

DHS Further Analysis Reports No. 151

**Trends in and Determinants of Neonatal Mortality and
Availability and Service Readiness for Newborn Care,
2016–2022 Nepal DHS Surveys and
2015–2021 Nepal HFS Surveys**

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PREFACE

The 2022 Nepal Demographic and Health Survey (2022 NDHS) is the sixth survey of its kind implemented in the country as part of the worldwide Demographic and Health Surveys (DHS) Program. It was implemented under the aegis of the Ministry of Health and Population (MoHP) of the Government of Nepal with the objective of providing reliable, accurate, and up-to-date data for the country. The survey received funding from the United States Agency for International Development (USAID). 2022 NDHS information has assisted policymakers and program managers in policy formulation, monitoring, and designing programs and strategies for improving health services in Nepal. The 2022 NDHS is a key data source for tracking the progress of the Nepal Health Sector Strategic Plan 2023–2030 and the Sustainable Development Goal indicators.

The 2022 NDHS further analysis reports provide additional in-depth knowledge and insights into key issues that emerged from the 2022 NDHS. This information provides guidance for planning, implementing, refocusing, monitoring, and evaluating health programs in Nepal. This further analysis is also an important initiative to strengthen the technical capacity of Nepali professionals for analyzing and using large-scale data to better understand specific issues related to the country’s needs. We are glad that in the sixth round of the NDHS, we were able to produce 11 further analysis reports. We urge that all policymakers, program administrators, program managers, health workers, and other key stakeholders optimally use the information from these reports in program planning and management. High-quality evidence should be the basis of our health programs planning, implementation, monitoring, and evaluation.

Finally, we would like to appreciate the leadership of the Policy Planning and Monitoring Division, and the efforts of the different individuals of the MOHP, and the Department of Health Services in generating these reports. We are thankful to USAID Nepal for their continued support in implementing the NDHS and further analysis studies in Nepal.

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FOREWORD

The 2022 Nepal Demographic and Health Survey (2022 NDHS) is the sixth nationally representative comprehensive survey conducted as part of the worldwide Demographic and Health Surveys (DHS) Program in the country. The survey was implemented by New ERA under the aegis of the Ministry of Health and Population (MoHP). Technical support for this survey was provided by ICF, with financial support from the United States Agency for International Development (USAID) through its mission in Nepal.

The standard format of the survey’s final report included descriptive presentations of findings and trends but not of analytical methods that could ascertain the significance of differences and associations among variables. Thus, although largely sufficient, the final report is limited, particularly in providing answers to “why” questions-answers those are essential for reshaping important policies and programs. After the dissemination of the 2022 NDHS, the MoHP, USAID, and other health development partners convened and agreed on key areas that are necessary for assessing progress, gaps, and determinants in high-priority public health programs being implemented by the MoHP. In this context, 11 further analysis studies have been conducted by Nepali consultants under the direct leadership of the MoHP. The consultants were supported by USAID through the Learning for Development Activity in Nepal and through The DHS Program.

The primary objective of the analysis studies was to provide more in-depth knowledge and insights into key issues that emerged from the 2022 NDHS. This information provides guidance for planning, implementing, refocusing, monitoring, and evaluating health programs in Nepal. One of the learning objectives is to strengthen the technical capacity of Nepali professionals for analyzing and using data from complex national population and health surveys to better understand specific issues related to country needs.

The further analysis of the 2022 NDHS was the concerted effort of many individuals and institutions, and it is with the great pleasure that we acknowledge the work involved in producing this useful document. The participation and cooperation of the officials of the MoHP and the Department of Health Services are highly valued. We would like to extend our appreciation to USAID Nepal for providing financial support for the further analysis. We would also like to acknowledge The DHS Program for its technical assistance at all stages. Our sincere thanks also goes to the USAID Learning for Development Activity team for the overall management and coordination of the entire process. Our special appreciation goes to the Policy Planning and Monitoring Division, MoHP, for their efforts and dedication to the completion of the further analysis of the 2022 NDHS.

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The further analysis of the 2022 Nepal Demographic and Health Survey (2022 NDHS) was conducted under the aegis of the Policy Planning and Monitoring Division of the Ministry of Health and Population (MoHP). The United States Agency for International Development (USAID) provided financial support, with technical assistance provided by the Demographic and Health Surveys (DHS) Program. Overall coordination, recruitment of local consultants, facilitation, administration, and logistic support were provided by the USAID Learning for Development Activity.

I am indebted to Dr. Bikash Devkota, Additional Secretary of the MoHP, for his unwavering guidance throughout the analysis process. I would like to acknowledge the efforts of Dr. Push pa Raj Poudel, Mr. Ravi Kanta Mishra, Mr. Manoj Tamrakar from the Policy Planning and Monitoring Division/MoHP. My special gratitude goes to all the co-authors for their input, coordination, data analysis, and writing of reports. My special thanks go to the co-authors from the MoHP and the Department of Health Services (DoHS) who provided significant contribution to ensure that the analysis aligned with our data needs and to improve the quality of the reports. My sincere appreciation goes to the peer reviewers: Dr. Gunanidhi Sharma from MoHP, Kabita Aryal, Sagar Dahal, Dr. Abhiyan Gautam, Dr. Uttam Pachya, Dr. Poma Thapa, and Dr. Bibek Lal from the DoHS; Pradeep Poudel from USAID Learning for Development; Tirtha Tamang from the United Nations Population Fund; Milima Dangol; Bidur Bastola from the USAID Adolescent Reproductive Health project; Dr. Rahul Pradhan from the World Health Organization; Abhilasha Gurung, and Naveen Poudyal from the United Nations Children’s Fund; and Dr. Saroj Dhakal, Dr. Jaganath Sharma, and Sabita Tuladhar from USAID for reviewing the reports.

Special thanks to Sabita Tuladhar from USAID for her continuous support of this process. My sincere appreciation to Dr. Kerry L. D. MacQuarrie from The DHS Program, Jade Lamb, Tarun Adhikari, Sagar Neupane, Lokesh Bhatta, and Alexandra Cervini from USAID Learning for Development for their hard work in supporting the completion of these 11 further analysis reports.

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ABSTRACT

For two decades, Nepal has made progress in reducing the neonatal mortality rate (NMR). However, the country has observed a stagnant NMR of 21 neonatal deaths (reported per 1,000 live births) since 2016. Widened equity gaps in NMR exist between socioeconomically disadvantaged and privileged groups. Health facility readiness and delivery of optimal quality newborn care are fundamental for improved health outcomes; however, limited evidence is available on NMR trends and determinants and the readiness of health facilities to deliver newborn care. Therefore, this study examined NMR trends and determinants using data from the 2016 Nepal Demographic and Health Survey (NDHS) and 2022 NDHS, as well as health facility readiness for maternal and newborn health (MNH) care using data from the 2015 Nepal Health Facility Survey (NHFS) and the 2021 NHFS.

The study included 106 neonatal deaths (out of 5,087 live births) from the NDHS and 105 neonatal deaths (out of 5,192 live births) from the 2022 NDHS. Independent variables included household-level background characteristics and characteristics related to pregnancy, MNH, women's empowerment, and health systems. The NMRs for 2016 and 2022 were constructed based on all births in the 5 years preceding the survey. General linear modeling was used to assess significant changes in NMR from 2016 to 2022 by background variables. NMR determinants were identified by conducting logit regression analyses. Further, the World Health Organization's (WHO's) service availability and readiness assessment framework was used to examine changes over time in health facility readiness for MNH care based on data from the 2015 and 2021 NHFS surveys.

Despite the stagnant NMR since 2016 at the national level in Nepal, an increase in NMR was found across socioeconomically disadvantaged groups and mothers who did not use MNH services. NMR equity gaps widened among advantaged and disadvantaged groups stratified by wealth status, education, and ethnicity. Higher NMRs were observed among newborns if they were from the poorest households, their mothers had no education, and they were from disadvantaged ethnicities, when compared with privileged counterparts. In contrast, NMRs were lower among mothers with higher empowerment status and those who utilized maternal services for their last births, such as deliveries assisted by skilled birth attendants and postnatal checkups for newborns. Despite slight improvements in health facility readiness for delivery and newborn care between 2015 and 2021 at the national level, no improvements were seen in health facilities in Madhesh and Lumbini provinces or in the Terai ecoregion.

Health system efforts should include the design and implementation of targeted interventions for disadvantaged groups and improve access to and delivery of MNH care. Peripheral health facilities need to be equipped with essential supplies and ensure that trained health workers are available for essential newborn care. Moreover, the findings call for the expansion of neonatal intensive care units and special newborn care units at higher-level health facilities. A specific survey focusing on neonatal mortality and causes of death is recommended to further examine the determinants after adjusting for covariables and possibly linking with health service readiness.

Key words: neonatal mortality rate, newborn care, service availability and readiness, Nepal

ACRONYMS AND ABBREVIATIONS

ANC	antenatal care
BEmONC	basic emergency obstetric and newborn care
BHCC	basic health care center
CB-NCP	Community-Based Newborn Care Program
CEmONC	comprehensive emergency obstetric and newborn care
DHS	Demographic and Health Surveys
DoHS	Department of Health Services
ENMR	early neonatal mortality rate
HMG	health mothers' group
IMNCI	integrated management of neonatal and childhood illness
LBW	low birthweight
LNMR	late neonatal mortality rate
MNH	maternal and newborn health
MoHP	Ministry of Health and Population
NDHS	Nepal Demographic and Health Survey
NHFS	Nepal Health Facility Survey
NICU	neonatal intensive care unit
NMR	neonatal mortality rate
PHCC	primary health care center
PNC	postnatal care
RANM	roving auxiliary nurse midwife
SBA	skilled birth attendant
SDG	Sustainable Development Goal
SNCU	special newborn care unit
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

1 INTRODUCTION

The world has achieved a significant reduction in neonatal mortality. Neonatal deaths have fallen by more than half from 5 million in 1990 to 2.4 million in 2020.¹ Nonetheless, mortality in the first month has declined more slowly than mortality among children under age 5, simply because the risk of death is most acute during delivery and in the vulnerable hours and days after birth. Nearly half of under-5 mortality (47%) occurs during this precarious period when the newborn transitions to risky conditions in a new environment, precisely when the infant and mother are exhausted from labor and delivery.¹ Even when the number of neonatal deaths have declined, the share of deaths among children under age 5 have tended to increase over time, most notably in low- and middle-income countries where relatively more early childhood deaths than newborn deaths are prevented. In Nepal, neonatal deaths accounted for 64% of under-5 mortality in 2020, up from 43% in 2000.^{2,3}

Mainly because of socioeconomic inequities that persist between countries and even within countries, neonatal disorders continue to be a leading cause of death. Globally, neonatal disorders have ranked as the sixth leading cause of all deaths since 2013.⁴ In sub-Saharan Africa, neonatal disorders rank as the second leading cause of death, in contrast with the European region, where they rank fifteenth. The burden of global newborn deaths is mostly shared between sub-Saharan Africa (43%) and southern Asia (36%).¹ In Nepal, maternal and neonatal disorders were the sixth leading cause of death in 2019, but progress is being made, as they ranked as the second leading cause of death in 1990.⁴

Recognizing that targeted investments are required to save newborn lives, the United Nations Sustainable Development Goals (SDGs) explicitly include an indicator for neonatal mortality: SDG Target 3.2 calls for all countries to end preventable deaths of newborns and children under age 5, aiming to reduce the neonatal mortality rate (NMR) to 12 or fewer deaths per 1,000 live births and the under-5 mortality rate to 25 or fewer deaths per 1,000 live births.⁵ To achieve the SDG target of reducing neonatal deaths by 2030, about 60 countries in sub-Saharan Africa and southern Asia must accelerate efforts to combat the major preventable causes, especially among preterm births, namely birth asphyxia and severe neonatal infections such as sepsis and meningitis.^{6,7} Verbal autopsy results from the 2016 Nepal Demographic and Health Survey (NDHS) have shown that the most common underlying causes of neonatal deaths are respiratory and cardiovascular disorders during the perinatal period (31%) and complications of pregnancy, labor, and delivery (31%), with more than half (56%) of deaths occurring at home.⁸ The country needs to persevere in its implementation and expansion of neonatal health interventions to avoid flattening or reversing the downward trend, which is a key concern and a major motivation for this study.¹

1.1 Health Policy and Systems for Maternal and Newborn Health in Nepal

Nepal has prioritized maternal and newborn health (MNH) care, with the Government of Nepal providing various policies and programs to reduce maternal and newborn deaths (Table 1). Over the past 30 years, the Ministry of Health and Population has formulated and implemented several MNH-related initiatives, including integrating family planning and community health,¹⁹ developing the National Neonatal Health Strategy (2004),²⁰ and providing quality promotive, preventive, and curative neonatal health services. The National Safe Motherhood and Newborn Health Long-Term Plan 2006–2017 supported the expansion of

comprehensive emergency obstetric and newborn care (CEmONC) facilities, basic emergency obstetric and newborn care (BEmONC) facilities, and health posts with skilled birth attendants (SBAs).²¹

Table 1 Major national maternal and newborn-related policies and programs in Nepal

Year	Policy or program	Major highlights
2002	National Safe Motherhood Plan (2002–2017)	Strengthens infrastructure for reproductive health service delivery
2004	National Neonatal Health Strategy	Ensures the provision of quality promotive, preventive, and curative neonatal health services
2005	Maternity Incentive Scheme	Promotes skilled birth attendants at health institutions by providing cash to support transport costs for women giving birth in public health facilities
2006	Safe Motherhood and Newborn Health Long-Term Plan (2006–2017)	Expands BEmONC and CEmONC, strengthens the newborn health component
	Skilled Birth Attendant Policy	Stresses the importance of a skilled birth attendant at every birth
2007	Community-Based Newborn Care Program	Provides prevention and management of newborn infections, management of hypothermia and low birthweight, post-delivery asphyxia, and referral of sick newborns
	Safe Delivery Incentive Program for Health Workers	Provides a cash incentive to health workers attending all forms of deliveries: normal, complicated, and cesarean section
	Chlorhexidine Cord Care Program	Aims at reducing newborn deaths in Nepal through using chlorhexidine gel for umbilical cord care
2009	Aama Program	Extends maternity intensive scheme to provide free delivery care at public and some private facilities
2014	Community-Based Integrated Management of Neonatal and Childhood Illness Program	Integrates newborn care into the program, which was started in 2005
	Maternal and Perinatal Death Surveillance and Response Guideline	Mandates reporting of maternal deaths from across Nepal for formulation of a plan to save the lives of mothers and newborns
2016	Nepal's Every Newborn Action Plan	Envisions reducing preventable newborn deaths by establishing newborn care corners in birthing centers, special newborn care units in hospitals, and neonatal intensive care units in tertiary-level health facilities
2019	Nepal Safe Motherhood and Newborn Health Roadmap 2030	Presents a roadmap to reduce neonatal mortality to less than 12 per 1,000 live births by the provision of high-quality, equitable maternal, newborn health services.

BEmONC = basic emergency obstetric and newborn care; CEmONC = comprehensive emergency obstetric and newborn care
Source: Nepal Safe Motherhood and Newborn Roadmap 2030 (2019)⁹

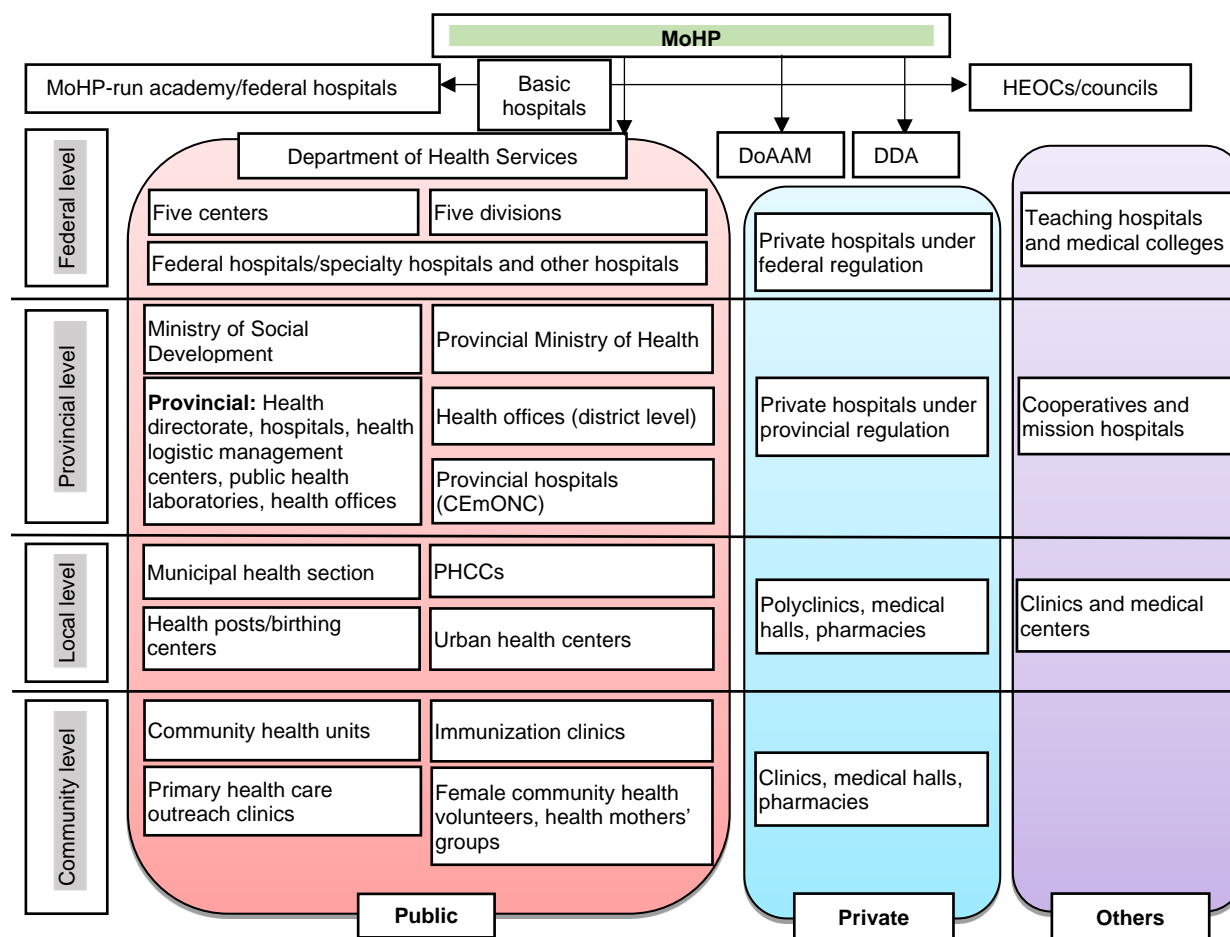
The implementation of the Safe Delivery Incentive Program (2007) ensured delivery attended by SBAs in health institutions, the provision of cash incentives for transport costs to women who deliver in health institutions, and free delivery services in health facilities (expanded in 2009).²² Similarly, Nepal piloted the Community-Based Newborn Care Program (2007) and later scaled it up nationwide. The program focused on preventing and managing newborn sepsis and babies with hypothermia, low birthweight, and birth asphyxia; referring sick newborns; and providing seven essential MNH interventions: behavior change communication, promotion of institutional delivery and clean delivery practices in case of home deliveries, postnatal care (PNC), community case management of possible severe bacterial infection, care of newborns with low birthweight, prevention and management of hypothermia, and management of birth asphyxia.²³

The interventions in the Community-Based Newborn Care Program were merged with the integrated management of newborn and child illness (IMNCI), forming the new community-based IMNCI program.^{24,25} Currently, Nepal's newborn care interventions are guided by Nepal's Every Newborn Action Plan 2016²⁶ and the Nepal Safe Motherhood and Newborn Health Roadmap 2030,⁹ which has the vision of

“no preventable deaths of newborns or stillbirths” and targets to reduce the NMR to 11 deaths per 1,000 live births and 13 stillbirths per 1,000 total births. By 2035, Nepal’s Every Newborn Action Plan will emphasize improving equity, delivery, and quality of health care for births and related services, and focus on care for small and sick newborns.²⁶ The Safe Motherhood and Newborn Health Roadmap 2030 calls for improved governance of MNH services, increased availability of equitable, high-quality MNH services, strengthened emergency preparedness and response, and increased demand for maternal and neonatal care.

The MNH section of the Family Welfare Division in the Department of Health Services, the federal-level unit under the Ministry of Health and Population, leads Nepal’s newborn care program. Figure 1 summarizes the health facilities and institutions responsible for providing and delivering newborn health services. Currently, specialized newborn care services are provided through 61 special newborn care units and 12 neonatal intensive care units in government health facilities across the country. A total of 105 health facilities provide CEmONC services in 76 of 77 districts across the country (all but Manang district).²⁷ BEmONC services are provided in basic hospitals (5–15 beds) and lower-level health facilities, which are both managed by local municipalities.²⁸ In addition, health facilities that are designated as birthing centers provide basic essential newborn care.

Figure 1 Health service architecture in Nepal



CEmONC = comprehensive emergency obstetric and neonatal care; DDA= Department of Drug Administration; DoAAM = Department of Ayurveda and Alternative Medicine; HEOC = health emergency operation center; MoHP = Ministry of Health and Population; PHCC = primary health care center

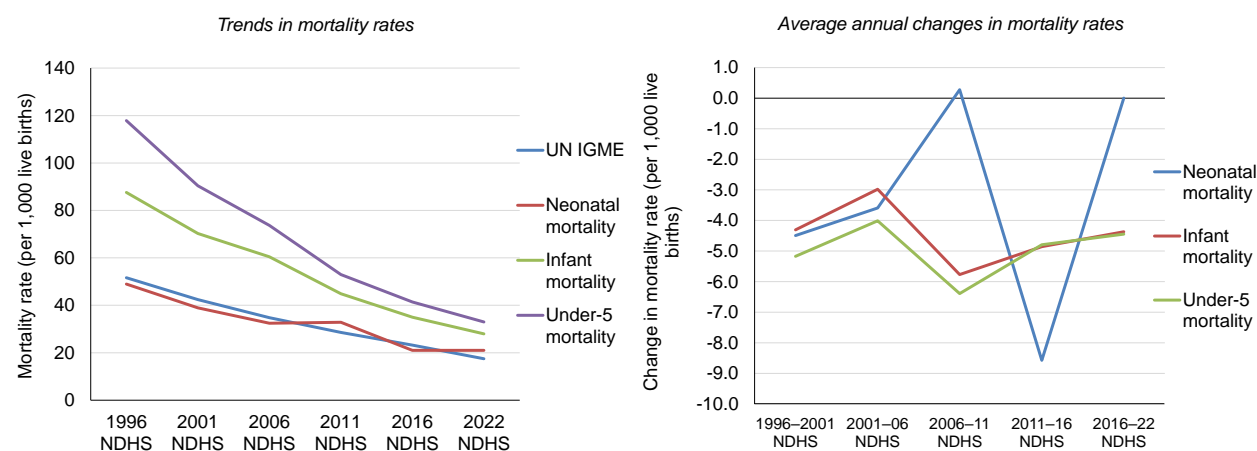
Source: Service architecture created by author based on a literature review and current health service organograms

Despite the myriad policies and MNH interventions, Nepal continues to experience challenges in providing quality essential MNH services. Health facilities' readiness-related challenges include too few skilled providers for delivery and postpartum services, lack of standard protocols, and the unavailability of inpatient care services for newborns at provincial-level hospitals.¹⁷ Other major challenges include an inadequate supply of medicine and medical supplies, limited health facilities with BEmONC and CEmONC services, low or no use of the partograph among service providers, and an inadequate number and uneven geographical distribution of SBAs. Service quality related to adherence to essential newborn care standards remains poor due to low coverage of essential newborn care services, lack of competency of SBAs to manage birth asphyxia, an inadequate supply of bags and masks, a lack of PNC guidelines for newborns at home, inadequate information on kangaroo mother care services, and a lack of health workers skilled in delivering these services.⁹

1.2 Study Rationale

Integrated community and facility-based interventions in Nepal have been effective in reducing child mortality, including neonatal mortality, over the past two decades. However, while the under-5 mortality rate and infant mortality rate have monotonically declined, the NMR has virtually stalled in two recent survey periods: 2006–2011 and 2016–2022^{2,3,8,13–15} (Figure 2).

