Aus der

Klinik für Allgemein-, Viszeral-, und Transplantationschirurgie

Klinikum der Ludwig-Maximilians-Universität München

Effect of Facility Readiness and Providers' Adherence to Standard Clinical Practices on Women's Choice to Deliver in Public or Private Health Facilities in Nepal

Dissertation

zum Erwerb des Doctor of Philosophy (Ph.D.)

an der Medizinischen Fakultät

der Ludwig-Maximilians-Universität München

vorgelegt von

Sabita Tuladhar

aus

Lalitpur / Nepal

Jahr

2025

Mit Genehmigung der Medizinischen Fakultät der
Ludwig-Maximilians-Universität München

Erstes Gutachten:	Prof. Dr. Matthias Siebeck
Zweites Gutachten:	Priv. Doz. Dr. Maria Delius
Drittes Gutachten:	Priv. Doz. Dr. Anna Hester
Viertes Gutachten:	Priv. Doz. Dr. Sarah Meister

Dekan: Prof. Dr. med. Thomas Gudermann

Tag der mündlichen Prüfung: 06.03.2025

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Dean's Office Medical Faculty
Faculty of Medicine

Affidavit

Tuladhar, Sabita

Surname, first name

I hereby declare, that the submitted thesis entitled

Out of the Institute of Medical Education, University Hospital, LMU Munich Effect of Facility Readiness and Providers' Adherence to Standard Clinical Practices on Women's Choice to Deliver in Public or Private Health Facilities in Nepal

is my own work. I have only used the sources indicated and have not made unauthorised use of services of a third party. Where the work of others has been quoted or reproduced, the source is always given.

I further declare that the dissertation presented here has not been submitted in the same or similar form to any other institution for the purpose of obtaining an academic degree.

Munich, March 07, 2025

Place, Date

Sabita Tuladhar

Signature doctoral candidate

LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

Dean's Office Medical Faculty
Doctoral Office

Confirmation of congruency between printed and electronic version of the doctoral thesis

Tuladhar, Sabita

Surname, first name

I hereby declare that the electronic version of the submitted thesis, entitled

Out of the Institute of Medical Education, University Hospital, LMU Munich Effect of Facility Readiness and Providers' Adherence to Standard Clinical Practices on Women's Choice to Deliver in Public or Private Health Facilities in Nepal

is congruent with the printed version both in content and format.

Munich, March 07, 2025

Place, Date

Sabita Tuladhar

Signature doctoral candidate

Table of content

Key Words

Maternal mortality, quality of care, health facility readiness, standards of care, satisfaction, public-private, satisfaction, Nepal

Abstract

Background: The Maternal Mortality Ratio (MMR) of Nepal was 151 deaths per 100,000 live births in 2021, indicating the need for accelerating efforts to meet the Sustainable Development Goal (SDG) of 70 deaths per 100,000 live births by 2030. Health facility (HF) deliveries are increasing in Nepal, and so are the maternal deaths at HFs, indicating sub-optimal quality of delivery care services at HFs. This study aimed to understand the status of HF readiness for providing normal low-risk delivery services, the functionality of basic and comprehensive emergency obstetric and neonatal care (B/CEmONC) services, providers' adherence to standards of care during delivery care provision, and determinants of women's satisfaction with normal low-risk delivery services.

Methods: Publicly available data from the Nepal Health Facility Survey 2015 and 2021 was used. Data of 457 HFs in 2015 and 804 in 2021 for readiness; 47 B/CEmONC HFs in 2015 and 95 in 2021 for functionality; and 320 women in 2021 for adherence to standards of care and determinants of women's satisfaction were analysed. Weighted t-tests compared changes in HF readiness and B/CEmONC functionality over time; principal component analysis constructed satisfaction variables; and multivariate logistic regressions analysed determinants of women's satisfaction.

Results: The HF readiness index improved significantly from 37.9% in 2015 to 43.7% in 2021, with private HFs performing slightly better than public HFs. The functionality of B/CEmONC signal functions in the designated HFs were low. Compliance with the standards of delivery care varied largely across different indicators. Provider-client interaction, audio-visual privacy, and the display of health statistics were associated with higher satisfaction levels. The availability of maternity waiting rooms and education materials and the implementation of the Maternity Incentive Scheme were associated with lower satisfaction levels.

Conclusion: To meet the SDG of MMR reduction, Nepal needs to improve quality of care by strengthening the supply chain system, ensuring trained providers, increasing the use of guidelines, supporting private HFs, promoting provider-client interaction, and addressing the operational challenges of the Maternity Incentive Scheme.

List of figures

List of tables

List of abbreviations

ANC	Antenatal Care
BEmONC	Basic Emergency Obstetric and Neonatal Care
BMC	Bio-Metric Center
CEmONC	Comprehensive Emergency Obstetric and Neonatal Care
CI	Confidence Interval
COVID	Corona virus disease
ERC	Ethical Review Committee
EmONC	Emergency Obstetric and Neonatal Care
HF	Health Facility
LMIS	Logistic Management Information System
LMICs	Low- and Middle-Income Countries
LMU	Ludwig-Maximilians-Universität
NHFS	Nepal Health Facility Survey
MOHP	Ministry of Health and Population
NHRC	Nepal Health Research Council
NHSS	Nepal Health Sector Strategy
NSO	National Statistics Office
OR	Odds Ratio
p	probability
PCA	Principal Component Analysis
QoC	Quality of Care
SARA	Service Availability and Readiness Assessment
SBA	Skilled Birth Attendant
SDG	Sustainable Development Goal
WHO	World Health Organization

List of publications

Tuladhar, S., Paudel, D., Rehfuess, E., Siebeck, M., Oberhauser, C., & Delius, M. (2024a). Changes in health facility readiness for obstetric and neonatal care services in Nepal: an analysis of cross-sectional health facility survey data in 2015 and 2021. *BMC pregnancy and childbirth*, *24*(1), 79. https://doi.org/10.1186/s12884-023-06138-8

Tuladhar, S., Rehfuess, E., Delius, M., Siebeck, M., Paudel, D., & Oberhauser, C. (2024c). Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021. *Health care for women international*, 1–18. Advance online publication. https://doi.org/10.1080/07399332.2024.2313659

Tuladhar, S., Delius, M., Siebeck, M., Oberhauser, C., Paudel, D., & Rehfuess, E. (2024b). Standards of care and determinants of women's satisfaction with delivery services in Nepal: a multiperspective analysis using data from a health facility-based survey. *BMC pregnancy and childbirth*, *24*(1), 132. https://doi.org/10.1186/s12884-024-06301-9

1. My contribution to the publications

1.1 Contribution to paper A

Title: Changes in health facility readiness for obstetric and neonatal care services in Nepal: An analysis of cross-sectional health facility survey data in 2015 and 2021

The Ph.D. candidate identified the topic and objectives for paper A, conceptualized the study, drafted an outline, and shared it with her local and LMU supervisors, who provided feedback on refining the study. She obtained ethical approval for the Ph.D. research project from both local authorities in Nepal and from the Ethics Board of the University Hospital LMU Munich in May and July 2021, respectively, for the entire research project; therefore, a separate ethical clearance was not required for this paper. She developed the study methods, conducted a literature review, prepared the data set for analysis, carried out all statistical analyses, and completed the interpretation of the results. In conducting the statistical analysis, she was supported by Dr. Cornelia Oberhauser of the Institute for Medical Information Processing, Biometry, and Epidemiology, LMU Munich, Germany, and the Pettenkofer School of Public Health, Munich, Germany. The Ph.D. candidate, as the first author of the manuscript, drafted it, coordinated with all co-authors (the local supervisor, three LMU supervisors, and Cornelia Oberhauser) for feedback, addressed comments, and finalized it. She identified BMC Pregnancy and Childbirth, an open access journal for publication, sought the consent of all the co-authors, fulfilled all the requirements of the journal, and submitted the manuscript and supplementary materials to the journal on April 15, 2023. As a corresponding author, the Ph.D. candidate communicated with the journal, reviewed peer reviewers' comments, shared them with co-authors, prepared a point-by-point response, made necessary edits to the paper, shared them with the co-authors and obtained their inputs, and finally submitted the response with an updated manuscript and the supplementary materials to the journal. The manuscript was accepted by BMC Pregnancy and Childbirth on November 18, 2023. The candidate completed the final proofreading of the paper, which was published on January 24, 2024.

1.2 Contribution to paper B

Title: Emergency obstetric and newborn care signal functions: the situation in health facilities in Nepal between 2015 and 2021

The Ph.D. candidate identified the topic and objectives for paper B, conceptualized the study, drafted an outline, and shared it with her local and LMU supervisors, who provided feedback on refining the study. She had already obtained ethical approval for the Ph.D. research project from the local authority in Nepal in May 2021 and from the Ethics Board of the University Hospital LMU Munich in July 2021; therefore, a separate ethical clearance was not required for this study. The Ph.D. candidate developed the study methods, conducted a literature review, prepared the data set for analysis, carried out all statistical analysis, and completed the interpretation of the results. In conducting the statistical analysis, the candidate was supported by Dr. Cornelia Oberhauser of the Institute for Medical Information Processing, Biometry, and Epidemiology, LMU Munich, Germany, and the Pettenkofer School of Public Health, Munich, Germany. The Ph.D. candidate, as the first author of the manuscript, drafted it, coordinated with all co-authors (the local supervisor, three LMU supervisors, and Cornelia Oberhauser) for feedback, addressed comments, and finalized it. She presented the key findings of this paper at the 9th International Conference of Public Health (ICOPH) 2023 in Kuala Lumpur, Malaysia, on August 3, 2023. She identified the journal Health Care for Women International for publication, sought the consent of all the co-authors, fulfilled all the requirements of the journal, and submitted the manuscript and supplementary materials to the journal on December 14, 2023. As a corresponding author, the Ph.D. candidate communicated with the journal, reviewed peer reviewers' comments, shared them with co-authors, prepared a point-by-point response, made necessary edits to the paper, shared them with the co-authors and obtained their inputs, and finally submitted the response with an updated manuscript and the supplementary materials to the journal. The manuscript was accepted by Health Care for Women International on January 30, 2024. The Ph.D. candidate completed the final proofreading of the manuscript, which was published on February 13, 2024.

1.3 Contribution to paper C

Title: Standards of care and determinants of women's satisfaction with delivery services in Nepal: A multi- perspective analysis using data from a health facility-based survey

The Ph.D. candidate identified the topic and objectives for paper C, conceptualized the study, drafted an outline, and shared it with her local and LMU supervisors, who provided feedback on refining the study. The Ph.D. candidate had already obtained ethical approval for the Ph.D research project from both local authorities in Nepal and from the Ethics Board of the University Hospital LMU Munich in May and July 2021 respectively; therefore, a separate ethical clearance was not required for this paper. She developed the study methods, conducted a literature review, prepared the data set for analysis, carried out all statistical analyses, and completed the interpretation of the results. In conducting the statistical analysis, the candidate was supported by Dr. Cornelia Oberhauser of the Institute for Medical Information Processing, Biometry, and Epidemiology, LMU Munich, Germany, and the Pettenkofer School of Public Health, Munich, Germany. The Ph.D. candidate, as the first author of the manuscript, drafted it, coordinated with all co-authors (the local supervisor, three LMU supervisors, and Cornelia Oberhauser) for feedback, addressed comments, and finalized it. She identified BMC Pregnancy and Childbirth, an open access journal for publication, sought the consent of all the co-authors, fulfilled all the requirements of the journal, and submitted the manuscript and supplementary materials to the journal on September 23, 2023. As a corresponding author, the Ph.D. candidate communicated with the journal, reviewed peer reviewers' comments, shared them with co-authors, prepared a point-by-point response, made necessary edits to the paper, shared them with the co-authors and obtained their inputs, and finally submitted the response with an updated manuscript and the supplementary materials to the journal. The manuscript was accepted by BMC Pregnancy and Childbirth on January 29, 2024. The candidate completed the final proofreading of the paper, which was published on February 13, 2024.

2. Introductory summary

2.1 Background

Care seeking during pregnancy, delivery, and the postpartum period is critical for healthy pregnancy outcomes. In low- and middle-income countries (LMICs), the demand for maternal healthcare services is on the rise, yet the availability remains inadequate, resulting in suboptimal birth outcomes and complications that can lead to maternal and perinatal mortality. In 2020, LMICs comprised 95% of global maternal deaths (World Health Organization [WHO], 2023). The enhancement of health facility (HF) readiness and the adherence of providers to standard clinical protocols during service delivery are critical measures of quality of care (QoC) for achieving healthy pregnancy outcomes, enhancing client satisfaction, and fostering greater trust towards health systems. The WHO defines QoC as the extent to which health care services provided to patients or individuals improve desired health outcomes. These services must be safe, effective, timely, efficient, equitable, integrated, and people-centred. With increasing access to healthcare services, the importance of QoC and client satisfaction has gained considerable momentum and has become the primary concern of health program managers. The United Nations Sustainable Development Goal (SDG) 3.1 calls for a reduction in the maternal mortality ratio (MMR) to less than 70 per 100,000 live births by 2030. This requires strengthening the health system and providing high-quality maternal health services.

2.1.1 The status of maternal health in Nepal

Between 1996 and 2006, Nepal made remarkable progress in reducing the MMR by 48.3%, from the alarming 543 deaths per 100,000 live births to 281 deaths per 100,000 live births. Subsequently, the reductions slowed down. The MMR decreased by 14.9% between 2006 and 2016 and by 36.8% between 2016 and 2021 (Figure 2.1). In 2021, the MMR of Nepal was 151 deaths per 100,000 live births (National Statistics Office [NSO] and Ministry of Health and Population [MOHP], 2023), which was one of the highest in the South Asia Region (WHO, 2023).

As a result of multi-prong interventions–delivery of integrated maternal, child health, and family planning services, adoption of community-based approaches, training skilled birth attendants (SBAs), strengthening and expanding birthing centres and emergency obstetric and neonatal care sites (EmONC), the nation-wide implementation of the Maternity Incentive Scheme (Aama Program), and empowerment of women, Nepal was close to meeting the Millennium Development Goal of reducing maternal deaths by three-quarters by 2015. These efforts contributed to significantly improving the uptake of maternal health services. Coverage of four antenatal care visits

(ANC), HF delivery, and SBA assistance was below 10% in 1996, which increased to 80.2%, 79.3%, and 80.1%, respectively, in 2022 (MOHP et. al., 2023).

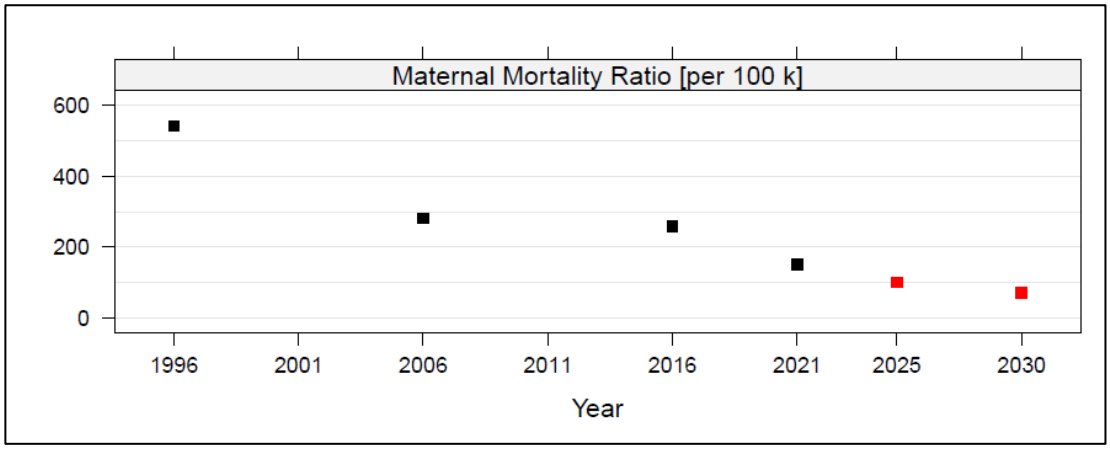

Figure 2.1: Trends in Maternal Mortality Ratio in Nepal, 1996-2021

Data Source: 1996-Nepal Fertility and Health Survey; 2006 and 2016-Nepal Demographic and Health Survey; 2021-Nepal Maternal Mortality Study; 2025 and 2030 SDG Targets-Nepal Sustainable Development Goals Status and Roadmap: 2016-2030

The majority of births in Nepal occur in public HFs and are normal low risk. The onset of normal low-risk deliveries is spontaneous, presenting a low-risk at the beginning of labour and persisting in this manner throughout the duration of labour and delivery. The baby is naturally born out of the vertex position between 37 and 42 weeks of pregnancy, and thereafter, both the mother and the infant are in good health (WHO, 1996). Between 2006 and 2022, the utilization of delivery services in private HFs increased by threefold, from 5.8% to 17.7% (MOHP et al., 2023). As the number of HF births in the private sector is increasing, the number of caesarean deliveries is also on the rise: 1.1% in 1996 to 18.3% in 2022 (MOHP et al., 2023). Delivery and postpartum complications constitute 67% of maternal deaths in Nepal, and 57% of them occur in HFs (NSO & MOHP, 2023). The leading causes were haemorrhage (25%), hypertension (11%), and infections (7%), and 15% of the deceased women were infected with coronavirus disease-19 (COVID-19) (NSO & MOHP, 2023). The high proportion of maternal deaths in HFs suggests poor quality of obstetric care.

2.1.2 Maternal health service policy context in Nepal

In Nepal, the policy environment for the provision of quality maternal healthcare services has improved over the past 30 years. The Government of Nepal (GON) initiated the Safe Motherhood Program in 1997, which emphasized the enhancement of infrastructure for reproductive health services. Subsequently, the National Safe Motherhood Plan was developed for the period 2002–2017, with the objective of implementing comprehensive EmONC (CEmONC), basic EmONC (BEmONC), and an increase in SBA services. Nepal initiated the Safe Delivery Incentive Program in 2005, which promoted delivery by SBA, and approved an SBA policy in 2006. In 2009, the national Maternity Incentive Scheme program was launched, which provided free care for normal

low-risk, complications management, and caesarean deliveries at public and selected private HFs. Several recent acts and strategies emphasize the importance of providing quality reproductive health services to women, including safe and equitable maternal health services (Family Welfare Division [FWD], 2019; MOHP, 2023).

With the promulgation of the new Constitution in 2015, the centralized government structure was reorganized in 2017 to comprise a federal, seven provincial, and 753 local governments. The Constitution requires local governments to provide basic health services free of charge, including normal low-risk delivery services. Nepal is committed to SDG 3.1 of reducing the MMR to 70 deaths per 100,000 live births. The key strategies include enhancing access to HF-based obstetric services and enhancing the QoC.

2.2 Research Questions

This study is concerned with the QoC of delivery services at HFs in Nepal and was conceptualized with three broad research questions:

i) How do HF readiness and providers' adherence to standards of care influence women's choice of HF types - public or private - for delivery services?
ii) What factors are associated with women's satisfaction with the utilization of delivery services in HFs in Nepal?
iii) How do the determinants of quality delivery services differ between public hospitals, other public HFs, and private hospitals in Nepal?

This study aimed to use secondary data from the nationally representative 2021 Nepal Health Facility Survey (NHFS), which was originally planned for implementation in January 2020. However, the COVID-19 pandemic struck Nepal in March 2020, resulting in lockdowns and travel restrictions, which subsequently delayed data collection until January 2021. The data collection was concluded in September 2021, with a pause of three months in May owing to the second wave of COVID-19 and the subsequent lockdowns. In August 2022, the 2021 NHFS data set was made publicly available at https://dhsprogram.com/Data/, after which data analysis began. The 2015 data was also used and was retrieved from https://dhsprogram.com/Data/. The data collection for the 2015 NHFS started in April 2015 and was completed in November, with a two-month break in between due to the 7.8 Richter Scale earthquake.

The extensive literature review, the guidance of the supervisory team, and the understanding of the NHFS data set and its limitations resulted in considerable changes to the study design and refinement of the research questions. Table 2.1 documents the changes made to the research questions and the rationale for the changes.

Table 2.1 Original and revised research question, and rationale for the changes:

Original research questions	Revised research questions	Rationale for changes
Research question 1: How the HF readiness, and providers' adherence to the standards of care influence women's choice of HF types: public or private for delivery services: Research question 2: What factors are associated with women's satisfaction of the utilization of delivery services in the HFs in Nepal? Research question 3: How the determinants of quality delivery services differ among the public hospitals, other public HF types, and private hospitals in Nepal?	1. How has the HF readiness to provide normal low-risk delivery services improved in Nepal between 2015 and 2021? 2. What is the availability and functionality of the BEmONC and CEmONC signal functions at the designated HFs? 3. How do the HFs in Nepal perform with regards to meeting the standards of care for normal low-risk deliveries? 4. What factors are associated with women's satisfaction with the utilization of normal low-risk delivery services at the HFs in Nepal?	This study is based on a secondary data analysis of the 2015 and 2021 NHFS and used data from inventory assessment and service provider interviews from both surveys, as well as observation of labour and delivery process, and exit interview with women from the 2021 NHFS. The women who attended the HFs for delivery in 2021 NHFS in general would not be aware of the various standards of care that they should receive at HFs. The decision-making process for selecting HFs for delivery occurred before the women visited the surveyed HFs for delivery. Therefore, the amenity they experience and the service they receive from the provider during the visit do not influence their decision-making process regarding the choice of HF, public or private. Furthermore, the 2021 NHFS did not ask questions related to decision making regarding the choice of HF for delivery. Therefore, the study design did not address questions related to choosing HFs. The NHFS data set and the study design were limited in answering the initial research requestions. The 2021 NHFS observed and interviewed only 320 women across the 94 surveyed HFs in Nepal, and the majority were from public hospitals. Due to the limited sample size of women who were observed and interviewed at private HFs, it was not possible to examine the disparity in the factors that determine the quality of normal low-risk delivery services between public and private HFs.

