-1.194	0.303	0.000	[0.216; 0.425]
Size of child				
Average (Ref. Category)			0.001	
Larger than Average	0.366	1.443	0.078	[0.960; 2.167]
Smaller than Average	-0.548	0.578	0.003	[0.400; 0.834]

* B – β; OR – Odds Ratio; CI – Confidence Interval; Ref. – Reference category.

Table 4. Random-effects model estimation of OR for 24 developing countries

Country name	Type of place of residence	Mother's education	Father's education	Living below poverty line	Mother's current working status	Birth order number	Mother's age at delivery	Number of foetuses	Undergoing ANC	Undergoing PNC	Size of child
	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
Afghanistan	0.608	0.857	0.878	0.883	1.966	1.082	0.803	0.197	0.549	0.701	0.555
Angola	0.702	0.561	0.765	0.649	1.257	0.755	0.577	0.287	0.409	0.369	0.730
Bangladesh	0.974	0.640	0.575	0.715	1.332	0.814	0.830	0.113	0.314	0.323	0.543
Benin	0.801	0.849	0.831	0.824	1.175	1.010	0.742	0.189	0.373	0.357	0.855
Chad	1.098	0.867	0.944	0.950	1.197	0.759	0.715	0.200	0.526	0.705	1.117
Cambodia	0.451	0.596	0.525	0.406	1.214	1.262	1.152	0.312	0.228	0.235	0.652
Egypt	0.699	0.706	0.888	0.700	0.738	0.819	0.564	0.206	0.916	0.535	0.299
Ethiopia	0.553	0.759	0.790	0.692	0.936	0.888	0.646	0.195	0.308	0.202	0.731
Guinea	0.544	0.530	0.661	0.658	1.188	1.185	0.851	0.228	0.516	0.437	0.872
India	0.737	0.563	0.628	0.588	1.154	1.056	0.670	0.138	0.354	0.333	0.665
Indonesia	0.923	0.731	0.751	0.757	1.404	1.159	0.667	0.139	0.212	0.138	0.673
Kenya	1.055	0.999	0.980	1.084	1.171	1.094	0.655	0.223	0.319	0.292	0.621
Lesotho	0.814	0.892	0.978	1.119	0.596	1.099	1.420	0.252	0.311	0.168	0.598
Malawi	0.847	0.988	0.903	0.866	1.224	0.644	0.593	0.174	0.261	0.170	0.873
Myanmar	0.660	0.637	0.816	0.682	1.436	1.412	0.888	0.097	0.202	0.215	0.695

Table 4. Random-effects model estimation of OR for 24 developing countries											
Country name	Type of place of residence	Mother's education	Father's education	Living below poverty line	Mother's current working status	Birth order number	Mother's age at delivery	Number of foetuses	Undergoing ANC	Undergoing PNC	Size of child
	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR	OR
Nepal	0.803	0.727	0.768	0.690	0.941	0.825	0.471	0.318	0.220	0.259	0.499
Nigeria	0.716	0.678	0.683	0.696	0.907	0.910	0.709	0.218	0.473	0.346	0.790
Pakistan	0.765	0.644	0.755	0.729	1.442	1.033	0.837	0.273	0.515	0.801	0.627
Sierra Leone	1.046	0.978	0.996	1.063	1.133	0.915	0.787	0.217	0.488	0.348	0.793
South Africa	1.249	0.684	2.054	0.492	0.514	0.971	0.437	0.167	0.329	0.120	0.369
Tanzania	1.264	1.131	1.417	1.198	1.010	0.705	0.592	0.184	0.318	0.267	0.504
Timor-Leste	0.707	0.969	0.837	0.910	1.278	0.743	0.646	0.127	0.557	0.496	0.574
Zambia	1.114	1.119	1.007	1.029	0.864	0.592	0.453	0.174	0.275	0.265	0.709
Zimbabwe	0.575	0.557	0.650	0.730	0.877	0.958	0.749	0.221	0.183	0.095	0.583
I^2	79.3	77.2	75.9	82.9	82.0	71.4	47.0	53.8	91.2	92.5	86.6
τ^2	0.043	0.043	0.031	0.041	0.049	0.029	0.017	0.027	0.098	0.258	0.055

OR – Odds Ratio; τ^2 – Estimate of between-study variance; I^2 – Between study variation.