Figure 2 Trends and changes in early childhood mortality rates (4 years prior to the surveys), 2011–2022 Nepal DHS surveys



UN IGME = United Nations Inter-Agency Group for Child Mortality Estimation

Overall, the average annual rate of reduction in NMR between 1993 and 2020 was 3.2%, but in the more recent 2006–2011 and 2016–2022 periods of the NDHS, there was virtually no decline. Although some plateauing of neonatal mortality can be expected as coverage of routine maternal and newborn care increases, further declines require targeted investments to address the more difficult-to-save cases.¹⁶ Despite the increase in coverage of antenatal care visits—which led to higher levels of institutional delivery—women from remote areas, those with higher birth order, and Maithili-speaking women are among the least likely to use delivery and PNC services¹⁷ due to perceived problems with access to female providers. As a case in point, Nepal has not observed continuous declines in NMR despite improved utilization of MNH interventions.¹⁸ This study will help to identify characteristics of the deaths during these periods as well as areas in which health care delivery needs to be strengthened to save lives.

1.3 Objectives

Compared with continuous declines in the infant mortality and under-5 mortality rates in Nepal, the NMR has virtually stalled in recent periods. Nepal needs long-term and likely additional efforts to achieve SDG Target 3.2, which aims to reduce the NMR to 12 deaths per 1,000 live births by 2030.⁹ However, to achieve this target, many factors at the individual, household, and health system levels must work together to bring about further improvements, especially for disadvantaged groups that continue to face the greatest risks.^{10–12} In this context, understanding any changes in the determinants of neonatal mortality in Nepal as well as the current determinants and status of service readiness for MNH is important. The three main objectives of this study were:

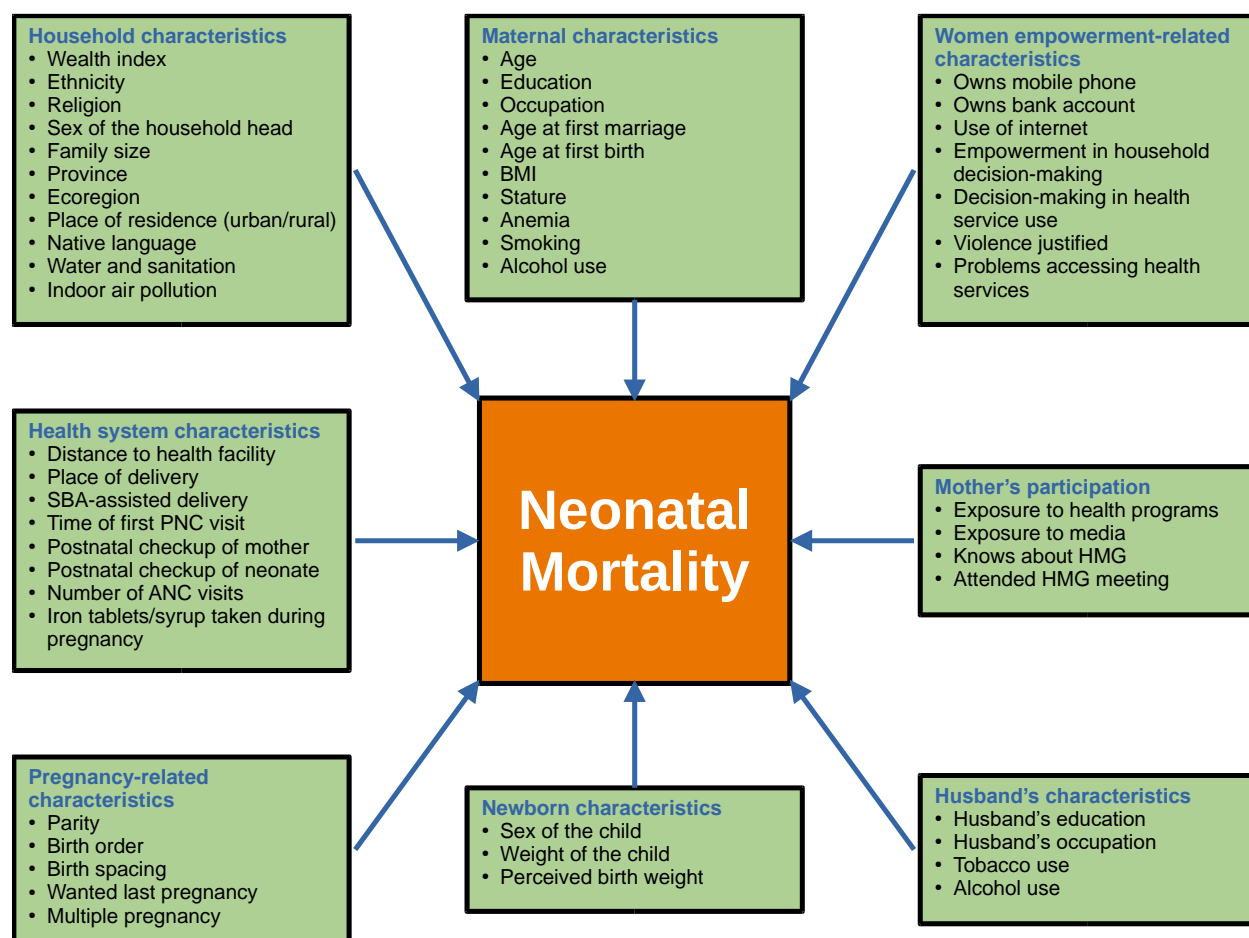
- To describe changes in NMR for key population groups using data from the 2016 and 2022 NDHS surveys
- To identify NMR determinants in the most recent period, using data from the 2022 NDHS
- To point out areas of service availability and readiness that require strengthening to save neonates' lives, using data from the 2015 and 2021 Nepal Health Facility Surveys

2 METHODS

2.1 Conceptual Framework

The conceptual framework for this research was developed using previous studies about the determinants of neonatal mortality, namely those measured in Demographic and Health Surveys (DHS).^{12,29–31} Within the framework, potential determinants are organized into blocks of indicators that are of programmatic importance and serve to facilitate analytical objectives. Figure 3 shows that neonatal mortality can be influenced by variables included in eight blocks: household characteristics, maternal characteristics, women’s empowerment-related characteristics, mother’s participation in health-related programs, husband’s characteristics, newborn characteristics, pregnancy-related characteristics, and health system characteristics.

Figure 3 Conceptual framework showing blocks of potential determinants from Nepal Demographic and Health Surveys



2.2 Data Sources

This study used data from the 2016 Nepal Demographic and Health Survey (NDHS) and the 2022 NDHS^{3,8} to examine the trends and determinants of neonatal mortality in Nepal. In addition, it drew on findings from

the 2015 Nepal Health Facility Survey (NHFS) and the 2021 NHFS^{32,33} to provide perspectives on maternal and newborn service availability and readiness in health facilities in Nepal. The NDHS and NHFS surveys are nationally representative household surveys and health facility surveys, respectively. Detailed information on the survey sample designs, sample selection, and sample weighting are available in the final reports.^{3,8,32,33} Table 2 provides information on the units of analysis from the two household surveys used for this analysis, including births and neonatal deaths in the 5 years preceding the surveys. In 2016, 12,862 women age 15–49 were interviewed. Of total live births (5,087), 106 neonatal deaths were recorded. In 2022, 14,845 women age 15–49 were interviewed. Of 5,192 live births, 105 neonatal deaths were recorded.

Table 2 Description of samples, 2016–2022 Nepal DHS surveys

Year	Date of fieldwork	Reference period for estimates	Reference date (mid-point)	Households interviewed (n)	Household response rate (%)	Women age 15–49 interviewed (n)	Eligible women response rates (%)	Live births ^a (n)	Early neonatal deaths ^a (n)	Late neonatal deaths ^a (n)	All neonatal deaths ^a (n)
2016	06/06/2016 to 01/30/2017	2001–2016	2013.5	11,040	98.5	12,862	98.3	5,087	84	22	106
2022	01/05/2022 to 06/22/2022	2016–2021	2019.8	13,786	99.7	14,845	97.4	5,192	85	20	105

^a 5 years preceding the survey

Similarly, Table 3 provides information on the sample of health facilities used for this analysis, including those offering antenatal care (ANC) and delivery and newborn services. In 2015, out of 963 health facilities, 47.6% (n=457) provided delivery and newborn care. In 2022, out of 1,576 facilities, 804 (51.4%) provided such services.

Table 3 Description of samples, 2015–2021 Nepal HFS surveys

	Number of facilities	Facility surveys completed (%)	Number of facilities offering ANC	Facilities offering ANC (%)	Number of facilities offering delivery and newborn care	Facilities offering delivery and newborn care (%)
04/25/2015 to 11/05/2015	963	97.1	919	97.8	457	47.6
01/27/2021 to 09/28/2021	1,576	96.9	1,538	98.4	804	51.4

ANC = antenatal care
Note: Facilities that offered delivery and newborn care were those that provided normal vaginal delivery services.

2.3 Study Variables

2.3.1 Neonatal mortality

The outcome variable was neonatal mortality rate (NMR), which is a binary variable indicating the death or survival of a newborn during the first month of life. The NMR is an indicator published in the NDHS final reports and on STATcompiler.³⁴ Both of these sources use the standard DHS calculation for NMR based on neonatal deaths in the first month (or 30 days) of life. The rate had been remarkably flat in the 5-year period prior to the surveys—at 20.8 deaths per 1,000 live births in both the 2016 and 2022 surveys—interrupting an otherwise smooth decline over previous decades.

For this study, however, a slightly different approach was applied to calculate the NMR. The study team used the cohort approach and applied the World Health Organization’s (WHO’s) definition of neonatal death, which is the death of a live birth in the first 28 days (completed days 0–27).³⁵ The resulting NMRs for Nepal were very close to the NDHS NMR estimates: 20.9 and 20.3 per 1,000 live births for the 2016 and 2022 surveys, respectively.

We analyzed 43 independent variables from the 2016 and 2022 NDHS surveys to estimate their direct or indirect effects on neonatal death. Variables were organized into eight blocks, as presented in the conceptual framework (see Figure 3). The variables in each block are described in more detail in the appendix (see Table A1).

2.3.2 Readiness of health facilities to provide services

The key variables of interest from the 2015 and 2021 NHFS surveys were the readiness of health facilities to provide delivery and newborn services. General readiness of health facilities was measured by the availability of six items: functional electricity, improved water source, visual and auditory privacy, functional client latrine, functional communication system, and ambulance. To determine specific readiness to provide delivery and newborn services, we assessed the availability of a variety of items in domains covering guidelines and trained providers, equipment and supplies for delivery and newborn care, and essential medicine for mothers and newborns (see Table A2).

In addition, six indicators of client satisfaction were assessed: waiting time, provider’s level of skill in delivering the baby, information received from providers, politeness and empathy of the staff with whom the client consulted, cleanliness of the facility, level of privacy, and care received. We also assessed whether providers had received in-service training on delivery and newborn care, specifically training related to labor and delivery care and training related to newborn care. These services can be part of primary-, secondary-, or tertiary-level health care that aims to prevent at least some deaths and save some lives, including newborn lives. Of note, these services are regarded as a starting point, as they are necessary but insufficient to increase the likelihood that a newborn survives.

2.4 Data Analyses

To examine changes in neonatal mortality, we calculated the early neonatal mortality rate (ENMR), the late neonatal mortality rate (LNMR), and the NMR per 1,000 births for the past 5 years using birth histories in the 2016 and 2022 NDHS surveys. The ENMR referred to deaths in the first 7 days, and the NMR to deaths in the first 28 days. The LNMR was calculated by subtracting the ENMR from the NMR ($LNMR = NMR - ENMR$). NDHS final reports defined NMR in terms of the “first month,” which differed slightly from the way we calculated estimates. In addition, the NDHS final reports did not include ENMR and LNMR.

For this study, ENMR, LNMR, and NMR were calculated within categories of variables, as shown in the conceptual framework (see Figure 3). All frequencies and rates were weighted to correct for the complex sample design. The study team used the birth cohort approach. The numbers of births and deaths for the past 5 years—the numerators and denominators of the rates—and the resulting rates per 1,000 live births for each category for each of the independent variables were collected from the 2016 and 2022 NDHS surveys. The reference dates for the estimates were approximately 2.5 years before the mean date of interviews in the two surveys, although estimates were usually identified within the year of the survey.

We used a logit model to obtain 95% confidence intervals for the estimates. We then calculated each difference as the value in the 2022 survey minus the value in the 2016 survey. A positive difference suggested an increase, and a negative difference implied a decline. In addition to 95% confidence intervals, p values were determined to assess the significance of each change for each category of each independent variable between 2016 and 2022.

To identify the subpopulations with the highest and lowest levels of neonatal mortality, we developed a logit regression model for each independent variable and obtained the resulting p values and pseudo- R^2 values for the NMR. McKelvey and Zavoina's pseudo- R^2 gives the proportion of residual variance that is explained by the independent variable. From this analysis, we identified the categories of significant ($p < .05$) variables for which the NMR was estimated to be 25 or more and those for which the NMR was estimated to be 15 or less. We then assessed the difference in NMR between the 2016 and 2022 NDHS surveys for the subset of significant variables, organizing the results into blocks per the conceptual model.

A multivariate analysis would be desirable in order to test the significance of specific determinants while controlling for the effect of selected background variables. However, such analysis was not possible due to neonatal mortality being a relatively rare event in statistical terms. Each survey included only about 100 neonatal deaths in the past 5 years, which was not enough for analysis with multiple independent or control variables.

Finally, to discover areas of service availability and readiness that require strengthening, we conducted general readiness and specific readiness assessments of the health facilities included in the 2015 and 2021 NHFS surveys. For each type of defined health service selected indicators of availability and readiness were compared in 2015 versus 2021.

3 RESULTS

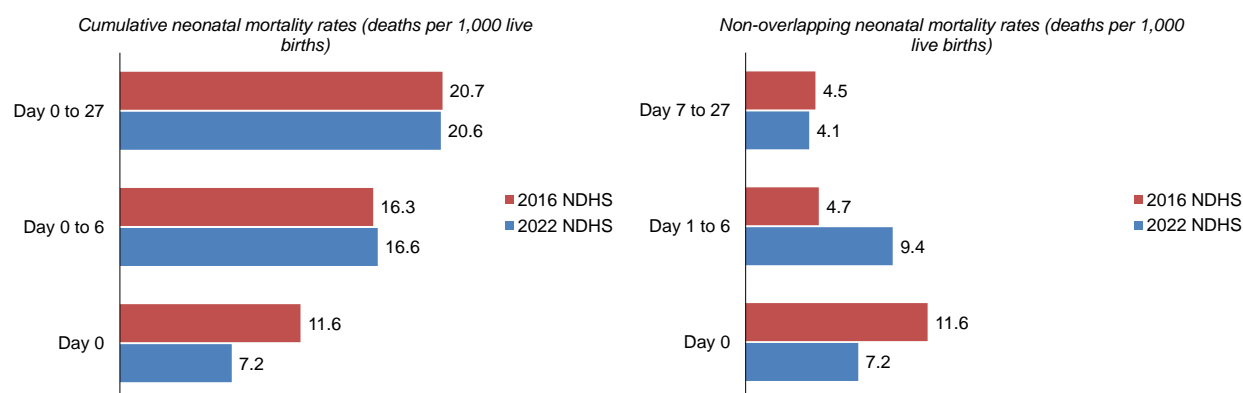
The appendix provides complete data on births, deaths, and neonatal mortality rates (NMRs) nationally and for all categories of variables in the 5 years preceding the 2016 Nepal Demographic and Health Survey (NDHS) (see Table A3) and the 2022 NDHS (see Table A4). It also presents changes over time in early neonatal mortality rates (see Table A5), late neonatal mortality rates (see Table A6), and overall neonatal mortality rates (see Table A7) by background variables, highlighting statistically significant changes (see Table A8).

3.1 Trends in Neonatal Mortality Rates

3.1.1 Trends in neonatal mortality by day of death

The highest number of neonatal deaths occurred on the day of birth. The NMR on day 0 (the day of birth) was 11.6 per 1,000 live births in 2016 and lower, at 7.2 per 1,000 live births in 2022. In contrast, the early neonatal mortality rate from birth through day 6 was 16.3 per 1,000 live births in 2016 and 16.6 per 1,000 live births in 2022 (Figure 4).

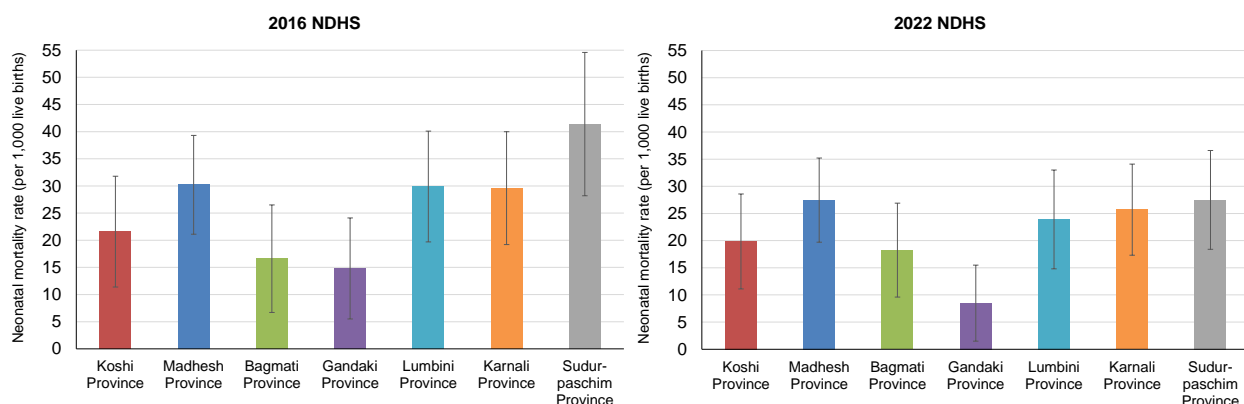
Figure 4 Neonatal mortality rates by day of death after birth, 2016–2022 Nepal DHS surveys



3.1.2 Differentials in neonatal mortality by province

In 2016, Sudurpaschim province had the highest NMR at 41.4 per 1,000 live births. Lumbini, Karnali, and Madhesh provinces had similar NMRs at around 30. Koshi province had an NMR slightly above the national level (21.6), while Bagmati (16.6) and Gandaki (14.8) had NMRs below the national level for the same period. In 2022, the provincial disparity in terms of NMR was markedly reduced. Except for Bagmati province, the rates declined in all provinces. Lumbini, Karnali, Madhesh, and Sudurpaschim provinces had similar NMRs, ranging from 24 to 27. Gandaki province had the lowest NMR at 8.5 per 1,000 live births, whereas Bagmati (18.2) and Koshi provinces (19.9) had similar NMRs (Figure 5).

Figure 5 Neonatal mortality rates by province, 2016–2022 Nepal DHS surveys

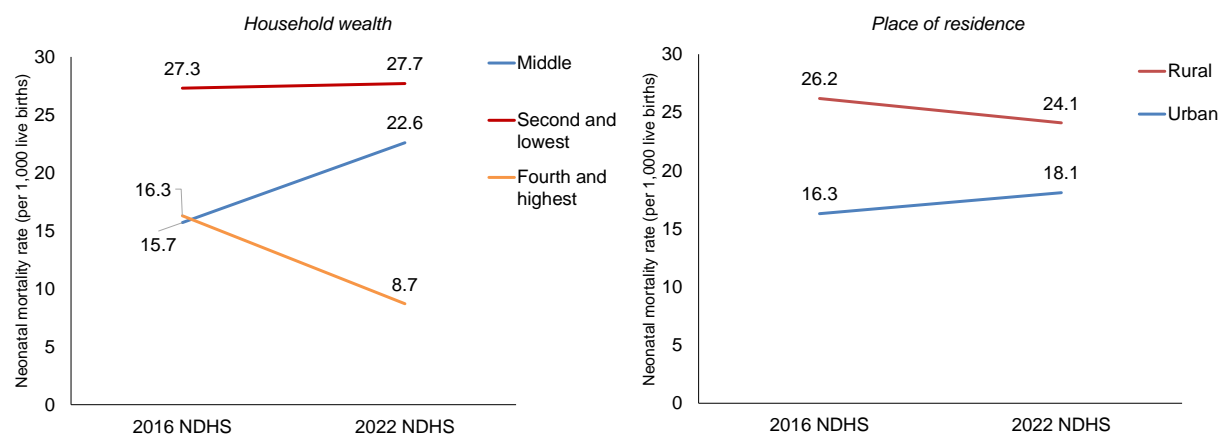


3.1.3 Differentials in neonatal mortality by place of residence and wealth status

The equity gap in neonatal mortality was estimated using the Demographic and Health Surveys (DHS) wealth index. The disparity between the lowest/second and the fourth/highest wealth groups increased from 2016 to 2022. In 2016, the combined lowest/second group had an NMR of 27.3, compared with an NMR of 16.3 for the fourth/highest group. In 2022, the lowest/second group had an NMR of 27.7, which was triple the NMR of 8.7 among the fourth/highest group (Figure 6).

The disparity in NMR was higher in 2016 than in 2022 between neonates in rural areas and those in urban areas. In 2016, the NMR was 26 per 1,000 live births in rural households and 16 per 1,000 live births in urban households. In 2022, the NMR was slightly higher in rural households (24.1 per 1,000 live births) than in urban households (18.1 per 1,000 live births) (Figure 6).

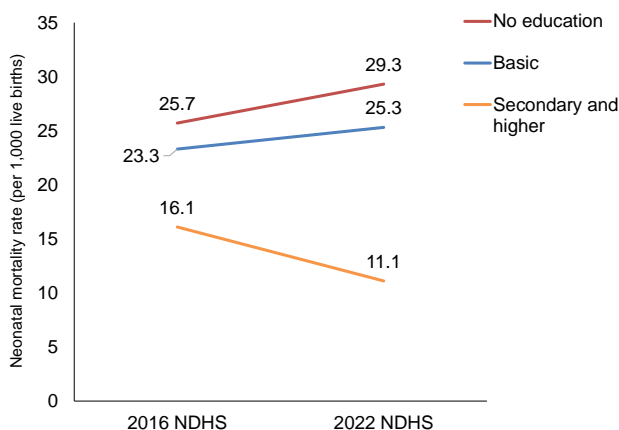
Figure 6 Neonatal mortality rate by wealth index and place of residence, 2016–2022 Nepal DHS surveys



3.1.4 Differentials in neonatal mortality by education

The disparity in NMR between mothers with no education and those with secondary and higher education increased from 2016 to 2022. Mothers with no education had an increase in NMR from 25.7 per 1,000 live births in 2016 to 29.3 per 1,000 live births in 2022. In contrast, mothers with secondary and higher education had a decrease in NMR, from 16.1 per 1,000 live births in 2016 to 11.1 per 1,000 live births in 2022 (Figure 7).