The revised research questions are:

1. How has the HF readiness to provide normal low-risk delivery services improved in Nepal between 2015 and 2021?
    - What is the overall readiness score of the HFs to provide normal low-risk delivery services?
    - How does the readiness score of the HFs to provide normal, low-risk deliveries vary between the public and private HFs?
2. What is the availability and functionality of the BEmONC and CEmONC signal functions at the designated HFs?
3. How do the HFs in Nepal perform with regards to meeting the standards of care for normal low-risk deliveries?
4. What factors are associated with women's satisfaction with the utilization of normal low-risk delivery services at the HFs in Nepal?

- Which standards of care determine women's satisfaction?
- Which contextual factors determine women's satisfaction?

Research question 1 is addressed in Paper A. Research question 2 is addressed in Paper B. Research questions 3 and 4 are addressed in Paper C.

2.3 Methods

2.3.1 Study design

This is a cross-sectional study that used quantitative analytical methods.

2.3.2 Data source

This study analysed data from the 2015 and 2021 NHFS. To answer research questions 1 and 2, data obtained from an inventory assessment and interviews conducted with service providers assisting deliveries were used (Tuladhar et al., 2024a; Tuladhar et al., 2024b). To answer research questions 3 and 4, observational data of normal low-risk deliveries and exit interviews with the women from the 2021 NHFS were used, which were supplemented by inventory assessment and service provider interview data (Tuladhar et al., 2024c). Sample weights were provided in the 2015 and 2021 NHFS data sets by the Demographic and Health Survey (DHS) Program, which were applied to adjust for the complex sampling design and for non-response in all three papers (Tuladhar et al., 2024a; Tuladhar et al., 2024b; & Tuladhar et al., 2024c).

2.3.3 Methods used in Paper A

The study population included all public and private HFs that reported providing normal low-risk delivery services in the 2015 and 2021 NHFSs. This comprised 457 and 808 HFs in the years 2015 and 2021, respectively (Tuladhar et al., 2024a). This study adapted the WHO Service Availability and Readiness Assessment (SARA) framework (WHO, 2015). The unit of analysis was HF providing normal low-risk delivery services. The outcome variable of interest was the HF readiness index for normal low-risk delivery services. Five readiness domains were used: trained providers, guidelines for delivery care, essential equipment and supplies, essential medicines for mothers, and essential medicines for newborns. The results were categorized into public or private HF types (Tuladhar et al., 2024a). The analysis was carried out in two distinct stages. In the initial stage, the weighted mean of the HF readiness index incorporating the five readiness domains and sub-components was calculated for the years 2015 and 2021, respectively. In the second step, a weighted t-test for independent samples was carried out to test for a statistically significant change between 2015 and 2021 in the outcome variables, assuming a p-value of 0.05 and a confidence interval (CI) (Tuladhar et al., 2024a).

2.3.4 Methods used in Paper B

In 2015 and 2021, there were 26 and 43 BEmONC HFs and 21 and 52 CEmONC HFs, respectively, from both public and private HF types (Tuladhar et al., 2024b). This study used the WHO

recommended signal functions for BEmONC and CEmONC services. The BEmONC has seven signal functions (parenteral administration of antibiotics, uterotonics, anticonvulsants, assisted vaginal delivery, manual removal of placenta, manual removal of retained products, and neonatal resuscitation), and the CEmONC has nine (seven signal functions for BEmONC and two additional signal functions for caesarean delivery and blood transfusion) (Tuladhar et al., 2024b). The unit of analysis was BEmONC/CEmONC HF. The availability of the signal functions was assessed based on the ever performance of the signal functions by the service providers in the HF, while the functionality was assessed based on the performance of the signal function at least once in the last three months before the data collection date (Tuladhar et al., 2024b). For both outcome variables, the weighted mean difference in availability and functionality of signal functions between 2015 and 2021 was calculated using independent sample t-tests. A statistically significant change was analysed, assuming a p-value of 0.05 and a CI of 95% (Tuladhar et al., 2024b).

2.3.5 Methods used in Paper C:

A total of 320 pregnant women who were observed and interviewed for normal, low-risk deliveries in 94 HFs were observed and interviewed in the 2021 NHFS (Tuladhar et al., 2024c). This study adapted the WHO Framework for the Quality of Maternal and Newborn Health Care, which postulates eight standards of care (WHO, 2016). These standards of care capture the three dimensions of the QoC: the provision of care, the experience of care, and the immediate physical environment in which the care is offered, along with providing indicators to assess each of the standards of care at the input, output, and outcome levels of the results chain. Figure 2.2 is the conceptual framework used in this study, which visualizes the eight standards of care and the contextual factors that influence women's satisfaction with normal low-risk delivery services (Tuladhar et al., 2024c).

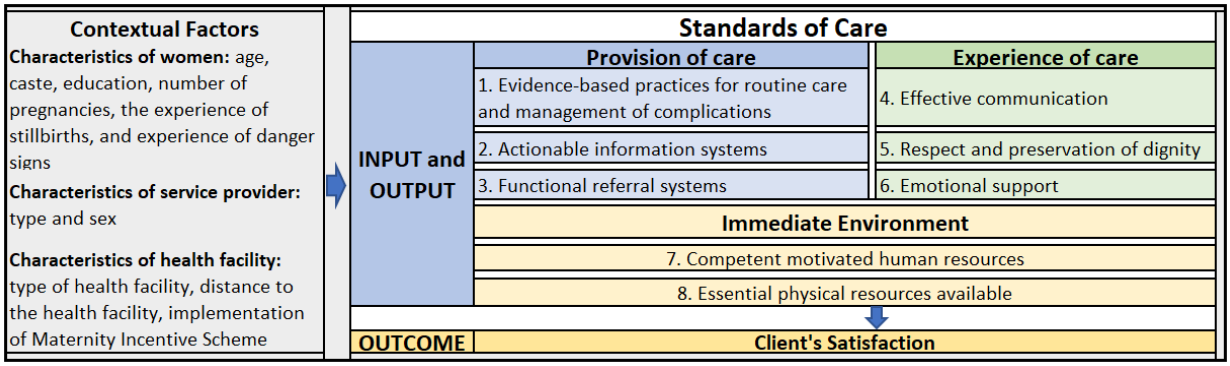

Figure 2.2: The conceptual framework of the study:
Linking the eight WHO standards for care and contextual variables with women's satisfaction with normal low-risk delivery services in health facilities in Nepal in 2021.

Women's satisfaction with normal low-risk delivery services is the outcome variable. It is derived from the exit interviews with 320 women, which asked about seven aspects of QoC. The Principal Component Analysis (PCA) method aggregated the responses to these seven aspects of QoC into a composite measure of satisfaction using variable loadings on the first principal component

that resulted from the PCA to compute a composite measure of women's satisfaction. The composite measure was dichotomized into higher satisfaction and lower satisfaction at the median level (Tuladhar et al., 2024c). The independent variables included 53 binary indicators (29 input and 24 output indicators) on standards of care from the HF inventory, service provider interviews, observations of labour and delivery, and client exit interviews, and 12 contextual variables (Tuladhar et al., 2024c).

A one-sample t-test analysed the proportion of normal low-risk deliveries that meet each of the 53 indicators of the standards of care. Subsequently, an average score for each of the eight standards of care was computed. Proportions of women with higher and lower satisfaction with the normal low-risk delivery services were calculated. The logistic regression analysed the effect of the standards of care and contextual factors on women's satisfaction with delivery care services. Assuming a 95% CI and a p-value of 0.05, the bivariate logistic regression calculated odds ratios (OR), and the multivariate regression model calculated the adjusted OR (Tuladhar et al., 2024c).

2.3.6 Data Analysis

The data analysis for all three papers was conducted using the IBM statistical package for social sciences (SPSS) version 25 (Tuladhar et al., 2024a, Tuladhar et al., 2024b, Tuladhar et al., 2024c).

2.3.7 Ethical Considerations

This research project was initially approved by the Ethical Review Committee (ERC) of the Nepal Health Research Council (NHRC) in May 2021, and subsequently by the Ethics Commission of Ludwig-Maximilians-Universität München (LMU Munich), Munich, Germany, in June 2021. Both the 2015 and 2021 NHFS were conducted after having received approval from the NHRC ERC.

2.4 Results

2.4.1 Health facility readiness to provide normal low-risk delivery services in Nepal in 2015 and 2021

Characteristics of HFs: The HFs providing normal low-risk delivery services in Nepal were primarily public basic healthcare centres in both years (85.8% in 2015 and 87.2% in 2021). In both years, private hospitals comprised less than ten percent of all HFs and showed a declining trend. The proportion of public and private hospitals was 14.2% in 2015 and 12.8% in 2021 (Tuladhar et al., 2024a).

Changes in HF readiness index: The findings indicate that the average HF readiness index for normal low-risk deliveries was below 50% in Nepal, despite a statistically significant increase from 37.9% in 2015 to 43.7% in 2021. The readiness score was not uniform across the five domains, with essential medicines for mothers achieving the highest readiness scores of more than three-quarters in both years, with a trend towards increasing scores. Conversely, the domain of

guidelines exhibited the lowest scores of less than one-quarter in both years, with a declining trend (Tuladhar et. al., 2024a).

Changes in the HF readiness index by public and private HFs: The HF readiness index for normal low-risk delivery services varied marginally by managing authority. Between 2015 and 2021, the HF readiness index increased from 37.6% to 43.6% among public HFs and from 39.9% to 45.3% among private HFs, and these improvements were statistically significant (Tuladhar et. al., 2024a). Among the public HFs, all changes at domain levels were statistically significant, while among the private HFs, the change was statistically significant only for domain essential medicines for newborns (Tuladhar et. al., 2024a).

2.4.2 Availability and functionality of BEmONC and CEmONC signal functions in 2015 and 2021

Characteristics of B/CEmONC HFs: Nearly all the BEmONC sites were public HFs (100% in 2015 and 97.7% in 2021), while 50.0% of CEmONC sites were public in 2021—a decrease from 63.8% in 2015 (Tuladhar et. al., 2024b).

Changes in availability and functionality of BEmONC and CEmONC signal functions: The study found irregular progress across the different BEmONC and CEmONC signal functions between the two time points. The improvements in functionality were slower than those in availability. The seven BEmONC signal functions with the lowest functionality were administered parenteral anticonvulsants (11.8%) in 2015 and assisted vaginal delivery (9.0%) in 2021. The administration of parenteral oxytocin was at its peak in both years; however, it experienced a decline from 93.7% in 2015 to 79.9% in 2021 (Tuladhar et al., 2024b). CEmONC's availability was better than its functionality, with overall improvements in the availability of all signal functions. Three signal functions—caesarean delivery, parenteral administration of anticonvulsants, and blood transfusion—increased, while the remaining six signal functions decreased over the two time points. The greatest increase of 13.1% points was found for caesarean delivery, and the greatest decline of 17.3% points was found for assisted vaginal delivery (Tuladhar et al., 2024b).

2.4.3 Standards of care for normal low-risk deliveries

Characteristics of the study: women, service providers, and HFs: The age of the women ranged between 18 and 36 years; 15.8% never went to school; and nearly one-quarter (24.4%) were multiparous. 14.3% of the women experienced complications during their current pregnancy, and 7.1% had already experienced a stillbirth. Nearly three-fifths (56.2%) were assisted by a nurse; seven out of ten women gave birth in a public hospital, and an overwhelming majority (85.6%) delivered at CEmONC HFs. More than eight out of ten women gave birth in a HF that implemented the Maternity Incentive Scheme (Tuladhar et al., 2024c).

Compliance with standards of care for normal low-risk deliveries: Of the eight standards of care, Standard 3 functional referral system was fulfilled for 92.0% of deliveries, and Standard 7

competent, motivated human resources was fulfilled for only 52.4% of the deliveries, performing the lowest amongst the eight standards of care (Tuladhar et al., 2024c).

2.4.4 Factors associated with women's satisfaction with delivery services.

In the bivariate logistic regression analyses, seven standards of care and one contextual variable were found to be significantly associated with women's satisfaction levels. Of the seven variables, five variables: i) women who were attended by a service provider when they called for support; ii) women who experienced caring behaviour from providers; iii) experienced good audio-visual privacy; iv) delivered in HFs that had delivery care guidelines; and v) displayed health statistics, had higher odds of being in the higher satisfaction category compared to the women who did not receive these services. Two standards of care variables: i) having maternity waiting rooms, and ii) having information material, and the contextual variable: women who delivered at HFs implementing the Maternity Incentive Scheme had lower odds of being in the higher satisfaction category compared to the women who delivered in HFs that did not have these services. In the full multivariate logistic regression model, all but one of the eight variables mentioned above, the delivery care guidelines, retained their significance. The implementation of the Maternity Incentive Scheme and the display of health statistics had a remarkable increase in influence in the multivariate model, while the presence of a maternity waiting room was found to have minimal influence (Tuladhar et al., 2024c).

2.5 Discussion

2.5.1 Key findings

Slow improvements in HF readiness to provide normal low-risk delivery services: The overall HF readiness to provide quality, normal, low-risk delivery services in 2021 in Nepal is below 50%, characterized by a slow rate of progress since 2015 and large variations in readiness scores across the five domains. The availability of essential medicines for mothers and the availability of essential equipment increased since 2015 and were met by over three-quarters of the HFs in 2021. In contrast, the availability of delivery care guidelines was below one-quarter in both years and has been declining since 2015. Many HFs were lacking essential medicines, such as magnesium sulfate, injectable antibiotics, and tetracycline eye ointments (Tuladhar et al., 2024b).

The findings are not different from those of other LMICs. Low levels of readiness and slow progress in obstetric services are common among LMICs. For example, in Nigeria, HF readiness to provide maternal health services was low and did not progress much between 2005 and 2009 (Gage et al., 2016). In Ethiopia, only one-quarter of hospitals had all essential medicines for delivery (Bayou et al., 2022); in Tanzania, only 40.7% of HFs had magnesium sulfate (Bintabara, 2019); and a study drawing data from 17 LMICs showed magnesium sulfate among the least available essential medicines (Kanyangarara et al., 2018).

Countries with strong management information systems can track consumption versus stock availability of medicines and take timely actions to minimize stockouts, but several challenges hinder this process. In Nepal, both the health management information system and the logistics management information system (LMIS) are quite functional, and many HFs have electronic LMIS that allow real-time monitoring of medicines at HFs. In Nepal, the functionality of the supply chain system is challenged by the rugged geographic terrain, narrow roads, irregular transport facilities, unclarity in procurement roles amongst the three tiers of the government, frequent transfers out of the trained storekeepers, and overall low human resource capacity to manage the system, particularly at the local levels.

The lack of trained providers and service provision guidelines is common across LMICs (Wang, 2017; Bintabara, 2019), and Nepal has also demonstrated similar results. The low availability of trained providers and the delivery care guidelines in 2021 can be partly attributed to the COVID-19 pandemic, where most routine activities, including training, could not happen or were managed remotely. The focus was on COVID-19 case management and response activities (Tuladhar et al., 2024a).

HF readiness between public and private HFs: There was a slight difference in the overall HF readiness score for normal low-risk delivery services between the public and private HFs, with the private HFs performing slightly better than the public HFs in both years. The availability of delivery care guidelines and training on delivery care was lower among private hospitals compared to public hospitals. In contrast, the availability of essential equipment and medicines was more readily available in private hospitals compared to public hospitals (Tuladhar et al., 2024a). Studies conducted across LMICs indicate mixed results regarding the readiness levels of public and private HFs. According to a study from Karnataka, India, private HFs were more likely to provide quality delivery services. For example, magnesium sulfate was available in 18% of primary health care centres, 48% of higher-level public health care facilities, and 70% of private health care facilities (Katageri et al., 2018). Another study from Bangladesh published in 2021 showed that the availability of staff for normal deliveries was 78.6% in public HFs compared to 15.8% in private HFs, and staff trained in essential childbirth care was available in 83.4% of public HFs, in contrast to 8.3% in private HFs (Tarannum & Afroz, 2022).

Low and declining availability and functionality of the BEmONC and CEmONC signal functions at the designated HFs: The HFs providing normal low-risk deliveries should be prepared to provide emergency obstetric services since 15% of pregnant women are estimated to undergo obstetric complications that require signal function services (WHO, 2009). The BEmONC and CEmONC signal function availability and functionality in the designated HFs were low in Nepal at both time points (Tuladhar et al., 2024b). Caesarean deliveries availability and functionality show increasing trends, while assisted deliveries are declining, raising questions on whether all the caesarean

deliveries are medically indicated or are based on women's choice. Increasing caesarean deliveries and declining assisted deliveries are common in other LMICs too. In Ethiopia, caesarean deliveries increased from 25.4% to 33.8% between 2011 and 2016, while assisted deliveries decreased from 15.8% to 9.9% (Yeshiwas & Eskinder, 2021).

Functionality of BEmONC and CEmONC is a strong supply-side measure of the health system, and our findings indicate low health system capacity (Tuladhar et al., 2024b). In the context of increasing HF delivery and a greater number of maternal deaths at HFs, ensuring skilled providers for 24/7 services, essential amenities, equipment, medicines, supplies, and guidelines, and strong referral systems needs to be emphasized for improved functionality of the BEmONC and CEmONC HFs. Moreover, it is utmost necessary to monitor the increasing uptake of caesarean deliveries that are not medically indicated.

Compliance with the standards of care for normal low-risk deliveries: In Nepal, providers' compliance with the eight standards of care for nomal low-risk deliveries was not uniform, with the output indicators performing slightly better than the input indicators. The inputs are pre-requisite for the process and outputs of care delivery; thus, the low compliance with input indicators blocks paths for quality service delivery (Tuladhar et al., 2024c). Compared to other LMICs, Nepal performed better in complying with many of the standards of care, for example, functional referral systems, providers' behaviour, emotional support for clients, and essential physical resources (Sheferaw et al., 2017; Bintabara et al., 2019; Sharma et al., 2019). However, the results from Nepal must be interpreted carefully because several of the important indicators of the standards of care recommended by WHO were not available in the 2021 NHFS data set and thus, could not be analysed. Therefore, the actual gaps in the standards of care might be larger than what is presented in this study.

Factors associated with women's satisfaction with the utilization of normal low-risk delivery services: In this study, women's satisfaction with delivery services was associated with six factors, representing three of the eight standards of care recommended by the WHO (Tuladhar et al., 2024c). The inter-personal communication of providers with clients—the caring behaviour, service provider paying attention when called by the women, and women's good experience of audio and visual privacy (Standard 5: respect and preservation of dignity)—were associated with higher satisfaction levels among women (Tuladhar et al., 2024c). The display of health statistics at the HF (Standard 2: actionable health information system), where women delivered, emerged as a strong predictor of higher satisfaction; in contrast, the availability of information materials on maternal care at the HF (Standard 4: effective communication) emerged as a predictor of lower satisfaction (Tuladhar et al., 2024c). Similarly, women who delivered in HFs with maternity waiting rooms were less satisfied, indicating that just having waiting rooms may not be adequate for high client satisfaction, but such rooms need to be fully equipped and functional, as found in a study from

Ethiopia where the availability of secure and comfortable waiting rooms was related to improved client satisfaction (Eziawdres et al., 2021). In addition, mothers might have been left alone with contractions in the waiting room without any provider caring for them in comparison to HFs, where women go immediately into the delivery room.

Implementation of the Maternity Incentive Scheme, an important contextual factor in this study, was found to be associated with low satisfaction rates among women (Tuladhar et al., 2024c). Although this scheme has been key to addressing the financial barriers to accessing HFs for maternal health services across Nepal, operational challenges such as difficulty monitoring women's ANC visits, delays in providing transportation incentives to women, stockouts of essential medicines and supplies at HFs, and a lack of basic amenities are likely to decrease levels of satisfaction. Studies on this scheme show that many women in Nepal are unaware of the scheme and that few women are fully satisfied with it (Pantha & Kafle, 2018; MOHP et al., 2023).