Table 5. Random-effects model estimation (summary effect) for various covariates in 24 developing countries			
Variables	Random-effects model		
	Overall OR	*p*	95% Confidence Interval (CI)
Type of place of residence	0.796	0.0001	[0.721; 0.877]
Mother's education	0.762	0.0001	[0.690; 0.842]
Father's education	0.817	0.0001	[0.750; 0.891]
Living below poverty line	0.784	0.0001	[0.715; 0.861]
Mother's current working status	1.117	0.0001	[1.008; 1.238]
Birth order number	0.909	0.0001	[0.835; 0.990]
Mother's age at delivery	0.689	0.0062	[0.636; 0.747]
Number of foetuses	0.193	0.0010	[0.176; 0.213]
Undergoing ANC	0.356	0.0001	[0.311; 0.407]
Undergoing PNC	0.302	0.0001	[0.243; 0.375]
Size of child	0.653	0.0001	[0.588; 0.726]

OR – Odds Ratio; CI – Confidence Interval.

The true treatment effect can estimate the average treatment effect that varies from study to study from the random-effects model, as illustrated in Tables 4 and 5. This study intended to use the random-effects model, as the study showed high between-study variations (heterogeneity). About 79.3% of the variation (I^2 = 79.3%) was observed for the type of place of residence. The overall OR was 0.796 (95% CI: 0.721 to 0.878), which means that individuals residing in urban areas have a 20.4% lower chance of experiencing infant deaths than their rural counterparts. About 77.2% of the variation (I^2 = 77.2%) was found for mother's education. The overall OR was 0.762 (95% CI: 0.690 to 0.842), meaning mothers who have above primary level education are 0.7622 times or 23.8% less likely to confront infant death compared to mothers who have up to primary education. Similarly, father's education showed about 75.9% of the variation, with an overall OR of 0.817 (95% CI: 0.750 to 0.891), which indicates that fathers have 0.817 times or a 18.3% lower chance with an increment in the education level of experiencing infant death. For living below the poverty line, I^2 was found to be 82.9%, where the overall OR was 0.784 (95% CI: 0.715 to 0.861), which reveals the odds of infant mortality is 0.784 times or 21.6% lower in individuals who do not live below the poverty line compared to those who live below the poverty line. About 82.0% of the variation (I^2 = 82.0%) was observed for mother's current working status. The overall OR was 1.117 (95% CI: 1.008 to 1.238), which means the odds of infant mortality are 1.117 times or 11.7% higher in women currently working compared to those not working currently. For birth order number, I^2 was found to be 71.4%, with an overall OR of 0.909 (95% CI: 0.835 to 0.990), indicating a 9.1% lower chance of infant mortality in the 2nd and above-born child than those who are the firstborn child. The overall OR was 0.689 (95% CI: 0.636 to 0.747) for mother's age at delivery, with a 47.0% variation. This suggests that with the increment of a mother's age, the risk of infant