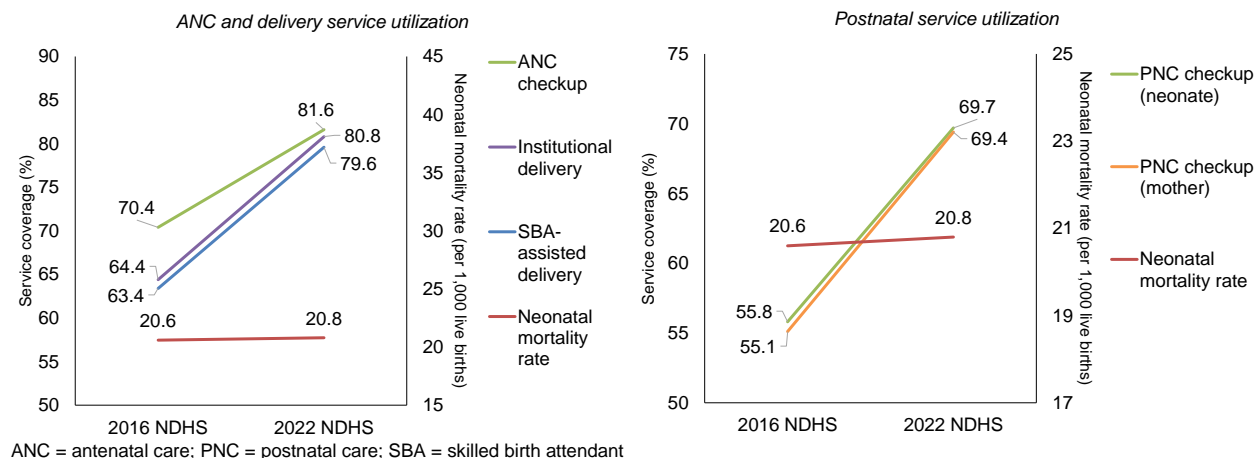
Figure 7 Neonatal mortality rate by education, 2016–2022 Nepal DHS surveys



3.1.5 Trends in use of maternal services in relation to neonatal mortality

Figure 8 shows rates of maternal service utilization (alongside NMR trends) from 2016 and 2022. Improvements were seen in all four service use indicators analyzed—attending at least four antenatal care (ANC) visits, institutional delivery, delivery assisted by skilled birth attendants (SBAs), and postnatal care (PNC). Uptake of ANC visits and institutional delivery increased to approximately 80% each in 2022 from around 65% each in 2016. Similarly, use of PNC for mothers and newborns (at least one PNC visit within 48 hours of childbirth) also increased from 55% in 2016 to 70% in 2022. Despite the improvements in service utilization indicators, the NMR stalled over the period (Figure 8).

Figure 8 Maternal health service utilization in context of neonatal mortality rates, 2016–2022 Nepal DHS surveys



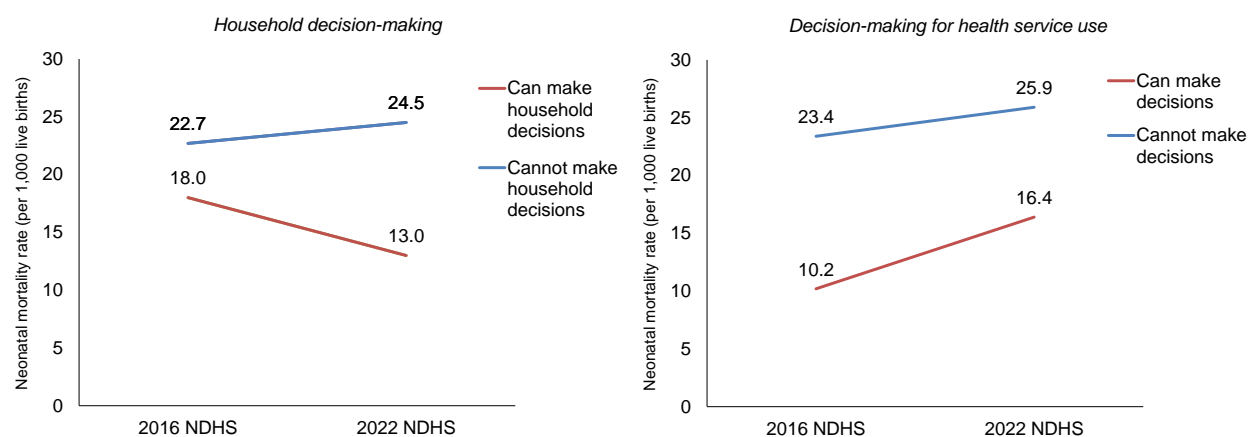
ANC = antenatal care; PNC = postnatal care; SBA = skilled birth attendant

3.1.6 Differentials in neonatal mortality by women's empowerment

Figure 9 presents the NMR by women's household decision-making capacity. Women with lower household decision-making capacity had a higher NMR than their counterparts in both survey years. Specifically, in 2022, the NMR among women who did not participate in household decisions was 24.5 per 1,000 live births, which was considerably higher than that of women who did participate in household decisions (13.0).

In 2022, the NMR for women who did not make their own decisions to use health services was higher than the NMR for those who did: 25.9 compared with 16.4. In 2016, the disparity in NMR had been more than two-fold higher (23.4 versus 10.2) (Figure 9).

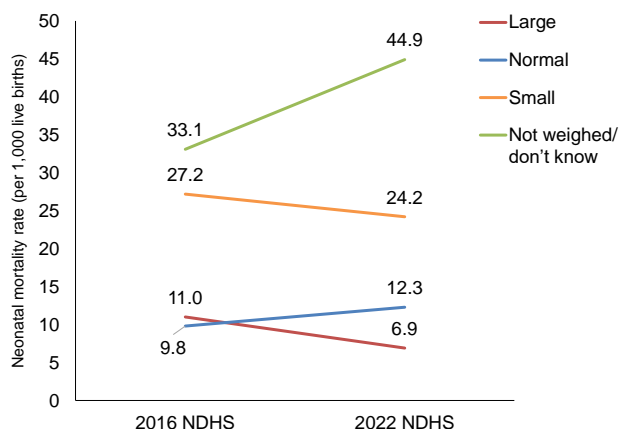
Figure 9 Neonatal mortality rate by women's decision-making capacity for household decisions and health service use, 2016–2022 Nepal DHS surveys



3.1.7 Differentials in neonatal mortality by birthweight

For both survey years, the NMR was higher among newborns with low birthweight (LBW) (<2,500 grams) and among newborns whose birthweights had not been taken or were unknown, when compared with newborns with normal to high/large birthweights (Figure 10). In 2022, the NMR for newborns with high/large birthweight was about 7 per 1,000 live births, much lower than for newborns with LBW (24 per 1,000 live births). From 2016 to 2022, the NMR for newborns with high/large birthweight declined from 11 to 7 per 1,000 live births (Figure 10).

Figure 10 Neonatal mortality rate by birthweight, 2016–2022 Nepal DHS surveys



3.2 Determinants of Neonatal Mortality

Table 4 shows the background variables that were significantly associated with NMR at a high level of significance ($p < .05$). These variables effectively differentiated subpopulations with high versus low NMRs. In the 2022 NDHS, specific variables within the eight indicator blocks in the conceptual model (see Figure 3) that were significantly associated with NMR were native language, ethnicity, level of wealth, ecoregion, indoor air pollution, maternal education, maternal age, possessing a bank account, using the internet, empowerment in household decisions, empowerment in health care decisions, exposure to television, exposure to radio, exposure to magazines, husband's education, husband's occupation, birthweight, SBAs, and newborn PNC within 2 days of birth.

Other background variables originally expected to influence NMR, but which were not significantly associated with NMR in our study, were province, religion, place of residence, size of the household, sex of the household head, improved water and sanitation, maternal use of tobacco, maternal stature, maternal anemia, mother's experience of violence, having a mobile phone, familiarity with health mothers' group meetings, time to reach a health facility, twin birth, sex of the child, birth order, and consumption of the day's iron tablet.

Table 4 Results of analysis of determinants of neonatal mortality rate, 2022 Nepal DHS

Background variable	p value	Significance level	Pseudo-R ^{2a}
Household characteristics			
Respondent's language	<.001	***	0.038
Ethnicity (two categories)	.002	**	0.010
Wealth terciles	.003	**	0.030
Wealth index (three categories based on quintiles)	.001	**	0.064
Province	.213	NS	0.032
Ecoregion	.034	*	0.009
Religion	.087	NS	0.013
Place of residence	.196	NS	0.008
Size of household	.361	NS	0.004
Sex of household head	.211	NS	0.008
Indoor air pollution	.002	**	0.055
Improved water and sanitation	.636	NS	0.005
Maternal characteristics			
Maternal education	.002	**	0.031
Maternal age (five categories)	.023	*	0.063
Maternal use of tobacco	.607	NS	0.001
Maternal stature	.115	NS	0.007
Maternal anemia	.765	NS	<0.001
Mother ever drinks alcohol	.809	NS	0.005
Women's empowerment			
Owns mobile phone	.153	NS	0.004
Possesses a bank account	<.001	***	0.039
Internet use	.001	***	0.016
Empowerment: household decisions	.007	**	0.015
Mother's experience of violence	.876	NS	<0.001
Empowerment: health care/family planning decisions	.021	*	0.014
Newspapers/magazines	<.001	***	0.026
Radio/TV	<.001	***	0.023
Knows about health mothers' group meetings	.972	NS	<0.001
Husband's characteristics			
Husband's education	.009	**	0.015
Husband's occupation (four categories)	.015	*	0.022
Birth characteristics			
Birthweight taken	<.001	***	0.078
Sex of child	.096	NS	0.010
Birthweight	.001	***	0.146
Twin birth	.535	NS	<0.001
Perceived birthweight	.017	*	0.025
Pregnancy characteristics			
Birth order	.124	NS	0.025
Mother's parity	.053	NS	0.031
Preceding birth interval	.001	***	0.054
Wanted last birth	.219	NS	0.011
Health system factors			
Time to health facility	.205	NS	0.009
Birth attendants	.01	**	0.033
Place of delivery	.052	NS	0.052
Cesarean section delivery	.106	NS	0.008
At least four ANC visits	.068	NS	0.030
Day's iron tablets taken	.117	NS	0.037
Newborn PNC within 2 days	.002	**	0.068
Mother PNC within 2 days	.126	NS	0.016

* $p < .05$, ** $p < .01$, *** $p < .001$

ANC = antenatal care; NS = not significant; PNC = postnatal care; TV = television

^a McKelvey and Zavoina's pseudo-R²

3.2.1 Determinants of high neonatal mortality rate (25 or more deaths per 1,000 live births)

Table 5 shows subpopulations with the highest NMRs in the 2022 NDHS. Most of them had a high NMR in the 2016 survey as well. The NMR national average would decline substantially if the rate could be reduced in these subpopulations. A few subpopulations were specific to Nepal, such as those in the Bhojपुरi and Maithili language groups and those in the Mountain ecoregion, but most are found in most countries. These included those related to lower levels of wealth, maternal age, education of the mother or her husband, and occupation. Other subpopulations that stood out were households with indoor air pollution, mothers who did not have a bank account, mothers who had never used the internet, mothers who did not participate in health care or family planning decisions, and mothers with little exposure to media (newspapers, magazines, radio, or television).

High NMRs were also observed among children who were delivered without SBAs, those whose birthweight was not measured or was perceived to be low/small, those born within 2 years of a preceding birth, or those who did not receive PNC within 2 days (bearing in mind that children who passed away shortly after birth may not have had the opportunity to receive PNC) (Table 5).

Table 5 Significant determinants of high neonatal mortality rate (25 or more deaths per 1,000 live births), 2016–2022 Nepal DHS surveys

Background variable	Variable category	2016 NMR	2022 NMR	Difference in NMR from 2016 to 2022	p value for change	Significance level
Household characteristics						
Respondent's language	Bhojपुरi	25.8	43.0	17.1	<.001	***
Respondent's language	Maithili	23.4	27.4	4.0	<.001	***
Wealth index (three categories based on quintiles)	Lowest/second	27.3	27.8	0.5	.001	**
Eco region	Mountain	36.5	26.2	-10.3	.034	*
Indoor air pollution	Yes	22.5	26.3	3.8	.002	**
Maternal characteristics						
Maternal education	Basic (grades 1–8)	23.3	25.3	2.0	.002	**
Maternal education	No education	25.7	29.3	3.6	.002	**
Maternal age (five categories)	15–19 years	33.2	29.3	-3.9	.023	*
Maternal age (five categories)	20–24 years	27.7	26.9	-0.8	.023	*
Women's empowerment						
Possesses a bank account	No	22.9	27.5	4.6	<.001	***
Internet use	Never used the internet	22.5	31.3	8.8	.001	***
Empowerment: health care/family planning decisions	No	23.4	25.9	2.5	.021	*
Newspapers/magazines	Less than once a week	22.6	27.1	4.6	<.001	***
Radio/TV	Less than once a week	22.5	26.6	4.1	<.001	***
Husband's characteristics						
Husband's education	No education/do not know	19.5	37.5	18.0	.009	**
Husband's occupation (four categories)	Manual (skilled/unskilled)	20.7	25.9	5.3	.015	*
Pregnancy characteristics						
Preceding birth interval	≤2 years	29.4	37.7	8.3	.001	***

Continued...

Table 5—Continued

Background variable	Variable category	2016 NMR	2022 NMR	Difference in NMR from 2016 to 2022	p value for change	Significance level
Birth characteristics						
Birthweight taken	Not taken	33.2	44.9	11.7	<.001	***
Birthweight	Not weighed or do not know	33.2	44.9	11.7	.001	***
Perceived birthweight/size	Very small	35.2	37.5	2.3	.017	*
Health system factors						
Birth attendants	Delivery without SBA	25.7	36.1	10.4	.010	**
Newborn PNC within 2 days	No PNC	14.6	26.3	11.6	.002	**

* $p < .05$, ** $p < .01$, *** $p < .001$

NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; TV = television

3.2.2 Determinants of low neonatal mortality rate (15 or fewer deaths per 1,000 live births)

Table 6 identifies subpopulations with low NMRs, typically contrasting with the categories with high NMRs (see Table 5). These subpopulations included those in the Nepali language group, in the Hill ecoregion, in the highest wealth category, and with secondary or higher education (for both mothers and husbands). Additionally, mothers age 30–34, those who possessed a bank account, those who had internet access, those involved in household decisions, those who read newspapers or magazines, and those who consumed radio/television content tended to have lower NMRs. Children also demonstrated lower NMRs if they had normal or high/large birthweight, had longer preceding birth intervals, were delivered by SBAs, or had received PNC care within 2 days. Caution should be exercised when interpreting low rates, especially below 10, due to wide confidence intervals.

Some variables outlined in the conceptual framework and regarded as potentially important interventions did not emerge as statistically significant determinants of low NMR (for example, ANC visits). It is anticipated that access to and utilization of health services serve as pathways through which household, maternal, and paternal characteristics impact child survival. Although the associations between ANC care and background variables was explored in final reports of both the 2016 and 2022 surveys, detailed articulation of these pathways was constrained by low statistical power in the samples.

Table 6 Significant determinants of low neonatal mortality rate (15 or fewer deaths per 1,000 live births), 2016–2022 Nepal DHS

Background variable	Variable category	2016 NMR	2022 NMR	Difference in NMR from 2016 to 2022	p value for change	Significance level
Household characteristics						
Respondent's language	Nepali	17.4	10.3	-7.0	<.001	***
Ethnicity (two categories)	Advantaged	18.3	10.7	-7.6	.002	**
Wealth index (lowest/second, middle, fourth/highest)	Fourth/highest	16.4	8.7	-7.7	.001	**
Ecoregion	Hill	16.4	13.2	-3.1	.034	*
Indoor air pollution	No	17.4	11.3	-6.1	.002	**
Maternal characteristics						
Maternal education	Secondary and above (≥ grade nine)	16.1	11.2	-4.9	.002	**
Maternal age (five categories)	30–34 years	15.0	6.8	-8.2	.023	*
Women's empowerment						
Possesses a bank account	Yes	17.2	9.6	-7.6	<.001	***
Internet use	Used at some time	13.7	14.6	0.9	.001	***
Empowerment: household decisions	Yes, can make decisions	18.0	13.0	-5.0	.007	**
Newspapers/magazines	At least once a week	19.4	11.9	-7.6	<.001	***
Radio/TV	At least once a week	19.5	12.2	-7.3	<.001	***
Husband's characteristics						
Husband's education	Secondary and above (≥ grade nine)	18.2	14.1	-4.1	.009	**
Husband's occupation (four categories)	Agriculture	30.6	12.5	-18.1	.015	*
Birth characteristics						
Birthweight taken	Yes, taken	12.5	12.3	-0.3	<.001	***
Birthweight	Large (≥3,500 g)	11.0	6.9	-4.1	.001	***
Birthweight	Normal (2,500–3,500 g)	9.8	12.4	2.6	.001	***
Perceived birthweight	Larger than average	32.2	11.2	-21.0	.017	*
Perceived birthweight	Smaller than average	34.9	12.5	-22.4	.017	*
Pregnancy characteristics						
Preceding birth interval	>2 years	14.6	11.5	-3.2	.001	***
Health system factors						
Birth attendants	Delivery with SBA	16.9	14.3	-2.5	.010	**
Newborn PNC within 2 days	Yes	7.0	7.7	0.7	.002	**

* $p < .05$, ** $p < .01$, *** $p < .001$

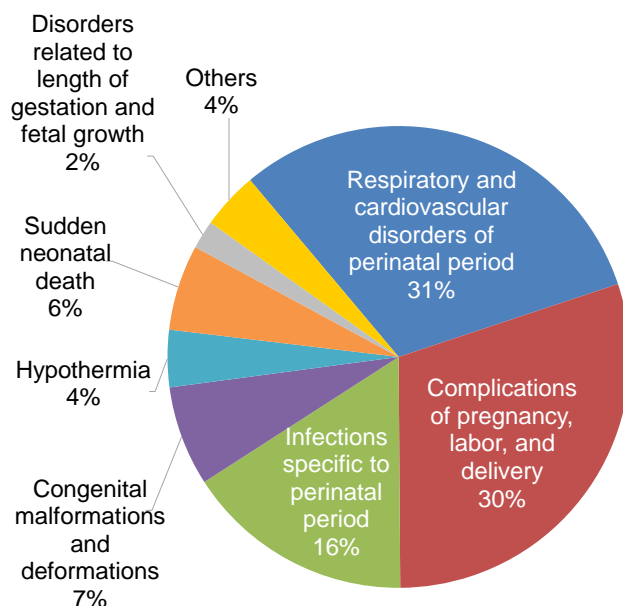
NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; TV = television

3.3 Causes of Neonatal Deaths

Tracking the causes of neonatal deaths provides information to decisionmakers on how best to prevent those deaths. The best source of these data is physician-certified causes of death, which are coded in accordance with the World Health Organization (WHO) International Classification of Diseases and are routinely generated by a well-functioning civil registration system. However, this data source is not yet sufficiently functional in providing complete and accurate data for Nepal.

An alternative data source is a population-based verbal autopsy assessment to ascertain the probable causes of neonatal death. Nepal conducted a verbal autopsy study in the 2016 NDHS.⁸ The study revealed that about one-third of neonatal deaths were caused by respiratory and cardiovascular disorders of the perinatal period, namely respiratory distress syndrome, congenital pneumonia, and meconium aspiration syndrome (Figure 11). Approximately one-third of deaths were caused by complications of pregnancy, labor, and delivery, including eclampsia, transverse lie, multiple pregnancies, and abruption of the placenta. Other neonatal deaths were caused by neonatal sepsis and pneumonia, prematurity and LBW, and congenital malformations. Together, these leading causes accounted for 84% of neonatal deaths.

Figure 11 Causes of neonatal deaths by percentage, 2016 Nepal DHS



Most neonatal deaths in the 2016 NDHS verbal autopsy study occurred within 2 days of delivery (74%), and they happened mostly in rural areas (58%). This suggests that immediate life-saving treatments may not have been accessible. Such life-saving measures call for emergency services in a well-equipped medical setting where necessary medicines, equipment, and professional skills are available. Data from the study suggested that treatment interventions were not accessed because more than half of neonates died at home (56%), and only 47% of neonates who died had received some treatment before death.⁸

3.4 Service Availability and Readiness for Maternal and Newborn Health Services

The 2015 and 2021 NHFS surveys offered insights into availability and readiness of newborn and maternal care services.^{32,36} MNH service availability improved between 2015 and 2021. Coverage of ANC services among pregnant women in the 5 years preceding the 2022 NDHS was high, so it is not surprising that virtually all health facilities (98%) in Nepal offer ANC.²⁷

3.4.1 Availability of newborn care services

Facilities that offered newborn care services were a subset of those that offered ANC. In 2021, about half of all health facilities (51%) offered normal vaginal delivery and essential newborn services. More than

90% of those health facilities offered essential newborn care practices including abdominal skin-to-skin contact after delivery, drying and wrapping newborns to keep warm, kangaroo mother care, initiation of breastfeeding within the first hour, routine head-to-toe examination of newborns before discharge, applying chlorhexidine gel to the umbilical cord stump, and weighing the newborn immediately upon delivery.

Comparing 2015 to 2021, chlorhexidine gel application to the umbilical cord stump increased, from 65.6% of health facilities in 2015 to 96.5% of health facilities in 2021. However, services such as administering injectable vitamin K1 to newborns, applying tetracycline eye ointment to both eyes, and giving the newborn the Bacille Calmette-Guerin vaccine before discharge was less than 20% in each survey year.^{32,36} In 2021, only 6% of health facilities (primarily federal and provincial hospitals) had neonatal intensive care units or special newborn care units, and only 44% of health facilities had newborn care units.

3.4.2 General readiness of health facilities

The analysis of general readiness showed the status of all health facilities (including but not limited to those providing ANC and delivery and newborn services). The indicators for basic amenities included electricity, improved water source and functioning latrine, visual and auditory privacy, communication equipment, computer, and emergency transport. Overall, only 17% of facilities had all of these items in 2021, which was a slight improvement from 11% in 2015. However, more notable progress was seen in the availability of electricity—a 13% increase from 2015—and the availability of functional computers—substantial growth of 38%, from 31% in 2015 to 69% in 2021 (Table 7).

Table 7 Percentages of facilities with basic amenities and percentage-point differences over time, 2015–2021 Nepal HFS surveys

Basic amenity	2015 NHFS (%)	2021 NHFS (%)	Difference from 2015 to 2021 (% points)	p value for change
Electricity	75.8	89.5	13.7	<.001
Improved water source	84.9	97.4	12.5	<.001
Visual and auditory privacy	82.3	94.3	12.0	<.001
Functioning client latrine	97.7	99.2	1.5	.113
Functional communication system	27.5	31.8	4.3	.154
Functional computer	31.3	69.2	37.9	<.001
Ambulance	59.3	72.2	12.9	.001
Number of health facilities	457	804		

NHFS = National Health Facility Survey

3.4.3 Specific readiness for delivery and newborn care

The mean readiness score for delivery and newborn care services rose from approximately 51% in 2015 to approximately 55% in 2021. The score for the domain of essential equipment and supplies increased from 68.9% in 2015 to 77.7% in 2021. Similarly, the percentage of health facilities with essential medicines and commodities increased from 55.4% to 65.9%. However, the readiness score pertaining to guidelines and staff training declined from 27.3% in 2015 to 20.1% in 2021.