2.5.2 Policy, practice, and research implications

The policy environment in Nepal is improving for providing quality health services, which is essential for ensuring maternal survival. Despite improving access to HFs and more women using them for delivery services, challenges persist that compromise compliance with standards of care. Nevertheless, the new government system provides novel opportunities for local governments to manage basic health services for their people and refocus on QoC (Tuladhar et al., 2024c). The findings of this study will be useful for the local, provincial, and federal governments of Nepal, as well as for other LMICs, researchers, donors, and the global community in improving policies and practices for improving QoC. The following are the key recommendations drawn from this study:

Improving the readiness of the HFs: All three tiers of government need to ensure HF readiness and the 24/7 availability of delivery services. The provincial and federal governments must provide training, mentorship, and coaching to providers working at the local level. Many HFs are lacking technical guidelines; therefore, local authorities should print them locally or ensure that electronic guidelines are available to service providers. The procurement roles need to be clarified among the three tiers of the government, and the supply chain system needs to be strengthened to ensure the year-round availability of essential commodities. The local governments should use their resources to buy easily available essential supplies such as waste receptacles, gloves, surgical masks, etc.

Improving the work environment for provider motivation: Although service providers in Nepal face many challenges pertaining to the workplace, they remain open and responsive to their clients (Tuladhar et al., 2024b). The health system should provide incentives such as quality supervision, coaching, mentorship, exchange visits, rewards, recognitions, etc. to help improve the motivation and job satisfaction of providers.

Addressing the challenges of the Maternity Incentive Scheme: To improve satisfaction with the Maternity Incentive Scheme, it is imperative that the ongoing challenges reported from various studies related to the timely provision of transportation allowances to mothers and the availability of medical supplies, routine tests, and maternity beds are addressed. HFs should have a system in place to collect and address client feedback.

Improving QoC among private HFs: The private healthcare sector in Nepal is expanding and is often the first point of contact for seeking care during delivery in several parts of the country (MoHP, 2017). Therefore, it is imperative to provide the private HFs with a conducive operating environment and inducement to implement the Maternity Incentive Scheme for enhancing coverage for HF-based maternal services (Tuladhar et al., 2024b).

Periodic assessment and regular monitoring of obstetric health services: Nepal should continue using routine quality improvement tools such as the Minimum Service Standard assessments, the Maternal and Perinatal Death Surveillance and Response, and periodic HF-based surveys to monitor compliance with the standards of care, identify gaps, and implement actions to improve QoC (Tuladhar et al., 2024a; Tuladhar et al., 2024c).

2.5.3 Strengths and Limitations

Strengths: All three papers draw data from the two nationally representative NHFS conducted in 2015 and 2021 as a part of the global DHS Program. The three papers use multiple data types for analysis: inventory assessment, service provider interviews, observations, and exit interviews, thus providing a holistic perspective on the status of the QoC of normal low-risk delivery services in Nepal. This study uses the frameworks recommended by WHO for the readiness assessment and B/CEmONC signal function and standards of care analysis, thus allowing comparison with other LMICs. The NHFS tools were validated, standardized, and pretested, and data were collected on tablets by thoroughly trained data collectors who were health workers.

Limitations: This study used secondary data to answer the research questions; therefore, several important variables related to QoC were not available in the data sets. The data collection in 2015 was affected by the 7.8 Richter scale earthquake and in 2021 by the COVID-19 pandemic, which made the health system vulnerable and might have affected the indicators. The analysis on compliance with standards of care is based on a limited number of observations of women during deliveries at lower-level HFs and private hospitals, thus limiting analysis by HF types (Tuladhar et al., 2024a; Tuladhar et al., 2024b; Tuladhar et al., 2024c).

2.6 Conclusion

With an increase in access to HF-based delivery services, Nepal achieved 79.4% of HF birth coverage in 2022, and the MMR declined to 151 deaths per 100,000 live births in 2021. However, the proportion of maternal deaths during the delivery and postpartum periods is increasing,

suggesting suboptimal standards of obstetric services. The annual MMR reduction over the fifteen-year period between 2006 and 2021 was nearly 9%. To achieve SDG 3.1 of 70, Nepal must achieve an annual MMR reduction of 9% over the next nine-year period from the current level of 151 in 2021. To achieve this, Nepal needs to re-focus on both the structural and procedural aspects of QoC, accelerate efforts by enhancing the supply chain framework for year-round availability of essential medicines, supplies, and basic equipment, and ensure skilled human resources. The new federal government structure presents a unique opportunity for local governments to focus on enhancing the standard of delivery services, and the provincial and federal governments must provide the necessary technical and financial resources to assist the local governments.

3. References

Ahmed H. M. (2020). Role of verbal and non-verbal communication of health care providers in general satisfaction with birth care: a cross-sectional study in government health settings of Erbil City, Iraq. *Reproductive health*, *17*(1), 35. https://doi.org/10.1186/s12978-020-0894-3

Ahmed, T., Rahman, A. E., Amole, T. G., Galadanci, H., Matjila, M., Soma-Pillay, P., Gillespie, B., Arifeen, S. E., & Anumba, D. (2021). The effect of COVID-19 on maternal newborn and child health (MNCH) services in Bangladesh, Nigeria and South Africa: Call for a contextualised pandemic response in LMICs. *International Journal for Equity in Health*, *20*(1), 77. https://doi.org/10.1186/s12939-021-01414-5

Ansari, H., & Yeravdekar, R. (2020). Respectful maternity care during childbirth in India: A systematic review and meta-analysis. *Journal of postgraduate medicine*, *66*(3), 133–140. https://doi.org/10.4103/jpgm.JPGM_648_19

Aranda, Z., Binde, T., Tashman, K., Tadikonda, A., Mawindo, B., Maweu, D., Boley, E. J., Mphande, I., Dumbuya, I., Montaño, M., Clisbee, M., Mvula, M. G., Ndayizigiye, M., Casella Jean-Baptiste, M., Varney, P. F., Anyango, S., Grépin, K. A., Law, M. R., Mugunga, J. C., Hedt-Gauthier, B., … Fulcher, I. R. (2022). Disruptions in maternal health service use during the COVID-19 pandemic in 2020: Experiences from 37 health facilities in low-income and middle-income countries. *BMJ Global Health*, *7*(1), e007247. https://doi.org/10.1136/bmjgh-2021-007247

Bell, G., Macarayan, E. K., Ratcliffe, H., Kim, J. H., Otupiri, E., Lipsitz, S., Hirschhorn, L., Awoonor-Williams, J. K., Nimako, B. A., Ofosu, A., Leslie, H., Bitton, A., & Schwarz, D. (2020). Assessment of bypass of the nearest primary health care facility among women in Ghana. *JAMA Network Open*, *3*(8), e2012552. https://doi.org/10.1001/jamanetworkopen.2020.12552

Bhutta, Z. A., Ali, S., Cousens, S., Ali, T. M., Haider, B. A., Rizvi, A., Okong, P., Bhutta, S. Z., & Black, R. E. (2008). Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: What difference can integrated primary health care strategies make? *Lancet (London, England)*, *372*(9642), 972–989. https://doi.org/10.1016/S0140-6736(08)61407-5

Bayou, N.B., Grant, L., Riley, S.C. *et al.* (2022) Structural quality of labor and delivery care in government hospitals of Ethiopia: a descriptive analysis. *BMC Pregnancy Childbirth* **22**, 523. https://doi.org/10.1186/s12884-022-04850-5

Bintabara D, Ernest A, Mpondo B. (2019). Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey. BMJ Open; 2019(9): e020608. https:// doi. org/ 10. 1136/ bmjop en-2017- 020608.

Darmstadt, G. L., Bhutta, Z. A., Cousens, S., Adam, T., Walker, N., & de Bernis, L. (2005). Evidence-based, cost-effective interventions: How many newborn babies can we save? *Lancet (London, England)*, *365*(9463), 977–988. https://doi.org/10.1016/S0140-6736(05)71088-6

Eziawdres, D., Worku, W., & Taye, M. (2021). Maternal Satisfaction With Delivery Services and its Associated Factors Among Mothers Who Gave Birth at Public Health Centers in Yeka Sub City, Addis Ababa, Ethiopia. *Health services insights*, *14*, 11786329211050722. https://doi.org/10.1177/11786329211050722

Family Welfare Division (FWD). (2019). Nepal *safe motherhood and newborn health road map* 2030. Family Welfare Division, Teku, Kathmandu, Nepal.

Gage AJ, Ilombu O, Akinyemi AI. (2016). Service readiness, health facility management practices, and delivery care utilization in five states of Nigeria: a cross-sectional analysis. BMC Pregnancy Childbirth; 16:297. https://doi. org/ 10. 1186/ s12884- 016- 1097-3.

Jubayer Biswas MAA, Hassan MZ, Monjur MR, et al. Assessment of standard precaution related to infection prevention readiness of healthcare facilities in Bangladesh: Findings from a national cross-sectional survey. Antimicrobial Stewardship & Healthcare Epidemiology. 2021;1(1):e52. doi:10.1017/ash.2021.226

Kanyangarara M, Chou VB, Creanga AA, Walker N. (1018). Linking household and health facility surveys to assess obstetric service availability, readiness, and coverage: evidence from 17 low- and middle-income countries. J Glob Health. 2018;8(1):010603. https:// doi. org/ 10. 7189/ jogh. 08. 010603. PMID:2986 2026; PMCID: PMC5963736.

Karkee, R., Lee, A. H., & Binns, C. W. (2015). Bypassing birth centres for childbirth: an analysis of data from a community-based prospective cohort study in Nepal. *Health policy and planning*, *30*(1), 1–7. https://doi.org/10.1093/heapol/czt090

Katageri, G., Charantimath, U., Joshi, A., Vidler, M., Ramadurg, U., Sharma, S., Bannale, S., Payne, B. A., Rakaraddi, S., Karadiguddi, C., Mungarwadi, G., Kavi, A., Sawchuck, D., Derman, R., Goudar, S., Mallapur, A., Bellad, M., Magee, L. A., Qureshi, R., von Dadelszen, P., (2018). Community Level Interventions for Pre-eclampsia (CLIP) India Feasibility Working Group. Availability and use of magnesium sulphate at health care facilities in two selected districts of North Karnataka, India. *Reproductive health*, *15*(Suppl 1), 91. https://doi.org/10.1186/s12978-018-0531-6

Manu, A., Zaka, N., Bianchessi, C., Maswanya, E., Williams, J., & Arifeen, S. E. (2021). Respectful maternity care delivered within health facilities in Bangladesh, Ghana and Tanzania: a cross-sectional assessment preceding a quality improvement intervention. *BMJ open*, *11*(1), e039616. https://doi.org/10.1136/bmjopen-2020-039616

Ministry of Health and Population (MOHP), & National Statistics Office (NSO). (2023). *National population and housing census 2021: Nepal maternal mortality study 2021*. Ministry of Health and Population, Nepal.

Ministry of Health and Population (MOHP), New ERA, & ICF. (2023). *Nepal demographic and health survey final report 2022*. Ministry of Health and Population, Nepal.

Ministry of Health and Population (MOHP), New ERA, & ICF. (2017). *Nepal demographic and health survey final report 2016*. Ministry of Health and Population, Nepal.

Ministry of Health and Population (MOHP). (2023). Nepal Health Sector Strategic Plan (NHSSP) 2023-2030.

National Planning Commission (NPC). (2017). Nepal's Sustainable Development Goals Status and Roadmap: 2016–2030. Published by Government of Nepal, National Planning Commission, Singha Durbar, Kathmandu Nepal. Available from http:// sdg. npc. gov. np/ media/ resou rces/

items/0/ bSust ainable_ Devel opment_ Goals_ Status_ and_ Roadm ap__ 2016- 2030_ 46E6X zP. pdf.

Pantha, A., Kafle, P. (2018). Maternal Satisfaction on Delivery Service among Postnatal Mothers in a Government Hospital, Mid-Western Nepal. Hindawi Obstetrics and Gynecology International Volume 2018, Article ID 4530161, 11 pages https://doi.org/10.1155/2018/4530161

Rishard, M., Fahmy, F. F., Senanayake, H., Ranaweera, A. K. P., Armocida, B., Mariani, I., & Lazzerini, M. (2021). Correlation among experience of person-centered maternity care, provision of care and women's satisfaction: Cross sectional study in Colombo, Sri Lanka. *PloS one*, *16*(4), e0249265. https://doi.org/10.1371/journal.pone.0249265

Sharma, G., Penn-Kekana, L., Halder, K. *et al.* An investigation into mistreatment of women during labour and childbirth in maternity care facilities in Uttar Pradesh, India: a mixed methods study. *Reprod Health* **16**, 7 (2019). https://doi.org/10.1186/s12978-019-0668-y

Sheferaw, E. D., Bazant, E., Gibson, H., Fenta, H. B., Ayalew, F., Belay, T. B., Worku, M. M., Kebebu, A. E., Woldie, S. A., Kim, Y. M., van den Akker, T., & Stekelenburg, J. (2017). Respectful maternity care in Ethiopian public health facilities. *Reproductive health*, *14*(1), 60. https://doi.org/10.1186/s12978-017-0323-4

Srivastava, A., Avan, B. I., Rajbangshi, P., & Bhattacharyya, S. (2015). Determinants of women's satisfaction with maternal health care: a review of literature from developing countries. *BMC pregnancy and childbirth*, *15*, 97. https://doi.org/10.1186/s12884-015-0525-0

Tarannum Dana, G. P., & Afroz, S. (2022). Readiness of Health Facilities to Provide Institutional Delivery Care: A Study Based On Bangladesh Health Facility Survey 2017. *Social Science Review*, *38*(1), 17–32. https://doi.org/10.3329/ssr.v38i1.56522

Thapa, R., Bam, K., Tiwari, P., Sinha, T. K., & Dahal, S. (2019). Implementing Federalism in the Health System of Nepal: Opportunities and Challenges. *International journal of health policy and management*, *8*(4), 195–198. https://doi.org/10.15171/ijhpm.2018.121

Tuladhar, S., Paudel, D., Rehfuess, E., Siebeck, M., Oberhauser, C., & Delius, M. (2024a). Changes in health facility readiness for obstetric and neonatal care services in Nepal: an analysis of cross-sectional health facility survey data in 2015 and 2021. *BMC pregnancy and childbirth*, *24*(1), 79. https://doi.org/10.1186/s12884-023-06138-8

Tuladhar, S., Delius, M., Siebeck, M., Oberhauser, C., Paudel, D., & Rehfuess, E. (2024b). Standards of care and determinants of women's satisfaction with delivery services in Nepal: a multi-perspective analysis using data from a health facility-based survey. *BMC pregnancy and childbirth*, *24*(1), 132. https://doi.org/10.1186/s12884-024-06301-9

Tuladhar, S., Rehfuess, E., Delius, M., Siebeck, M., Paudel, D., & Oberhauser, C. (2024c). Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021. *Health care for women international*, 1–18. Advance online publication. https://doi.org/10.1080/07399332.2024.2313659

Wang, W., Winner, M., & Burgert-Brucker, C. R. (2017). Limited Service Availability, Readiness, and Use of Facility-Based Delivery Care in Haiti: A Study Linking Health Facility Data and

Population Data. *Global health, science and practice*, *5*(2), 244–260. https://doi.org/10.9745/GHSP-D-16-00311

World Health Organization (WHO). (1996). *Care in Normal Birth: A Practical Guide. Report of a Technical Working Group*. Reproductive Health and Research, WHO, Geneva. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2413/2014/08/WHO_FRH_MSM_96.24.pdf

World Health Organization (WHO). (2006). Quality of care: a process for making strategic choices in health systems. Geneva: WHO. Available from https:// apps. who. int/ iris/ handle/ 10665/ 43470.

World Health Organization. (2016). Standards for improving quality of maternal and newborn Care in Health Facilities. Geneva 27, Switzerland: WHO Press, World Health Organization, 20 Avenue Appia, 1211.

World Health Organization (WHO). (2015). Service Availability and Readiness Assessment (SARA): an annual monitoring system for service delivery, reference manual. Version 2.2. Revised July 2015. Available from https:// apps. who. int/ iris/ bitst ream/ handle/ 10665/ 149025/ WHO_HIS_ HSI_ 2014.5_ eng. pdf? seque nce= 1& isAll owed=y

World Health Organization (WHO). (2023). *Trends in maternal mortality 2000 to 2020: Estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division*. World Health Organization.

Yeshiwas, A., & Eskinder, K. (2021). Trends in operative delivery in Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia: A 5 years. Retrospective review. Ethiopian Journal of Health Sciences, 31(6), 1199. Yeshiwas & Eskinder, 2021 https://doi.org/10.4314/ejhs.v31i6.15

4. Publications

4.1 Paper A

Changes in health facility readiness for obstetric and neonatal care services in Nepal: An analysis of cross-sectional health facility survey data in 2015 and 2021

Journal: BMC Pregnancy and Childbirth
DOI: https://doi.org/10.1186/s12884-023-06138-8
Published date: January 24, 2024

Tuladhar, S., Paudel, D., Rehfuess, E., Siebeck, M., Oberhauser, C., & Delius, M. (2024a). Changes in health facility readiness for obstetric and neonatal care services in Nepal: an analysis of cross-sectional health facility survey data in 2015 and 2021. *BMC pregnancy and childbirth*, *24*(1), 79. https://doi.org/10.1186/s12884-023-06138-8

4.2 Paper B

Emergency obstetric and newborn care signal functions: the situation in health facilities in Nepal between 2015 and 2021

Journal: Health Care for Women International
DOI: https://doi.org/10.1080/07399332.2024.2313659
Published date: February 13, 2024

Tuladhar, S., Rehfuess, E., Delius, M., Siebeck, M., Paudel, D., & Oberhauser, C. (2024c). Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021. *Health care for women international*, 1–18. Advance online publication. https://doi.org/10.1080/07399332.2024.2313659

4.3 Paper C

Standards of care and determinants of women's satisfaction with delivery services in Nepal: A multi- perspective analysis using data from a health facility-based survey

Journal: BMC Pregnancy and Childbirth
DOI: https://doi.org/10.1186/s12884-024-06301-9
Published date: February 13, 2024

Tuladhar, S., Delius, M., Siebeck, M., Oberhauser, C., Paudel, D., & Rehfuess, E. (2024b). Standards of care and determinants of women's satisfaction with delivery services in Nepal: a multi-perspective analysis using data from a health facility-based survey. *BMC pregnancy and childbirth*, *24*(1), 132. https://doi.org/10.1186/s12884-024-06301-9

Acknowledgements

This study was carried out for my Ph.D. Thesis at the Center for International Health, Ludwig Maximilians University of Munich, Germany. The Center for International Health (CIH) is funded by the German Federal Ministry for Economic Cooperation and Development through the German Academic Exchange Service, and this study would not have been possible without their funding support for the program and the scholarship for the Ph.D. candidate. Coursework, workshops on global health topics, training on soft skills, statistical software, symposium organization during module blocks I and II, and continuous academic guidance from the supervisors helped me to accomplish this study successfully.

My deepest gratitude goes to my LMU supervisors, Dr. Maria Dalius, Prof. Dr. Eva A. Rehfuess, and Professor Dr. Matthias Siebeck, who provided brilliant academic and professional guidance on study methodology, analysis of results, and preparation of this thesis, as well as emotional support to accomplish this study. My sincere gratitude also goes to my local supervisor, Dr. Deepak Paudel, from Save the Children Nepal, for this exemplary guidance and support in developing manuscripts and mentoring throughout the Ph.D. course. I am indeed very thankful to Ms. Cornelia Oberhauser, from the Institute for Medical Information Processing, Biometry, and Epidemiology, who provided me with statistical advisory support for all three publications.

I am grateful to Professor Dr. Michael Hoelscher, Chairperson; Dr. Günter Fröschl, Head of Teaching & Training Unit at Division of Infectious Diseases and Tropical Medicine, CIH; Ms. Adea Borova, Dr. Sarah Scholze and Dr. Arlett Heiber, Ph.D. MR-IH Program Coordinators at CIH; and the rest of the CIH Project Coordination Team for their technical guidance and administrative support throughout the study period. I am equally grateful to my host institution, the United States Agency for International Development (USAID) Nepal, for granting me a flexible work schedule to complete this Ph.D. My appreciation goes to all my colleagues at USAID Nepal, and to my fellow Ph.D. colleagues at CIH who shared their knowledge and ideas and supported me emotionally during difficult times. My special gratitude goes to my colleague, Mr. Prakash Gnyawali, for encouraging me to join the Ph.D. program in early 2019 and for his expert advisory support throughout the study period.

Last but not the least, I would like to express hearty thanks to my family, especially my husband Sagar Raj Pradhan, my daughter Aryana Pradhan, and my son Aaron Raj Pradhan, for their understanding, patience, flexibility, and cooperation during my Ph.D. course.