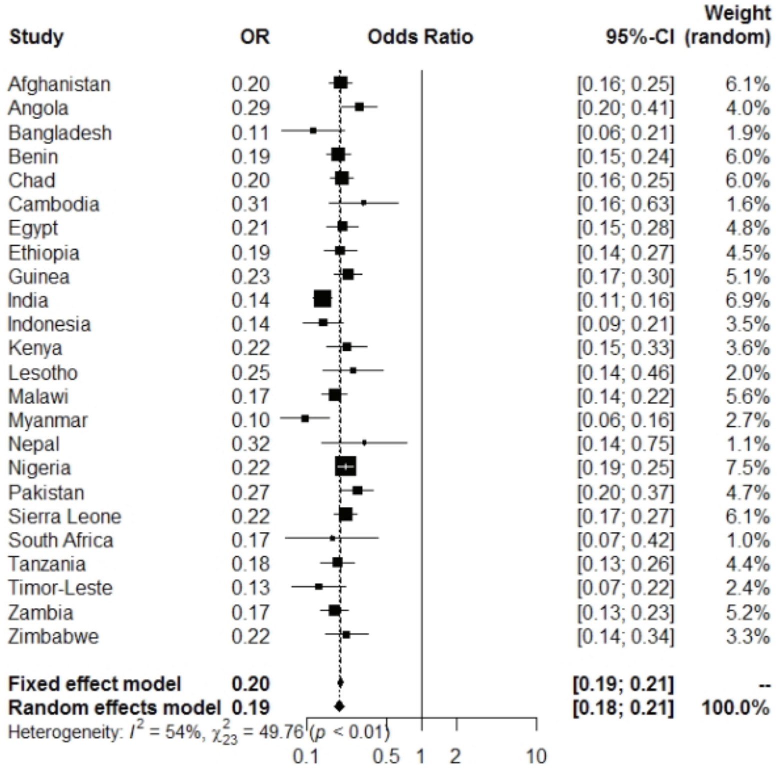

Figure 2. Forest plot for the number of foetuses, showing the weight of the study by the size of each box, while each crossed line indicates 95% CI

death decreases. The overall OR for the number of the foetuses was 0.193 (95% CI: 0.176 to 0.213), with a 53.8% variation. This indicates that infant death occurs at a rate of 0.193 times or is 80.7% less likely in women carrying a single foetus than those who carry multiple foetuses. About 91.2% of the variation (I^2 = 91.2%) was found for undergoing ANC. The overall OR was 0.356 (95% CI: 0.311 to 0.407), which means infant death occurs 0.356 times or is 64.4% less likely in women who undergo antenatal care than those who do not. For undergoing PNC, I^2 was found to be 92.5%, with an overall OR of 0.302 (95% CI: 0.243 to 0.375), expressing a lower chance of infant mortality in the respondents who undergo postnatal check-ups. The size of child showed 86.6% variation (I^2 = 86.6%), with an overall OR of 0.653 (95% CI: 0.588 to 0.726). This indicates that infant death is 0.653 times or 34.7% less likely in an average-sized child than in those who are larger or smaller than average.

The result from meta-analysis is displayed in table 4 which narrated that urban residents are 0.974 times or have a 2.6% lower chance of confronting infant death than rural residents. Similarly, mother's education, father's education, living below the poverty line, birth order number and mother's age at delivery are positively associated with infant mortality, with ORs of 0.640, 0.575, 0.715, 0,814 and 0.830, respectively. The number of foetuses, undergoing ANC, PNC services and the child's size are also positively associated with infant mortality, where the ORs are 0.113, 0.314, 0.323 and 0.543, respectively. We considered that the respondents from the reference categories are the controlled group respondent and the respondent from other categories are the treated group respondent. However, mother's working status had a noticeable negative influence on infant mortality, with an OR of 1.332. Overall, the number of foetuses and undergoing ANC and PNC services are the most significant factors that affect the risk of infant mortality for both methods of random-effects meta-analysis and binary logistic regression for BDHS.

Figure 2 illustrates that the women of Myanmar who carried a single foetus had the lowest chance of confronting infant deaths among all the countries, as the OR was 0.10 with 95% CI: 0.06 to 0.16. On the other hand, the women of Nepal had the lowest chance (OR 0.32 with 95% CI: 0.14 to 0.75) of experiencing infant mortality with a single foetus. The overall estimate is statistically significant, with a p-value ≤ 0.01 at a 5% level of significance.

Discussion

The present studies show the disparity and reasons behind infant mortality across developing countries. Through the outcome of the logistic regression model, mother's education, father's education, wealth index, birth order number, mother's age at delivery, number of foetuses, undergoing ANC, PNC and child's size was found to have a significant influence on infant death for Bangladesh.