Regarding selected tracer items, we found notable increases in the availability of examination lights by 33 percentage points, injectable antibiotics by 25 percentage points, soap and water by 22 percentage points,

infant weighing scales by 18 percentage points, and emergency transport facilities by 13 percentage points. However, a notable decrease of 33 percentage points was seen in the availability of eye ointment in 2021 compared with 2015 (Table 8).

The specific readiness score for delivering newborn care services exhibited a positive trend, with an overall increase of 4 percentage points between 2015 and 2021. This increase was consistently observed across hospitals managed by private and public authorities and in the Mountain and Hill ecoregions. However, the score decreased in Madhesh province, and either increased or remained nearly unchanged in all other provinces (Table 9).

Table 8 Average readiness score for delivery and newborn care services, percentages of facilities having available selected tracer items, and changes in availability of items over time, 2015–2021 Nepal HFS surveys

	2015 NHFS (%)	2021 NHFS (%)	Difference from 2015 to 2021 (% points)
Average readiness score^a [% (SD)]	50.6 (15.6)	54.6 (13.1)	
Tracer item			
Guidelines	22.0	12.8	-9.2
Training	32.8	27.5	-5.3
Emergency transport	59.3	72.2	12.9
Sterilization equipment	78.5	66.2	-12.3
Examination light	60.8	93.8	33.0
Delivery pack	92.5	97.7	5.2
Suction apparatus	62.1	65.7	3.0
Manual vacuum extractor	20.7	23.2	2.5
Vacuum aspirator	19.4	21.0	1.6
Newborn resuscitation	82.9	91.7	8.8
Delivery bed	96.4	98.7	2.3
Blank partograph	80.1	90.4	10.3
Latex gloves	92.6	97.5	4.9
Infant weighing machine	60.4	78.7	18.3
Blood pressure apparatus	84.2	95.2	11.0
Soap and water	74.4	96.2	21.8
Injectable antibiotics	40.9	66.0	25.1
Injectable uterotonic	88.2	97.0	8.8
Magnesium sulphate	72.1	70.7	-1.4
Injectable diazepam	17.2	28.2	11.0
Injectable IV fluid	90.3	97.2	6.9
Skin disinfectant	91.4	98.1	6.7
Eye ointment	39.4	7.8	-31.6
Chlorhexidine ointment	58.0	80.2	22.2
Ceftriaxone	12.0	38.1	26.1
Amoxicillin suspension	25.6	62.1	36.5
Gentamycin	74.6	79.7	5.1
Number of health facilities	457	804	

NHFS = National Health Facility Survey; SD = standard deviation

^aHealth facility readiness score for maternal and newborn care services was calculated by averaging the total scores of three domains using the World Health Organization's (WHO's) service availability and readiness assessment covering three domains: guidelines and staff training (2 items), essential equipment and supplies (14 items), and essential medicine and commodities (11 items). Tracer items in each domain were assessed as binary variables (1 for availability, 0 for absence).

Table 9 Readiness scores for delivery and newborn care services and changes over time by background variables, 2015–2021 Nepal HFS surveys

Background variable	2015 NHFS [% (LB, UB)]	2021 NHFS [% (LB, UB)]	Difference from 2015 to 2021 (% points)	p value
Average readiness score^a	50.6 (49.0, 52.2)	54.6 (53.3, 55.9)	4.0	<.001
Health facility type				
Public hospitals	69.2 (66.8, 71.7)	68.7 (64.4, 73.1)	-0.5	.857
Private hospitals	48.1 (44.2, 52.0)	53.3 (49.7, 56.9)	5.2	.057
Primary health care centers	57.4 (55.5, 59.3)	61.2 (59.4, 63.0)	3.8	.005
Basic health care centers	49.0 (47.0, 51.0)	53.3 (51.8, 54.8)	4.3	<.001
Managing authority				
Public	50.9 (49.2, 52.7)	54.8 (53.5, 56.1)	3.8	<.001
Private	46.2 (41.8, 50.5)	52.1 (48.2, 56.0)	5.9	.047
Ecoregion				
Mountain	50.3 (46.3, 54.3)	57.3 (54.6, 60.1)	7.0	.004
Hill	48.4 (46.1, 50.7)	52.9 (51.2, 54.6)	4.5	.001
Terai	55.9 (53.2, 58.6)	55.4 (53.1, 57.8)	-0.5	.802
Province				
Koshi	48.0 (43.6, 52.3)	54.3 (51.1, 57.5)	6.3	.022
Madhesh	55.7 (51.2, 60.3)	52.5 (48.3, 56.8)	-3.2	.314
Bagmati	50.0 (46.3, 53.7)	56.4 (52.6, 60.3)	6.4	.019
Gandaki	49.1 (44.7, 53.6)	55.7 (52.0, 59.4)	6.6	.025
Lumbini	56.5 (52.6, 60.4)	51.6 (49.0, 54.2)	-4.9	.043
Karnali	44.7 (39.5, 49.9)	56.4 (53.3, 59.5)	11.7	<.001
Sudurpaschim	52.3 (48.5, 56.0)	53.3 (51.0, 55.7)	1.1	.628
Location				
Rural	na	54.6 (52.8, 56.3)	na	na
Urban	na	54.6 (52.9, 56.4)	na	na
Number of health facilities	457	804		

LB = lower bound; na = not available; NHFS = Nepal Health Facility Survey; UB = upper bound

NHFS = National Health Facility Survey^a Health facility readiness score for maternal and newborn care services was calculated by averaging the total scores of three domains using WHO's service availability and readiness assessment covering three domains: guidelines and staff training (2 items), essential equipment and supplies (14 items), and essential medicine and commodities (11 items). Tracer items in each domain were assessed as binary variables (1 for availability, 0 for absence).

3.4.4 Satisfaction with care among postpartum mothers

In 2021, the level of satisfaction among postpartum mothers receiving delivery and newborn care services was higher in 2021 than 2015 for almost all seven satisfaction items. The most substantial improvement in satisfaction was noted in the cleanliness of the facility, with a notable increase of 9.2 percentage points from 2015 to 2021, followed by a 6.8 percentage point increase regarding the politeness of the service provider. However, we found a slight decrease in satisfaction regarding the level of privacy, with a reduction of 2.1 percentage points from 2015 to 2021 (Table 10).

Table 10 Percentages of postpartum mothers satisfied with selected domains of care and changes over time, 2015–2021 Nepal HFS surveys

Satisfaction domain	2015 NHFS	2021 NHFS	Difference from 2015 to 2021 (% points)	p value
	%	%		
Waiting time	81.4	84.9	3.5	.332
Provider's level of skill in delivering the baby	85.4	89.1	3.7	.299
Information received from providers	80.4	83.5	3.1	.466
Politeness and empathy of the staff with whom the patient consulted	81.1	87.9	6.8	.088
Cleanliness of the facility	69.4	78.6	9.2	.070
Level of privacy	82.1	80.0	-2.1	.649
Care received	85.4	87.7	2.3	.583
Number of postpartum mothers	309	546		

NHFS = National Health Facility Survey

The level of satisfaction across all items increased in 2021, even after disaggregation by the type of health facility. Notably, satisfaction with the politeness of health staff increased in public hospitals from 76.1% in 2015 to 85.7% in 2021. However, satisfaction with the cleanliness of private facilities decreased from 89.2% in 2015 to 83.1% in 2021 (Table 11).

Table 11 Percentages of postpartum mothers satisfied with selected domains of care by type of health facility, 2015–2021 Nepal HFS surveys

Satisfaction domain	2015 NHFS			2021 NHFS		
	PHCC/ BHCC	Private hospital	Public hospital	PHCC/ BHCC	Private hospital	Public hospital
	(%)	(%)	(%)	(%)	(%)	(%)
Waiting time	82.9	84.0	80.0	93.6	90.0	81.1
Provider's level of skill in delivering the baby	93.2	88.7	83.6	95.8	90.7	87.3
Information received from provider	86.3	82.9	79.0	95.8	86.6	80.2
Politeness and empathy of the staff with whom the patient consulted	82.9	91.6	76.1	91.8	91.4	85.7
Cleanliness of the facility	86.3	89.2	59.4	78.9	83.1	76.5
Level of privacy	100.0	90.9	77.3	81.2	86.5	76.8
Care received	89.8	91.5	82.5	95.6	92.0	84.4
Number of post-partum mothers	7	97	205	54	154	338

BHCC = basic health care center; NHFS = Nepal Health Facility Survey; PHCC = primary health care center

3.4.5 In-service training for providers

Among delivery or newborn care service providers, the percentage of providers receiving specific training varied between 2015 and 2021. The percentages receiving SBA training, early and exclusive breastfeeding training, and newborn infection management training declined. Conversely, the percentage of providers with MNH skills increased during this period (Table 12).

Table 12 Percentages of providers of delivery or newborn care who received in-service training at least once, by type of training, 2015–2021 Nepal HFS surveys

Type of training	NHFS 2015	NHFS 2021
	(%)	(%)
Trainings related to labor and delivery care		
Skilled birth attendant	41.2	37.8
Advanced skilled birth attendant	16.3	15.9
Routine care during labor and delivery	35.6	36.0
Active management of third stage of labor	37.0	38.9
MNH update/emergency obstetric care/life-saving skills	26.4	30.6
Trainings related to newborn care		
Neonatal resuscitation using bag and mask	41.3	36.3
Early and exclusive breastfeeding	41.3	34.4
Newborn infection management (including injectable antibiotics)	29.1	23.7
Thermal care (including immediate drying and skin-to-skin care)	35.5	32.9
Sterile cord cutting and appropriate cord care	36.9	33.4
Kangaroo mother care for LBW babies	39.8	43.5
Number of providers of delivery or newborn care	1,757	2,742
Specialized newborn care (for hospitals only)		
Number of hospital providers of delivery or newborn care	na	1,147

na = not available; LBW = low birthweight; MNH = maternal and newborn health; NHFS = Nepal Health Facility Survey

4 DISCUSSION

4.1 Modest and Uneven Reduction in Neonatal Mortality Rates

The trend analysis showed that the reduction in Nepal's neonatal mortality rate (NMR) has been modest but uneven since approximately 1996, with stagnant rates between two inter-survey periods (2006–2011 and 2016–2022). However, Nepal's NMR declined substantially during the 2011–2016 inter-survey period. This impressive reduction might have been due to the expansion of maternal and neonatal services, including basic and emergency obstetric neonatal care services; the Aama program, which provided free delivery services and incentives for mothers completing four antenatal care (ANC) visits; capacity strengthening of health workers through the community-based integrated management of neonatal and childhood illness (IMNCI) program; and expansion of newborn care services.³⁷ The stagnant NMR since 2016 may be due to the impact of federalism since 2017, when the unitary government was transformed into three tiers of government and the health care delivery system changed.³⁸ The transition to federalism required rigorous staff adjustment, devolution of the responsibility for basic health care services toward local governments, and changes from a district health system to a municipal health system. During the transition, the health system suffered from inadequate staff and, hence, the capacity of municipalities to provide technical support to health facilities.^{39,40}

Recommendations: At the policy level, the non-functionality of comprehensive emergency obstetric and newborn care (CEmONC) due to the shortage of skilled human resources needs to be addressed by establishing a locum system for CEmONC at federal and provincial hospitals to support CEmONC sites in district-level hospitals. In addition, the federal Ministry of Health and Population (MoHP) needs to increase the number of skilled birth attendant (SBA) trainings and improve the training curricula for advanced SBA for quality maternal and newborn health (MNH) care. The MoHP needs to incorporate CEmONC and basic emergency obstetric and newborn care (BEmONC) in the Bachelor of Medicine, Bachelor of Surgery, and nursing pre-service curricula. Furthermore, our findings underscore that the federal MoHP may need to revise and expand maternity incentive programs, which can be linked to continuity of care indicators.⁴¹ For example, mothers and health facilities could be incentivized if a mother completes all ANC visits (with a standard of eight recommended visits), gives birth in a health institution, and attends recommended postnatal checkups. Verification could be done by tracking service utilization through the health management information system. In addition, the MoHP should support local levels in establishing newborn care corners in all birthing center, BEmONC, and CEmONC sites, as well as expanding special newborn care units and neonatal intensive care units in large hospitals to receive referrals. This is crucial because a verbal autopsy report of newborn deaths in the 2016 Nepal Demographic and Health Survey (NDHS)⁸ showed that a higher number of newborns required special care to prevent deaths from asphyxia and birth-related complications.

At the implementation level, lower-level health facilities that provide delivery and newborn care services as birthing centers need to address common barriers such as poor quality and the non-availability of delivery services because of the lack of skilled human resources.⁴² Local governments should prioritize the availability and retention of SBAs at birthing centers for uninterrupted MNH services. In addition, the current government practice is to establish 5-to-15 bed basic hospitals at local levels.²⁸ Local governments need strengthened BEmONC services in local-level basic hospitals along with adequate human resources,

improved MNH training, and readiness for MNH care. Further, these hospitals must be linked with a community-based IMNCI program through a strengthened referral mechanism. At the implementation level, local governments can incentivize female community health volunteers and health workers, who can contribute to newborn referrals to designated health facilities. Effective community-based measures would be helpful in providing counseling services to mothers/caregivers on essential care for newborns, identifying danger signs for newborns and postpartum women, and establishing a place for the management of sick newborns and mothers. Community-level services should focus more on mothers from disadvantaged castes/ethnicities, the poorest households, and those who are less empowered in making decisions in the household and in seeking health care.

4.2 Reduced Neonatal Mortality Rates on First Day of Birth

The NMR on the first day of birth was lower in the 5 years preceding the 2022 NDHS than in the 5 years preceding the 2016 NDHS. Newborn deaths in health facilities might have been reduced as the country implemented the continuum of care guideline prioritizing postnatal checkups with a provision to keep new mothers and babies at the health facility for at least 24 hours after birth.⁴¹ Another reason could be increased institutional SBA-assisted deliveries, as shown by Nepal service coverage data.²⁷ In addition, service availability and readiness for delivery and newborn care in 2021 have slightly improved since 2015, as shown by the analysis of health facility surveys in Nepal that may have contributed to reducing neonatal deaths on the first day of birth.⁴³

Recommendations: The trend shows some average improvement at the point of service delivery. At the implementation level, lower-level health facilities should be equipped with newborn care corners: The 2021 Nepal Health Facility Survey (NHFS) report outlined that only 40% of basic health service centers (for example, health posts, urban health centers, and community health units) and 67% of primary health care centers have newborn care corners. Such corners could enable mothers and babies to stay at least 24 hours after delivery, which minimizes the deaths of newborns after discharge and enhances referral if complications arise. The continuum of care should target women from disadvantaged ethnicities, those with low wealth status, those who are illiterate, and those with low routine MNH continuum.⁴⁴ The NMR for some deliveries was higher in 2022 than in 2016, although the changes was not statistically significant. At the policy level, community-based IMNCI and facility-based IMNCI should be linked to ensure that newborns can be referred to designated health institutions for complications during home deliveries.

4.3 Widened Equity Gaps Across Background Variables of Mothers

Our findings show that the NMR equity gap is evident across household and sociodemographic characteristics. The NMR gap between the poorest and richest households widened in 2022 compared with 2016. With the increasing trend in NMR among the poorest households, it would be difficult to achieve the target of Nepal's Every Newborn Action Plan to reduce the NMR to 12 deaths per 1,000 live births by 2030 in the lowest wealth quintile. With the NMR levels of 2016, an equity analysis has projected that the poorest households may only achieve Nepal's Every Newborn Action Plan's target by 2067, instead of 2030.¹⁰ The NMR has increased significantly among mothers whose native languages are Maithili or Bhojpuri (primarily spoken in Madhesh province), mothers from the poorest households, and those from households with indoor air pollution. Our analysis of the 2021 NHFS in this study also showed that Madhesh province has comparatively poor service availability and readiness for delivery and newborn care.

Among the seven provinces in Nepal, Gandaki province has already achieved an NMR lower than the Sustainable Development Goal Target 3.2 (12 deaths per 1,000 live births), whereas Karnali and Madhesh provinces each had an NMR of 27 per 1,000 live births in the 10 years preceding the 2022 NDHS. The NMR in the Mountain ecoregion significantly declined from 2016 to 2022, although the rate from the 2022 NDHS was still higher than the national level. Surprisingly, changes in NMR according to place of residence were unexpected, although they were not statistically significant; the rural NMR slightly declined and the urban NMR slightly increased between the 2016 and 2022 surveys. By contrast, Nepali native speakers, those from advantaged castes/ethnicities, those from the richest households, and those in the Hill ecoregion had NMRs less than 13 in the 2022 survey, which is close to Sustainable Development Goal Target 3.2.

The gap for NMR widened between mothers with no education and those with secondary and higher levels of education between 2016 and 2022. Mothers who experienced multiple disadvantages including lack of education, disadvantaged ethnicity, and lower wealth status were less likely to achieve the MNH continuum.⁴⁵ Mothers with a basic level of education (grades 1–8) and those with no education had significantly higher NMRs in the 2022 survey. These results were similar to those from the previous analyses of 2006, 2011, and 2016 NDHS surveys, which identified that mothers with no education had higher neonatal mortality.^{11,46}

Recommendations: The MoHP has developed a gender and social inclusion strategy in the health sector⁴⁷ to ensure the delivery of inclusive, quality, and equitable health services. At the implementation level, mothers with no education, from the poorest households, from disadvantaged castes/ethnicities, from Madhesh province, who are urban poor, and who are from rural areas need to be targeted for improved MNH service utilization. The strategy needs effective implementation across all levels of government to target unreached people. Locally tailored community-based solutions are needed, such as providing information and counseling to mothers in their local language, educating mothers about identifying danger signs of newborn complications, and providing a place for seeking services when newborn complications arise. At the policy and program level, the MoHP, when preparing its annual work plan and budget, needs to allocate more resources and technical support for women in Madhesh province, those from the poorest households, and those in the Mountain ecoregion.

4.4 Stagnant Neonatal Mortality Rate Amid Increasing Use of Maternal Health Services

Data on maternal health service utilization showed increased uptake of ANC. Mothers who received at least four ANC visits also increased use of institutional and SBA-assisted delivery by above 80%. However, postnatal care (PNC) coverage for mothers and newborns, according to the protocol, was low.²⁷ Having four or more ANC visits was not significantly associated with neonatal survival. This may be due to a lack of completion of the continuum of care covering institutional delivery and PNC among the mothers who utilized ANC services. A lack of positive input and process-level factors for ANC, such as lack of infrastructure, provision of commodities and supplies, and health workforce, may have compromised the quality of ANC.⁴⁸ A Nepal-based cross-sectional study has shown that the completion rate for the continuum of care was only around 41%.⁴⁹ In addition, socioeconomically disadvantaged populations have relatively lower utilization of ANC and PNC service in distant parts of the country.⁵⁰

Recommendations: ANC coverage and institutional delivery have increased and reached around 80% among pregnant women surveyed, which is a good sign of maternal health service use. However, the mothers often do not attend all eight recommended ANC visits. Simultaneously, PNC service use needs to be increased, especially in lower-level health facilities. At the implementation level, follow-up in PNC outreach services after discharge of the newborn should be made at least within a week of birth. In addition, those who have poor access to maternal services should be prioritized according to the government's strategy for reaching the unreached.⁵¹ At the policy level, the MoHP needs to identify bottlenecks to quality of essential delivery and newborn services for all levels of health facilities and provide technical assistance, including regulation of private health facilities.

4.5 High Neonatal Mortality Rates Among Mothers with Low or No Education and Those Who Marry Early

Parents' characteristics, such as mothers and husband's education, were important determinants for higher neonatal mortality in 2022. A lack of maternal education and young maternal age (15–19 and 20–23) correlated with higher neonatal mortality. Women with no education, those whose husbands had no formal education and those whose occupations involved manual/skilled labor, also experienced significantly higher neonatal mortality. Adolescent pregnancy may be attributed to higher neonatal mortality, as a hospital-based study has shown that adolescent pregnancies had higher odds of preterm birth and malformation.⁵²

Recommendations: Nepal's Health Sector Strategic Plan 2023–2030⁵³ calls for multi-sector health collaboration in all relevant sectors with MNH. At the policy level, the MoHP needs to prioritize interventions to address family planning and the reproductive health rights of adolescents and young mothers. At the implementation level, local health authorities need to expand sectoral collaboration with education and women and children, and link the maternal and newborn agenda to ANC, PNC, and institutional delivery.

4.6 Positive Association of Women's Decision-Making and Use of Media with Lower Neonatal Mortality Rates

This study also revealed that women's empowerment was significantly associated with lower NMR. In the 2022 survey, mothers who possessed a bank account and used the internet had significantly lower NMRs. Using media and technology and possessing a bank account influenced the use of skilled delivery options in Nepal.⁵⁴ Likewise, women who lacked the ability to participate in household decision-making or make decisions regarding their health services exhibited significantly higher NMRs. A meta-analysis conducted in low- and middle-income countries showed that a low level of woman's empowerment was associated with higher neonatal mortality.⁵⁵ Maternal exposure to the media to obtain health-related messages, such as reading the newspaper, listening to the radio, and watching television, was also associated with significantly lower NMR. However, familiarity with health mothers' group (HMG) meetings and attending HMGs was not significantly associated with changes in the NMR over the 6 years between the 2016 and 2022 NDHS surveys. The decision to participate in HMGs might be one of the challenges for women when the decision comes from the husband alone or from family members.⁵⁶ In this analysis, NMR level was not significantly associated with violence experienced by women. This could be due to the smaller subsample of women selected to participate in domestic violence questionnaires and the tendency of women to underreport instances of violence in face-to-face interviews.⁵⁷

Recommendations: At the policy level, the health sector should collaborate with other sectors, such as information technology, women and children, and education, to more broadly disseminate information on safe motherhood and newborn care practices and to promote access to health services. At the implementation level, tailored community- and household-level interventions, such as male engagement and giving women decision-making power at home for health services, would help mothers increase access to and make better use of MNH services. HMG meetings should be vitalized through capacity strengthening from female community health volunteers and with regular support from health workers.

4.7 Positive Associations of Delivery by Skilled Birth Attendants and Postnatal Care with Lower Neonatal Mortality Rates

This analysis found that quality of MNH care provided by SBAs was significantly associated with lower NMR. NMR was significantly higher in babies who were delivered without SBAs or who did not receive PNC within 2 days. Mothers may have missed opportunities for safe delivery and essential newborn care as they lacked services from SBAs.⁵⁴ Although statistically insignificant, more newborn deaths occurred during home deliveries than during deliveries in government or private health facilities. Babies who were delivered at home and lacked SBA-assisted delivery usually did not receive essential newborn care, such as cord care, drying, and wrapping.⁵⁸

Recommendations: At the policy level, programs need to be designed to ensure that women who have not utilized an SBA-assisted or institutional delivery have information about and access to these services. This includes women in hard-to-reach populations and of poor socioeconomic status. For example, the MoHP should provide local-level guidelines for implementing the roving auxiliary nurse midwife (RANM) program, which provides home visits by RANMs at the household level. RANMs should be able to provide basic examinations, counseling, and referral services to mothers and newborns. At the implementation level, health workers can be incentivized at the local level to extend follow-up visits to the homes of pregnant mothers and newborns for counseling and referrals.