Complete list of my publications

1. **Proceedings from the CIHLMU 2022 Symposium: "Availability of and Access to Quality Data in Health"**
   Journal: BMC Proceedings
   DOI: https://doi.org/10.1186/s12919-023-00270-1
   Published date: August 17, 2023

Tuladhar, S., Mwamelo, K., Manyama, C. *et al.* Proceedings from the CIHLMU 2022 Symposium: "Availability of and Access to Quality Data in Health". *BMC Proc* 17 (Suppl 10), 21 (2023). https://doi.org/10.1186/s12919-023-00270-1

2. **Changes in health facility readiness for obstetric and neonatal care services in Nepal: An analysis of cross-sectional health facility survey data in 2015 and 2021**
   Journal: BMC Pregnancy and Childbirth
   DOI: https://doi.org/10.1186/s12884-023-06138-8
   Published date: January 24, 2024

Tuladhar, S., Paudel, D., Rehfuess, E., Siebeck, M., Oberhauser, C., & Delius, M. (2024a). Changes in health facility readiness for obstetric and neonatal care services in Nepal: an analysis of cross-sectional health facility survey data in 2015 and 2021. *BMC pregnancy and childbirth*, *24*(1), 79. https://doi.org/10.1186/s12884-023-06138-8

3. **Emergency obstetric and newborn care signal functions: the situation in health facilities in Nepal between 2015 and 2021**
   Journal: Health Care for Women International
   DOI: https://doi.org/10.1080/07399332.2024.2313659
   Published date: February 13, 2024

Tuladhar, S., Rehfuess, E., Delius, M., Siebeck, M., Paudel, D., & Oberhauser, C. (2024c). Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021. *Health care for women international*, 1–18. Advance online publication. https://doi.org/10.1080/07399332.2024.2313659

4. **Standards of care and determinants of women's satisfaction with delivery services in Nepal: A multi- perspective analysis using data from a health facility-based survey**
   Journal: BMC Pregnancy and Childbirth
   DOI: https://doi.org/10.1186/s12884-024-06301-9
   Published date: February 13, 2024

Tuladhar, S., Delius, M., Siebeck, M., Oberhauser, C., Paudel, D., & Rehfuess, E. (2024b). Standards of care and determinants of women's satisfaction with delivery services in Nepal: a multi-perspective analysis using data from a health facility-based survey. *BMC pregnancy and childbirth*, *24*(1), 132. https://doi.org/10.1186/s12884-024-06301-9

BMC Pregnancy and Childbirth

RESEARCH

Open Access

Changes in health facility readiness for obstetric and neonatal care services in Nepal: an analysis of cross-sectional health facility survey data in 2015 and 2021

Sabita Tuladhar[1,2*], Deepak Paudel[3], Eva Rehfuess[4,5], Matthias Siebeck[6], Cornelia Oberhauser[4,5] and Maria Delius[7]

Abstract

Background Nepal is committed to achieving the Sustainable Development Goal (SDG) 2030 target 3.1 of reducing the maternal mortality ratio to 70 deaths per 100,000 live births. Along with increasing access to health facility (HF)-based delivery services, improving HF readiness is critically important. The majority of births in Nepal are normal low-risk births and most of them take place in public HFs, as does the majority of maternal deaths. This study aims to assess changes in HF readiness in Nepal between 2015 and 2021, notably, if HF readiness for providing high-quality services for normal low-risk deliveries improved; if the functionality of basic emergency obstetric and neonatal care (BEmONC) services increased; and if infection prevention and control improved.

Methods Cross-sectional data from two nationally representative HF-based surveys in 2015 and 2021 were analyzed. This included 457 HFs in 2015 and 804 HFs in 2021, providing normal low-risk delivery services. Indices for HF readiness for normal low-risk delivery services, BEmONC service functionality, and infection prevention and control were computed. Independent sample T-test was used to measure changes over time. The results were stratified by public versus private HFs.

Results Despite a statistically significant increase in the overall HF readiness index for normal low-risk delivery services, from 37.9% in 2015 to 43.7%, in 2021, HF readiness in 2021 remained inadequate. The availability of trained providers, essential medicines for mothers, and basic equipment and supplies was high, while that of essential medicines for newborns was moderate; availability of delivery care guidelines was low. BEmONC service functionality did not improve and remained below five percent facility coverage at both time points. In private HFs, readiness for good quality obstetrical care was higher than in public HFs at both time points. The infection prevention and control index improved over time; however, facility coverage in 2021 remained below ten percent.

Conclusions The slow progress and sub-optimal readiness for normal, low-risk deliveries and infection prevention and control, along with declining and low BEmONC service functionality in 2021 is reflective of poor quality of care and provides some proximate explanation for the moderately high maternal mortality and the stagnation of neonatal mortality in Nepal. To reach the SDG 2030 target of reducing maternal deaths, Nepal must hasten its efforts

*Correspondence:
Sabita Tuladhar
Sabita.Tuladhar@lrz.uni-muenchen.de
Full list of author information is available at the end of the article

© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

to strengthen supply chain systems to enhance the availability and utilization of essential medicines, equipment, and supplies, along with guidelines, to bolster the human resource capacity, and to implement mechanisms to monitor quality of care. In general, the capacity of local governments to deliver basic healthcare services needs to be increased.

Keywords Delivery services, Maternal health, Newborn health, Quality of care, Emergency obstetric and neonatal care

Introduction

Nepal made good progress in reducing the maternal mortality ratio (MMR) over the last two and half decades, as illustrated by a 72.2% MMR reduction, from 539 to 151 per 100,000 live births between 1996 and 2021 [1, 2]. However, the rate of decline in MMR has not been uniform over time: between 1996 and 2016, Nepal observed modest gains in maternal survival with a 2.6% annual MMR reduction; in contrast, after 2016 until 2021 the MMR reduction accelerated to an annual rate of decline of 6.9% [1, 2]. Because of the slow rates of progress until 2016, Nepal's endeavor to meet the United Nations (UN) Millennium Development Goal (MDG) 4 of reducing the MMR to 134 per 100,000 live births by 2015 [3] was only partly realized. The challenge continues with regard to reaching the ambitious UN Sustainable Development Goal (SDG) target 3.1 of reducing the MMR to less than 70 per 100,000 live births by 2030 [4], which calls for a further 53.6% reduction of the MMR from the levels observed in 2021, translating into a 5.9% annual rate of reduction. The biggest gains in maternal survival can be achieved through universal access to health facility (HF)-based delivery and immediate postpartum services [5]. Although access to HF-based delivery services has improved in Nepal over the past two decades through a variety of dedicated programs and interventions, there are large inequities across different regions and population groups of the country [1, 6]. Furthermore, the neonatal mortality rate (NMR) has stagnated at 21 per 1,000 live births since 2016 and SDG target 3.2 is reducing it to 12 deaths per 1,000 live births by 2030 [4, 6].

Between 2000 and 2015, the uptake of maternal health services improved steeply in Nepal (Fig. 1). Population coverage with four or more antenatal care visits during the fourth, sixth, eighth, and nine months of pregnancy increased nine-fold from 8.9% in 2001 to 80.2% in 2022, births taking place at a HF changed from a mere 8.2% in 1996 to 79.3% in 2022, and postpartum check ups within two days after delivery improved from 21.5% in 2006 to 70.3% in 2022 [1, 6, 7]. The majority of these services were provided through public HFs, however, over the years, service uptake in private HFs has also been increasing gradually. For example, in 2016, 15.8% of births took place in a private HF compared to only 1.2% of births in 1996 [7].

Normal delivery, as characterised by the World Health Organization (WHO), is spontaneous in onset, low risk at the start of labour, and remains so throughout labour and delivery; the infant is born spontaneously out of a vertex position between 37 and 42 completed weeks of pregnancy; and after birth mother and infant are in good condition [8]. According to the Health Management Information System of Nepal in 2021, 77.8% births were spontaneous, 2.2% assisted, and 20.0% cesarean [9]. In this study, normal spontaneous deliveries are referred to as "normal low-risk deliveries". To achieve SDG target 3.1, Nepal aims for 90.0% population coverage with regard to recommended antenatal care, births taking place at HFs, and recommended postnatal care by 2030 [4]. Nepal is likely to be on track to meet these targets, provided the current level of investment in the safe motherhood program is continually and sustainably increased. However, for these improvements to be translated into better maternal survival, the increase in access to HF-based delivery services must be matched with improvements in the quality of care (QoC).

QoC is multi-dimensional and implies that health care must be safe, effective, people-centered, timely, efficient, equitable, and integrated [10]. The present need for any country is a high-quality health system that is valued and trusted by all people, can respond to changing population needs and is able to consistently deliver care that improves or maintains health [11]. Currently, the quality of delivery services at HFs is sub-optimal in Nepal, for example, in 2021, only 46.8% of the providers took the woman's temperature during delivery, and only 48.4% washed their hands properly prior to a physical examination of a woman during delivery [12].

The WHO QoC Framework for Maternal and Newborn Health [13, 14] and the Donabedian QoC Model [15] emphasize three distinct constructs, i.e. *structural factors* (also referred to as facility readiness), *clinical procedures* (comprising the provider's knowledge, skills, and behavior), and the *patients' experience of care* as

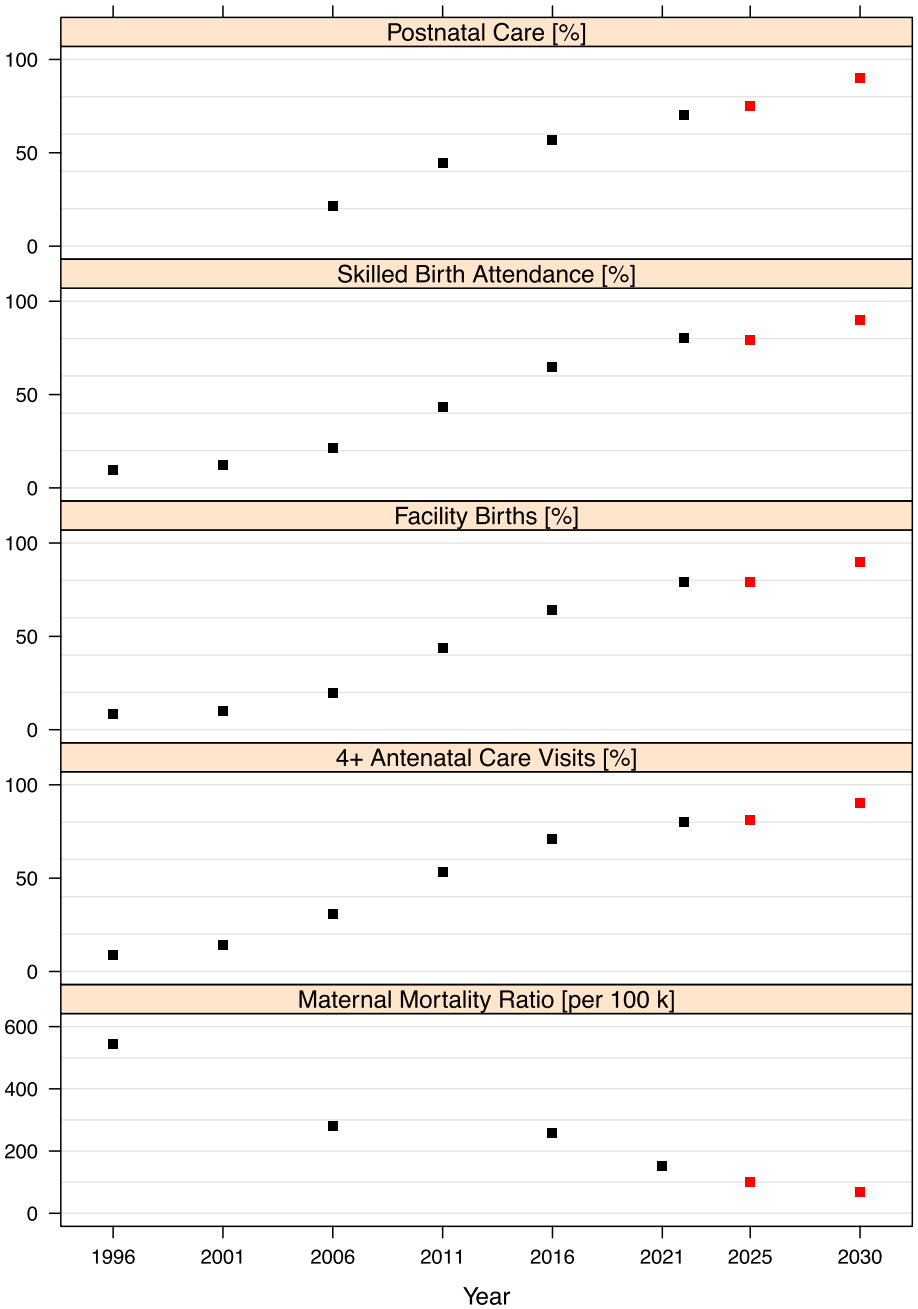

Fig. 1 Trends in maternal mortality ratio, antenatal care, health facility births, skilled birth attendance, and postnatal care in Nepal, 1996 to 2022, and SDG targets. Data source: 1996, 2001, 2006, 2011, and 2022: The DHS Program STATCompiler; 2021: Nepal Maternal Mortality Study (NMMS) 2021; 2025 and 2030 targets: SDG Status and Roadmap: 2016-2030

fundamental to ensuring high QoC. Structural factors can be equated with "facility readiness", i.e. the capacity of HFs to provide high-quality delivery services [16]. Furthermore, HFs offering normal low-risk delivery services should be equipped to provide basic emergency obstetric and neonatal care (BEmONC), which is measured as the seven signal functions and key medical interventions used to treat the direct obstetric complications that cause most maternal deaths around the globe [7].

The recent coronavirus disease (COVID)-19 pandemic posed additional challenges to the delivery of maternal

health services and maternal survival in Nepal. The four-month-long COVID-19 lockdown in early-2020 interrupted delivery services in public basic healthcare centers due to facility closure, stock out of medicines, and lack of ambulance services; in contrast, all referral hospitals remained open for delivery, except for the initial days of the lockdown [17]. It also showcased that pregnant and postpartum women and their newborns are at risk of infection in HFs, potentially leading to severe consequences of COVID-19 disease [18–20]. Thus, proper infection prevention and control (IPC) measures form a critical part of HF readiness for providing high-quality delivery services.

Nepal faced an earthquake on a 7.8 Richter scale in 2015. In 2017, Nepal transitioned to a federal republic with the adoption of a new constitution in 2015 that divided the country into one federal, seven provincial, and 753 local governments. The constitution mandated that local governments provide basic healthcare services, including normal low-risk delivery services, free of cost to their people [21]. In this context, several policies seek to contribute to a reduction in the MMR and include the National Health Policy (2014), the Nepal Health Sector Strategic Plan (NHSSP) (2023–2030), and the Nepal Safe Motherhood and Newborn Health Road Map (2030). Additionally, the implementation of the National Health Care Quality Assurance Framework (2022) will guide both public and private sectors in the provision of quality maternal and newborn health services [22, 23]. Finally, there is a nationwide implementation of the maternity incentive scheme called "*Aama program*", which ensures free delivery services and financial support through the provision of a transportation allowance to women who complete four scheduled antenatal visits and give birth at HFs.

While the increasing availability and use of HF-based delivery services represent important improvements, it is disconcerting that a large percentage of maternal deaths take place at HFs and that NMR are stagnating. This indicates that there may be a problem with the QoC of delivery services. This study aims to understand the supply-side issues among the HFs offering normal low-risk delivery services in Nepal. The primary objective is to assess changes in the HFs readiness to provide high quality in low risk deliveries and BEmONC services between 2015 and 2021. Secondary objectives are: the implementation of appropriate IPC in HFs providing delivery services, and to examine differences between public and private HFs regarding readiness and BEmONC service functionality. This study will have an impact on the health system by improving the HFs readiness on high quality delivery services by identifying areas lacking progress since 2015.

Methods

Data source

Data were drawn from the 2015 and 2021 Nepal Health Facility Surveys (NHFSs), with data being publicly available from https://dhsprogram.com/Data/. Both are comparable, nationally representative and cross-sectional surveys comprising the following components: inventory assessment; service provider interviews; observations of client-provider sessions for selected services; and exit interviews with patients or those taking care of patients for the selected services upon being discharged from a HF or leaving the service site. This study used data from the inventory assessment and delivery service provider interviews.

Study population

This analysis comprised all formal sector HFs of Nepal that reported providing normal low-risk delivery services when data for the 2015 and 2021 NHFSs were collected. The NHFSs obtained their sampling frame from the Ministry of Health and Population of Nepal, which included 4,719 HFs in 2015 and 5,681 HFs in 2021 [12]. The increase in the number of HFs in 2021 was primarily due to the establishment of community health units by the local governments after the country's health system was federalized in 2017. The NHFSs in 2015 and 2021 surveyed 940 and 1,564 HFs out of which 48.6% (457) and 51.4% (808) HFs respectively provided normal low-risk delivery services. The sample size of the NHFSs in 2015 and 2021 are comparable and allow for representative estimates nationally and by managing authority. The larger sample size in the NHFS 2021 accounts for the seven provinces of a federal Nepal, in contrast to the five administrative regions in 2015.

Sampling

The HFs included in this analysis comprise all public hospitals offering basic healthcare services and all primary health care centers, and a sample of other basic healthcare centres (health/sub-health posts, community health units, and urban health centers). Similarly, for private HFs, this analysis in 2015 comprises sample of private hospitals with 15 or more in-patient beds, and complete enumeration of all private hospitals with 100 in-patient beds. In 2021, the analysis includes a sample of private hospitals with at least one in-patient bed, but complete enumeration of all private hospitals in the provinces which have fewer private hospitals.

Analytical framework

The WHO Service Availability and Readiness Assessment (SARA) framework is used which is composed of three domains: i) staff and guidelines; ii) equipment; and

iii) medicines and commodities [16]. To make the analysis of HF readiness for normal low-risk delivery services more granular and contextualised for Nepal, this study sub-divided the domain "staff and guidelines" into two distinct domains, i.e. "trained provider" and "guidelines". The availability of guidelines merits to be assessed separately due to continuous changes in the evidence base informing health care delivery and related revisions of guidelines. Similarly, the domain "medicines and commodities" was sub-divided into a domain on "essential medicines for mothers", and a domain on "essential medicines for newborns" to ensure adequate attention to newborn care. Each of these five domains received equal weight. For the BEmONC service functionality analysis, seven signal functions prediscribed by the SARA framework were used [16]. As the SARA framework does not contain a separate measure for IPC, this study applied selected domains of general HF readiness – i.e., i) trained provider, ii) guidelines, and iii) equipment and supplies – and used data on universal precaution measures and IPC available in the surveys. Each of the three domains received equal weight. This study focused on supply-side issues at the level of HFs and the domains recommended by WHO's SARA manual. In contrast, further critical determinants of HF readiness according to the WHO health system building blocks framework, notably governance, information system and financing, where not explicitly addressed, as these primarily exert their influence at local or national government level, rather than at HF level.

Study variables

For each HF, three summary indices were calculated and used as the main outcome variables in subsequent statistical analyses: (a) HF readiness index for normal low-risk delivery services; (b) BEmONC services functionality; and (c) IPC index.

Original variables: Tables 1, 2 and 3 show the original indicators and signal functions available in the NHFS 2015 and 2021 dataset for each SARA domain.

Calculation of domain scores and indices: For each SARA domain, a domain score was calculated (see Tables 1, 2 and 3, column 'Calculation'), ranging from 0 to 100%. At the end of each table, a summary index is described, calculated as the mean of the related domain scores, and ranging from 0 to 100%.

Statistical analysis

Data analysis was conducted using IBM SPSS Statistics 25. Sample weights were applied to ensure the actual representativeness of findings at the national level and according to the managing authority. Initially, the weighted mean of the three outcome variables with their domains and sub-components, overall and stratified by the managing authority, was calculated for 2015 and 2021 respectively. Subsequently, a weighted t-test for independent samples was carried out to test for a statistically significant change over time in each of the outcome variables. The weighted mean difference of the change observed between 2015 and 2021 and its 95% confidence interval (CI) were calculated. A level of significance of 0.05 was assumed for all analyses.

Ethical approval

The 2015 and 2021 NHFSs obtained ethical approval from the Nepal Health Research Council, while this study was approved both by the Ludwig-Maximilians-Universität (LMU Munich) Ethics Commission, Munich, Germany and by the Nepal Health Research Council in June 2021.

Results

Characteristics of HFs providing normal low-risk delivery services in Nepal

As shown in Table 4, this study analyzed 457 and 804 HFs providing normal low-risk deliveries in 2015 and 2021 respectively. In both years, more than eight out of ten HFs providing normal low-risk delivery services were public basic healthcare centres;

HF readiness for normal low-risk delivery services

As shown in Fig. 2, nationally, the average HF readiness index for normal low-risk delivery services was below 50% in both years despite a statistically significant increase from 37.9% in 2015 to 43.7% in 2021. There was, however, considerable variation between domain scores. Between 2015 and 2021, the greatest improvement was observed for essential medicines for newborns (statistically significant increase from 42.0% to 53.6%), followed by essential medicines for mothers (from 76.6% to 85.8%), equipment and supplies (from 70.0% to 78.2%), and trained providers (from 62.2% to 71.1%). Only one score showed a statistically significant decrease, i.e. the use of guidelines for essential delivery care decreased from 21.8% to 12.8%. Details are presented in Supplemental Table a.