In this study, the odds of infant death are lower among births to mothers who have above primary level education than mothers with up to primary level education for BDHS data. For instance, mothers who had secondary level education were 0.537 times or 46.3% less likely to confront infant death compared to mothers who had up to primary education. The findings from the meta-analysis also supports this result. This finding is in line with the outcomes of other research [29, 30, 32–35]. Mother's education may influence child health and mortality with the help of various pathways [49]. This could be mothers having a secondary and above level of education, resulted in better knowledge of health-related services. Besides this, better education helps them to live in affluent communities with better access to health services [32].

Both of the logistic regression models for BDHS data and the meta-analysis for 24 developing countries revealed that, similar to mother's education, the father's higher education reduces the risk of infant mortality. Infant mortality is 0.344 times or 65.6% less likely for higher educated fathers than those who have up to primary education (Ref. category) in Bangladesh. From the overall estimate of the meta-analysis, it was found that fathers who had above primary level education are 0.8174 times or 18.26% less likely to experience infant death compared to fathers who had up to primary education. Some other studies support this finding [32, 33, 35]. In our social orders, the father is the fundamental worker and head of the family. Father's education leads to a secure job and significant earning, which guarantees nutrition, clothing, housing and so forth. In other words, there might be a direct connection between a father's education and access to facilities for the wellbeing of children [35].

Both the outcome of the logistic regression model for BDHS data and meta-analysis revealed that individuals whose ages are above 19 years could reduce infant death compared to those who are 19 years or younger in Bangladesh, holding the other covariates at a controlled level. From the outcome of BDHS data, we know that women whose ages were above 19 are 0.477 times or 52.3% less likely to experience infant mortality than women whose ages were 19 or younger. In the meta-analysis, the overall random effect for mother's age at delivery expressed a 31% lower chance of infant death when the individuals are above 19 years of age. This result is supported by other findings [15, 29, 30, 35]. Lack of childbearing knowledge might be responsible for a younger mother's higher risk of infant mortality [17]. Additionally, children born to young mothers are more likely to be premature and have low birth weights, and consequently, the mother will experience complexity at the time of delivery [50].

The number of foetuses shows a highly significant impact on infant mortality in Bangladesh, as the odds ratio is 6.634 for multiple foetuses, which means the risk of infant mortality is 6.634 times higher in the case of women who carry multiple foetuses than women with a single foetus. From the outcome of the overall meta-analysis estimate, infant death is 0.1934 times or 80.66% less likely in women who carried a single foetus than those women who carried multiple foetuses. Thus, the odds of infant death were higher among twin births than single births. This study is supported by a study conducted in Indonesia [51]. A possible explanation for this finding could be that pregnancy with twin foetuses usually leads to premature birth, the most common cause of infant death. Besides this, twin-to-twin transfusion syndrome may occur, which further leads to death [52]. A twin pregnancy also usually ends with low birth weight, which increases a child's weakness to contamination and diminishes their resistance [53]. As a result, the child's survival is decreased. Similar results were found by the researcher in Burkina Faso [54]. This study shows the importance of primary care because it helps to reduce the infant mortality rate and improve the health of children around the world [55, 56]. Mothers with at least one ANC visit decreased the chance of infant death compared to mothers with no ANC visits in for the case of both Bangladesh and the 23 other developing countries. The overall estimate from the meta-analysis uncovered that infant death is 0.3560 times or 64.4% less likely in women who undergo antenatal care than those who do not. This result is supported by other studies and shows the significance of primary care for the mother and new-born children [57–59]. A conceivable explanation could be women undergoing ANC visits get the opportunity for prompt detection of complications and early inception of breastfeeding, which help increase the resistance of a child [60]. Likewise, women who had total ANC follow-up had expanded the likelihood of receiving the skilled birth attendant during their delivery, which lessens the chances of infant death [61]. In addition, a follow-up with ANC usually leads to having quality essential new-born care, which increases infant survival [55].