4.8 Positive Associations of Shorter Birth Interval (Less than 2 Years) and Low Birthweight with Higher Neonatal Mortality Rates

Some newborns' birth characteristics were significantly associated with neonatal mortality. Newborns with low birthweight (LBW) and a small perceived size, and those whose weight was not registered, had higher death rates. The finding of the analysis about LBW is corroborated by findings from another study in Nepal, which showed that premature birth is the major cause of neonatal deaths.⁷ Our findings regarding higher neonatal mortality among babies born within a 2-year birth interval are supported by results of a meta-analysis showing that babies born within short birth intervals were more likely to die in low- and middle-income countries.⁵⁹ We did not find any significant differences in NMR based on the sex of the child.

Recommendations: Services for early detection of birth defects and prematurity need to be enhanced at all hospitals. At the policy level, special newborn care units and neonatal intensive care units need to be better equipped to provide essential newborn care at hospitals, as the analysis showed that LBW babies are more likely to die. At the implementation level, to increase birth intervals family planning programs need to be integrated to respond to the high unmet need for family planning among young mothers.

4.9 Improved Service Readiness but Province-Wide Disparities

Results of our analysis showed that between the 2015 and 2021 NHFS surveys, the availability of five of seven essential amenities in all health facilities significantly improved; two essential amenities—functional client latrines and functional communication systems—did not improve. The readiness score that was calculated based on 27 items, using the World Health Organization’s (WHO)’s service availability and readiness assessment framework, significantly increased from 2015 to 2021, but remained at 55% of the total. However, a recent analysis also showed low functionality of BEmONC and CEmONC sites since 2015.⁶⁰ Assessment of service readiness by health facility types showed that readiness did not significantly improve in public hospitals over the period. The readiness score in public health facilities was only 69% in 2021. The readiness score for delivery and newborn care increased in primary health care centers and basic health care centers, but remained lower than that in hospitals. The analysis of the 2015 NHFS also showed that lower-level health facilities and facilities from Karnali province had poor structural quality for the provision of routine MNH services.⁶¹ As demonstrated in the Terai ecoregion, Madhesh province, and Lumbini province, low NMRs corresponded with low newborn care-specific readiness scores. An earlier study also showed that in 2015, the technical quality of ANC and PNC was poor in Madhesh province and lower-level health facilities, compared with other provinces and higher-level facilities.⁶²

Recommendations: At the policy level, health facilities in the Terai ecoregion, Madhesh and Lumbini provinces, and public hospitals should be equipped with basic essential amenities and specific requirements for delivery and newborn care services. At the implementation level, municipalities should assess and build essential infrastructure to improve the readiness of health facilities along with regular assessments of guidelines for minimum service standards.⁶³

4.10 Decreased Proportions of Providers with Essential Newborn Care Training

Regarding training status, the percentages of providers receiving SBA training, early and exclusive breastfeeding training, and newborn infection management training declined from 2015 to 2022. Conversely, the percentage of providers with MNH skills increased during the same period. Updating MNH training could reduce neonatal mortality, as this analysis has shown that PNC for newborns is a protective factor against neonatal mortality.

Recommendations: After the staff adjustment process, local levels have contracted a new cadre of health workers because health facilities are experiencing a shortage of SBA-trained workers. At the implementation level, SBA training needs to be provided at lower-level health facilities. At the policy level, a specialized newborn care training package including instruction on managing preterm babies, birth-related complications, and severe infections should be developed and provided to clinicians and nurses in provincial hospitals and higher-level health facilities.

4.11 Low Level of Satisfaction Among Postpartum Women in Public Health Facilities

Among postpartum mothers who received delivery and postpartum care in health facilities, the cleanliness of the health facility was the only domain of satisfaction that significantly improved from 2015 to 2021. Unfortunately, satisfaction regarding the perceived privacy level decreased, contrary to the readiness

indicator showing that the level of visual and auditory privacy improved. A recent analysis in Nepal showed that women who experience caring behaviors from providers, and those who receive services in private, have higher levels of satisfaction.⁶⁴ Furthermore, the level of satisfaction was lower in public hospitals than in private hospitals in all domains—waiting time, provider’s level of skill in delivering the baby, information received from the provider, politeness and empathy of the staff with whom the patient consulted, cleanliness of the facility, level of privacy, and care received.

Recommendations: At the policy level, the MoHP should develop pre-service curricula and in-service training materials for service providers concerning supportive and respectful behavior while providing services at all stages of the continuum of care: ANC, delivery, and PNC. At the implementation level, staff of public health facilities need to give more attention to respectful maternity care while providing delivery and newborn care services. Maintaining privacy should be included among necessary arrangements at birthing centers and BEmONC and CEmONC sites.

5 CONCLUSION

5.1 Key Findings

- Since 2000, there has been a modest and uneven reduction in Nepal’s neonatal mortality rate (NMR).
- Data from the 2016 Nepal Demographic and Health Survey (NDHS) and the 2022 NDHS showed a decrease over time in NMR on the first day of birth.
- The 2022 NDHS showed widened NMR equity gaps by household characteristics, ethnicity, and wealth index.
- NDHS data from 2016 to 2022 identified a paradox in that NMR stagnated while the use of maternal and neonatal services increased.
- NMRs were higher among mothers with low or no education and among those experiencing early marriage.
- A positive association was found between women’s decision-making power and lower NMR.
- Positive associations with lower NMR were also found for postnatal care for newborns and for deliveries assisted by skilled birth attendants.
- A birth interval of less than 2 years and low birthweight were associated with higher NMR.
- Overall, service readiness improved, but disparities existed across types of health facilities, provinces, and ecoregions.
- Essential newborn care training for service providers decreased between the 2015 Nepal Health Facility Survey (NHFS) and the 2021 NHFS.
- Overall, postpartum women expressed a low level of satisfaction with care received at public health facilities.

5.2 Key Recommendations

Our trend analysis showed that NMRs are higher in socially and economically disadvantaged groups, which may be a result of poor service utilization. The major health system factors identified were poor use of services such as deliveries assisted by skilled birth attendants, postnatal care for newborns, and special care for babies with low birthweight. Data from the most recent two NHFS surveys showed that maternal and newborn health (MNH) service availability and facility readiness have not been improved in Madhesh province, at government health facilities, and at lower-level health facilities since 2015. Based on the findings and interpretations, we recommend the following:

- The equity gap in MNH services needs to be addressed by designing locally led solutions, such as providing MNH messages in local languages; increasing local and female service providers; and targeting households in the lowest and second wealth quintiles, mothers with low levels of education, and those from disadvantaged castes/ethnicities.
- As stated in Nepal’s Every Newborn Action Plan, the country needs to establish functional newborn care corners in birthing centers, improve the functionality of basic and comprehensive emergency obstetric and newborn care, and strengthen the capacity of special newborn care units and neonatal intensive care units.

- To provide quality essential newborn care, increase the number of skilled birth attendant and specialized newborn care trainings for newborn care service providers at first service delivery points.
- For essential quality MNH services, the government should improve the priority areas of service readiness in lower-level health facilities by providing adequate and appropriate guidelines, ensuring the availability of skilled human resources, and meeting other specific requirements for MNH care.
- Additional newborn-focused studies are warranted to explore the determinants of NMR after adjusting for important independent variables and linking them with service access and availability, as this study precluded multivariate analysis.

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APPENDIX

Table A1 Variables and variable categories included in the analysis of the 2016 and 2022 Nepal DHS surveys

Variable	Definition	Variable category (reference coding)
Outcome variable	NMR: Death of neonates in the first month of life (0–30 days) per 1,000 live births within the 5 years preceding the survey	High (>25 per 1,000) Low (<15 per 1,000)
Independent variables		
Household characteristics		
Language	The respondent's native language	Nepali Maithili Bhojpuri Others (Newari, Gurung, Magar)
Ethnicity	Ethnic categorization (see above)	Advantaged Disadvantaged Dalit Disadvantaged Janajati
Wealth terciles	Households divided into three equal groups based on level of wealth	Lower Middle Higher
Wealth index	Household wealth based on quintiles as defined by the standard wealth index	Second and lowest Middle Fourth and highest
Province	Province	Koshi Madhesh Bagmati Gandaki Lumbini Karnali Sudurpaschim
Place of residence	Rural and urban	Rural Urban
Ecoregion	Ecological region	Terai Hill Mountain
Religion	The respondent's religion	Hindu Buddhist Muslim Kirat Cristian Other
Indoor air pollution	Cooking inside the home using solid fuel	Yes No
Improved water and sanitation	Sanitation: households with access to both improved drinking water and improved toilet facilities	Yes No
Maternal characteristics		
Mother's education	Level of education is classified as the years of schooling/grades completed	No education Basic education (grades 1–8) Secondary and above (≥ grade nine)
Maternal age	Age of the mother in years	15–19 20–24 25–29 29–33 20–34 35 and above

Continued...

Table A1—Continued

Variable	Definition	Variable category (reference coding)
Maternal employment	Cash earning from the job	Not working Agriculture Manual labor (skilled/unskilled) Paid Job
Body mass index	Body mass index of the mother (kg/m ²)	Normal (18.5–25) Less (<18.5) Overweight/Obese (≥25)
Anemia	<12 g/dl for non-pregnant and <11 g/dl for pregnant women	Yes No
Stature	Stature of the mother	Normal (>145 cm) Less (145 cm)
Tobacco use	Tobacco use habit of the respondent	Yes
Alcohol use	Alcohol use at some point in time	Yes No
Husband's characteristics		
Husband's alcohol use	Alcohol use at some point in time	Yes No
Husband's employment	Cash earning from the job	Not working Agriculture Manual labor (skilled/unskilled) Working paid
Husband's education	Level of education is classified as the years of schooling/grades completed	No education Basic education (grades 1–8) Secondary and above (≥ grade nine)
Access related variables		
Access to a bank account	Possesses a bank account	Yes No
Has a mobile phone	Owns mobile phone	Yes No
Internet use	Use of internet at some point in time	Yes No
Exposure to health programs in media	Heard or seen at least two health programs in media	Yes No
Attended HMG meeting	Attended an HMG meeting at least once	Yes No
Distance to health facility	Duration to reach the nearest health facility in minutes	>30 mins <30 mins
Problems in accessing health care services	Problems in accessing health care services classified as whether the women perceived the following problems: getting permission to go for treatment (medical help), getting money needed for treatment, distance to health facility, not wanting to go alone to the health facility, concern of no female health provider	All four problems None
Women's empowerments and domestic violence		
Empowerment in household decision-making	Women's position in decision-making in the household	Can make decisions Cannot make decisions
Domestic violence	Experienced any spousal violence (beating, burning, or arguing)	Yes No
Decision-making on health service use	Mother's decision-making ability for health service use	Yes No
Awareness on HMG	Awareness of HMGs in the respective wards	No Yes

Continued...

Table A1—Continued

Variable	Definition	Variable category (reference coding)
Health system-related factors		
Number of ANC visits	ANC visits times	≥four times ≤four times Do not know
Preceding birth interval	Birth interval of the women in recent birth	>two years ≤two years First birth
Iron tables/syrup during pregnancy	Days of iron tablets taken	≥180 days <180 days/not taken/do not know
Perceived problem not having female providers	Classified as if having no female health care provider is a perceived problem	No problem Big problem
Birth characteristics		
Sex of the child	Sex of the child	Male Female
Place of delivery	Place and type of delivery	Home delivery Public health facility Private health facility
Mode of delivery	Delivery procedure	Non-cesarean Cesarean
Attendant at delivery	Delivery attended by SBA	Yes No
Twin birth	Whether the pregnancy ended as twin birth	Yes No
Birthweight	Weight of the newborn	Small (<25,00 gm) Normal (2,500–3500 gm) Large (≥3,500 gm) Not weighted at birth/do not know
Perceived birthweight	Birthweight perceived by the mother	Very small Smaller than average Very large Do not know
Postnatal checkup for mother	PNC provided to mothers	Yes No
Postnatal checkup for neonate	Postnatal checkup done for neonate	Yes No
Pregnancy-related characteristics		
Wanted pregnancy	Woman wanted the recent pregnancy	Wanted then Wanted later Wanted no more
Birth spacing	Birth spacing of the child	None 1–2 years More than two years
Birth order	Birth order of the last child born	First Second Third or higher

ANC = antenatal care; HMG = health mothers' group; NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant

Table A2 Definitions of health service readiness items

Readiness item	Definition
Guidelines	Availability of at least one checklist or job aid, or guideline on essential delivery and newborn care
Trained provider	At least one trained provider who is available to provide essential delivery and newborn care
Emergency transport	Availability of a functional ambulance or transport means
Sterilization equipment	Availability of functioning sterilization equipment
Examination light	Availability of functioning lighting equipment
Delivery pack	The five items consisting of cord clamp, episiotomy scissors, scissors or blade, suture material with a needle, and needle holder
Suction apparatus	Availability of suction apparatus
Neonatal bag and mask	Availability of neonatal bag and mask
Delivery bed	Availability of functioning delivery bed
Soap and water	Availability of soap and water for cleaning
A blank partograph	Availability of partograph
Baby weighing scale	Availability of functioning weighing scale for baby
Blood pressure set	Availability of blood pressure set
Latex gloves	Availability of latex gloves for health worker
Manual vacuum extractor	Availability of a functioning manual vacuum extractor
Vacuum aspiration kit	Availability of a vacuum aspiration kit
Essential medicines for delivery	Availability of at least one unit of injectable uterotonic, injectable antibiotic, injectable magnesium sulphate, skin disinfectant, and fluid with an infusion set
Essential medicines for newborn	Availability of one valid unit of chlorhexidine gel, tetracycline eye ointment, injection gentamycin, amoxicillin syrup, and ceftriaxone powder for injection

Table A3 Births, neonatal deaths, and neonatal mortality rates per 1,000 births for all categories of variables in the 5 years preceding the 2016 Nepal DHS

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
National	National	5,087	84	22	106	16.6	4.3	20.9
Household characteristics								
Respondent's language	Bhojpuri	707	12	6	18	17.6	8.2	25.8
	Maithili	920	16	6	22	16.9	6.5	23.4
	Nepali	2,128	31	6	37	14.7	2.6	17.4
	Other	1,332	25	5	30	18.8	3.5	22.3
Ethnicity (three categories)	Advantaged	2,615	38	11	48	14.4	4.0	18.4
	Disadvantaged Dalit	1,065	22	6	29	21.1	5.9	27.0
	Disadvantaged Janajati	1,407	24	5	29	17.3	3.6	20.9
Ethnicity (two categories)	Advantaged	1,600	24	5	29	15.0	3.3	18.3
	Disadvantaged	3,487	60	17	77	17.3	4.8	22.1
Wealth terciles	Lower	1,412	27	7	34	19.3	4.8	24.1
	Middle	1,806	33	6	39	18.2	3.2	21.4
	Higher	1,869	24	9	34	13.0	5.0	18.0
Wealth index (three categories based on quintiles)	Middle	1,124	15	3	18	13.4	2.4	15.8
	Second and lowest	2,163	48	11	59	22.1	5.2	27.3
	Fourth and highest	1,799	21	8	29	11.9	4.5	16.4
Province	Koshi	816	14	5	19	17.1	5.8	22.8
	Madhesh	1,376	24	10	33	17.3	7.0	24.3
	Bagmati	825	9	0	9	10.9	†	10.9
	Gandaki	390	4	1	5	†	†	†
	Lumbini	897	13	4	17	14.1	4.3	18.4
	Karnali	341	9	2	11	26.4	4.9	31.3
	Sudurpaschim	441	12	1	13	26.7	3.2	29.9
Ecoregion	Hill	1,918	28	4	31	14.5	1.8	16.4
	Mountain	360	10	3	13	28.5	7.9	36.5
	Terai	2,809	46	16	62	16.4	5.6	22.0
Religion	Buddhist	217	2	0	2	7.3	†	7.3
	Hindu	4,337	77	20	98	17.8	4.7	22.5
	Muslim	362	5	2	7	15.2	4.3	19.4
	Other	170	0	0	0	†	†	†
Place of residence	Rural	2,335	50	11	61	21.5	4.8	26.3
	Urban	2,752	34	11	45	12.4	4.0	16.3
Size of household	<Six members	2,399	43	8	51	18.0	3.3	21.2
	≥Six members	2,688	41	14	55	15.3	5.3	20.6
Sex of household head	Female	1,470	23	2	25	15.7	1.6	17.3
	Male	3,617	61	20	81	16.9	5.4	22.4
Indoor air pollution	No	1,571	19	9	27	11.8	5.6	17.4
	Yes	3,516	66	13	79	18.7	3.8	22.5
Improved water and sanitation	Improved	3,334	55	11	65	16.4	3.2	19.6
	Not a de jure resident	386	10	4	15	26.4	11.6	38.0
	Unimproved	1,367	19	7	26	14.3	5.0	19.3
Maternal characteristics								
Maternal education	Basic (grades 1–8)	1,025	23	1	24	22.1	1.3	23.3
	No education	1,761	35	11	45	19.6	6.1	25.7
	Secondary and above (≥ grade nine)	2,301	27	10	37	11.8	4.3	16.1
Maternal age (five categories)	15–19 years	369	11	2	12	29.0	4.2	33.2
	20–24 years	1,662	33	13	46	19.7	8.0	27.7
	25–29 years	1,805	24	5	29	13.3	2.7	16.0
	30–34 years	824	11	1	12	13.4	1.6	15.0
	35 and above	426	6	1	7	13.4	2.7	16.1

Continued...

Table A2—Continued

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
Maternal age (three categories)	15–19 years	369	11	2	12	29.0	4.2	33.2
	20–34 years	4,292	68	19	87	15.8	4.5	20.3
	≥35 years	426	6	1	7	13.4	2.7	16.1
Maternal use of tobacco	No	4,796	81	21	102	16.8	4.5	21.3
	Yes	291	4	1	4	12.4	2.1	14.5
Maternal stature	<145 cm	279	4	4	8	14.4	14.7	29.2
	≥145 cm	2,271	44	7	51	19.4	2.9	22.3
Maternal anemia	Anemic	1,153	28	5	33	24.4	4.6	29.0
	Not anemic	1,387	19	5	25	14.0	3.9	17.8
Women's empowerment-related characteristics								
Owns a mobile phone	No	1,172	23	11	34	19.6	9.2	28.8
	Yes	3,915	61	11	73	15.7	2.9	18.5
Possesses a bank account	No	3,284	57	19	75	17.2	5.7	22.9
	Yes	1,803	28	3	31	15.3	1.9	17.2
Internet use	Never used internet	4,149	74	20	94	17.8	4.8	22.5
	Used at some time	938	11	2	13	11.2	2.5	13.7
Empowerment: household decisions	No	3,131	57	14	71	18.1	4.6	22.7
	Yes, can make decisions	1,956	28	8	35	14.2	3.9	18.0
Violence justified	Violence is not justified	3,621	58	14	72	16.1	3.8	19.9
	Violence is justified	1,466	26	8	34	17.6	5.6	23.3
Empowerment: health care/family planning decisions	No	4,116	79	17	96	19.3	4.1	23.4
	Yes	971	5	5	10	5.1	5.1	10.2
Newspapers/magazines	At least once a week	2,713	41	12	53	15	4.4	19.4
	Less than once a week	2,374	43	10	54	18.3	4.3	22.6
Radio/TV	Less than once a week	2,385	43	10	54	18.2	4.2	22.5
	At least once a week	2,702	41	12	53	15.1	4.4	19.5
Knows about HMG	No	3,405	58	16	74	17.0	4.6	21.7
	Yes	1,682	26	6	33	15.6	3.8	19.4
Husband's characteristics								
Husband's education	Basic (grades 1–8)	1,155	32	3	35	27.3	2.6	29.9
	No education/do not know	772	11	4	15	14.6	4.8	19.5
	Secondary and above (≥ grade nine)	3,122	41	15	57	13.3	4.9	18.2
Husband's occupation (four categories)	Agriculture	954	23	6	29	23.9	6.7	30.6
	Manual (skilled/unskilled)	2,019	36	6	42	17.6	3.0	20.7
	Not working	161	0	0	0	†	†	†
	Sales, clerical, other	1,915	26	10	35	13.5	5.0	18.5
Birth characteristics								
Birthweight taken	Not taken	1,941	58	6	64	30.0	3.2	33.2
	Yes, taken	3,048	24	15	38	7.8	4.8	12.5
Sex of child	Female	2,426	35	7	42	14.3	3.0	17.3
	Male	2,661	50	15	64	18.6	5.5	24.2
Birthweight	Large (≥3,500 g)	901	7	3	10	7.9	3.1	11.0
	Normal (2,500 g–3,500 g)	1,768	7	10	17	4.2	5.6	9.8
	Not weighed or do not know	1,941	58	6	64	30.0	3.2	33.2
	Small (<2,500 g)	376	8	2	10	22.2	5.0	27.2

Continued...