Table 5 shows inter- and intra-domain variability of HF readiness. Availability of all 13 basic equipments and supplies for normal low-risk delivery services was excessively low and insignificantly increased from 6.5% in 2015 to 8.8% in 2021. Of the 13 items, the availability of nine significantly increased: emergency transport, examination light, delivery pack, neonatal bag and mask, delivery bed, partograph, blood pressure set, latex gloves, and infant weighing scale with levels in 2021 between 82.0% and 98.7%. The availability of the four remaining items – manual vacuum extractor, vacuum aspiration kit, suction

Table 1 Operational definition of HF readiness index for normal low-risk delivery services

Domain/Index	*Indicators analyzed from the NHFS 2015 and 2021 data set*	*Calculation*
Domain 1: Trained provider	*1 indicator* – At least one trained provider, regardless of the duration of training, is available to provide essential childbirth care regardless of the timing and duration of the training	Domain score = Indicator (0% = no provider, 100% = at least one provider)
Domain 2: Guidelines	*1 indicator* – Observed availability of at least one guideline on essential childbirth care, checklists and/or job aids for essential childbirth care	Domain score = Indicator (0% = no guideline, 100% = at least one guideline)
Domain 3: Equipment and supply	*13 indicators* – Observed availability and reported functionality of: i) emergency transport—this included ambulance or another vehicle for emergency transport, ii) delivery pack: a sterile delivery pack or all of the following 5 items: cord clamp, episiotomy scissors, scissors or blade, suture material with a needle, and needle holder, iii) examination light, iv) suction apparatus (mucus extractor), v) neonatal bag and mask, vi) delivery bed, vii) a blank partograph, viii) infant weighing scale, and ix) blood pressure (BP) set, x) latex gloves, xi) sterilization equipment, xii) manual vacuum extractor, and xiii) vacuum aspiration kit	Domain score = Percentage of functioning items available (Range: From 0% = no items to 100% = (at least 1 functioning unit of) all 13 items, e.g. 9/13 = 69.2% in the case of 9 functioning items available)
Domain 4: Essential medicines for mothers	*5 indicators* – Observed availability of at least one valid unit of: i) injectable uterotonic, ii) injectable antibiotic, iii) injectable magnesium sulfate, iv) skin disinfectant, and v) fluid with an infusion set	Domain score = Percentage of essential medicines for mothers available (Range: From 0% = no medicines to 100% = (at least 1 valid unit of) all 5 medicines, e.g. 4/5 = 80.0% in the case of 4 essential medicines for mothers available)
Domain 5: Essential medicines for newborns	*5 indicators* – Observed availability of at least one valid unit of: i) chlorhexidine gel, ii) tetracycline eye ointment, iii) injection gentamycin, iv) amoxicillin syrup, and v) ceftriaxone powder for injection	Domain score = Percentage of essential medicines for newborns available (Range: From 0% = no medicines to 100% = (at least 1 valid unit of) all 5 medicines, e.g. 2/5 = 40.0% in the case of 2 essential medicines for newborns available)
HF readiness index for normal low-risk delivery services	Readiness for normal low-risk delivery service is measured across 5 domains: i) trained provider, ii) guidelines, iii) equipment and supplies, iv) essential medicines for mothers, and v) essential medicines for newborns	HF readiness Index = Mean score of the five domain scores. (Range: From 0% = no readiness to 100% = complete readiness, e.g. (0% + 0% + 69.2 % + 80.0% + 40.0%) / 5 = 37.8%)

Table 2 Operational definition of BEmONC service functionality

Index	*Signal functions analyzed the NHFS 2015 and 2021 data set*	*Calculation*
BEmONC service functionality	Reported performance of the following seven signal functions at least once during the three months before the survey—parenteral administration of: i) antibiotics, ii) oxytocin, and iii) anticonvulsants, iv) assisted vaginal delivery, v) manual removal of placenta, vi) removal of retained products of conception, and vii) neonatal resuscitation	BEmONC service functionality = Percentage of signal functions performed (Range: From 0% = none performed to 100% = all performed, e.g., 6/7 = 85.7% in the case of 6 signal functions performed)

apparatus and sterilization equipment – increased but not in a statistically significant manner.

Nationally, one in two HFs (49.8%) had in stock all five essential medicines and commodities for mothers in 2021 which represents a significant increase from 29.7% in 2015. The availability of injectable uterotonics, skin antiseptics, and intravenous solutions with an infusion set was high, being in stock at nearly nine out of ten HFs in 2015, which improved significantly to nearly all HFs in 2021. Injectable antibiotics were available at two-thirds (66.1%) of facilities in 2021, representing a significant increase from 40.9% in 2015. Seven out of ten HFs stocked magnesium sulphate in both years. Compared to the availability of all five essential

Table 3 Operational definition of IPC index

Domain/Index	*Indicators analyzed the NHFS 2015 and 2021 data set*	*Calculation*
Domain 1: Trained provider	*1 indicator* – At least one provider available in the HF who is reported to be trained on IPC or waste management regardless of the timing and duration of the training	Domain score = Indicator (0% = no trained provider, 100% = at least one trained provider)
Domain 2: Guidelines	*1 indicator* – Observed availability of at least one guideline on health care waste management or infection control and prevention	Domain score = Indicator (0% = no guideline, 100% = at least one guideline)
Domain 3: Equipment and supplies	*10 indicators* – Observed availability and reported functionality of: i) soap and running water or alcohol-based hand rub, ii) needle destroyer, iii) waste receptacle, iv) disinfectant, v) gown or apron, vi) surgical mask, vii) latex gloves, viii) syringe, ix) eye protection, and x) sterilization equipment	Domain score = Percentage of functioning items available (Range: From 0% = no equipment and supplies to 100% = complete equipment and supplies, e.g. 6/10 = 60.0% in the case of 6 functioning items available)
IPC index	Readiness for IPC is measured across 3 domains: i) trained provider, ii) guidelines, and iii) equipment and supplies	IPC index = Mean score of the three domains (Range: From 0% = no IPC to 100% = complete IPC, e.g. (0% + 0% + 60.0%) / 3 = 20%)

Table 4 (Weighted) distribution of health facilities providing normal low-risk delivery services in Nepal in 2015 and 2021 by health facility type and managing authority

Background characteristics	2015		2021	
	Percent	Number	Percent	Number
Facility type				
Public hospitals	4.4	20	5.2	42
Public basic healthcare centers	85.8	392	87.2	701
Private hospitals	9.8	45	7.6	61
Managing authority				
Public	90.2	412	92.4	743
Private	9.8	45	7.6	61
Total health facilities	**100.0**	**457**	**100.0**	**804**

medicines and commodities for mothers, the availability of all five essential medicines for newborns in both surveys was extremely low and changed only slightly from 0.7% in 2015 to 2.2% in 2021. Stockout of tetracycline eye ointment was paramount, with only one in ten HFs having this stock in 2021. The availability of 4% chlorhexidine antiseptics, amoxicillin syrup, ceftriaxone injection, and injection gentamycin significantly increased between 2015 and 2021, ranging from 38.1% to 80.2% in 2021.

BEmONC service functionality

Overall, at the national-level, functionality of BEmONC services was inadequate in HFs providing normal low-risk delivery services and did not show relevant improvements by 2021. As Table 6 shows, BEmONC service functionality was extremely low in both years, 4.2% in 2015 and 2.5% in 2021. Of the seven signal functions, the administration of parenteral oxytocin was high in both years and slightly increased to 88.2% by 2021, while all other signal functions decreased between 2015 and 2021. A significant decrease in functionality was found for assisted vaginal delivery, neonatal resuscitation, removal of retained products of conception, and manual removal of the placenta. The administration of anti-convulsants and assisted vaginal delivery were performed least frequently, below or at ten percent, among the seven signal functions in both years.

Infection prevention and control

Figure 3 shows, on average, that the IPC index among HFs providing normal low-risk delivery services is very low in Nepal, despite a statistically significant increase from 6.0% in 2015 to 8.0% by 2021. Inter-domain variations were large. The availability of at least one provider trained regarding IPC had the highest score in both years and significantly increased from 79.7% in 2015 to 86.4% by 2021. The availability and functionality of IPC equipment and supplies had the largest increment in score (20.5% points), reaching 72.6% by 2021. The availability of guidelines on IPC was below ten percent in both years, which significantly lowered the overall IPC index. Details are presented in Supplemental Table b.

The availability of all ten items under IPC equipment and supplies increased significantly from 0.7% in 2015 to 6.3% by 2021 (mean difference: 5.5, CI: [3.7; 7.4], $p < 0.0001$), however, these levels are far too low to ensure appropriate IPC measures. The availability of

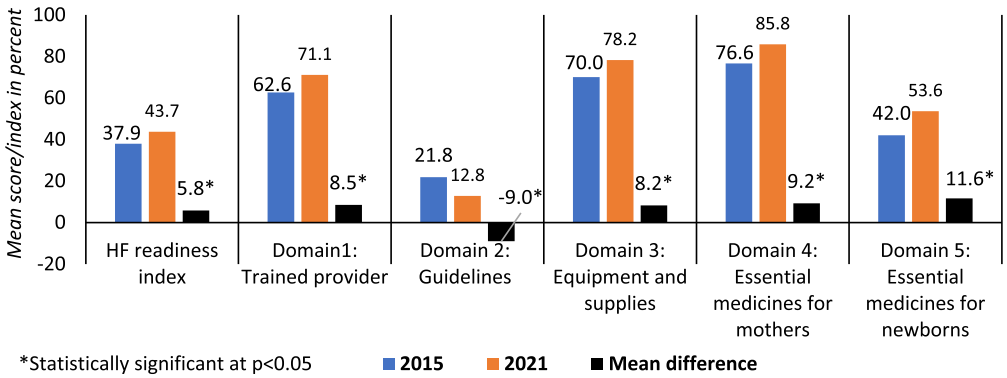

Fig. 2 Health facility (HFs) readiness index for normal low-risk delivery services and domain-wise scores in Nepal in 2015 and 2021

all four items of personal protective equipment – latex gloves, surgical masks, eye protection, and gowns or aprons – significantly increased from a mere 5.9% in 2015 to 51.1% in 2021 (mean difference: 45.3, CI: [41.2; 49.3], $p < 0.0001$), however, this level is still considered inadequate, particularly for eye protection supplies.

Key findings by managing authority

The HF readiness index for normal low-risk delivery services showed statistically significant increases from 37.6% to 43.6% among public HFs, and from 39.9% to 45.3% among private HFs between 2015 and 2021 respectively, thus showing small differences by managing authority. Differences regarding the changes in HF readiness domains between public and private HFs are reported in Supplemental Table a.

In 2021, the disparity in BEmONC service functionality of HFs providing normal low-risk delivery services by managing authority was large: public 1.8% and private 10.5%, which was a decline from 3.0% in public and from 15.7% in private HFs from 2015 respectively. The statistically significant changes in two signal functions among the public HFs are reported in Supplemental Table c.

The IPC index was found to be low for both managing authorities, with a slightly better score among private HFs (6.9% in 2015, 8.4% in 2021) than among public HFs (5.9% in 2015, 7.9% in 2021). The statistically significant changes in domain level scores between public and private HFs are reported in Supplemental Table b.

Discussion

Key findings and locating them in the literature

In the context of the constitutional right of the Nepali people to free basic healthcare services, the mandate for local governments to manage their basic healthcare services, the inclusion of normal-low risk delivery services into the basic healthcare package, and a strategic focus on improving the QoC, the present study analyzed nationally representative data from HFs providing low-risk delivery services with regard to their readiness, functionality of basic emergency obstetric and newborn care services, and infection prevention and control.

Health facility readiness for normal low-risk delivery services- quality of care

The readiness of HFs in Nepal for normal, low-risk delivery services is suboptimal. While there have been improvements in the HF readiness index from 37.9% in 2015 to 43.7% in 2021, these changes are small and equate to a 0.9% annual improvement rate. This indicates that the majority of HFs in Nepal have low scores for HF readiness. A number of studies published using the NHFS 2015 data identifies inadequate number of service providers, irregular services, supply chain issues being key challenges for continuum and quality of delivery care across both public and private HFs [24, 25]. The low readiness of HFs to provide high-quality, normal, low-risk delivery services is not surprising because the QoC for other basic healthcare services is also sub-optimal. For instance, less than two percent of HFs meet minimum standards of care for antenatal, family planning, and sick child services [12, 26]. Similar results have been observed in other low- and middle-income countries (LMICs). For example, in Nigeria, between 2005 and 2009, there was no statistically significant progress in the availability of trained providers for labor and delivery care (from 50.8% to 57.1%). Indeed, the readiness of HFs to provide maternal health services was low in both years [27]. One major challenge for LMICs is the lack of commonly agreed upon QoC indicators, which hinders measuring progress nationally and makes it difficult to compare indicators across countries. The use of the Minimum Service Standard (MSS) tool in public HFs is a relatively new concept but its use has now standardized monitoring of HF readiness in Nepal. The reporting

Table 5 Availability of equipment and supplies, essential medicines for mothers and essential medicines for newborns among health facilities providing normal low-risk delivery services in Nepal in 2015 and 2021

	Mean in % (Percentage)		Mean difference in %	95% CI of mean difference in %	*P*-value
	2015	2021			
Readiness domain: Equipment and supplies					
i. Emergency transport	62.6	82.0	19.4	[14.2; 24.5]	< 0.0001*
ii. Examination light	60.7	93.8	33.1	[28.3; 37.9]	< 0.0001*
iii. Delivery pack	92.9	97.9	5.0	[2.3; 7.5]	< 0.0001*
iv. Suction apparatus	62.0	65.7	3.7	[-1.8; 9.3]	0.1890
v. Neonatal bag and mask	82.8	91.6	8.8	[4.9; 12.8]	< 0.0001*
vi. Delivery bed	96.3	98.7	2.4	[0.5; 4.3]	0.0140*
vii. Partograph	80.0	90.4	10.4	[6.2; 14.6]	< 0.0001*
viii. Blood pressure apparatus	84.1	95.3	11.2	[7.5; 14.8]	< 0.0001*
ix. Latex gloves	92.5	97.5	5.0	[2.3; 7.6]	< 0.0001*
x. Sterilization equipment	65.0	66.1	1.2	[-4.3; 6.7]	0.6690
xi. Infant weighing scale	89.9	94.1	4.2	[1.1; 7.5]	0.0090*
xii. Manual vacuum extractor	20.7	23.2	2.5	[-2.2; 7.2]	0.3030
xiii. Vacuum aspiration kit	19.2	20.9	1.7	[-2.8; 6.3]	0.4540
All 13 pieces of equipment	6.5	8.8	2.3	[-0.7; 5.3]	0.1320
Readiness domain: Essential medicines for mothers					
i. Injectable uterotonic	88.2	97.0	8.8	[5.6; 12.0]	< 0.0001*
ii. Injectable antibiotic	40.9	66.1	25.2	[19.6; 30.8]	< 0.0001*
iii. Injectable magnesium sulfate	72.2	70.7	-1.5	[-6.7; 3.7]	0.5700
iv. Skin antiseptic	91.4	98.1	6.7	[4.0; 9.5]	< 0.0001*
v. Intravenous solution with an infusion set	90.3	97.2	6.9	[3.9; 9.8]	< 0.0001*
All five essential medicines and commodities	29.7	49.8	20.1	[14.7; 25.6]	< 0.0001*
Readiness domain: Essential medicines for newborns					
i. 4% Chlorhexidine	58.0	80.2	22.2	[16.9; 27.5]	< 0.0001*
ii. Tetracycline eye ointment	39.5	7.8	-31.7	[-36.6; -26.8]	< 0.0001*
iii. Injection gentamycin	74.8	79.8	5.0	[0.2; 9.90]	0.0420*
iv. Amoxycillin syrup	25.7	62.2	36.5	[31.3; 41.80]	< 0.0001*
v. Ceftriaxone powder for injection	12.0	38.1	26.1	[21.6; 30.6]	< 0.0001*
All 5 essential medicines and commodities	0.7	2.2	1.50	[0.3; 2.8]	0.0180*
Total health facilities	**457**	**804**	-		-

* Statistically significant at $p < 0.05$

Table 6 BEmONC service functionality among health facilities providing normal low-risk delivery services in Nepal in 2015 and 2021

Signal functions performed	Mean in % (Percentage)		Mean difference in %	95% CI of mean difference in %	*p*-value
	2015	2021			
i. Administration of parenteral antibiotics	40.7	36.5	-4.2	[-9.9; 1.3]	0.1340
ii. Administration of parenteral oxytocin	85.8	88.2	2.4	[-1.5; 6.3]	0.2310
iii. Administration of parenteral anticonvulsants	10.0	8.9	-1.1	[-4.5; 2.3]	0.5290
iv. Assisted vaginal delivery	16.1	8.1	-8.0	[-11.8; -4.1]	0.0000*
v. Manual removal of placenta	42.8	36.7	-6.1	[-11.8; -0.5]	0.0340*
vi. Removal of retained products of conception	33.0	26.4	-6.6	[-11.9; -1.3]	0.0150*
vii. Neonatal resuscitation	36.8	29.6	-7.2	[-12.7; -1.8]	0.0090*
All seven signal functions performed	4.2	2.5	-1.7	[-3.9; 0.4]	0.1140
Total health facilities	**457**	**804**	-	-	-

* Statistically significant at $p < 0.05$

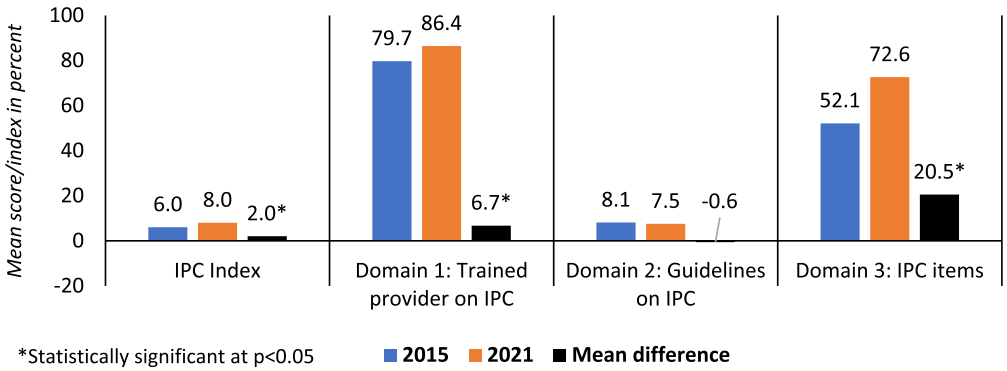

Fig. 3 IPC index and domain-wise scores for health facilities providing normal low-risk delivery services for infection prevention and control in Nepal in 2015 and 2021

of MSS scores as part of the routine Health Management Information System database has helped local governments and HFs identify gaps in HF readiness, link them with service utilization data, and take corrective actions. This tool has led to positive changes and that policy implications are to strengthen this standardized monitoring.

In this study, wide variation across the five domains of HF readiness was found between the survey years. Four out of five domains, namely equipment and supplies, essential medicines for mothers, trained providers, and essential medicines for newborns, significantly improved in 2021 with large variations within the components. This could be due to the focus on improving QoC during the implementation of the Nepal Health Sector Strategy (NHSS) 2016–2022. In contrast, the fifth domain, the availability of guidelines on delivery care, performed the least and significantly decreased from 21.8% in 2015 to 12.8% in 2021. This is low compared to other LMICs such as Haiti and Tanzania where delivery care guidelines were available in 24.1% and 29.8% of the HFs in 2017 and 2019, respectively [26, 28]. The low and diminished availability of guidelines in 2021 in Nepal could be due to COVID-19 restrictions, resulting in a largely virtual mode of operations and halting the printing of guidelines or their dissemination to HFs. Nevertheless, during the COVID-19 pandemic, digital guidelines, particularly on COVID-19 topics, were provided to HFs. Program guidelines comprise evidence-informed recommendations intended to standardize and optimize care for patients, and their use during clinical decision-making is intended to improve healthcare outcomes [29, 30]. Even though both paper and digital guidelines were included in this analysis, the low results in 2021 suggest little or no effort made to improve guideline availability since 2015. Anecdotal evidence indicates improper storage of digital guidelines in electronic devices, that cannot be accessed by service providers when needed. Improving the skills of providers in accessing these guidelines on computers and mobile devices can support increased use of the digital guidelines. The COVID-19 pandemic disrupted regular trainings [31, 32], but Nepal was able to significantly increase the availability of trained delivery service providers by 2021. Reaching the SDG target of attaining 90% skilled birth attendance was a focus of NHSS (2016-2022), and several training packages were available to train the delivery care service providers on enhancing their knowledge and skills, which were continued virtually during COVID-19. However, gaps still exist, with nearly one in three HFs lacking a provider trained in delivery care. Human resource availability and their skills remain a significant health system challenge that is not unique to Nepal but relevant for many other LMICs [33].