PNC has a higher impact on infant mortality, which indicates that the risk of infant mortality is lower in children who are taken for the postnatal check-ups. The study uncovered that a lower risk of infant death is found in children who were taken for postnatal care in Bangladesh, holding the other covariates at a controlled level, i.e. infant mortality is 0.303 times or 69.7% less likely in a child who was taken for a postnatal check-up than in those who did not go for a postnatal check-up. In a meta-analysis, the overall random effect for undergoing PNC as treatment showed about a 70% lower chance of infant death in the children who were taken for postnatal care than those who were not taken for the check-ups. Another finding supports this outcome [62].

This study provides crucial information about infant mortality in developing countries by focusing on the prevalence and addressing the associated triggering factors. The primary healthcare provider can use this information to make policies that may reduce the infant mortality rate, as the role of primary care in enhancing health outcomes in developing countries is well recognised [63–65].

Strength and limitations of the study

We confronted several limitations while conducting the research. The primary constraint is that we had limited access to DHS data due to authorised permission. For this reason, we could only collect data from 24 of the 91 countries from the DHS database. Another limitation is that a bias selection may be found in our study, as the DHS data utilised in this study covered a more comprehensive range and different time points. For estimating OR from random-effects meta-analysis, we had to create 2 x 2 cross-tabulation, for which each variable was categorised into two categories only. Additionally, our study could not include many factors that could influence infant mortality because of the unavailability of these variables in the DHS dataset.

The study has some strengths despite these constraints. We combined two methods: Binary Logistic Regression Model of BDHS data and meta-analysis of 24 DHS datasets. The integrated findings enlarged the validity of the research outcome and showed the consistency of the effect across the developing countries. We unfolded a new research approach by introducing this mixed-method design. Better knowledge and insight could be generated due to its extensive and acute quality.

Conclusions

Infant mortality, as a significant part of under-five child mortality, is undoubtedly the most grounded pointer of a nation's prosperity and needs to be reduced. This study showed that women having their first birth at an early age who undergo low ANC and PNC services and have no mother's education were more at risk of infant mortality in developing countries, including Bangladesh. Policymakers need to be concerned about these women, and proper initiatives need to be introduced to reduce infant mortality. As previously mentioned, living in an urban area, having an educated father and a wealthy family background can significantly reduce the infant mortality rate in developing countries. Modernised healthcare services should be provided to both rural and urban regions with accessible medical facilities for unprivileged counterparts. Mothers with multiple foetuses and children of greater than average size should be under proper surveillance as they are at high risk of infant mortality. If these required schemes can be implemented, then the destined reduction of infant mortality of the Sustainable Development Goals by 2030 can be met.

Acknowledgments. We would also like to show our gratitude to the Demographic and Health Surveys (DHS) Programme for providing data.

Source of funding: This work was funded from the authors' own resources.
Conflicts of interest: The authors declare no conflicts of interest.