Table A2—Continued

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
Perceived birthweight	Very large	175	5	0	5	26.5	†	26.5
	Larger than average	646	15	5	21	23.7	8.5	32.2
	Average	3,306	36	8	43	10.8	2.3	13.0
	Smaller than average	622	15	7	22	23.5	11.5	34.9
	Very small	230	8	1	8	32.8	2.5	35.2
	Do not know	10	4	0	4	†	†	†
Pregnancy-related characteristics								
Birth order	First born	2,000	40	9	49	19.9	4.4	24.3
	2–4	2,653	35	11	47	13.2	4.3	17.6
	Five or more	434	9	2	11	21.4	4.0	25.5
Mother's parity	Primigravida	2,688	53	16	69	19.6	6.0	25.6
	Multigravida	2,399	32	6	38	13.2	2.5	15.7
Preceding birth interval	>2 years	2,324	25	9	34	10.8	3.8	14.6
	First birth	2,000	40	9	49	19.9	4.4	24.3
	≤2 years	754	18	4	22	23.7	5.8	29.4
Twin birth	No	5,023	79	22	101	15.7	4.4	20.1
	Yes	30	2	0	2	74.3	†	74.3
Wanted last birth	Wanted then	3,920	66	17	83	17.0	4.3	21.2
	Wanted later	655	10	1	12	15.6	2.1	17.7
	Wanted no more	463	8	4	12	16.4	8.5	24.9
Health system factors								
Time to health facility	≤30 minutes	1,156	2	3	5	1.8	2.4	4.2
	>30 minutes	1,096	10	1	11	9.2	0.6	9.8
Birth attendants	Delivery without SBA	2,102	47	7	54	22.6	3.1	25.7
	Delivery with SBA	2,887	34	14	49	11.9	4.9	16.9
Place of delivery	Home delivery	2,074	46	8	54	22.3	3.6	25.9
	Public health facility	2,147	24	8	32	11.1	3.9	14.9
	Private health facility	768	12	5	17	15.5	6.4	21.9
Cesarean section past delivery	Cesarean	450	2	2	4	4.6	3.7	8.3
	Not cesarean	4,539	80	19	99	17.6	4.2	21.8
ANC visits (three categories)	1–3 visits	976	18	2	20	18.4	2.5	20.9
	Four-plus visits	2,715	13	4	17	4.8	1.3	6.1
	Do not know/none	236	3	1	4	14.0	†	17.3
ANC visits (two categories)	0–3 visits	1,212	21	3	25	17.6	2.6	20.2
	Four-plus visits	2,715	13	4	17	4.8	1.3	6.1
Days iron tablets taken	<180 days	1,936	26	2	28	13.2	1.3	14.4
	180-plus days	1,628	7	2	9	4.3	1.4	5.7
Newborn PNC within 2 days	No PNC	1,787	24	2	26	13.6	1.1	14.6
	Yes PNC	2,140	10	5	15	4.7	2.3	7.0
Mother PNC within 2 days	No PNC	1,813	19	2	21	10.3	1.1	11.4
	Yes PNC	2,114	16	5	21	7.4	2.3	9.7

† = insufficient sample size

ANC = antenatal care; HMG = health mothers' group; NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; TV = television

Table A4 Births, neonatal deaths, and neonatal mortality rates per 1,000 births for all categories of variables in the 5 years preceding the 2022 Nepal DHS

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
National	National	5,192	85	20	105	16.4	3.9	20.3
Respondent's language	Bhojpuri	495	20	1	21	40.7	2.2	43.0
	Maithili	1,049	24	5	29	23.1	4.3	27.4
	Nepali	2,433	15	10	25	6.2	4.1	10.3
	Other	1,215	26	4	30	21.1	3.6	24.7
Ethnicity (three categories)	Advantaged	2,443	36	13	48	14.6	5.1	19.7
	Disadvantaged Dalit	1,301	30	4	34	23.3	2.9	26.3
	Disadvantaged Janajati	1,448	19	4	23	13.2	2.5	15.8
Ethnicity (two categories)	Advantaged	1,436	11	4	15	7.8	2.9	10.7
	Disadvantaged	3,755	74	16	90	19.7	4.2	23.9
Wealth terciles	Lower	1,180	20	7	26	16.7	5.7	22.4
	Middle	1,767	41	11	52	23.3	6.1	29.4
	Higher	2,245	24	3	27	10.8	1.1	12.0
Wealth index (three categories based on quintiles)	Middle	1,079	22	2	24	20.8	1.9	22.7
	Second and lowest	2,358	50	16	65	21.0	6.8	27.8
	Fourth and highest	1,755	13	2	15	7.5	1.2	8.7
Province	Koshi	899	21	2	23	23.5	2.6	26.0
	Madhesh	1,412	35	7	42	24.9	4.8	29.7
	Bagmati	822	9	0	9	11.2	†	11.2
	Gandaki	331	0	0	0	†	†	†
	Lumbini	880	10	5	15	11.6	5.6	17.2
	Karnali	383	5	2	7	12.7	6.3	18.9
	Sudurpaschim	466	5	4	8	10.0	7.8	17.8
Ecoregion	Hill	1,777	20	4	24	11.1	2.2	13.2
	Mountain	332	7	2	9	19.9	6.3	26.2
	Terai	3,083	59	14	73	19.1	4.6	23.7
Religion	Buddhist	259	2	0	2	7.3	1.9	9.2
	Hindu	4,344	67	18	84	15.3	4.0	19.4
	Muslim	327	13	1	14	40.5	3.5	44.0
	Other	262	3	1	4	12.8	3.3	16.1
Place of residence	Rural	1,822	35	9	44	19.4	4.7	24.1
	Urban	3,370	50	11	61	14.8	3.4	18.2
Size of household	<six members	2,776	52	10	62	18.8	3.5	22.2
	≥six members	2,416	33	10	44	13.7	4.3	18.0
Sex of household head	Female	1,643	22	5	27	13.5	2.8	16.3
	Male	3,548	63	15	78	17.7	4.3	22.1
Indoor air pollution	No	2,089	20	3	24	9.8	1.5	11.3
	Yes	3,103	65	17	82	20.9	5.4	26.3
Improved water and sanitation	Improved	3,890	63	18	81	16.2	4.5	20.7
	Not a de jure resident	454	5	1	6	11.0	2.5	13.5
	Unimproved	848	17	1	19	20.3	1.7	21.9
Maternal education	Basic (grades 1–8)	1,837	36	10	46	19.6	5.7	25.3
	No education	1,168	30	4	34	25.6	3.7	29.3
	Secondary and above (≥ grade nine)	2,187	19	5	24	8.8	2.4	11.2
Maternal age categories	15–19 years	267	6	2	8	22.1	7.1	29.3
	20–24 years	1,744	38	8	47	22.1	4.8	26.9
	25–29 years	1,776	30	6	36	16.9	3.3	20.2
	30–34 years	940	3	3	6	3.2	3.6	6.8
	35 and above	464	8	0	8	16.9	1.0	17.9
Maternal age (three categories)	15–19 years	267	6	2	8	22.1	7.1	29.3
	20–34 years	4,460	71	18	89	16.0	4.0	20.0
	≥35 years	464	8	0	8	16.9	1.0	17.9

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Table A4—Continued

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
Maternal use of tobacco	No	4,927	81	20	101	16.5	4.0	20.5
	Yes	265	4	0	4	15.0	1.7	16.8
Maternal stature	<145 cm	244	8	1	9	33.9	3.5	37.4
	≥145 cm	2,433	42	8	50	17.3	3.3	20.6
Maternal anemia	Anemic	988	19	2	22	19.4	2.4	21.8
	Not anemic	1,671	33	7	40	19.8	3.9	23.7
Mother ever drinks alcohol	Never drank alcohol	4,791	78	20	98	16.3	4.2	20.5
	At some time	401	7	0	7	18.0	†	18.0
Owns mobile phone	No	893	21	4	25	24.0	4.0	28.0
	Yes	4,298	64	17	80	14.8	3.8	18.7
Possesses a bank account	No	3,099	71	14	85	22.9	4.6	27.5
	Yes	2,093	14	6	20	6.8	2.8	9.6
Internet use	Never used internet	1,767	45	10	55	25.4	5.9	31.3
	Used at some time	3,424	40	10	50	11.8	2.8	14.6
Empowerment: household decisions	No	3,275	67	14	80	20.4	4.1	24.5
	Yes, can make decisions	1,917	18	6	25	9.6	3.4	13.0
Violence justified	Violence is not justified	4,249	68	17	85	16.0	4.1	20.1
	Violence is justified	943	17	3	20	18.3	2.8	21.0
Empowerment: health care/ family planning decisions	No	2,104	41	14	55	19.5	6.4	25.9
	Yes	3,088	44	6	51	14.3	2.1	16.4
Newspapers/magazines	At least once a week	2,337	19	9	28	7.9	3.9	11.9
	Less than once a week	2,855	67	11	77	23.3	3.8	27.1
Radio/TV	Less than once a week	2,915	67	11	77	22.9	3.7	26.6
	At least once a week	2,277	19	9	28	8.1	4.0	12.2
Knows about HMG	No	3,624	62	12	73	17.0	3.2	20.2
	Yes	1,567	23	8	32	15.0	5.4	20.4
Husband's education	Basic (grades 1–8)	2,036	37	7	44	18.1	3.3	21.5
	No education/do not know	695	21	5	26	30.6	6.9	37.5
	Secondary and above (≥ grade nine)	2,407	27	7	34	11.2	2.9	14.1
Husband's occupation (four categories)	Agriculture	752	8	1	9	10.7	1.8	12.5
	Manual (skilled/unskilled)	2,673	60	10	69	22.3	3.7	25.9
	Not working	131	1	0	1	4.7	†	4.7
	Sales, clerical, other	1,582	17	7	24	10.7	4.7	15.4
Birthweight taken	Not taken	604	23	5	27	37.3	7.6	44.9
	Yes, taken	2,386	19	10	29	8.1	4.1	12.3
Sex of child	Female	2,458	31	9	40	12.7	3.6	16.3
	Male	2,733	54	11	65	19.7	4.1	23.8
Birthweight	Large (≥3,500 g)	651	3	1	4	4.7	2.2	6.9
	Normal (2,500–3,500 g)	1,455	14	4	18	9.8	2.5	12.4
	Not weighed or do not know	604	23	5	27	37.3	7.6	44.9
	Small (<2,500 g)	279	2	5	7	7.4	16.9	24.2
Perceived birthweight	Very large	61	1	0	1	21.2	†	21.2
	Larger than average	318	1	2	4	4.0	7.2	11.2
	Average	2,173	32	9	42	14.9	4.2	19.1
	Smaller than average	299	2	1	4	7.7	4.8	12.5
	Very small	133	3	2	5	25.4	12.1	37.5
	Do not know	5	1	0	1	†	†	†
Birth order	First born	2,116	42	10	52	19.7	4.8	24.6
	2–4	2,855	37	9	47	13.0	3.3	16.3
	Five or more	220	6	0	7	28.1	2.1	30.2
Mother's parity	Primigravida	2,938	58	13	71	19.6	4.5	24.0
	Multigravida	2,254	28	7	35	12.3	3.1	15.3

Continued...

Table A4—Continued

Variable	Variable category	Number of births	Number of early neonatal deaths	Number of late neonatal deaths	Number of neonatal deaths	Early NMR	Late NMR	NMR
Preceding birth interval	>2 years	2,369	20	7	27	8.4	3.1	11.5
	First birth	2,116	42	10	52	19.7	4.8	24.6
	≤2 years	692	24	3	26	34.1	3.7	37.7
Twin birth	No	5,126	84	19	103	16.5	3.6	20.1
	Yes	33	0	0	0	10.7	†	10.7
Wanted last birth	Wanted then	2,765	59	15	73	21.2	5.2	26.5
	Wanted later	641	8	1	8	11.9	1.3	13.2
	Wanted no more	272	4	3	8	16.5	12.0	28.6
Time to health facility	≤30 minutes	4,494	69	17	86	15.4	3.7	19.1
	>30 minutes	697	16	3	19	22.8	4.7	27.5
Birth attendants	Delivery without SBA	623	17	6	22	27.2	8.9	36.1
	Delivery with SBA	2,367	25	9	34	10.6	3.7	14.3
Place of delivery	Home delivery	598	16	6	21	26.4	9.5	35.9
	Public health facility	1,812	18	8	26	9.8	4.4	14.1
	Private health facility	580	8	1	9	14.6	1.4	16.1
Cesarean section past years	Cesarean	559	4	1	5	6.7	2.6	9.3
	Not cesarean	2,431	38	13	51	15.7	5.3	21.1
ANC visits (three categories)	1–3 visits	443	9	2	11	21.4	4.3	25.7
	Four-plus visits	2,251	19	6	25	8.6	2.5	11.1
	Do not know/none	69	0	0	0	7.1	†	7.1
ANC visits (two categories)	0–3 visits	511	10	2	12	19.5	3.8	23.3
	Four-plus visits	2,252	19	6	25	8.6	2.5	11.1
Days iron tablets taken	<180 days	862	13	4	17	14.6	4.9	19.4
	180-plus days	1,805	16	3	20	9.0	1.9	10.9
Newborn PNC within 2 days	No PNC	838	18	4	22	21.7	4.6	26.3
	Yes PNC	1,925	11	4	15	5.8	1.9	7.7
Mother PNC within 2 days	No PNC	849	14	3	16	16.2	3.2	19.4
	Yes PNC	1,914	16	5	20	8.1	2.5	10.6

† = insufficient sample size

ANC = antenatal care; HMG = health mothers' group; NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; TV = television

Table A5 Early neonatal mortality rates and changes over time by background variables, 2016–2022 Nepal DHS surveys

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Change from 2016 to 2022 with 95% confidence interval			p value for change
		ENMR	LB	UB	ENMR	LB	UB	ENMR	LB	UB	
National	National	16.6	13.1	21.0	16.4	12.7	21.2	-0.2	-5.9	5.6	.954
Respondent's language	Bhojpuri	17.6	8.8	35.0	40.7	26.4	62.4	23.1	2.2	44.1	.030
	Maithili	16.9	10.6	26.8	23.1	13.5	39.1	6.2	-8.2	20.5	.401
	Nepali	14.7	10.4	20.9	6.2	3.9	9.8	-8.5	-14.4	-2.6	.005
	Other	18.8	11.6	30.2	21.1	13.3	33.5	2.4	-10.9	15.6	.727
Ethnicity (three categories)	Advantaged	14.4	10.4	19.9	14.6	10.2	20.8	0.2	-6.8	7.2	.951
	Disadvantaged Dalit	21.1	12.8	34.6	23.3	14.5	37.5	2.3	-13.0	17.5	.770
	Disadvantaged Janajati	17.3	10.8	27.4	13.2	7.8	22.4	-4.0	-14.7	6.6	.456
Ethnicity (two categories)	Advantaged	15.0	10.3	21.9	7.8	4.6	13.2	-7.2	-14.2	-0.2	.043
	Disadvantaged	17.3	13.0	23.1	19.7	14.9	26.0	2.4	-5.0	9.8	.526
Wealth terciles	Lower	19.3	13.2	28.0	16.7	11.0	25.3	-2.6	-12.6	7.5	.616
	Middle	18.2	12.4	26.7	23.3	16.9	32.0	5.1	-5.1	15.3	.330
	Higher	13.0	8.3	20.2	10.8	6.5	18.1	-2.1	-10.1	5.9	.603
Wealth index (three categories based on quintiles)	Middle	13.4	7.2	25.1	20.8	12.2	35.0	7.3	-6.4	21.1	.297
	Second and lowest	22.1	16.2	30.1	21.0	16.0	27.5	-1.1	-10.0	7.8	.810
	Fourth and highest	11.9	7.3	19.2	7.5	3.9	14.3	-4.3	-11.8	3.1	.254
Province	Koshi	17.1	8.3	34.9	23.5	13.2	41.5	6.4	-11.7	24.5	.486
	Madhesh	17.3	11.2	26.6	24.9	17.0	36.4	7.6	-4.4	19.6	.215
	Bagmati	10.9	5.1	23.1	11.2	4.8	26.0	0.3	-12.2	12.7	.967
	Gandaki	†	†	†	†	†	†	†	†	†	†
	Lumbini	14.1	7.3	26.9	11.6	5.5	24.4	-2.5	-15.0	10.0	.691
	Karnali	26.4	16.4	42.3	12.7	7.6	20.9	-13.8	-27.7	0.2	.053
	Sudurpaschim	26.7	15.0	47.2	10.0	4.4	22.5	-16.7	-33.9	0.5	.057
Ecoregion	Hill	14.5	9.2	22.7	11.1	7.3	16.7	-3.5	-11.4	4.5	.395
	Mountain	28.5	16.6	48.5	19.9	8.0	48.8	-8.6	-31.8	14.6	.467
	Terai	16.4	11.9	22.6	19.1	13.7	26.6	2.7	-5.5	10.9	.525
Religion	Buddhist	7.3	1.0	48.9	7.3	1.6	32.2	0.1	-17.6	17.7	.995
	Hindu	17.8	13.9	22.8	15.3	11.8	20.0	-2.5	-8.5	3.6	.425
	Muslim	15.2	5.3	42.5	40.5	18.3	87.4	25.3	-9.6	60.2	.155
Type of place	Rural	21.5	15.7	29.4	19.4	14.6	25.7	-2.1	-10.8	6.6	.633
	Urban	12.4	8.6	17.7	14.8	10.0	21.8	2.4	-4.9	9.7	.518
Size of household	<six members	18.0	12.7	25.4	18.8	13.9	25.3	0.8	-7.6	9.2	.853
	≥six members	15.3	11.2	21.0	13.7	8.7	21.4	-1.6	-9.4	6.2	.681
Sex of household head	Female	15.7	9.5	25.8	13.5	8.6	21.2	-2.2	-12.1	7.8	.669
	Male	16.9	13.0	22.1	17.7	13.2	23.7	0.8	-6.1	7.7	.819
Indoor air pollution	No	11.8	6.7	20.5	9.8	5.8	16.5	-2.0	-10.3	6.3	.639
	Yes	18.7	14.5	24.2	20.9	15.7	27.6	2.1	-5.4	9.7	.580
Improved water and sanitation	Improved	16.4	12.2	22.1	16.2	11.9	22.1	-0.2	-7.2	6.8	.956
	Not a de jure resident	26.4	12.6	54.5	11.0	4.0	30.1	-15.4	-37.7	6.9	.177
	Unimproved	14.3	8.8	23.1	20.3	11.5	35.4	6.0	-7.3	19.3	.375
Maternal education	Basic (grade 1–8)	22.1	13.6	35.6	19.6	13.4	28.5	-2.5	-15.3	10.4	.708
	No education	19.6	13.8	27.9	25.6	16.1	40.5	6.0	-7.7	19.7	.389
	Secondary and above (≥ grade nine)	11.8	7.5	18.4	8.8	5.5	14.1	-3.0	-9.7	3.7	.380
Maternal age (five categories)	15–19 years	29.0	14.0	59.2	22.1	9.8	49.3	-6.9	-34.4	20.7	.625
	20–24 years	19.7	13.3	29.2	22.1	15.7	31.0	2.4	-8.4	13.2	.667
	25–29 years	13.3	8.7	20.5	16.9	11.0	25.8	3.5	-5.7	12.7	.454
	30–34 years	13.4	6.6	26.8	3.2	1.0	9.8	-10.2	-20.2	-0.2	.045
	35 and above	13.4	5.4	33.0	16.9	7.0	39.8	3.4	-15.6	22.4	.724

Continued...

Table A5—Continued

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Change from 2016 to 2022 with 95% confidence interval			p value for change
		ENMR	LB	UB	ENMR	LB	UB	ENMR	LB	UB	
Maternal age (three categories)	15–19 years	29.0	14.0	59.2	22.1	9.8	49.3	-6.9	-34.4	20.7	.625
	20–34 years	15.8	12.1	20.7	16.0	12.0	21.3	0.2	-6.0	6.4	.951
	≥35 years	13.4	5.4	33.0	16.9	7.0	39.8	3.4	-15.6	22.4	.724
Maternal use of tobacco	No	16.8	13.2	21.5	16.5	12.6	21.5	-0.3	-6.4	5.7	.910
	Yes	12.4	5.7	26.7	15.0	7.0	31.9	2.6	-12.2	17.4	.728
Maternal stature	<145 cm	14.4	5.5	37.3	33.9	16.8	67.2	19.4	-7.8	46.7	.161
	≥145 cm	19.4	14.1	26.7	17.3	11.7	25.5	-2.1	-11.2	7.0	.654
Maternal anemia	Anemic	24.4	16.4	36.2	19.4	12.3	30.5	-5.0	-18.1	8.1	.454
	Not anemic	14.0	8.6	22.6	19.8	12.7	30.7	5.8	-5.2	16.8	.303
Owns mobile phone	No	19.6	12.5	30.6	24.0	13.7	41.9	4.4	-11.6	20.4	.592
	Yes	15.7	11.8	20.8	14.8	11.2	19.7	-0.8	-7.0	5.3	.789
Possesses a (bank account)	No	17.2	12.8	23.2	22.9	17.2	30.5	5.6	-2.7	14.0	.184
	Yes	15.3	10.2	23.0	6.8	4.2	11.0	-8.6	-15.6	-1.5	.017
Internet use	Never used internet	17.8	13.7	23.1	25.4	18.6	34.7	7.6	-1.6	16.8	.104
	Used at some time	11.2	6.0	20.8	11.8	7.9	17.4	0.6	-7.8	8.9	.895
Empowerment: household decisions	No	18.1	13.7	23.9	20.4	15.4	26.8	2.3	-5.3	9.8	.553
	Yes, can make decisions	14.2	9.2	21.7	9.6	5.9	15.6	-4.5	-12.2	3.1	.247
Violence justified	Violence is not justified	16.1	12.3	21.2	16.0	12.3	20.8	-0.2	-6.2	5.9	.961
	Violence is justified	17.6	11.2	27.7	18.3	9.7	34.3	0.6	-13.4	14.7	.931
Empowerment: health care/family planning decisions	No	19.3	15.1	24.6	19.5	13.8	27.4	0.2	-8.0	8.4	.967
	Yes	5.1	2.0	12.7	14.3	10.4	19.6	9.3	2.8	15.8	.005
Newspaper/Magazine	At least once a week	15.0	10.9	20.7	7.9	4.9	12.8	-7.1	-13.2	-1.0	.023
	Less than once a week	18.3	13.1	25.6	23.3	17.7	30.8	5.0	-3.9	13.9	.269
Radio/TV	Less than once a week	18.2	13.0	25.4	22.9	17.3	30.2	4.6	-4.2	13.4	.303
	At least once a week	15.1	10.9	20.8	8.1	5.0	13.1	-7.0	-13.2	-0.8	.028
Knows about HMG	No	17.0	12.8	22.6	17.0	12.3	23.5	0.0	-7.4	7.3	.993
	Yes	15.6	10.5	23.1	15.0	10.2	22.0	-0.6	-9.1	7.8	.885
Husband's education	Basic (grades 1–8)	27.3	18.3	40.5	18.1	12.6	26.1	-9.1	-21.8	3.5	.157
	No education/do not know	14.6	7.6	28.0	30.6	18.3	50.9	16.0	-2.3	34.3	.087
	Secondary and above (≥ grade nine)	13.3	9.4	18.7	11.2	7.1	17.7	-2.1	-9.0	4.8	.548
Husband's occupation (four categories)	Agriculture	23.9	16.1	35.3	10.7	5.9	19.3	-13.3	-24.6	-2.0	.021
	Manual (skilled/unskilled)	17.6	12.0	25.8	22.3	16.3	30.3	4.6	-5.0	14.3	.345
	Sales, clerical, other	13.5	9.0	20.3	10.7	6.5	17.7	-2.8	-10.5	4.9	.480
Birthweight taken	Not taken	30.0	22.4	40.1	37.3	21.1	65.2	7.3	-15.5	30.1	.530
	Yes, taken	7.8	5.0	12.1	8.1	4.8	13.7	0.4	-5.1	5.8	.893
Sex of child	Female	14.3	10.0	20.5	12.7	8.5	19.2	-1.6	-8.9	5.7	.673
	Male	18.6	13.6	25.5	19.7	14.3	27.1	1.1	-7.5	9.7	.809
Birthweight	Large (≥3,500 g)	7.9	3.8	16.5	4.7	1.4	15.6	-3.2	-11.3	4.9	.435
	Normal (2,500–3,500 g)	4.2	2.0	8.8	9.8	5.2	18.6	5.6	-1.4	12.7	.114
	Not weighed or do not know	30.0	22.4	40.1	37.3	21.1	65.2	7.3	-15.5	30.1	.530
	Small (<2,500 g)	22.2	10.6	46.1	7.4	2.9	18.8	-14.9	-32.6	2.9	.100
Perceived birthweight	Very large	26.5	10.5	65.2	21.2	4.9	86.9	-5.3	-44.1	33.5	.789
	Larger than average	23.7	13.5	41.3	4.0	1.0	15.4	-19.8	-34.0	-5.5	.007
	Average	10.8	7.6	15.3	14.9	9.7	22.9	4.2	-3.2	11.6	.268
	Smaller than average	23.5	12.8	42.6	7.7	2.5	23.5	-15.7	-32.2	0.8	.062
	Very small	32.8	16.0	65.9	25.4	9.4	66.7	-7.4	-41.3	26.5	.669
Birth order	First born	19.9	14.1	28.0	19.7	14.2	27.4	-0.2	-9.6	9.2	.967
	2–4	13.2	9.3	18.8	13.0	8.6	19.6	-0.2	-7.3	6.9	.953
	Five or more	21.4	11.2	40.6	28.1	12.8	60.8	6.7	-19.2	32.6	.612

Continued...