Supply chain issues have emerged, particularly with essential medicines for newborns and basic equipment and supplies. The frequent lack of equipment could be a reason for the low rates of assisted deliveries in HFs. Additionally, the low availability of sterilization equipment increases the risk of nosocomial infections for both the mother and the newborn, and the low availability of tetracycline ointment for the treatment of newborn eye infections illustrates poor readiness for newborn care. This is alarming since the NMR has not been reduced below 21 deaths per 1,000 live births since 2016 [6]. Although the stock of essential medicines for mothers was better than for newborns in both managing authorities, there is still a significant lack of supply, mainly for injectable magnesium sulphate and injectable antibiotics. This is alarming because in 2021, 12.0% and 11.2% of maternal deaths during the post-partum period were due to hypertensive disorders and infections respectively; and 10.2% of the maternal deaths during delivery had fits, seizures, and convulsions [2]. Data from 28 hospitals over the four-year

period from 2015 to 2018 reports eclampsia to be the leading cause of maternal deaths (19.0%). The availability of magnesium sulphate in LMICs is consistently low. A study published in 17 LMICs in 2018 revealed that magnesium sulphate was amongst the least available essential medicines and commodities for mothers (median: 63%, range: 10.0–97.0%) [34]. It is important to ensure a reliable supply of magnesium sulfate and antibiotics and enforce its correct use in training. The supply chain system of any country is affected by the service delivery structure. Prior to Nepal being declared a federal republic in 2017, medicines were procured by the central government system. Now, all three tiers of government procure medicines, but there is a lack of clarity on which level of government should be responsible for which task. As a result, there is often over or understocking of medicines at HFs. The overall capacity of local governments to procure medicines through systematic data-driven forecasting and following public procurement guidelines is limited. While both push and pull supply-chain systems are in place, establishing a strong supply chain system remains an ongoing challenge. Data-driven procurement, efficient transportation management, and improving governance at all levels should be prioritized.

Basic emergency obstetric and neonatal care (BEmONC) service functionality

Fifteen percent of pregnant women develop a potentially life-threatening complication that requires skilled medical care, and some may even require major obstetrical intervention for survival [35]. According to verbal autopsy reports on maternal deaths conducted in Nepal in 2021, the majority of maternal deaths occur during the postpartum period due to obstetric hemorrhage and take place at HFs [2]. This underscores the importance of functional BEmONC services. Sadly, in 2021, only 2.5% of HFs had functional BEmONC services, indicating a decline from 4.5% reported in 2015, which may be attributed to health system challenges arising from the COVID-19 pandemic such as HF closures or disfunctional supply-chain systems. In 2022, eight out of ten deliveries at HFs were attended by skilled birth attendants at HFs [1]. This means that the majority of HFs can provide assisted vaginal delivery services to pregnant women in need. However, in 2021, only 16.2% of HFs offering normal low-risk deliveries reported having assisted vaginal delivery services available. Private HFs consistently had higher BEmONC service functionality in both surveys than public HFs; this could be because all private HFs analyzed in this study were hospitals, unlike only about 5% of the public HFs analyzed. Studies on BEmONC in Africa and Pakistan have identified a shortage of trained providers, high absenteeism rates, poor ambulance services, and supply chain issues as barriers to quality BEmONC services [28, 36]. These barriers are also relevant in the Nepalese context. Other obstacles to quality BEmONC in LMICs include poor provider remuneration and demoralization, high turnover, increased workload and burnout rates, poor coordination, inefficient referral mechanisms, inadequate allocation of limited resources, lack of training and monitoring, and inequality in the distribution of BEmONC sites [37]. In Nepal, under the *Aama Program*, HFs receive unit costs for attending normal-low-risk, complicated, and cesarean deliveries, a small amount of which is provided to the birth attending team, which can motivate the providers [38]. However, this study did not analyze the barriers and the motivation factors in depth.

With improved access to HF-based delivery services, eight out of ten women giving birth in HFs [6] and over half of the maternal deaths occurring in HFs, the low functionality of the BEmONC service and lack of progress are alarming in fulfilling the SDG commitment of reducing maternal deaths. The low volume of deliveries in basic healthcare centers, due to improper location and inadequate HF readiness, results in overcrowding in hospitals [0 24]. Considerable home deliveries, lack of awareness of the *Aama Program*, and the impact of the COVID-19 pandemic for 2021 could explain the low BEmONC service functionality in Nepal. Furthermore, these findings reinforce the thrust of the Nepal Safe Motherhood and Newborn Health Road Map (2030) and NHSSP 2023–2030 and suggest re-thinking the strategic locations of the HFs providing BEmONC services, and creating demand for those HFs, as well as improving services, including staffing in hospitals.

Infection prevention and control

Universal precautions for IPC are important not only in the face of the COVID-19 pandemic and other disease outbreaks but also in routine healthcare provision. Birth itself and vaginal examinations make pregnant women more susceptible to infections. Despite significant improvements in the IPC index between 2015 and 2021 found in this study, the 2021 IPC levels of 7.9% for public HFs and 8.4% for private HFs are excessively low. Although the availability of trained providers on IPC and personal protective equipment significantly improved in 2021 due to COVID-19 response efforts, the availability of IPC guidelines is also low, and the overall IPC status is inadequate. The low readiness for IPC found in this study is comparable to HFs in Bangladesh, where only 16.4% of the standard precaution elements were available for delivery and newborn care services in 2017 [29], and another analysis of 17 LMICs where the median national availability of sterilization equipment was

51.0% in 2018 [34]. Items such as waste receptacles and needle destroyers were often not available in HFs, indicating a need to strengthen supply chain systems and put into place quality improvement teams [13, 39]. In the new federal system in Nepal, resources can be leveraged from local governments for local purchase of these easily available items.

Strengths and limitations of the study

This study has both strengths and limitations. It is the first study to draw on data from two nationally representative NHFSs implemented under the global Demographic and Health Survey (DHS) Program to measure changes in HF readiness for normal low-risk deliveries. This occurred over a time period when Nepal was hit by a 7.8 Richter Scale earthquake and the recent COVID-19 pandemic and amid the country's transition to a federal government system. Methodologically, the NHFS derived a sampling frame from Nepal's national health system that included both public and private HFs. The survey instruments were validated, and verbal responses were confirmed by observations. Data were collected in tablets by thoroughly trained medical, nursing, or public health personnel. Data quality was checked daily by the local research firm and the DHS Program, and the analysis was guided by publicly available code books, weighing techniques, and tutorials at https://dhsprogram.com/Data/. Although data collection for the 2015 and 2021 NHFSs was impacted by the earthquake and the COVID-19 pandemic, respectively, standard operating procedures were fully followed, and there were no major quality concerns except that data collection was delayed and took longer than planned. However, there are some limitations. These include, for example, the small sample size for private HFs since only private hospitals were surveyed, and the fact that stock data were impacted by the timing of receipt of the stocks at HFs, and that the 2015 earthquake and the COVID-19 pandemic made supply chains vulnerable and irregular. General amenities like waiting areas, sanitation, and drinking water facilities were not analyzed, and newborn care was not comprehensively covered in the analysis. This study focused only on the variables recommended by WHO's SARA manual and did not analyze other health system factors.

Implications for policy, practice and research

The policy environment for improving QoC is progressing in Nepal. However, several challenges exists that need to be addressed. For instance, the establishment of an accrediting body for quality assurance in the public and private health sector, as envisioned in the NHSSP (2023–2030), has not been fully effective yet; local governments have limited human resource capcity to provide basic healthcare services; monitoring mechanisms for basic healthcare services remain unclear; and the lack of accountability mechanisms is hindering progress which impacts the HF readiness to provide delivery services. The standards for normal low-risk deliveries are equal for all HFs regardless of their size and managing authority [16, 23, 40, 41]. While the private sector in Nepal is expanding, it represents the first point of contact for women seeking delivery services in several parts of the country [1] but monitoring QoC in the private sector is challenging due to unclear regulations. Comparatively, private HFs have slightly better readiness than public HFs, with better availability of essential medicines and equipment. However, they lack adequately trained providers and delivery care guidelines. While they are more ready to provide BEmONC services, and generally more resourceful compared with public HFs, they need a better operating environment and a motivation to implement the *Aama Program*, which can create a win–win situation for both the public and the private sectors, ensuring high QoC for pregnant women.

The earthquake in 2015 claimed the lives of over 9,000 people, while the COVID-19 pandemic resulted in a death toll of over 12,000 people [42] and continues to impact Nepal's health system. Although Nepal's transition from a unitary to a federal country allowed for local planning and management of basic healthcare services, unclear demarcation of authority between jurisdictions in the three tiers of government led to slow decision-making and adversely affected healthcare service delivery [43]. This study indicates that, following the shift to a federal system, increased emphasis was placed on expanding the number of HFs, but not enough attention was paid to improving their readiness and the QoC. The challenges of inadequate and insufficiently skilled staff at HFs need to be addressed by local governments through robust planning, budgeting, implementation, and oversight of basic healthcare services. Similarly, clarifying the roles and responsibilities of the three tiers of government in the delivery of basic healthcare services and fostering proper coordination among them remain crucial to ensure HF readiness for high-quality services, including normal low-risk births, obstetric complication management, and improved maternal survival.

Data availability for QoC is improving in Nepal [12]. The implementation of previous health sector strategies has informed the government and other stakeholders to develop the NHSSP (2023–2030), the Nepal Safe Motherhood and Newborn Health Road Map 2030, and a nationally representative, comprehensive NHFS to monitor changes in QoC at five-year intervals. The NHFS 2021 is the key data sources to track HF readiness indicators of the NHSSP (2023–2030), its continuity will provide opportunities for researchers and policymakers to

analyze trends and rates of changes in HF readiness for delivery and other basic healthcare services. However, Nepal also needs a functional information system that can routinely track QoC indicators in both public and private sectors. While the Health Management Information System and Logistic Management Information System monitor service utilization rates, medicine stock, and Minimum Service Standard scores at HFs, they are limited in monitoring other important QoC indicators.

Improving QoC needs to remain a top priority in the health system in Nepal, with clear roles, evidence-based strategies, and interventions designed for all providers, including the three tiers of government and the private sector. The gaps in HF readiness identified in this study, as well as those in NHFS 2021, the Minimum Service Standard tool implementation in public HFs, and other studies, need to be collated to generate knowledge and translate them into budgeted plans for the relevant governments. These actions should ensure effective supply chain management, training and regular availability of service providers, availability of program guidelines, and functioning quality improvement systems. The local governments and HFs need to leverage internal and external resources and monitor the effective implementation of basic healthcare services, which are key to increasing HF births, managing obstetric complications, preventing women from nosocomial infections, and ultimately reducing maternal deaths. The results of this study can complement the baseline and review of the result framework for the NHSSP (2023–2030), with suggested QoC indicators, monitoring approaches, and support for tracking progress over time.

Conclusions

The slow progress and sub-optimal readiness for normal, low-risk deliveries and IPC, along with declining and low BEmONC service functionality in 2021, is reflective of poor QoC and provides some proximate explanation for the moderately high maternal mortality and the stagnation of NMR in Nepal. However, these findings need to be interpreted within the context of the effects of the 2015 earthquake, the COVID-19 pandemic, and the new federal government system in Nepal. Despite QoC being a strategic focus of the NHSS (2016–2022) and HF readiness being a prerequisite for ensuring the process of care provision and client satisfaction, there are gaps in the current supply chain system, human resource capacity, quality improvement approaches adopted, and the operating environment for the private sector. To fulfil the constitutional mandate of managing basic healthcare services and providing high-quality delivery services to pregnant women, improving the capacity of local governments is critical, ultimately contributing to meeting SDG 3.1 target of reducing maternal deaths.

Abbreviations

SDG	Sustainable Development Goal
HF	Health facility
BEmONC	Basic emergency obstetric and neonatal care
EmONC	Emergency obstetric and neonatal care
UN	United Nations
NMMS	Nepal Maternal Mortality Study
NMR	Neonatal Mortality Rate
DHS	Demographic and Health Survey
WHO	World Health Organization
QoC	Quality of Care
COVID	Corona virus disease
IPC	Infection prevention and control
NHSS	Nepal Health Sector Strategy
NHSSP	Nepal Health Sector Strategic Plan
NHFS	Nepal Health Facility Survey
SARA	Service Aaialbility and Readiness Assessment
SPSS	Statistical Package for the Social Sciences
LLMU	Ludwig-Maximilians-Universität
CI	Confidence interval
LMIC	Low and middle income countries
MSS	Minimum Service Standards

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-023-06138-8.

Additional file 1: Supplemental Table a. Health facility readiness index and domain-wise scores of HFs to provide normal low-risk delivery services in Nepal in 2015 and 2021 in total and by managing authority. **Supplemental Table b.** Infection prevention and control index and domain-wise score for of health facilities providing normal low-risk delivery services in Nepal in 2015 and 2021, in total and by managing authority. **Supplemental Table c.** BEmONC service functionality among health facilities providing normal low-risk delivery services in Nepal in 2015 and 2021, by managing authority.

Acknowledgements

The authors would like to acknowledge Kiran Acharya for assisting in processing data, and Prakash Gnyawali for editorial support.

Authors' contributions

S.T. conceptualized and designed the study, performed statistical analysis, and wrote the manuscript. D.P., M.D., E.R., and M.S. provided inputs during the study design, reviewed, and edited the manuscript. C.O. provided advice on statistical analysis and reviewed for interpretation of data. All authors read and approved the final manuscript.

Authors' information

Not provided.

Funding

The authors would like to thank CIH[LMU, the German Academic Exchange Service (DAAD) with its exceed program, and the German Federal Ministry for Economic Cooperation and Development (BMZ) for financial support.

Availability of data and materials

The data used in the study is publicly available at the DHS Program website: https://dhsprogram.com/Data/.

Declarations

Ethics approval and consent to participate

The 2015 and 2021 Nepal Health Facility Surveys obtained ethical approval from the Nepal Health Research Council, while this study was approved both by the Ludwig-Maximilians-Universität (LMU Munich) Ethics Commission, Munich, Germany and by the Nepal Health Research Council in June 2021.

Consent for publication
All authors have provided consent for publication.

Competing interests
The authors declare no competing interests.

Author details
[1]Teaching & Training Unit, Division of Infectious Diseases and Tropical Medicine, University Hospital, LMU, Munich, Germany. [2]Center for International Health, LMU, Munich, Germany. [3]Save the Children, Kathmandu, Nepal. [4]Institute for Medical Information Processing, Biometry and Epidemiology, LMU, Munich, Germany. [5]Pettenkofer School of Public Health, Munich, Germany. [6]Institute of Medical Education, LMU, University Hospital, LMU, Munich, Germany. [7]Department of Obstetrics and Gynecology, University Hospital, LMU, Munich, Germany.

Received: 15 April 2023 Accepted: 18 November 2023
Published online: 24 January 2024

References

1. Ministry of Health (MOH) Nepal; New ERA, Nepal; ICF. Nepal Demographic and Health Survey 2016. Kathmandu: Ministry of Health; 2017.
2. Ministry of Health and Population (MOHP) and National Statistics Office (NSO). National population and housing census 2021. A report on maternal mortality. Government of Nepal. 2022. Available from https://mohp.gov.np/uploads/Resources/Final%20Report-26%20March-%202023-UPDATED.pdf.https://www.dhsprogram.com/pubs/pdf/fr336/fr336.pdf.
3. Malla DS, Giri K, Karki C, Chaudhary P. Achieving millennium development goals 4 and 5 in Nepal. BJOG. 2011;18 Suppl 2:60–8. https://doi.org/10.1111/j.1471-0528.2011.03113.x.
4. National Planning Commission (NPC). Nepal's Sustainable Development Goals Status and Roadmap: 2016–2030. Published by Government of Nepal, National Planning Commission, Singha Durbar, Kathmandu Nepal. 2017. Available from http://sdg.npc.gov.np/media/resources/items/0/bSustainable_Development_Goals_Status_and_Roadmap__2016-2030_46E6XzP.pdf.
5. Bhutta ZA, Das JK, Bahl R, et al. Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost? Lancet. 2014;384:347–70. https://doi.org/10.1016/S0140-6736(14)60792-3.
6. Ministry of Health and Population (MOHP) Nepal, New ERA, Nepal; ICF. Nepal Demographic and Health Survey (NDHS) 2022. Ministry of Health and Population, Kathmandu, Nepal. 2022. Available from The DHS Program. Nepal: DHS; 2022. Final Report (English).
7. ICF. The DHS Program STATcompiler. Funded by USAID. 2012. Available from http://www.statcompiler.com. February 28, 2023.
8. World Health Organization (WHO). Care in normal birth: a practical guide. report of a technical working group. Reproductive health and research. Geneva: WHO; 1996. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2413/2014/08/WHO_FRH_MSM_96.24.pdf.
9. Department of Health Services (DOHS). Annual Report 2020/2021. Government of Nepal. Kathmandu: Ministry of Health and Population. https://dohs.gov.np/annual-report-fy-2077-78-2019-20/.
10. World Health Organization (WHO). Quality of care: a process for making strategic choices in health systems. Geneva: WHO; 2006. Available from https://apps.who.int/iris/handle/10665/43470.
11. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, Adeyi O, Barker P, Daelmans B, Doubova SV, English M, García-Elorrio E, Guanais F, Gureje O, Hirschhorn LR, Jiang L, Kelley E, Lemango ET, Liljestrand J, Malata A, Pate M. High-quality health systems in the Sustainable Development Goals era: time for a revolution. Lancet Glob health. 2018;6(11):e11096–252. https://doi.org/10.1016/S2214-109X(18)30386-3.
12. Ministry of Health and Population (MOHP), Nepal. New ERA, Nepal, ICF. Nepal Health Facility Survey 2021. 2022. Available fromhttps://dhsprogram.com/pubs/pdf/SPA35/SPA35.pdf.
13. World Health Organization (WHO). Standards for improving quality of maternal and newborn care in health facilities. Printed by the WHO Document Production Services, Geneva, Switzerland. 2016. Available fromhttps://cdn.who.int/media/docs/default-source/mca-documents/qoc/quality-of-care/standards-for-improving-quality-of-maternal-and-newborn-care-in-health-facilities.pdf.
14. World Health Organization (WHO). Quality of care for maternal and newborn health: a monitoring framework for network countries. February 2019. Department of Maternal, Newborn, Child and Adolescent Health (MCA), World Health Organization HQ Avenue Appia 20, 1211 Genève, Switzerland. Available fromhttps://cdn.who.int/media/docs/default-source/mca-documents/qoc/qed-quality-of-care-for-maternal-and-newborn-health-a-monitoring-framework-for-network-countries.pdf?sfvrsn=19a9f7d0_1.
15. Loporto. J Soc Change. 2020;12(1):40-70. https://doi.org/10.5590/JOSC.2020.12.1.05. https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=1252&context=jsc.
16. World Health Organization (WHO). 2015. Service Availability and Readiness Assessment (SARA): an annual monitoring system for service delivery, reference manual. Version 2.2. Revised July 2015. Avaialble from https://apps.who.int/iris/bitstream/handle/10665/149025/WHO_HIS_HSI_2014.5_eng.pdf?sequence=1&isAllowed=y
17. Management Division. Assess impact of COVID-19 pandemic in selected health services with estimation of 'excess maternal deaths'. Government of Nepal Ministry of Health and Population Department of Health Service Management Division Integrated Health Information Management Section Kathmandu, Nepal. 2021. https://dohs.gov.np/wp-content/uploads/2021/09/Impact-of-COVID-19-on-selected-health-services.pdf.
18. Hongbo Q, Miaomiao C, Xin L, Xiyao L, Yuan S, Tianjiao L, Hua Z, Jun Z, Yangyu Z, Chao T, Philip NB. Management of a delivery suite during the COVID-19 epidemic. Eur J Obstet Gynecol Reprod Biol. 2020;250:250–2. https://doi.org/10.1016/j.ejogrb.2020.05.031. ISSN 0301-2115.
19. Aaron N, Michael LN, Andrew WM, Gary LG, Santiago JM, Ernesto M. Nosocomial COVID-19 infection in women undergoing elective cesarean delivery: a prospective cohort study. Am J Obstet Gynecol MFM. 2022;4(1):100490. https://doi.org/10.1016/j.ajogmf.2021.100490.
20. Abbas M, Robalo NT, Martischang R, et al. Nosocomial transmission and outbreaks of coronavirus disease 2019: the need to protect both patients and healthcare workers. Antimicrob Resist Infect Control. 2021;10:7. https://doi.org/10.1186/s13756-020-00875-7.
21. Curative Division (CD). Basic Healthcare Service. Ministy of Health and Population. 2018. Available fromhttps://publichealthupdate.com/basic-health-service-package-2075-dohs-mohp-nepal/.
22. Ministry of Health and Population (MOHP). Nepal Health Sector Strategic Plan 2023–2030. Ramshahpath, Kathmandu: Government of Nepal, Ministry of Health and Population; 2023.
23. Family Welfare Division (FWD). Nepal Safe Motherhood and Newborn Health Roadmap 2019. 2019. Available from https://fwd.gov.np/cms/nepal-safe-motherhood-and-newborn-health-road-map-2030/.
24. Acharya K, Subedi RK, Dahal S, et al. Basic emergency obstetric and newborn care service availability and readiness in Nepal: analysis of the 2015 Nepal Health Facility Survey. PLoS One. 2021;16:e0254561. https://doi.org/10.1371/journal.pone.0254561. Epub ahead of print July 21, 2021.
25. Khatri RB, Assefa Y, Durham J. Assessment of health system readiness for routine maternal and newborn health services in Nepal: analysis of a nationally representative health facility survey, 2015. PLOS Glob Public Health. 2022;2:e0001298. https://doi.org/10.1371/journal.pgph.0001298. Epub ahead of print November 21, 2022.
26. Wenjuan W, Michelle W, Clara RB. Limited service availability, readiness, and use of facility-based delivery care in haiti: a study linking health facility data and population Data. Glob Health Sci Pract. 2017;5(2):244–60. https://doi.org/10.9745/GHSP-D-16-00311.
27. Gage AJ, Ilombu O, Akinyemi AI. Service readiness, health facility management practices, and delivery care utilization in five states of Nigeria: a cross-sectional analysis. BMC Pregnancy Childbirth. 2016;16:297. https://doi.org/10.1186/s12884-016-1097-3.
28. Bintabara D, Ernest A, Mpondo B. Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania national survey. BMJ Open. 2019;2019(9):e020608. https://doi.org/10.1136/bmjopen-2017-020608.
29. Pantoja T, Soto M. Clinical practice guidelines development and implementation: an introduction. Rev Med Chil. 2014;142(1):98–104. https://doi.org/10.4067/S0034-98872014000100015BottomofForm.
30. O'Neill K, Takane M, Sheffel A, Abou-Zahr C, Boerma T. Monitoring service delivery for universal health coverage: the service availability and readiness assessment. Bull World Health Organ. 2013;91(12):923–31. https://doi.org/10.2471/BLT.12.116798. Epub 2013 Sep 30. PMID: 24347731; PMCID: PMC3845262.