References

1. Blaxter M. *The health of the children. A review of research on the place of health in cycles of disadvantage*. Heinemann Educational Books; 1981.
2. Taskaya S, Demirkiran M. Determinants of infant mortality in last two decades: a bibliometric analysis. *Int J Community Med Public Health* 2016; 3: 776–780.
3. Miller NZ, Goldman GS. Infant mortality rates regressed against number of vaccine doses routinely given: Is there a biochemical or synergistic toxicity? *Hum Exp Toxicol* 2011; 30(9): 1420–1428.
4. Vakili R, Emami Moghadam Z, Khademi G, et al. Child mortality at different world regions: a comparison review. *Int J Pediatr* 2015; 3(4–2): 809–816.
5. Khodaee GH, Khademi G, Saeidi M. Under-five Mortality in the World (1900–2015). *Int J Pediatr* 2015; 3(6.1): 1093–1095.
6. Dadipoor S, Alavi A, Ziapour A, et al. Factors Involved in the Mortality of Infants under the Age of One Year in Bandar Abbas-Iran: A Document-Based Study. *Int J Pediatr* 2018; 6(4): 7519–7527.
7. Safari Moradabadi A, Rajaei M, Naderi S. Investigating the underlying causes of mortality among less than one year old infants in pediatric hospital of Bandar Abbas, Iran. *Hormozgan Medical Journal* 2014; 18(3): 180–186.
8. Kamal SM, Ashrafuzzaman M, Nasreen S. Risk factors of neonatal mortality in Bangladesh. *Journal of Nepal Paediatric Society* 2012; 32(1): 37–46.
9. Målqvist M. Neonatal mortality: an invisible and marginalised trauma. *Glob Health Action* 2011; 4(1): 5724.
10. Rajaratnam JK, Marcus JR, Flaxman AD, et al. Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970–2010: a systematic analysis of progress towards Millennium Development Goal 4. *Lancet* 2010; 375(9730): 1988–2008.
11. Titaley CR, Dibley MJ, Agho K, et al. Determinants of neonatal mortality in Indonesia. *BMC Public Health* 2008; 8(1): 1–15.
12. Lu Z, Bandara JS, Paramati SR. Impact of sanitation, safe drinking water and health expenditure on infant mortality rate in developing economies. *Australian Economic Papers* 2020; 59(1): 13–33.
13. Talukder A, Sathi NJ, Islam A, et al. Prevalence and Factors Associated with under-5 Mortality in Nigeria: Evidence from 2018 Nigeria Demographic and Health Survey. *Dr Sulaiman Al Habib Medical Journal* 2021; 3(4): 154–161.
14. WHO. World health statistics 2019: monitoring health for the SDGs, sustainable development goals. 2019. Available from URL: https://www.who.int/publications/i/item/9789241565707.
15. Karmaker S, Lahiry S, Roy D, et al. Determinants of infant and child mortality in Bangladesh: time trends and comparisons across South Asia. *Bangladesh Journal of Medical Science* 2014; 13(4): 431–437.
16. Islam MA, Tabassum T. Does antenatal and post-natal program reduce infant mortality? A meta-analytical review on 24 developing countries based on Demographic and Health Survey data. *Sex Reprod Healthc* 2021; 28: 100616, doi: 10.1016/j.srhc.2021.100616.
17. Schell CO, Reilly M, Rosling H, et al. Socioeconomic determinants of infant mortality: a worldwide study of 152 low-, middle-, and high-income countries. *Scand J Public Health* 2007; 35(3): 288–297.
18. The World Bank. Countries and Economies 2019. Available from URL: https://data.worldbank.org/country.