Table A5—Continued

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Change from 2016 to 2022 with 95% confidence interval			p value for change
		ENMR	LB	UB	ENMR	LB	UB	ENMR	LB	UB	
Mother's parity	Primigravida	19.6	14.3	26.9	19.6	14.4	26.6	0.0	-8.7	8.6	.995
	Multigravida	13.2	9.2	18.9	12.3	7.8	19.1	-0.9	-8.1	6.3	.804
Preceding birth interval	>two years	10.8	7.1	16.4	8.4	5.2	13.5	-2.5	-8.5	3.6	.426
	First birth	19.9	14.1	28.0	19.7	14.2	27.4	-0.2	-9.6	9.2	.967
	≤two years	23.7	13.5	41.0	34.1	19.6	58.7	10.4	-12.4	33.2	.371
Twin birth	No	15.7	12.3	20.0	16.5	12.7	21.3	0.8	-4.9	6.5	.784
	Yes	74.3	21.4	227.5	10.7	1.4	76.2	-63.6	-152.8	25.6	.162
Wanted last birth	Wanted then	17.0	12.9	22.3	21.2	15.5	29.0	4.3	-3.8	12.4	.303
	Wanted later	15.6	8.0	30.3	11.9	5.3	26.2	-3.7	-17.7	10.3	.604
	Wanted no more	16.4	7.7	34.6	16.5	5.9	45.4	0.1	-20.8	20.9	.994
Time to health facility	≤30 minutes	1.8	0.4	7.3	15.4	11.7	20.3	13.6	8.7	18.6	.000
	>30 minutes	9.2	5.0	17.0	22.8	12.6	40.9	13.6	-0.9	28.2	.067
Skilled birth attendant (SBA)	Delivery without SBA	22.6	16.3	31.2	27.2	13.4	54.4	4.6	-15.8	25.0	.659
	Delivery with SBA	11.9	8.4	17.0	10.6	6.8	16.4	-1.4	-7.6	4.9	.671
Place of delivery	Home delivery	22.3	16.1	30.9	26.4	12.5	55.3	4.1	-16.9	25.1	.699
	Public health facility	11.1	7.2	17.1	9.8	5.6	17.0	-1.3	-8.6	5.9	.719
	Private health facility	15.5	8.6	27.6	14.6	7.7	27.8	-0.8	-13.9	12.2	.899
Cesarean section past years	Cesarean	4.6	1.1	18.4	6.7	2.1	21.3	2.1	-8.0	12.2	.683
	Not cesarean	17.6	13.8	22.4	15.7	10.5	23.6	-1.9	-9.5	5.8	.634
ANC visits (three categories)	1–3 visits	18.4	10.8	31.2	21.4	10.5	43.2	2.9	-15.1	20.9	.750
	Four-plus visits	4.8	2.7	8.6	8.6	5.1	14.4	3.8	-1.5	9.0	.163
	Do not know/none	14.0	4.6	42.2	7.1	1.0	49.2	-6.9	-27.7	13.9	.516
ANC visits (two categories)	0–3 visits	17.6	11.0	28.0	19.5	9.8	38.5	1.9	-13.7	17.6	.810
	Four-plus visits	4.8	2.7	8.6	8.6	5.1	14.4	3.8	-1.5	9.0	.163
Days iron tablets taken	<180 days	13.2	8.3	20.8	14.6	7.8	27.0	1.4	-9.5	12.3	.802
	180-plus days	4.3	2.0	9.5	9.0	5.0	15.9	4.6	-1.5	10.8	.140
Newborn PNC within 2 days	No PNC	13.6	8.7	21.1	21.7	12.4	37.6	8.1	-5.3	21.5	.238
	Yes PNC	4.7	2.5	8.8	5.8	2.9	11.2	1.0	-3.8	5.9	.675
Mother PNC within 2 days	No PNC	10.3	6.4	16.7	16.2	8.6	30.1	5.9	-5.4	17.1	.306
	Yes PNC	7.4	4.2	13.0	8.1	4.5	14.6	0.7	-5.6	7.0	.830

† = insufficient sample size

ANC = antenatal care; ENMR = early neonatal mortality rate; HMG = health mothers' group; LB = lower bound; PNC = postnatal care; SBA = skilled birth attendant; UB = upper bound

Table A6 Late neonatal mortality rates and changes over time by background variables, 2016–2022 Nepal DHS surveys

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Difference with 95% confidence interval			p value for difference
		LNMR	LB	UB	LNMR	LB	UB	LNMR	LB	UB	
National	National	4.3	2.6	7.1	3.9	2.5	5.9	-0.5	-3.2	2.3	.737
Respondent's language	Bhojpuri	8.2	2.4	27.5	2.2	0.6	8.8	-6.0	-16.2	4.2	.250
	Maithili	6.5	2.3	18.4	4.3	1.4	13.3	-2.2	-10.4	6.1	.610
	Nepali	2.6	1.1	6.4	4.1	2.3	7.3	1.5	-1.8	4.8	.379
	Other	3.5	1.4	8.6	3.6	1.5	8.7	0.1	-4.3	4.6	.953
Ethnicity (three categories)	Advantaged	4.0	1.9	8.5	5.1	2.9	9.1	1.1	-3.1	5.3	.609
	Disadvantaged Dalit	5.9	2.5	14.1	2.9	1.3	6.8	-3.0	-8.7	2.7	.302
	Disadvantaged Janajati	3.6	1.2	11.0	2.5	0.9	7.2	-1.1	-5.9	3.7	.654
Ethnicity (two categories)	Advantaged	3.3	1.1	9.9	2.9	1.4	6.0	-0.4	-4.6	3.8	.843
	Disadvantaged	4.8	2.7	8.4	4.2	2.5	7.1	-0.6	-4.0	2.9	.749
Wealth terciles	Lower	4.8	2.2	10.4	5.7	2.8	11.3	0.9	-4.5	6.3	.752
	Middle	3.2	1.1	9.1	6.1	3.3	11.4	2.9	-2.2	8.0	.260
	Higher	5.0	2.2	11.5	1.1	0.3	3.9	-3.9	-8.3	0.5	.081
Wealth index (three categories based on quintiles)	Middle	2.4	0.7	8.4	1.9	0.5	6.7	-0.4	-4.3	3.4	.820
	Second and lowest	5.2	2.6	10.2	6.8	4.2	10.9	1.6	-3.2	6.3	.525
	Fourth and highest	4.5	2.0	10.1	1.2	0.3	5.1	-3.3	-7.4	0.7	.104
Province	Koshi	5.8	1.7	19.7	2.6	0.8	8.2	-3.2	-10.9	4.4	.412
	Madhesh	7.0	3.1	15.7	4.8	2.0	11.2	-2.2	-9.1	4.7	.532
	Bagmati	†	†	†	†	†	†	†	†	†	†
	Gandaki	†	†	†	†	†	†	†	†	†	†
	Lumbini	4.3	1.4	13.2	5.6	2.1	14.8	1.3	-5.9	8.6	.718
	Karnali	4.9	1.8	13.5	6.3	2.9	13.5	1.4	-5.5	8.2	.693
	Sudurpaschim	3.2	0.8	13.0	7.8	3.4	17.5	4.6	-3.1	12.3	.239
Ecoregion	Hill	1.8	0.6	5.2	2.2	1.1	4.3	0.4	-2.1	2.8	.776
	Mountain	7.9	2.8	22.6	6.3	2.2	17.9	-1.7	-12.1	8.7	.751
	Terai	5.6	2.9	10.5	4.6	2.6	8.0	-1.0	-5.4	3.4	.655
Religion	Buddhist	†	†	†	1.9	0.3	13.7	†	†	†	†
	Hindu	4.7	2.8	7.9	4.0	2.5	6.4	-0.7	-3.8	2.4	.664
	Muslim	4.3	0.6	29.0	3.5	0.5	25.6	-0.7	-11.4	9.9	.893
Type of place	Rural	4.8	2.3	10.0	4.7	2.6	8.5	-0.1	-4.6	4.4	.978
	Urban	4.0	2.0	7.8	3.4	1.8	6.3	-0.6	-4.0	2.9	.751
Size of household	<six members	3.3	1.4	7.9	3.5	1.8	6.6	0.2	-3.5	3.8	.920
	≥six members	5.3	2.9	9.6	4.3	2.4	7.8	-1.0	-5.0	3.1	.646
Sex of household head	Female	1.6	0.4	6.4	2.8	1.2	6.5	1.2	-2.1	4.5	.470
	Male	5.4	3.3	9.0	4.3	2.6	7.2	-1.1	-4.6	2.4	.544
Indoor air pollution	No	5.6	2.3	13.4	1.5	0.5	4.9	-4.1	-9.3	1.1	.123
	Yes	3.8	2.0	6.9	5.4	3.4	8.6	1.7	-1.7	5.1	.332
Improved water and sanitation	Improved	3.2	1.7	6.0	4.5	2.8	7.2	1.3	-1.6	4.2	.379
	Not a de jure resident	11.6	3.9	34.2	2.5	0.3	17.4	-9.2	-22.7	4.4	.184
	Unimproved	5.0	1.9	13.2	1.7	0.4	6.9	-3.4	-8.8	2.0	.221
Maternal education	Basic (grades 1–8)	1.3	0.2	8.9	5.7	3.1	10.3	4.4	0.2	8.6	.039
	No education	6.1	3.0	12.4	3.7	1.2	11.1	-2.4	-8.3	3.5	.428
	Secondary and above (≥ grade nine)	4.3	2.2	8.6	2.4	1.2	4.9	-1.9	-5.4	1.5	.268

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Table A6—Continued

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Difference with 95% confidence interval			p value for difference
		LNMR	LB	UB	LNMR	LB	UB	LNMR	LB	UB	
Maternal age (five categories)	15–19 years	4.2	0.6	27.9	7.1	2.1	23.6	3.0	-8.7	14.7	.621
	20–24 years	8.0	4.2	14.9	4.8	2.6	9.0	-3.2	-9.0	2.7	.289
	25–29 years	2.7	1.0	7.2	3.3	1.4	8.0	0.7	-3.3	4.6	.747
	30–34 years	1.6	0.2	11.2	3.6	1.1	12.1	2.1	-3.3	7.4	.453
	35 and above	2.7	0.4	18.8	1.0	0.1	7.0	-1.7	-7.2	3.9	.556
Maternal age (three categories)	15–19 years	4.2	0.6	27.9	7.1	2.1	23.6	3.0	-8.7	14.7	.621
	20–34 years	4.5	2.6	7.7	4.0	2.5	6.3	-0.5	-3.6	2.5	.727
	≥35 years	2.7	0.4	18.8	1.0	0.1	7.0	-1.7	-7.2	3.9	.556
Maternal use of tobacco	No	4.5	2.7	7.4	4.0	2.6	6.2	-0.5	-3.4	2.4	.738
	Yes	2.1	0.3	14.6	1.7	0.2	12.4	-0.4	-5.7	4.9	.894
Maternal stature	<145 cm	14.7	5.2	41.2	3.5	0.5	24.9	-11.2	-28	5.5	.189
	≥145 cm	2.9	1.3	6.4	3.3	1.7	6.5	0.4	-2.7	3.6	.784
Maternal anemia	Anemic	4.6	1.8	11.6	2.4	0.9	6.8	-2.1	-7.1	2.8	.393
	Not anemic	3.9	1.3	11.5	3.9	1.8	8.5	0.0	-5.2	5.3	.987
Owns mobile phone	No	9.2	4.9	17.0	4.0	1.1	14.1	-5.2	-12.8	2.4	.176
	Yes	2.9	1.4	6.0	3.8	2.4	6.1	1.0	-1.8	3.7	.489
Possesses a bank account	No	5.7	3.4	9.6	4.6	2.7	7.7	-1.1	-4.9	2.7	.573
	Yes	1.9	0.6	6.3	2.8	1.3	6.1	0.9	-2.2	4.1	.568
Internet use	Never used internet	4.8	2.8	8.1	5.9	3.1	11.1	1.2	-3.4	5.7	.616
	Used at some time	2.5	0.6	10.6	2.8	1.6	5.0	0.3	-3.6	4.3	.867
Empowerment: household decisions	No	4.6	2.5	8.3	4.1	2.5	7.0	-0.5	-4.0	3.0	.792
	Yes, can make decisions	3.9	1.7	8.8	3.4	1.5	7.4	-0.5	-4.6	3.6	.814
Violence justified	Violence is not justified	3.8	2.1	6.8	4.1	2.6	6.5	0.3	-2.6	3.2	.838
	Violence is justified	5.6	2.4	13.0	2.8	0.8	9.2	-2.9	-8.7	2.9	.331
Empowerment: health care/ family planning decisions	No	4.1	2.4	7.2	6.4	3.7	11.1	2.3	-1.9	6.5	.279
	Yes	5.1	1.9	13.8	2.1	1.0	4.4	-3.0	-8.3	2.3	.266
Newspaper/Magazine	At least once a week	4.4	2.3	8.6	3.9	2.2	7.1	-0.5	-4.2	3.3	.806
	Less than once a week	4.3	2.0	9.1	3.8	2.0	7.1	-0.4	-4.5	3.6	.828
Radio/TV	Less than once a week	4.2	2.0	9.1	3.7	2.0	7.0	-0.5	-4.5	3.5	.804
	At least once a week	4.4	2.3	8.6	4.0	2.2	7.3	-0.4	-4.2	3.4	.843
Knows about HMG	No	4.6	2.5	8.6	3.2	1.8	5.6	-1.4	-4.8	2.0	.417
	Yes	3.8	1.6	8.7	5.4	2.7	10.7	1.6	-3.2	6.5	.514
Husband's education	Basic (grades 1–8)	2.6	0.5	13.2	3.3	1.4	7.7	0.7	-4.4	5.8	.789
	No education/do not know	4.8	1.6	14.1	6.9	2.8	16.7	2.0	-6.0	10.0	.622
	Secondary and above (≥ grade nine)	4.9	2.7	8.9	2.9	1.6	5.4	-2.0	-5.4	1.5	.263
Husband's occupation (four categories)	Agriculture	6.7	2.9	15.2	1.8	0.4	8.1	-4.9	-11.0	1.3	.120
	Manual (skilled/unskilled)	3.0	1.1	8.6	3.7	1.9	7.0	0.6	-3.3	4.6	.753
	Not working	†	†	†	†	†	†	†	†	†	†
	Sales, clerical, other	5.0	2.4	10.1	4.7	2.4	9.1	-0.3	-5.0	4.4	.909
Birthweight taken	Not taken	3.2	1.4	7.5	7.6	2.6	21.8	4.4	-4.1	12.9	.312
	Yes, taken	4.8	2.6	8.8	4.1	2.2	7.7	-0.7	-4.5	3.2	.742
Sex of child	Female	3.0	1.2	7.2	3.6	1.9	6.7	0.6	-2.9	4.0	.754
	Male	5.5	3.0	10.3	4.1	2.3	7.5	-1.4	-5.6	2.8	.516

Continued...

Table A6—Continued

Variable	Variable category	2016 with 95% confidence interval			2022 with 95% confidence interval			Difference with 95% confidence interval			p value for difference
		LNMR	LB	UB	LNMR	LB	UB	LNMR	LB	UB	
Birthweight	Large (≥3,500 g)	3.1	0.8	12.4	2.2	0.3	15.5	-0.9	-7.0	5.2	.779
	Normal (2,500–3,500 g)	5.6	2.8	11.2	2.5	1.0	6.2	-3.1	-7.6	1.4	.180
	Not weighed or do not know	3.2	1.4	7.5	7.6	2.6	21.8	4.4	-4.1	12.9	.312
	Small (<2,500 g)	5.0	1.1	22	16.9	6.5	43.1	11.9	-5.7	29.5	.186
Perceived birthweight	Very large	†	†	†	†	†	†	†	†	†	†
	Larger than average	8.5	3.4	21.3	7.2	1.9	26.5	-1.3	-13.5	11.0	.840
	Average	2.3	1.0	5.1	4.2	2.1	8.3	1.9	-1.5	5.3	.276
	Smaller than average	11.5	5.1	25.7	4.8	0.7	33.2	-6.7	-19.9	6.5	.319
	Very small	2.5	0.3	17.7	12.1	2.7	53.4	9.7	-9.1	28.5	.313
Don't know	†	†	†	†	†	†	†	†	†	†	
Birth order	First born	4.4	2.1	9.2	4.8	2.8	8.3	0.4	-3.8	4.6	.846
	2–4	4.3	2.1	8.8	3.3	1.6	6.7	-1.0	-4.9	2.8	.599
	Five or more	4.0	0.9	16.9	2.1	0.3	14.9	-1.9	-9.0	5.1	.592
Mother's parity	Primigravida	6.0	3.2	11.1	4.5	2.7	7.2	-1.5	-5.8	2.8	.495
	Multigravida	2.5	1.1	5.6	3.1	1.3	7.3	0.6	-2.8	3.9	.738
Preceding birth interval	>2 years	3.8	1.8	8.0	3.1	1.3	7.1	-0.7	-4.5	3.1	.710
	First birth	4.4	2.1	9.2	4.8	2.8	8.3	0.4	-3.8	4.6	.846
	≤2 years	5.8	2.2	15.1	3.7	1.1	12.1	-2.1	-9.2	4.9	.557
Twin birth	No	4.4	2.7	7.2	3.6	2.3	5.6	-0.8	-3.5	2.0	.586
	Yes	†	†	†	†	†	†	†	†	†	†
Wanted last birth	Wanted then	4.3	2.4	7.5	5.2	3.2	8.7	1.0	-2.6	4.6	.589
	Wanted later	2.1	0.5	8.6	1.3	0.3	5.4	-0.8	-4.3	2.7	.652
	Wanted no more	8.5	3.1	23.2	12.0	3.4	41.3	3.6	-13.7	20.8	.686
Time to health facility	≤30 minutes	2.4	0.7	7.7	3.7	2.3	6.1	1.3	-2.0	4.7	.432
	>30 minutes	0.6	0.1	3.9	4.7	2.0	10.8	4.1	0.0	8.2	.049
Birth attendants	Delivery without SBA	3.1	1.4	7.0	8.9	3.4	23.5	5.8	-3.2	14.8	.208
	Delivery with SBA	4.9	2.6	9.1	3.7	2.0	7.0	-1.2	-5.0	2.7	.548
Place of delivery	Home delivery	3.6	1.6	8.0	9.5	3.6	24.6	5.8	-3.7	15.3	.230
	Public health facility	3.9	1.8	8.0	4.4	2.2	8.7	0.5	-3.6	4.6	.807
	Private health facility	6.4	1.9	21.9	1.4	0.4	5.9	-5.0	-13.2	3.2	.230
C-section past pregnancy	Cesarean	3.7	0.9	15.7	2.6	0.6	10.8	-1.1	-7.6	5.4	.734
	Not cesarean	4.2	2.4	7.3	5.3	3.0	9.5	1.1	-2.7	5.0	.565
ANC visits (three categories)	1–3 visits	2.5	0.6	10.0	4.3	0.6	30.3	1.8	-7.3	11.0	.694
	Four-plus visits	1.3	0.5	3.7	2.5	1.2	5.5	1.2	-1.2	3.6	.314
	Do not know/none	†	†	†	†	†	†	†	†	†	†
ANC visits (two categories)	0–3 visits	2.6	0.8	8.4	3.8	0.5	26.4	1.1	-6.9	9.1	.785
	Four-plus visits	1.3	0.5	3.7	2.5	1.2	5.5	1.2	-1.2	3.6	.315
Days iron tablets taken	<180 days	1.3	0.3	5.1	4.9	1.9	12.5	3.6	-1.3	8.5	.151
	180-plus days	1.4	0.4	4.5	1.9	0.6	6.3	0.5	-2.3	3.3	.722
Newborn PNC within two days	No PNC	1.1	0.3	4.3	4.6	1.4	14.5	3.5	-2.0	9.0	.208
	Yes PNC	2.3	0.7	7.4	1.9	0.7	5.2	-0.3	-3.6	3.0	.850
Mother PNC within two days	No PNC	1.1	0.3	4.3	3.2	0.8	13.5	2.2	-2.7	7.0	.381
	Yes PNC	2.3	0.7	7.5	2.5	1.1	6.0	0.3	-3.2	3.8	.887

† = insufficient sample size

LB = lower bound; LNMR = late neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; UB = upper bound

Table A7 Neonatal mortality rates and changes over time by background variables, 2016–2022 Nepal DHS surveys