31. Gyanwali P, Bista NR, Khadka M, Vaidya A, Mahato NK, Karn MK, Pant S, Ghimire N, Pokhrel A, Dhimal M. Assessment of preparedness of government of Nepal in COVID designated hospitals and clinics for pandemic response. J Nepal Health Res Counc. 2021;19(1):48–54. https://doi.org/10.33314/jnhrc.v19i1.3237.
32. Giri S, Panth A. Knowledge and Perceptions of Corona Virus Disease (COVID 19) among Nurses Working at Teaching Hospital, Banke, Nepal. 2022.
33. Bolan N, Cowgill KD, Walker K, Kak L, Shaver T, Moxon S, et al. Human Resources for Health-Related Challenges to Ensuring Quality Newborn Care in Low- and Middle-Income Countries: A Scoping Review. Glob Health Sci Pract. 2021;160–76. https://doi.org/10.9745/ghsp-d-20-00362.
34. Kanyangarara M, Chou VB, Creanga AA, Walker N. Linking household and health facility surveys to assess obstetric service availability, readiness and coverage: evidence from 17 low- and middle-income countries. J Glob Health. 2018;8(1):010603. https://doi.org/10.7189/jogh.08.010603. PMID:29862026;PMCID:PMC5963736.
35. World Health Organization (WHO). Monitoring emergency obstetric care: a handbook. WHO Library Cataloguing-in-Publication. 2009. Available from https://apps.who.int/iris/bitstream/handle/10665/44121/9789241547734_eng.pdf?sequence=1&isAllowed=y
36. Utz B, Zafar S, Arshad N, Kana T, Gopalakrishnan S; Nynke van den Broek. Status of emergency obstetric care in four districts of Punjab, Pakistan - results of a baseline assessment. J Pak Med Assoc. 2015;65(5):480-5. PMID: 26028380.
37. Chi PC, Bulage P, Urdal H, Sundby J. Barriers in the delivery of emergency obstetric and neonatal care in post-conflict Africa: qualitative case studies of Burundi and Northern Uganda. PLoS One. 2015;10(9):e0139120. https://doi.org/10.1371/journal.pone.0139120.
38. Mother and Newborn Program Guidelines 2021 (Aaman tatha Nawajat Sishu Surakshya Karyakram 2078 Nidershika) Nepali. Government of Nepal, Ministry of Health and Population, Department of Health Services, Family Welfare Division, Teku, Kathmandu, Nepal. https://digitallibrary.fwd.gov.np/list/13?categoryName=MATERNAL+%26+NEWBORN+HEALTH&subCategoryName=Safe+Motherhood.
39. Md A, Md ZH, Mohammad RM, Md SI, Aninda R, Zubair A, Fahmida C, Sayera B, Nusrat H. Assessment of standard precaution related to infection prevention readiness of healthcare facilities in Bangladesh: Findings from a national cross-sectional survey PhD6,7. Antimicrob Steward Healthc Epidemiol. 2021;1:e52, 1–7.https://doi.org/10.1017/ash.2021.226.
40. Dominic M, Katie G, Michelle KN, Kali PR, Ananta BS, Kovid S, Cathy G, May S. Results of a person-centered maternal health quality improvement intervention in Uttar Pradesh, India, Published: December 11, 2020.https://doi.org/10.1371/journal.pone.0242909.
41. Family Welfare Division (FWD). National Medical Standard (NMS) Volume III. Ministry of Health and Population. 2019. Available from https://nhssp.org.np/Resources/SD/NMS%20for%20Maternal%20&%20New%20Born%20Care%20-%20PD%20R6%20-%20July%202020.pdf.
42. Ministry of Health and Population (MOHP). Government of Nepal SitRep# 1052. 2022. Available from https://covid19.mohp.gov.np/covid/englishSituationReport/63aad308882e1_SitRep1052_COVID-19_27-12-2022_EN.pdf.
43. Thapa R, Bam K, Tiwari P, Sinha TK, Dahal S. Implementing federalism in the health system of Nepal: opportunities and challenges. Int J Health Policy Manag. 2019;8(4):195–8. https://doi.org/10.15171/ijhpm.2018.121.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Taylor & Francis
Taylor & Francis Group

Health Care for Women International

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/uhcw20

Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021

Sabita Tuladhar, Eva Rehfuess, Maria Delius, Matthias Siebeck, Deepak Paudel & Cornelia Oberhauser

To cite this article: Sabita Tuladhar, Eva Rehfuess, Maria Delius, Matthias Siebeck, Deepak Paudel & Cornelia Oberhauser (12 Feb 2024): Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021, Health Care for Women International, DOI: 10.1080/07399332.2024.2313659

To link to this article: https://doi.org/10.1080/07399332.2024.2313659

© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.

View supplementary material

Published online: 12 Feb 2024.

Submit your article to this journal

View related articles

View Crossmark data

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=uhcw20

HEALTH CARE FOR WOMEN INTERNATIONAL
https://doi.org/10.1080/07399332.2024.2313659

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Emergency obstetric and newborn care signal functions: The situation in health facilities in Nepal between 2015 and 2021

Sabita Tuladhar[a,b], Eva Rehfuess[c,d], Maria Delius[e], Matthias Siebeck[f], Deepak Paudel[g†] and Cornelia Oberhauser[c,d†]

[a]Teaching & Training Unit, Division of Infectious Diseases and Tropical Medicine, University Hospital, LMU, Munich, Germany; [b]Center for International Health, LMU, Munich, Germany; [c]Institute for Medical Information Processing, Biometry and Epidemiology, LMU, Munich, Germany; [d]Pettenkofer School of Public Health, Munich, Germany; [e]Department of Obstetrics and Gynecology, University Hospital, LMU, Munich, Germany; [f]Institute of Medical Education, LMU University Hospital, LMU, Munich, Germany; [g]Save the Children, Kathmandu, Nepal

ABSTRACT

Expanding access to facility-based delivery services and improving the functionality of emergency obstetric and neonatal care (EmONC) are important strategies toward achieving a maternal mortality ratio of 70 deaths per 100,000 live births by 2030. In this study the researchers assess signal functions at designated facilities in Nepal, using Nepal Health Facility Survey data for 2015 and 2021. The functionality of basic and comprehensive EmONC sites was low, declining over the six-year period. Lack of progress may partly be attributed to the COVID-19 pandemic. Nepal needs to expand EmONC sites strategically, strengthen referral systems, improve service readiness, and periodically assess service quality.

ARTICLE HISTORY
Received 14 December 2023
Accepted 30 January 2024

Maternal mortality reduction remains a global priority. According to an estimate for 2020, globally, one woman died every two minutes, 800 women died every day, and 287,000 women died in the year due to pregnancy-related causes (World Health Organization [WHO], 2023). The United Nations Sustainable Development Goal (SDG) 3.1 targets reducing the global Maternal Mortality Ratio (MMR) to 70 maternal deaths per 100,000 live births, but in 2020, the MMR was 223 maternal deaths per 100,000 live births. To achieve the target, an annual reduction rate of 11.6% between 2021 and 2030 will be required (WHO, 2023). Low- and middle-income countries (LMICs) contribute to 95% of these global maternal deaths, and meeting this target is challenged by fragile health systems and a lack of adequate resources. Expanding access to health facility

CONTACT Sabita Tuladhar Sabita.Tuladhar@lrz.uni-muenchen.de Teaching & Training Unit, Division of Infectious Diseases and Tropical Medicine, University Hospital, LMU, Munich, Germany; Center for International Health, LMU, Munich, Germany
†Shared last authorship

Supplemental data for this article can be accessed online at https://doi.org/10.1080/07399332.2024.2313659.

© 2024 The Author(s). Published with license by Taylor & Francis Group, LLC.
This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

(HF)-based obstetric services during pregnancy, delivery, and the postpartum period and improving service quality at HFs are important strategies to ensure maternal survival in LMICs.

In this paper, we present the case of Nepal, a LMIC in South Asia, to demonstrate why expanding access to HF-based delivery services and improving the functionality of emergency obstetric and neonatal care (EmONC) sites should be prioritized for maternal death reduction. The authors intend to contribute to global learning as well as improve programs and practices in LMICs on quality maternal health care service provision for women within the purview of the SDG 3.1 target of 70 MMR by 2030.

Background

Globally, the majority of maternal deaths are due to obstetric complications, and around fifteen percent of pregnancies result in obstetric complications. These require implementing certain medical interventions known as "signal functions" for EmONC at HFs (WHO, 2009). Therefore, having accessible and functional basic EmONC (BEmONC) or comprehensive EmONC (CEmONC) services in HFs providing delivery services is essential for maternal survival. The World Health Organization (WHO) identifies seven and nine signal functions for BEmONC and CEmONC services, respectively, as summarized in Table 1.

Maternal mortality and emergency obstetric and newborn care services in Nepal

The MMR decreased significantly in Nepal over the past 25 years, from 539 to 151 deaths per 100,000 live births between 1996 and 2021 (MOHP et al., 2023; MOHP & National Statistics Office [NSO], 2023). Nepal continues to strive toward achieving the SDG target 3.1, which calls for a reduction in the MMR to 70 per 100,000 live births by 2030. With the nation-wide implementation of the Maternity Incentive Scheme, the *Aama Program*, which ensures free delivery services in HFs, and a transportation

Table 1. Signal functions for BEmONC and CEmONC services.

Signal functions	BEmONC	CEmONC
(i) Parenteral administration of antibiotics	Yes	Yes
(ii) Parenteral administration of uterotonics	Yes	Yes
(iii) Parenteral administration of anticonvulsants	Yes	Yes
(iv) Assisted vaginal delivery	Yes	Yes
(v) Manual removal of placenta	Yes	Yes
(vi) Manual removal of retained products	Yes	Yes
(vii) Neonatal resuscitation	Yes	Yes
(viii) Cesarean delivery		Yes
(ix) Blood transfusion		Yes

Source. Monitoring emergency obstetric care: a handbook, WHO (2009).

allowance for women seeking antenatal and delivery services at HFs, Nepal has made significant improvements in access to and utilization of HF-based delivery services. In 2021, 98.4% of HFs in Nepal provided antenatal care services, 51.4% provided normal low-risk delivery services, and 5.3% provided cesarean services. The population coverage of HF-based delivery services increased from 44.0% in 2011 to 79.4% in 2022 (MOHP et al., 2023). However, these improvements in access and coverage have not translated into corresponding improvements in meeting the standards of care for delivery and emergency obstetric services at HFs. For example, in 2021, the five essential medicines for delivery services (oxytocin, injectable antibiotics, skin antiseptic, intravenous fluid, and magnesium sulfate) were available in only 20.2% of HFs providing normal low-risk delivery services, and a skilled birth attendant was present during only 31.0% of the deliveries; similarly, when taking the pregnancy history, the provider asked about vaginal bleeding in only 47.5% of the pregnant women, and the temperature of oxytocin was maintained during only one-third (65.5%) of the deliveries (MOHP et al., 2022). When standards of care are not met during delivery, service quality is compromised, which increases the risk of complications for both mothers and newborns. At present, the biggest challenge to achieving further maternal mortality reductions in Nepal is the suboptimal quality of obstetric care in HFs.

In 2021, over three-fifths of maternal deaths in Nepal occurred at HFs (MOHP & NSO, 2023); two-thirds of them happened during delivery and the postpartum period, and the major causes of these deaths were obstetric hemorrhage, hypertensive diseases, and infections (MOHP et al., 2023), all of which require management based on signal functions. The Government of Nepal (GON) has designated HFs providing delivery services as EmONC, BEmONC, and CEmONC sites to provide equitable access to the signal functions for pregnant women across the country (Family Welfare Division [FWD], 2019). EmONC sites in Nepal provide the first three signal functions, and they generally comprise Basic Health Care Centers (BHCCs) and other lower-level HFs. BEmONC services are provided by Primary Health Care Centers (PHCCs), and CEmONC services are provided by hospitals. During the Millennium Development Goal period, Nepal emphasized reducing maternal deaths by formulating policies to address barriers and implementing high impact interventions. As a result, BEmONC and CEmONC site expansion accelerated, which continued during the SDG period. In 2022, there were 226 designated CEmONC sites and 2,275 EmONC and BEmONC sites in Nepal, which include both public and private HFs (Department of Health Services [DOHS], 2023). The GON plans to ensure 24/7 availability of EmONC services, increase the number of CEmONC sites to cover all 77 districts, fully functionalize the BEmONC sites, and strengthen referral systems, including ambulances, means of

communication, and linkages with pre-identified, fully functional CEmONC sites (FWD, 2019). However, optimal infrastructure, staffing, equipment, referral, and finance continue to be a challenge for the operation of the different EmONC sites.

After the promulgation of the Constitution in 2015, and Nepal's transition to a federalized government structure in 2017, the 753 local governments are mandated to provide basic health services free of charge to Nepali citizens, including normal low-risk delivery services. In addition, the national Maternity Incentive Scheme ensures free delivery services to Nepali women, including EmONC, BEmONC, and CEmONC services (FWD, 2019). However, designating HFs as EmONC, BEmONC, and CEmONC sites and increasing the number of service sites does not necessarily ensure the routine availability of high-quality obstetric services. It is therefore important to assess the functionality of these EmONC, BEmONC, and CEmONC sites, which entails that the HFs are equipped to manage complications and provide the signal functions on time and as per the service standards. Evidence suggests that availability and use of EmONC can reduce maternal mortality by 85% and perinatal mortality by more than 75% (Darmstadt et al., 2005; Bhutta et al., 2008; Pasha et al., 2010; Pattinson et al., 2011) and effective BEmONC can prevent up to 40% of intrapartum neonatal and maternal mortality (Lee et al., 2011). In this context, our study examines the availability and functionality of the seven BEmONC and nine CEmONC signal functions at the designated sites in Nepal, compares the changes between 2015 and 2021, and provides important learnings that could be useful to other LMICs facing similar health system challenges in reducing maternal deaths.

Methods

Data source and data collection

We used data from the nationally representative, cross-sectional Nepal Health Facility Survey (NHFS) implemented in 2015 and 2021 (MOH et al., 2016; MOHP et al., 2022) under the global Demographic and Health Survey (DHS) Program. These surveys assessed public and private HFs regarding their availability and readiness to provide basic health care services and examined the process and experience of care for selected basic services. The data from these surveys is publicly available at https://dhsprogram.com/Data/.

In both NHFSs, individuals with public health, nursing, or medical qualifications were recruited as field researchers who received four weeks of training on NHFS implementation and collected data from the interviews with the HF manager and other service providers. Interviews were

validated by observations. In the NHFS, a standard Service Provision Assessment (SPA) DHS tool was adapted for Nepal, and data was collected using computer-assisted personal interviews (MOH et al., 2016; MOHP et al., 2022). We analyzed data from the delivery and newborn care service module of the NHFSs, which includes an assessment of delivery service availability and readiness using the HF inventory tool. This module also includes interviews with the providers at a given HF about whether their HF is a designated BEmONC or CEmONC service site.

Sample size and weights

We analyzed a subset of the NHFS 2015 and 2021 data. In the NHFS, designated BEmONC and CEmONC service sites were oversampled, with all of them being included in the sample; in addition, to make our analysis representative of designated BEmONC and CEmONC sites overall in Nepal, we used weights, which corrected for the oversampling of the designated BEmONC and CEmONC HFs as well as any non-response. The weighted data included 26 BEmONC and 21 CEmONC sites in 2015, and 43 BEmONC and 52 CEmONC sites in 2021.

Variables

Signal function availability and functionality: In Table 2, we describe how the availability and functionality of each of the signal functions were calculated.

We define BEmONC and CEmONC service availability as the relevant signal functions having ever been performed by the service providers at a designated BEmONC or CEmONC site. Based on the interviews with the service providers, categorical variables assess whether each of seven BEmONC and each of nine CEmONC signal functions have ever been performed by the service providers (coded 1) or have never been performed by the service provider (coded 0) across the health facility to measure availability. Overall BEmONC or CEmONC service availability is assessed through a composite index, which is coded as 1 when all relevant signal functions were available (and 0 otherwise).

We define BEmONC and CEmONC service functionality as the relevant signal functions having been performed at a designated BEmONC or CEmONC site during the three months prior to data collection. Based on the interviews with service providers, categorical variables designate whether each of the relevant signal functions have been performed by the service providers over the relevant time period. Overall BEmONC or CEmONC service functionality is assessed through a composite index, which is coded as 1 when all relevant signal functions have been put

Table 2. Definition and measurement of variables.

Variables	*Definition*	*Calculations*
BEmONC signal function availability	Each of the seven individual signal functions have ever been performed by the service providers within the designated BEmONC site.	For each of the seven signal functions, coded "1" when the signal function characteristic of a BEmONC site has ever been performed, coded "0" if otherwise.
Overall BEmONC availability	All seven signal functions have ever been performed by the service providers within the designated BEmONC site.	A composite index was created, which is coded "1" when all seven signal functions characteristic of a designated BEmONC site have ever been performed, and "0" if otherwise.
CEmONC signal function availability	Each of the nine individual signal functions have ever been performed by the service providers within the designated CEmONC site.	For each of the nine signal functions, coded "1" when the signal function characteristic of a CEmONC site has ever been performed, coded "0" if otherwise.
Overall CEmONC availability	All nine signal functions have ever been performed by the service providers within the designated CEmONC site.	A composite index was created, which is coded "1" when all nine signal functions characteristic of a designated CEmONC site have ever been performed, and "0" if otherwise.
BEmONC signal function functionality	Each of the seven individual signal functions have been performed by the service providers within the designated BEmONC site in the last three months prior to the data collection day.	For each of the seven signal functions, coded "1" when the signal function characteristic of a BEmONC site has been performed in the last three months, coded "0" if otherwise.
Overall BEmONC functionality	All seven individual signal functions have been performed by the service providers within the designated BEmONC site in the last three months prior to the data collection day.	A composite index was created, which is coded "1" when all seven signal functions characteristic of a designated BEmONC site have been performed in the last three months, and "0" if otherwise.
CEmONC signal function functionality	Each of the nine individual signal functions have been performed by the service providers within the designated CEmONC site in the last three months prior to the data collection day.	For each of the nine signal functions, coded "1" when the signal function characteristic of a CEmONC site has been performed in the last three months, coded "0" if otherwise.
Overall CEmONC functionality	All nine individual signal functions have been performed by the service providers within the designated CEmONC site in the last three months prior to the data collection day.	A composite index was created, which is coded "1" when all nine signal functions characteristic of a designated CEmONC site have been performed in the last three months and "0" if otherwise.

into practice during the three months prior to data collection (and 0 otherwise).

Health facility characteristics: We used "managing authority" (public, private) and "HF types" (hospitals, PHCCs, BHCCs) as categorical variables to describe the characteristics of HFs.

Statistical analysis

We conducted (weighted) descriptive analyses, relating designated BEmONC and CEmONC sites to the managing authority and the type of HF. However, we did not disaggregate subsequent analyses by the

managing authority and by HF types due to the small sample size of the private HFs (hospitals), and the BHCCs, respectively. To analyze gaps in BEmONC and CEmONC signal function availability and functionality in each of the survey years, we calculated the weighted mean (i.e., the weighted percentage) of BEmONC and CEmONC availability and functionality in 2015 and 2021. We carried out a weighted independent sample t-test to calculate the (weighted) mean difference in BEmONC and CEmONC availability and functionality between 2015 and 2021, with a level of significance of 0.05 and presenting the corresponding 95% confidence interval (CI) for the mean difference. We used Statistical Package for Social Science (SPSS) software, IBM SPSS Statistics 25, for all analyses.

Ethical approval

Both NHFS 2015 and 2021 were approved by the Nepal Health Research Council (NHRC). Our study was approved by the NHRC and Ludwig-Maximilians-Universität München (LMU Munich) Ethics Commission, Munich, Germany, in 2021.