19. Hug L, Dharrow D, Zhong K, et al. Levels and trends in child mortality: Report 2018. The World Bank; 2018.
20. Sartorius BK, Sartorius K. Global infant mortality trends and attributable determinants – an ecological study using data from 192 countries for the period 1990–2011. *Popul Health Metrics* 2014; 12(1): 1–15.
21. Rubayet S, Shahidullah M, Hossain A, et al. Newborn survival in Bangladesh: a decade of change and future implications. *Health Policy Plan* 2012; 27(Suppl. 3): iii40–iii56.
22. UNDP. Africa Human Development Report 2016. Accelerating Gender Equality and Women's Empowerment in Africa. United Nations Development Programme (UNDP), 2016. Available from URL: https://www.afdb.org/fileadmin/uploads/afdb/Documents/AEC/2016/AfHDR_Summary_highres_EN.pdf.
23. The World Bank. World development report 2016: digital dividends. Available from URL: https://www.worldbank.org/en/publication/wdr2016.
24. National Institute of Population Research and Training, Mitra and Associates, and ICF International. *Bangladesh Demographic and Health Survey 2014: Key Indicators.* Dhaka, Bangladesh, Rockville, Maryland, USA: NIPORT, Mitra and Associates, and ICF International; 2015.
25. Lamichhane R, Zhao Y, Paudel S, et al. Factors associated with infant mortality in Nepal: a comparative analysis of Nepal demographic and health surveys (NDHS) 2006 and 2011. *BMC Public Health* 2017; 17(1): 1–18.
26. Minnery M, Firth S, Hodge A, et al. Neonatal mortality and inequalities in Bangladesh: Differential progress and sub-national developments. *Matern Child Health J* 2015; 19(9): 2038–2047, doi: 10.1007/s10995-015-1716-z.
27. Rahman MM, Ara T, Mahmud S, et al. Revisit the correlates of infant mortality in Bangladesh: findings from two nationwide cross-sectional studies. *BMJ Open* 2021; 11(8): e045506.
28. Chowdhury AH, Hanifi SMA, Mia MN, et al. Socioeconomic inequalities in under-five mortality in rural Bangladesh: evidence from seven national surveys spreading over 20 years. *Int J Equity Health* 2017; 16(1): 197, doi: 10.1186/s12939-017-0693-9.
29. Huda TM, Tahsina T, Arifeen SE, et al. 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: 29741, doi: 10.3402/gha.v9.29741.
30. Ezeh OK, Agho KE, Dibley MJ, et al. Risk factors for postneonatal, infant, child and under-5 mortality in Nigeria: a pooled cross-sectional analysis. *BMJ Open* 2015; 5(3): e006779.
31. Ntenda PAM, Chuang K-Y, Tiruneh FN, et al. Factors associated with infant mortality in Malawi. *JECM* 2014; 6(4): 125–131.
32. Abuqamar M, Coomans D, Louckx F. The impact of parental education on infant mortality in Gaza strip, Palestine. *J Public Health Epidemiol* 2011; 3(1): 28–33.
33. 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.
34. Kumar PP, File G. Infant and child mortality in Ethiopia: a statistical analysis approach. *Ethiopian Journal of Education and Sciences* 2010; 5(2), doi: 10.4314/ejesc.v5i2.65373.
35. Mondal MNI, Hossain MK, Ali MK. Factors influencing infant and child mortality: A case study of Rajshahi District, Bangladesh. *Journal of Human Ecology* 2009; 26(1): 31–39.
36. Islam MA, Biswas B. 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. *Clinical Epidemiology and Global Health* 2021: 11(10010): 100801, doi: 10.1016/j.cegh.2021.100801.