Variable	Variable category	2016			2022			Change from 2016 to 2022			p value for change
		NMR	95% LB	95% UB	NMR	95% LB	95% UB	NMR	NMR	95% LB	
National	National	20.9	16.9	25.9	20.3	16.2	25.4	-0.6	-7.0	5.7	.844
Respondent's language	Bhojpuri	25.8	13.0	50.6	43.0	28.3	64.8	17.1	-7.3	41.6	.170
	Maithili	23.4	15.0	36.2	27.4	16.3	45.8	4.0	-13.3	21.4	.651
	Nepali	17.4	12.5	24.0	10.3	7.2	14.8	-7.0	-13.8	-0.3	.042
	Other	22.3	14.7	33.4	24.7	16.5	37.0	2.5	-11.0	16.0	.718
Ethnicity (three categories)	Advantaged	18.4	13.4	25.2	19.7	14.6	26.5	1.3	-6.9	9.5	.755
	Disadvantaged Dalit	27.0	17.2	42.1	26.3	17.1	40.1	-0.7	-17.2	15.7	.931
	Disadvantaged Janajati	20.9	13.8	31.6	15.8	9.8	25.2	-5.1	-16.5	6.3	.376
Ethnicity (two categories)	Advantaged	18.3	12.4	26.8	10.7	6.9	16.6	-7.6	-16.1	0.8	.077
	Disadvantaged	22.1	17.2	28.4	23.9	18.7	30.6	1.8	-6.3	9.9	.658
Wealth terciles	Lower	24.1	17.3	33.4	22.4	15.7	31.8	-1.7	-12.9	9.5	.766
	Middle	21.4	15.1	30.5	29.4	22.2	38.9	8.0	-3.2	19.1	.161
	Higher	18.0	11.7	27.6	12.0	7.4	19.2	-6.0	-15.6	3.5	.216
Wealth index (three categories based on quintiles)	Middle	15.8	8.7	28.4	22.7	13.8	36.9	6.9	-7.6	21.4	.353
	Second and lowest	27.3	20.8	35.7	27.8	21.7	35.6	0.5	-9.6	10.5	.928
	Fourth and highest	16.4	10.7	25.0	8.7	4.8	15.6	-7.7	-16.3	0.9	.079
Province	Koshi	22.8	12.6	41.0	26.0	15.4	43.8	3.2	-15.8	22.2	.739
	Madhesh	24.3	16.1	36.6	29.7	20.6	42.6	5.4	-9.2	19.9	.469
	Bagmati	10.9	5.1	23.1	11.2	4.8	26.0	0.3	-12.2	12.7	.967
	Gandaki	†	†	†	†	†	†	†	†	†	†
	Lumbini	18.4	11	30.7	17.2	9.8	30.1	-1.2	-14.6	12.2	.861
	Karnali	31.3	20.3	48.1	18.9	12.0	29.8	-12.4	-28.3	3.5	.127
	Sudurpaschim	29.9	17.7	50.0	17.8	9.7	32.3	-12.1	-30.7	6.6	.204
Ecoregion	Hill	16.4	10.8	24.7	13.2	9.1	19.2	-3.1	-11.5	5.3	.467
	Mountain	36.5	24.2	54.7	26.2	12.7	53.2	-10.3	-33.8	13.2	.391
	Terai	22.0	16.4	29.4	23.7	17.7	31.6	1.7	-7.7	11.0	.728
Religion	Buddhist	7.3	1.0	48.9	9.2	2.6	31.6	1.9	-16	19.9	.832
	Hindu	22.5	18.1	28.1	19.4	15.3	24.5	-3.1	-9.9	3.6	.360
	Muslim	19.4	8.0	46.3	44.0	21.0	89.9	24.6	-11.2	60.3	.178
Type of place	Rural	26.3	19.7	35.1	24.1	18.5	31.4	-2.2	-12.1	7.7	.667
	Urban	16.3	11.9	22.4	18.2	13.0	25.4	1.9	-6.2	9.9	.650
Size of household	<six members	21.2	15.4	29.2	22.2	16.9	29.3	1.0	-8.1	10.1	.833
	≥six members	20.6	15.3	27.7	18.0	12.4	26.0	-2.6	-11.6	6.4	.574
Sex of household head	Female	17.3	10.9	27.5	16.3	10.7	24.8	-1.0	-11.5	9.6	.858
	Male	22.4	17.6	28.4	22.1	17.1	28.4	-0.3	-8.0	7.4	.942
Indoor air pollution	No	17.4	10.7	28.2	11.3	7.1	18.1	-6.1	-16.0	3.9	.233
	Yes	22.5	17.9	28.2	26.3	20.5	33.7	3.8	-4.5	12.1	.369
Improved water and sanitation	Improved	19.6	15.0	25.5	20.7	15.8	27.0	1.1	-6.5	8.7	.775
	Not a de jure resident	38.0	21.5	66.4	13.5	5.5	32.3	-24.5	-49.0	-0.1	.049
	Unimproved	19.3	12.6	29.4	21.9	12.9	37.1	2.6	-11.5	16.8	.714
Maternal education	Basic (grades 1–8)	23.3	14.4	37.8	25.3	18.4	34.7	2.0	-11.9	15.8	.780
	No education	25.7	18.8	35.2	29.3	19.5	43.9	3.6	-10.8	18.0	.623
	Secondary and above (≥ grade nine)	16.1	10.9	23.7	11.2	7.5	16.7	-4.9	-12.6	2.8	.208
Maternal age (five categories)	15–19 years	33.2	17.1	63.6	29.3	15.0	56.3	-3.9	-33.1	25.2	.792
	20–24 years	27.7	20.1	38.0	26.9	19.9	36.1	-0.8	-12.7	11.1	.896
	25–29 years	16.0	10.8	23.6	20.2	13.8	29.4	4.2	-5.6	14.0	.405
	30–34 years	15.0	7.3	30.5	6.8	3.0	15.4	-8.2	-20.3	3.9	.184
	35 and above	16.1	7.1	36.1	17.9	7.8	40.4	1.7	-17.9	21.4	.862
Maternal age (three categories)	15–19 years	33.2	17.1	63.6	29.3	15.0	56.3	-3.9	-33.1	25.2	.792
	20–34 years	20.3	15.9	25.9	20.0	15.6	25.5	-0.3	-7.3	6.6	.922
	≥35 years	16.1	7.1	36.1	17.9	7.8	40.4	1.7	-17.9	21.4	.862

Continued...

Table A7—Continued

Variable	Variable category	2016			2022			Change from 2016 to 2022			p value for change
		NMR	95% LB	95% UB	NMR	95% LB	95% UB	NMR	NMR	95% LB	
Maternal use of tobacco	No	21.3	17.1	26.5	20.5	16.2	25.8	-0.8	-7.5	5.8	.805
	Yes	14.5	7.3	28.6	16.8	8.2	33.8	2.3	-13.1	17.6	.773
Maternal stature	<145 cm	29.2	12.5	66.5	37.4	19.4	71.0	8.2	-26.1	42.6	.639
	≥145 cm	22.3	16.4	30.2	20.6	14.4	29.4	-1.6	-11.6	8.4	.748
Maternal anemia	Anemic	29.0	19.7	42.3	21.8	14.3	33.1	-7.1	-21.5	7.2	.328
	Not anemic	17.8	10.9	29.2	23.7	15.9	35.2	5.8	-7.1	18.7	.375
Owns mobile phone	No	28.8	20.1	41.1	28.0	16.9	46.1	-0.9	-18.3	16.6	.924
	Yes	18.5	14.2	24.1	18.7	14.6	23.8	0.1	-6.6	6.8	.969
Possesses a bank account	No	22.9	17.7	29.6	27.5	21.4	35.3	4.6	-4.5	13.6	.323
	Yes	17.2	11.8	25.1	9.6	6.3	14.4	-7.6	-15.2	-0.1	.048
Internet use	Never used internet	22.5	18.0	28.2	31.3	23.5	41.6	8.8	-1.5	19.0	.093
	Used at some time	13.7	7.8	23.9	14.6	10.4	20.3	0.9	-8.2	10.0	.847
Empowerment: household decisions	No	22.7	17.6	29.2	24.5	19.0	31.5	1.8	-6.6	10.3	.674
	Yes, can make decisions	18.0	12.4	26.1	13.0	8.7	19.5	-5.0	-13.6	3.5	.249
Violence justified	Violence is not justified	19.9	15.5	25.5	20.1	16.0	25.2	0.2	-6.6	6.9	.964
	Violence is justified	23.3	15.9	34.0	21.0	11.9	37.0	-2.2	-17.1	12.6	.767
Empowerment: health care/family planning decisions	No	23.4	18.8	29.2	25.9	19.1	35.0	2.5	-6.9	11.9	.605
	Yes	10.2	5.1	20.0	16.4	12.3	21.8	6.2	-2.1	14.6	.143
Newspapers/magazines	At least once a week	19.4	14.4	26.2	11.9	8.2	17.2	-7.6	-14.9	-0.3	.042
	Less than once a week	22.6	16.7	30.4	27.1	20.9	35.2	4.6	-5.2	14.3	.359
Radio/TV	Less than once a week	22.5	16.6	30.3	26.6	20.5	34.5	4.1	-5.5	13.8	.403
	At least once a week	19.5	14.4	26.4	12.2	8.4	17.6	-7.3	-14.8	0.1	.052
Knows about HMG	No	21.7	16.7	28.1	20.2	15.0	27.2	-1.4	-9.7	6.8	.732
	Yes	19.4	13.7	27.4	20.4	14.7	28.2	1.0	-8.5	10.4	.837
Husband's education	Basic (grades 1–8)	29.9	20.3	43.8	21.5	15.5	29.7	-8.4	-21.9	5.0	.218
	No education/do not know	19.5	11.3	33.4	37.5	23.5	59.3	18.0	-2.3	38.3	.082
	Secondary and above (≥ grade nine)	18.2	13.4	24.6	14.1	9.6	20.7	-4.1	-11.8	3.7	.303
Husband's occupation (four categories)	Agriculture	30.6	21.2	44.0	12.5	7.2	21.5	-18.1	-31.2	-5.1	.006
	Manual (skilled/unskilled)	20.7	14.5	29.3	25.9	19.7	34.0	5.3	-4.8	15.4	.306
	Sales, clerical, other	18.5	13.1	26.1	15.4	10.4	22.9	-3.1	-11.9	5.8	.497
Birthweight taken	Not taken	33.2	25.3	43.5	44.9	27.1	73.5	11.7	-12.4	35.8	.342
	Yes, taken	12.5	8.9	17.7	12.3	8.1	18.5	-0.3	-6.9	6.3	.934
Sex of child	Female	17.3	12.2	24.6	16.3	11.3	23.4	-1.0	-9.5	7.4	.814
	Male	24.2	18.4	31.7	23.8	18.0	31.4	-0.3	-9.7	9.0	.943
Birthweight	Large (≥3,500 g)	11.0	5.8	20.8	6.9	2.5	19.2	-4.1	-14.1	5.9	.420
	Normal (2,500–3,500 g)	9.8	5.9	16.1	12.4	7.2	21.1	2.6	-5.6	10.8	.538
	Not weighed or do not know	33.2	25.3	43.5	44.9	27.1	73.5	11.7	-12.4	35.8	.342
	Small (<2,500 g)	27.2	14.1	51.9	24.2	11.7	49.5	-3.0	-27.9	21.9	.813
Perceived birthweight	Very large	26.5	10.5	65.2	21.2	4.9	86.9	-5.3	-44.1	33.5	.789
	Larger than average	32.2	20.1	51.3	11.2	4.2	29.4	-21.0	-39.6	-2.4	.027
	Average	13.0	9.5	18.0	19.1	13.2	27.6	6.1	-2.1	14.3	.147
	Smaller than average	34.9	21.8	55.5	12.5	4.5	34.3	-22.4	-43.1	-1.8	.033
	Very small	35.2	17.8	68.5	37.5	16.3	83.9	2.3	-36.5	41.0	.908
Birth order	First born	24.3	18.1	32.7	24.6	18.4	32.7	0.2	-9.9	10.3	.967
	2–4	17.6	12.9	23.9	16.3	11.5	23.1	-1.2	-9.1	6.6	.755
	Five or more	25.5	14.2	45.2	30.2	14.4	62.5	4.8	-21.8	31.4	.726

Continued...

Table A7—Continued

Background variable	Variable category	2016			2022			Change from 2016 to 2022			p value for change
		NMR	95% LB	95% UB	NMR	95% LB	95% UB	NMR	NMR	95% LB	
Mother's parity	Primigravida	25.6	19.3	33.8	24.0	18.4	31.4	-1.5	-11.1	8.1	.757
	Multigravida	15.7	11.4	21.6	15.3	10.4	22.5	-0.3	-8.1	7.4	.930
Preceding birth interval	>2 years	14.6	10.3	20.8	11.5	7.6	17.2	-3.2	-10.1	3.8	.371
	First birth	24.3	18.1	32.7	24.6	18.4	32.7	0.2	-9.9	10.3	.967
	≤2 years	29.4	18.0	47.9	37.7	22.6	62.4	8.3	-15.7	32.3	.498
Twin birth	No	20.1	16.1	25.0	20.1	16.0	25.2	0.0	-6.3	6.4	.988
	Yes	74.3	21.4	227.5	10.7	1.4	76.2	-63.6	-152.8	25.6	.162
Wanted last birth	Wanted then	21.2	16.7	27.0	26.5	20.3	34.5	5.2	-3.4	13.9	.236
	Wanted later	17.7	9.6	32.3	13.2	6.4	27.2	-4.5	-18.9	9.8	.538
	Wanted no more	24.9	13.8	44.7	28.6	13.2	60.5	3.6	-22.5	29.8	.785
Time to health facility	≤30 minutes	4.2	1.7	10.3	19.1	15.0	24.4	15.0	9.0	21.0	.000
	>30 minutes	9.8	5.4	17.6	27.5	16.4	45.6	17.7	2.6	32.8	.022
Birth attendants	Delivery without SBA	25.7	19.1	34.5	36.1	20.3	63.4	10.4	-11.5	32.3	.352
	Delivery with SBA	16.9	12.4	22.8	14.3	9.9	20.7	-2.5	-9.9	4.8	.498
Place of delivery	Home delivery	25.9	19.1	35.2	35.9	19.7	64.6	10.0	-12.8	32.7	.391
	Public health facility	14.9	10.4	21.4	14.1	9.0	22.0	-0.8	-9.1	7.5	.848
	Private health facility	21.9	12.8	37.3	16.1	8.7	29.7	-5.8	-21.2	9.5	.455
Cesarean section past pregnancy	Cesarean	8.3	3.0	22.6	9.3	3.6	23.4	1.0	-11.0	13.0	.874
	Not cesarean	21.8	17.4	27.3	21.1	15.1	29.4	-0.7	-9.3	7.8	.866
ANC visits (three categories)	1–3 visits	20.9	12.8	34.0	25.7	13.1	49.8	4.8	-15.2	24.7	.640
	Four-plus visits	6.1	3.7	10.1	11.1	7.1	17.2	5.0	-0.8	10.7	.089
	Do not know/none	17.3	6.5	45.1	7.1	1.0	49.2	-10.2	-31.8	11.5	.358
ANC visits (two categories)	0–3 visits	20.2	13.2	30.9	23.3	12.1	44.3	3.0	-14.4	20.4	.732
	Four-plus visits	6.1	3.7	10.1	11.1	7.1	17.2	5.0	-0.8	10.7	.090
Days iron tablets taken	<180 days	14.4	9.4	22.2	19.4	11.6	32.5	5.0	-6.8	16.8	.406
	180-plus days	5.7	2.9	11.0	10.9	6.5	18.1	5.2	-1.6	11.9	.132
Newborn PNC within 2 days	No PNC	14.6	9.6	22.2	26.3	16.0	42.9	11.6	-2.7	26.0	.112
	Yes PNC	7.0	4.0	12.2	7.7	4.4	13.4	0.7	-5.1	6.5	.807
Mother PNC within 2 days	No PNC	11.4	7.2	17.8	19.4	11.0	34.1	8.0	-4.1	20.2	.194
	Yes PNC	9.7	5.8	16.1	10.6	6.5	17.3	0.9	-6.2	8.1	.796

† = insufficient sample size

ANC = antenatal care; HMG = health mothers' group; LB = lower bound; NMR = neonatal mortality rate; PNC = postnatal care; SBA = skilled birth attendant; UB = upper bound

Table A8 Significance of changes in early neonatal mortality, late neonatal mortality, and neonatal mortality rates over time for all background variables, 2016–2022 Nepal DHS surveys

Variable	Variable category	<i>p</i> value for ENMR difference		<i>p</i> value for LNMR difference		<i>p</i> value for NMR difference	
National	National	.954	NS	.737	NS	.844	NS
Respondent's language	Bhojpuri	.030	+	.250	NS	.170	NS
	Maithili	.401	NS	.610	NS	.651	NS
	Nepali	.005	--	.379	NS	.042	-
	Other	.727	NS	.953	NS	.718	NS
Ethnicity (three categories)	Advantaged	.951	NS	.609	NS	.755	NS
	Disadvantaged Dalit	.770	NS	.302	NS	.931	NS
	Disadvantaged Janajati	.456	NS	.654	NS	.376	NS
Ethnicity (two categories)	Advantaged	.043	-	.843	NS	.077	NS
	Disadvantaged	.526	NS	.749	NS	.658	NS
Wealth terciles	Lower	.616	NS	.752	NS	.766	NS
	Middle	.330	NS	.260	NS	.161	NS
	Higher	.603	NS	.081	NS	.216	NS
Wealth index (three categories based on quintiles)	Middle	.297	NS	.820	NS	.353	NS
	Second and lowest	.810	NS	.525	NS	.928	NS
	Fourth and highest	.254	NS	.104	NS	.079	NS
Province	Koshi	.486	NS	.412	NS	.739	NS
	Madhesh	.215	NS	.532	NS	.469	NS
	Bagmati	.967	NS	†	†	†	†
	Gandaki	†	†	†	†	†	†
	Lumbini	.691	NS	.718	NS	.861	NS
	Karnali	.053	NS	.693	NS	.127	NS
	Sudurpaschim	.057	NS	.239	NS	.204	NS
Ecoregion	Hill	.395	NS	.776	NS	.467	NS
	Mountain	.467	NS	.751	NS	.391	NS
	Terai	.525	NS	.655	NS	.728	NS
Religion	Buddhist	.995	NS	†	---	.832	NS
	Hindu	.425	NS	.664	NS	.360	NS
	Muslim	.155	NS	.893	NS	.178	NS
Type of place	Rural	.633	NS	.978	NS	.667	NS
	Urban	.518	NS	.751	NS	.650	NS
Size of household	<six members	.853	NS	.920	NS	.833	NS
	≥six members	.681	NS	.646	NS	.574	NS
Sex of household head	Female	.669	NS	.470	NS	.858	NS
	Male	.819	NS	.544	NS	.942	NS
Indoor air pollution	No	.639	NS	.123	NS	.233	NS
	Yes	.580	NS	.332	NS	.369	NS
Improved water and sanitation	Improved	.956	NS	.379	NS	.775	NS
	Not a de jure resident	.177	NS	.184	NS	.049	-
	Unimproved	.375	NS	.221	NS	.714	NS
Maternal education	Basic (grades 1–8)	.708	NS	.039	+	.780	NS
	No education	.389	NS	.428	NS	.623	NS
	Secondary and above (≥ grade nine)	.380	NS	.268	NS	.208	NS
Maternal age (five categories)	15–19 years	.625	NS	.621	NS	.792	NS
	20–24 years	.667	NS	.289	NS	.896	NS
	25–29 years	.454	NS	.747	NS	.405	NS
	30–34 years	.045	-	.453	NS	.184	NS
	35 and above	.724	NS	.556	NS	.862	NS
Maternal age (three categories)	15–19 years	.625	NS	.621	NS	.792	NS
	20–34 years	.951	NS	.727	NS	.922	NS
	≥35 years	.724	NS	.556	NS	.862	NS

Continued...

Table A8—Continued

Variable	Variable category	<i>p</i> value for ENMR difference		<i>p</i> value for LNMR difference		<i>p</i> value for NMR difference	
Maternal use of tobacco	No	.910	NS	.738	NS	.805	NS
	Yes	.728	NS	.894	NS	.773	NS
Maternal stature	<145 cm	.161	NS	.189	NS	.639	NS
	≥145 cm	.654	NS	.784	NS	.748	NS
Maternal anemia	Anemic	.454	NS	.393	NS	.328	NS
	Not anemic	.303	NS	.987	NS	.375	NS
Owns mobile phone	No	.592	NS	.176	NS	.924	NS
	Yes	.789	NS	.489	NS	.969	NS
Possesses a bank account	No	.184	NS	.573	NS	.323	NS
	Yes	.017	-	.568	NS	.048	-
Internet use	Never used internet	.104	NS	.616	NS	.093	NS
	Used at some time	.895	NS	.867	NS	.847	NS
Empowerment: household decisions	No	.553	NS	.792	NS	.674	NS
	Yes, can make decisions	.247	NS	.814	NS	.249	NS
Violence justified	Violence is not justified	.961	NS	.838	NS	.964	NS
	Violence is justified	.931	NS	.331	NS	.767	NS
Empowerment: health care/family planning decisions	No	.967	NS	.279	NS	.605	NS
	Yes	.005	++	.266	NS	.143	NS
Newspapers/magazines	At least once a week	.023	-	.806	NS	.042	-
	Less than once a week	.269	NS	.828	NS	.359	NS
Radio/TV	Less than once a week	.303	NS	.804	NS	.403	NS
	At least once a week	.028	-	.843	NS	.052	NS
Knows about HMG	No	.993	NS	.417	NS	.732	NS
	Yes	.885	NS	.514	NS	.837	NS
Husband's education	Basic (grades 1–8)	.157	NS	.789	NS	.218	NS
	No education/do not know	.087	NS	.622	NS	.082	NS
	Secondary and above (≥ grade nine)	.548	NS	.263	NS	.303	NS
Husband's occupation (four categories)	Agriculture	.021	-	.120	NS	.006	--
	Manual (skilled/ unskilled)	.345	NS	.753	NS	.306	NS
	Not working	†	--	†	†	†	†
	Sales, clerical, other	.480	NS	.909	NS	.497	NS
Birthweight taken	Not taken	.530	NS	.312	NS	.342	NS
	Yes, taken	.893	NS	.742	NS	.934	NS
Sex of child	Female	.673	NS	.754	NS	.814	NS
	Male	.809	NS	.516	NS	.943	NS
Birthweight	Large (≥3,500 g)	.435	NS	.779	NS	.420	NS
	Normal (2,500–3,500 g)	.114	NS	.180	NS	.538	NS
	Not weighed or do not know	.530	NS	.312	NS	.342	NS
	Small (<2,500 g)	.100	NS	.186	NS	.813	NS
Perceived birthweight	Very large	.789	NS	†	†	†	†
	Larger than average	.007	--	.840	NS	.027	-
	Average	.268	NS	.276	NS	.147	NS
	Smaller than average	.062	NS	.319	NS	.033	-
	Very small	.669	NS	.313	NS	.908	NS
	Do not know	.550	NS	†	†	†	†
Birth order	First born	.967	NS	.846	NS	.967	NS
	2–4	.953	NS	.599	NS	.755	NS
	Five or more	.612	NS	.592	NS	.726	NS
Mother's parity	Primigravida	.995	NS	.495	NS	.757	NS
	Multigravida	.804	NS	.738	NS	.930	NS

Continued...

Table A8—Continued

Variable	Variable category	<i>p</i> value for ENMR difference		<i>p</i> value for LNMR difference		<i>p</i> value for NMR difference	
Preceding birth interval	>2 years	.426	NS	.710	NS	.371	NS
	First birth	.967	NS	.846	NS	.967	NS
	≤2 years	.371	NS	.557	NS	.498	NS
Twin birth	No	.784	NS	.586	NS	.988	NS
	Yes	.162	NS	†	†	.162	NS
Wanted last birth	Wanted then	.303	NS	.589	NS	.236	NS
	Wanted later	.604	NS	.652	NS	.538	NS
	Wanted no more	.994	NS	.686	NS	.785	NS
Time to health facility	≤30 minutes	†	+++	.432	NS	.000	+++
	>30 minutes	.067	NS	.049	+	.022	+
Birth attendants	Delivery without SBA	.659	NS	.208	NS	.352	NS
	Delivery with SBA	.671	NS	.548	NS	.498	NS
Place of delivery	Home delivery	.699	NS	.230	NS	.391	NS
	Public health facility	.719	NS	.807	NS	.848	NS
	Private health facility	.899	NS	.230	NS	.455	NS
Cesarean section past years	Cesarean	.683	NS	.734	NS	.874	NS
	Not cesarean	.634	NS	.565	NS	.866	NS
ANC visits (three categories)	1–3 visits	.750	NS	.694	NS	.640	NS
	Four-plus visits	.163	NS	.314	NS	.089	NS
	Do not know/none	.516	NS	†	†	†	†
ANC visits (two categories)	0–3 visits	.810	NS	.785	NS	.732	NS
	Four-plus visits	.163	NS	.315	NS	.090	NS
Days iron tablets taken	<180 days	.802	NS	.151	NS	.406	NS
	180-plus days	.140	NS	.722	NS	.132	NS
Newborn PNC within 2 days	No PNC	.238	NS	.208	NS	.112	NS
	Yes PNC	.675	NS	.850	NS	.807	NS
Mother PNC within 2 days	No PNC	.306	NS	.381	NS	.194	NS
	Yes PNC	.830	NS	.887	NS	.796	NS

† = insufficient sample size

ANC = antenatal care; ENMR = early neonatal mortality rate; HMG = health mothers' group; LNMR = late neonatal mortality rate; NMR = neonatal mortality rate; NS = not significant; PNC = postnatal care; SBA = skilled birth attendant

Note: Symbols show the direction and strength of change: + for an increase with $p < .05$, ++ for an increase with $p < .01$, and +++ for an increase with $p < .001$. The symbols -, --, and --- are used for significant declines in the respective rates. Almost none of these symbols appear in the table, because of the absence of significant changes.