37. Siddiquee T, Halder HR, Islam MA. Exploring the influencing factors for non-utilisation of healthcare facilities during childbirth: a special mixed-method study of Bangladesh and 13 other low-and middle-income countries based on Demographic and Health Survey data. *Fam Med Community Health* 2019; 7(4), doi: 10.1136/fmch-2018-000008.
38. Program TD [cited 29.01.2020]. Available from URL: https://dhsprogram.com/data/data-collection.cfm.
39. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg* 2010; 8(5): 336–341.
40. Islam MA, Rahman A. Age at first marriage and fertility in developing countries: A meta analytical view of 15 Demographic and Health Surveys. *Clinical Epidemiology and Global Health* 2020; 8(3): 775–779.
41. Tranmer M, Elliot M. Multiple linear regression. The Cathie Marsh Centre for Census and Survey Research (CCSR). *Journal of Software Engineering and Applications* 2008; 5(5): 1–5.
42. Cramer JS. The origins of logistic regression. *Tinbergen Institute Discussion Papers* 2002, doi: 10.2139/ssrn.360300.
43. Rücker G, Schwarzer G, Carpenter JR, et al. Undue reliance on I 2 in assessing heterogeneity may mislead. *BMC Med Res Methodol* 2008; 8(1): 1–9.
44. Higgins JP, Thompson SG, Deeks JJ, et al. Measuring inconsistency in meta-analyses. *BMJ* 2003; 327(7414): 557–560.
45. DerSimonian R, Laird N. Meta-analysis in clinical trials. *Control Clin Trials* 1986; 7(3): 177–188.
46. Borenstein M, Hedges LV, Higgins JP, et al. A basic introduction to fixed-effect and random-effects models for meta-analysis. *Res Synth Methods* 2010; 1(2): 97–111, doi: 10.1002/jrsm.12.
47. Verhagen A, Ferreira ML. Forest plots. *J Physiother* 2014; 60(3): 170–173.
48. Szumilas M. Explaining odds ratios. *J Can Acad Child Adolesc Psychiatry* 2010; 19(3): 227–229.
49. Hobcraft J. Women's education, child welfare and child survival: a review of the evidence. *Health Transit Rev* 1993; 3(2): 159–175.
50. Pandey A. Infant and child mortality in India. *National Family Health Survey Subject Reports* 1998; 11.
51. Febriyuna N. *Determinants of Infant Mortality in Indonesia.* The Hague: Publisher; 2015.
52. Hehir MP, Mctiernan A, Martin A, et al. Improved perinatal mortality in twins-changing practice and technologies. *Am J Perinatol* 2016; 33(1): 84–89.
53. Townsend R, Khalil A. Fetal growth restriction in twins. *Best Pract Res Clin Obstet Gynaecol* 2018; 49: 79–88.
54. Becher H, Müller O, Jahn A, et al. Risk factors of infant and child mortality in rural Burkina Faso. *Bull World Health Organ* 2004; 82: 265–273.
55. Tafere TE, Afework MF, Yalew AW. Does antenatal care service quality influence essential newborn care (ENC) practices? In Bahir Dar City Administration, North West Ethiopia: a prospective follow up study. *Ital J Pediatr* 2018; 44(1): 1–8.
56. Das U, Chaplot B, Azamathulla HM. The Role of Place of Delivery in Preventing Neonatal and Infant Mortality Rate in India. *Geographies* 2021; 1(1): 47–62.
57. Hollowell J, Oakley L, Kurinczuk JJ, et al. The effectiveness of antenatal care programmes to reduce infant mortality and preterm birth in socially disadvantaged and vulnerable women in high-income countries: a systematic review. *BMC Pregnancy Childbirth* 2011; 11(1): 1–20.
58. McDermott J, Steketee R, Larsen S, et al. Syphilis-associated perinatal and infant mortality in rural Malawi. *Bull World Health Organ* 1993; 71(6): 773.
59. Partridge S, Balayla J, Holcroft CA, et al. Inadequate prenatal care utilization and risks of infant mortality and poor birth outcome: a retrospective analysis of 28,729,765 US deliveries over 8 years. *Am J Perinatol* 2012; 29(10): 787.
60. Phukan D, Ranjan M, Dwivedi L. Impact of timing of breastfeeding initiation on neonatal mortality in India. *Int Breastfeed J* 2018; 13: 27.
61. Rarani MA, Rashidian A, Khosravi A, et al. Changes in socio-economic inequality in neonatal mortality in Iran between 1995–2000 and 2005–2010: an Oaxaca decomposition analysis. *Int J Health Policy Manag* 2017; 6(4): 219–228.
62. Baqui AH, Ahmed S, El Arifeen S, et al. Effect of timing of first postnatal care home visit on neonatal mortality in Bangladesh: a observational cohort study. *BMJ* 2009; 339, doi: https://doi.org/10.1136/bmj.b2826.
63. Russo LX, Scott A, Sivey P, et al. Primary care physicians and infant mortality: evidence from Brazil. *PLoS One* 2019; 14(5): e0217614.
64. Macinko J, Starfield B, Shi L. The contribution of primary care systems to health outcomes within Organization for Economic Cooperation and Development (OECD) countries, 1970–1998. *Health Serv Res* 2003; 38(3): 831–865.
65. Macinko J, Starfield B, Erinosho T. The impact of primary healthcare on population health in low-and middle-income countries. *J Ambul Care Manage* 2009; 32(2): 150–171.

Tables: 5
Figures: 2
References: 65

Received: 16.05.2021
Reviewed: 04.06.2021
Accepted: 05.07.2022

Address for correspondence:
Md. Akhtarul Islam, MSc
Statistics Discipline, Science Engineering and Technology School
Khulna University
Khulna-9208
Bangladesh
Tel.: +880 1722736875
E-mail: akhtarulstat@ku.ac.bd