Results

Distribution of the designated BEmONC and CEmONC sites by managing authority and HF types

We present Table 3 to show the weighted distribution of designated BEmONC and CEmONC sites by managing authority and HF type in 2015 and 2021. For both years, we found that in Nepal, BEmONC sites were almost exclusively public HFs. In contrast, 50.0% of CEmONC sites in 2021 were public, fewer than in 2015 (63.8%). In 2015, all but one of the BEmONC sites were hospitals or PHCCs, but in 2021, 12 BEmONC sites (27.9%) were BHCCs. In 2015, all public CEmONC sites were hospitals; in 2021, one public CEmONC site was a PHCC.

Changes in availability and functionality of signal functions at BEmONC sites

We present Figure 1(a,b) to demonstrate the changes in the availability and functionality of the seven signal functions at the designated BEmONC sites over time. In both years, the availability of assisted vaginal delivery scored lowest (54.4% in 2015 and 28.5% in 2021) and administration of parenteral oxytocin scored highest (97.6% in 2015 and 89.5% in 2021), also indicating a declining trend. While the availability of two signal functions—administration of parenteral anticonvulsants and removal of

Table 3. Weighted distribution of designated CEmONC and BEmONC sites in the total samples of NHFS 2015 and 2021.

Sites by managing authority and health facility types	2015		2021	
	Number	Percent	Number	Percent
Total BEmONC sites	**26**	**100**	**43**	**100**
Public	26	100	42	97.7
Hospitals	*4*	*15.8*	*7*	*17.6*
Primary health care centers (PHCCs)	*21*	*78.8*	*23*	*53.4*
Basic health care centers (BHCCs)	*1*	*4.6*	*12*	*27.9*
Private hospitals	0	0	1	2.3
Total CEmONC sites	**21**	**100**	**52**	**100**
Public	13	63.8	26	50.0
Hospitals	*13*	*63.8*	*25*	*49.0*
Primary health care centers (PHCCs)	*0*	*0*	*1*	*1.0*
Private hospitals	8	36.2	26	50.0

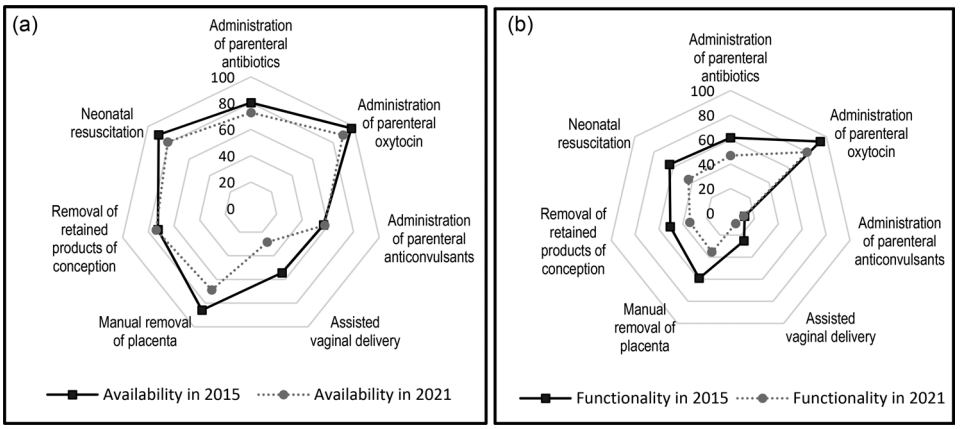

Figure 1. (a) Availability of signal functions at BEmONC sites in 2015 and 2021. (b) Functionality of signal functions at BEmONC sites in 2015 and 2021.

retained products of conception—improved, it regressed for the other five signal functions.

Overall, we found functionality was lower than availability, with the lowest functionality observed for the administration of parenteral anticonvulsants in 2015 (11.8%) and for assisted vaginal delivery in 2021 (9.0%). The administration of parenteral oxytocin was highest in both years but showed a declining trend (93.7% in 2015 and 79.9% in 2021). The functionality of all seven signal functions had decreased in 2021, but the decline was statistically significant only for assisted vaginal delivery (54.4% in 2015; 28.5% in 2021). We have reported the distribution of BEmONC sites by mean of signal function availability and functionality and 95% CI of the mean difference in Nepal in 2015 and 2021 in Supplementary Table A.

Table 4. Distribution of BEmONC sites by difference in signal functions availability and functionality in Nepal in 2015 and 2021.

	2015			2021		
Signal functions	Availability (%)	Functionality (%)	Difference (%)	Availability (%)	Functionality (%)	Difference (%)
Administration of parenteral antibiotics	80.4	61.5	18.9	72.8	47.0	25.8
Administration of parenteral oxytocin	97.6	93.7	3.9	89.5	79.9	9.6
Administration of parenteral anticonvulsants	56.6	11.8	44.8	57.5	11.0	46.5
Assisted vaginal delivery	54.4	25.2	29.2	28.5	9.5	19.0
Manual removal of placenta	85.9	59.1	26.8	68.8	35.3	33.5
Removal of retained products of conception	72.5	50.5	22.0	74.0	34.1	39.9
Neonatal resuscitation	89.8	63.7	26.1	81.0	44.1	36.9
All 7 (overall) signal functions	**29.2**	**3.9**	25.3	**15.9**	**2.2**	13.7
Total BEmONC sites	26	26	–	43	43	–

Low signal function availability and functionality and declining trends between the two time points are indicative of limited HF preparedness to provide the relevant service. This may place pregnant women and their newborns at high risk during obstetric complications.

In Table 4, we present the difference between signal functions available and functional at the designated BEmONC sites in 2015 and 2021. Overall, the gap between availability and functionality of the signal functions was 25.3% in 2015, and 13.7% points in 2021. In both years, the gap in availability and functionality was widest for the administration of parenteral anticonvulsants (44.8% in 2015 and 46.5% in 2021) and narrowest for the administration of parenteral oxytocin (3.9% in 2015 and 9.6% in 2021).

Changes in availability and functionality of signal functions at CEmONC sites

In Figure 2(a,b) we present changes in the availability and functionality of the nine signal functions at the designated CEmONC sites between 2015 and 2021. In 2015, blood transfusion was the most available (93.9%) and administration of parenteral anticonvulsants was the least available (75.1%) signal function, whereas in 2021, cesarean delivery (98.9%) and assisted vaginal delivery (85.7%) were the most and least available, respectively. Overall, this indicates improvements in the availability of signal functions. We found the largest improvement of 12.5% points and the smallest improvement of only 1.7% points for the administration of

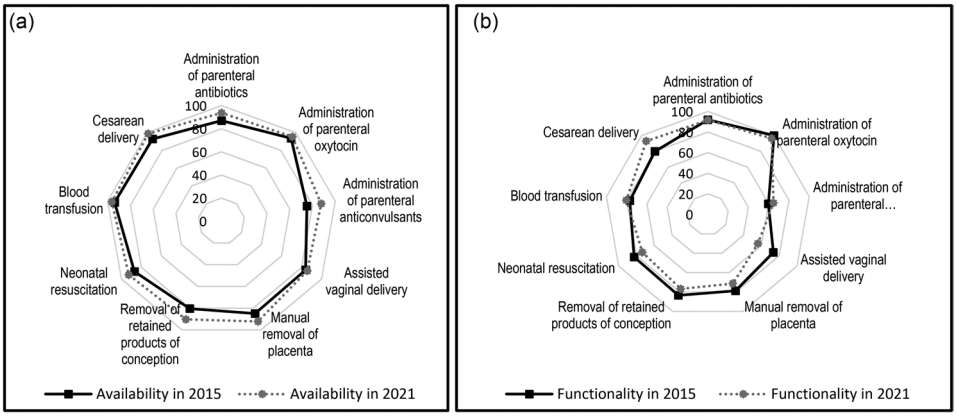

Figure 2. (a) Availability of signal functions at CEmONC sites in 2015 and 2021. (b) Functionality of signal functions at CEmONC sites in 2015 and 2021.

parenteral anticonvulsants and the administration of parenteral oxytocin, respectively.

In 2015, we observed the lowest (59.7%) functionality for administration of parenteral anticonvulsants and 100% functionality for administration of parenteral oxytocin. In contrast, in 2021, we found the lowest (56.2%) functionality for assisted vaginal delivery while administration of parenteral oxytocin continued to be the most functional (96.5%) signal function. Functionality of three signal functions—cesarean delivery, parenteral administration of anticonvulsants, and blood transfusion—increased by 13.1%, 5.0%, and 3.4% points, respectively. Contrastingly, the remaining six signal functions decreased over the same time period. We observed the greatest decline of 17.3% points for assisted vaginal delivery.

These results highlight uneven progress across the different CEmONC signal functions, with improvements in functionality lagging behind improvements in availability. We reported the distribution of CEmONC sites by mean of signal function availability and functionality and 95% CI of the mean difference in Nepal in 2015 and 2021 in Supplementary Table B.

We present Table 5 to show gaps between the availability and functionality of CEmONC signal functions at the two time points. Overall, the gap between signal functions available and functional was 26.1% points in 2015, increasing to 42.2% points in 2021. The gap was not uniform across the nine signal functions, with blood transfusion (17%) and assisted vaginal delivery (29.5%) having the widest gaps in 2015 and 2021, respectively. In contrast, the removal of retained products of conception (3.1%) and the administration of parenteral oxytocin (1.1%) presented the narrowest gaps in 2015 and 2021, respectively.

Table 5. Distribution of CEmONC sites by difference in signal functions availability and functionality in Nepal in 2015 and 2021.

	2015			2021		
Signal functions	Availability (%)	Functionality (%)	Difference (%)	Availability (%)	Functionality (%)	Difference (%)
Administration of parenteral antibiotics	87.0	91.9	−4.9	93.8	91.7	2.1
Administration of parenteral oxytocin	93.7	100	−6.3	95.4	96.5	−1.1
Administration of parenteral anticonvulsants	75.1	59.7	15.4	87.6	64.7	22.9
Assisted vaginal delivery	84.1	73.5	10.6	85.7	56.2	29.5
Manual removal of placenta	85.0	78.8	6.2	92.2	71.2	21.0
Removal of retained products of conception	80.4	83.5	−3.1	90.3	76.8	13.5
Neonatal resuscitation	87.0	82.6	4.4	92.7	73.4	19.3
Blood transfusion	93.9	76.9	17.0	96.4	80.3	16.1
Cesarean delivery	92.9	79.9	13.0	98.9	93.0	5.9
All 9 (overall) signal functions	**61.3**	**35.2**	26.1	**70.1**	**27.9**	42.2
All seven signal functions (BEmONC)	**21.4**	**8.7**	12.7	**45.5**	**17.4**	28.1
Total CEmONC sites	21	21	–	52	52	–

Discussion

Key findings and locating them in the literature

Expanding access to skilled birth attendants, HF-based obstetric services, and improving the functionality of EmONC are important strategies toward achieving the maternal mortality reduction goal. Nepal adopted improving access to functional BEmONC and CEmONC sites as a key strategy to improve maternal survival. There are abundant publications on the functionality of EmONC sites in LMICs, but this is the first study of its kind in Nepal, assessing signal function availability and functionality using nationally representative samples of HFs. Over the six-year period between 2015 and 2021, both the availability and functionality of signal functions at the BEmONC sites declined. In contrast, the availability of signal functions at the CEmONC sites increased considerably, but the overall functionality of the signal functions at the CEmONC sites did not improve and, in some cases, declined. Of the nine CEmONC signal functions, only three—cesarean deliveries, parenteral administration of anticonvulsants, and blood transfusion—improved functionality over the two time points.

The decline in functionality of both BEmONC and CEmONC sites in Nepal may in part be explained by the health system challenges posed by

the coronavirus disease (COVID)-19 pandemic. During most of 2020 and 2021, due to lockdowns, HFs were closed, or services were limited. Even when HFs were open, pregnant women were hesitant to visit them due to fear of contracting COVID-19, thereby lowering service utilization rates (Management Division [MD], 2021; Kc et al., 2020). The pandemic also affected the supply chain system, resulting in stockouts of essential commodities at HFs, limited in-person trainings, a lack of clinical guidelines and protocols at HFs, and limited monitoring and supervision. Support for HFs was provided remotely, and the focus was mainly on mitigating the direct effects of COVID-19. The impact of COVID-19 on maternal deaths in Nepal is reported in a 2021 nationally representative maternal mortality study based on verbal autopsies, where nearly 15% of the deceased women were reported to be infected with the coronavirus (MOHP & NSO, 2023). Several LMICs faced similar challenges during the pandemic. A study from Bangladesh, Nigeria, and South Africa published in 2021 reports a reduction in utilization of antenatal care, family planning, and immunization due to the implementation of lockdowns, a shift of focus toward the pandemic causing detriment to other health services, and resource constraints (Ahmed et al., 2021). Another study published in 2021 analyzed data from 37 non-governmental organization-supported HFs in Haiti, Lesotho, Liberia, Malawi, Mexico and Sierra Leone. It reported significant declines in first antenatal care visits in Haiti (18% drop) and Sierra Leone (32% drop), as well as fewer HF deliveries in all countries except Malawi during the pandemic (Aranda et al., 2022)

Studies across LMICs show that the availability and functionality of BEmONC and CEmONC services are generally low. In our study, the full performance of all seven BEmONC signal functions was less than five percent at both time points, which is comparable to Ghana (4.8%) but somewhat higher than in India, where no single BEmONC site performed full signal functions in a study published in 2023 (Gausman et al., 2023). Similarly, in our study, 35.2% and 27.9% of the CEmONC sites in 2015 and 2021, respectively, showed full CEmONC performance, which is relatively high compared to the performance reported for Argentina (8.8%) and India (23.1%), but was lower than in Ghana, where 57.1% of the sites performed full CEmONC functions in 2023 (Gausman et al., 2023). The availability of assisted vaginal delivery and parenteral administration of anticonvulsants performed the least amongst the signal functions in both BEmONC and CEmONC-designated sites in both years, which is comparable to the findings from a recent study in Bangladesh where assisted vaginal delivery was the least-available signal function, offered by about 35% of district hospitals, and parenteral anticonvulsants were scarcely available, ranging between 11% and 62% across HF types (Roy et al., 2017).

The poor performance of assisted vaginal delivery services with a declining trend between 2015 and 2021 in Nepal could be due to an increase in cesarean delivery, which had the highest availability (above 90%) and functionality (above 79%) in both years amongst the nine CEmONC signal functions. Nationally, the availability of cesarean services at HFs remained stable, 5.1% in 2015 and 5.3% in 2021 (MOHP et al, 2022), but the population coverage for cesarean deliveries almost doubled from 9.0% in 2016 to 18.3% in 2022 (MOHP et al., 2023). A study from Ethiopia published in 2021 reports that between 2011 and 2016, the assisted vaginal delivery rate declined from 15.8% to 9.9%, while the cesarean section rate increased from 25.4% to 33.8% (Yeshiwas & Eskinder, 2021). In LMICs, the rate of cesarean sections is increasing due to fear of vaginal delivery complications, including assisted delivery (Yeshiwas & Eskinder, 2021). Skills get lost if not used; thus, often, missing skills tend to be a greater constraint on functionality than the lack of equipment. In addition, in Nepal, the low availability and functionality of the BEmONC signal functions in the CEmONC sites further hints at the reasons behind the increasing trends and higher rates of cesarean deliveries in hospitals. Nepali women might perceive cesarean deliveries to be safer than assisted vaginal deliveries, as indicated by the Ethiopian study.

The perceived quality of care is higher for hospitals and private HFs than for lower-level HFs and public HFs; therefore, families generally choose well-equipped hospitals with medical officers or obstetricians for deliveries (Karkee et al., 2014), which could be the reason for the lower functionality of BEmONC sites compared to CEmONC sites. In 2021, the availability of providers trained in delivery care was 58.4% in referral hospitals, in contrast to only 31.5% in the PHCCs (MOHP et al., 2022), which not only indicates better training opportunities for providers in the big hospitals but also indicates the possibility of providers preferring to work in big hospitals. In Nepal, 92.7% of the 457 normal low-risk deliveries observed in a nationally representative HF-based survey in 2021 took place in hospitals, most of which were CEmONC sites (MOHP et al., 2022), and in another study from Nepal's Chitwan district published in 2016, more than half of the women delivered at a hospital rather than in a lower-level HF (Shah, 2016). Important reasons for not giving birth in a lower-level HF, most of which generally comprise the EmONC and BEmONC sites, were the lack of services and facilities, such as cesarean sections, video x-rays, blood tests, medicines and equipment, skilled birth attendants, and inadequate physical facilities (Shah, 2016). These findings are comparable with similar studies, one published in 2016 in Gujrat, India, where 37.7% of the pregnant women traveled further to give birth at HFs that were more functional than those nearby (Salazar et al., 2016); another study from Ghana showed that in 2017, 32.0% of pregnant women

bypassed their nearest HF, seeking care at hospitals and private HFs even though they had to pay nearly double the price (Bell et al., 2020). These findings clearly convey the family's preference for CEmONC sites due to a fear of complications during delivery. In addition, these findings also indicate the importance of measuring the experience of care periodically—an important dimension of the quality of care. Improving client and public awareness of the obstetric services available and building population trust in these services are key to improving service utilization rates and clients' satisfaction with care.

Policy, program, and research implications

In the changing context of increased public awareness of healthcare services, most women in LMICs are using antenatal care services and giving birth in HFs. Furthermore, most deliveries in LMICs now take place in hospitals and clinics due to the suboptimal care provided in lower-level HFs (Montagu et al., 2017). The higher-level HFs make up the majority of the BEmONC and CEmONC sites, where people expect to receive higher-quality services, but our findings raise questions with regards to the accessibility and functionality of the vital signal functions. Not meeting service standards due to dysfunctional BEmONC and CEmONC sites increases the risk of maternal deaths during obstetric complications. Periodic assessment of these sites for readiness, adherence to the standards of care, and understanding the client's experience of care are critical for ensuring full signal function and functionality and improving maternal survival. The functionality of these sites can be enhanced by ensuring the presence of skilled birth attendants 24/7, providing the basic amenities, equipment, essential medicines, and supplies, encouraging respectful provider behaviors, and improving the work environment for providers.

The designated CEmONC sites have remarkably increased in Nepal but are still limited, and the low availability and functionality of the signal functions in the designated BEmONC sites are concerning. Although BEmONC site expansion has been achieved as planned, our study showed that most of these sites are not functional; thus, policymakers and planners need to carefully consider the demand of the local community for services, the capabilities of the local government, the achievement of service standards, and the continuity of the services before establishing new BEmONC sites or upgrading the existing EmONC sites to BEmONC sites. The findings of our study will be useful to LMICs that are rapidly expanding EmONC sites, emphasizing that a focus on quality of care is critical. If the sites cannot attract clients, the resources will be wasted, making the health system weak. In addition, strengthening referral mechanisms to transfer pregnant women from BEmONC to CEmONC sites should be prioritized.

Improving the functionality of the existing BEmONC and CEmONC sites should be of utmost priority for LMICs. Nepal needs to carefully monitor the increase in cesarean deliveries, limit the unnecessary use of cesarean deliveries, strengthen and expand quality improvement approaches such as the Maternal and Perinatal Death Surveillance and Response (MPDSR) program (FWD & WHO , 2023), and teach practical skills such as instrumental vaginal deliveries. BEmONC and CEmONC sites need to be periodically assessed for functionality using the Minimum Service Standard (MSS) and other available tools, and necessary actions need to be taken to mitigate the identified gaps. Other LMICs may also benefit from the implementation of the above-described tools. In Nepal, raising public awareness of the availability of free BEmONC and CEmONC services in public HFs is important since a considerable 20.6% of Nepalese women do not give birth in HFs.

Strengths and limitations of the study

Our study used data from the nationally representative NHFS 2015 and 2021, which employed the DHS Program's standardized Service Provision Assessment methodology to collect data on the availability and functionality of signal functions in designated BEmONC and CEmONC HFs. These surveys used computer-assisted personal interviews, intensive training for the field researchers collecting the data, standardized and pre-tested tools, and interviews validated by observations, which ensured high-quality data collection. We used the WHO recommended indicators to measure EmONC availability and functionality, thereby allowing for comparisons of results across LMICs. Our study has three major limitations: first, the sampling wasn't done to be representative of BEmONC and CEmONC sites; second, it does not examine the BEmONC and CEmONC sites' population coverage, which is an important United Nations process indicator on EmONC services; and third, the factors affecting signal function performance at the designated BEmONC and CEmONC sites were not examined.

Conclusion

The current pace of improvements with regards to BEmONC and CEmONC services in Nepal found in this study needs to be accelerated to achieve the maternal mortality reductions targeted through the SDGs. BEmONC and CEmONC functionality is a strong supply-side measure of the health system, and our findings indicate low health system capacity and low service readiness. The BEmONC and CEmONC sites should be well equipped with trained staff, core amenities, basic equipment, essential medicines, supplies, and guidelines that meet the standards of care and

provide a good work environment for providers. In the current context of increasing HF births and the high volume of maternal deaths at HFs, particularly during delivery and the postpartum period, the overall low performance of the designated BEmONC sites and the declining functionality of the designated CEmONC sites over the two time points raise serious concerns about quality of care. In the present federal systems of government, service site expansions are happening rapidly without proper attention to service demand, resource availability to meet standards of care, or the sustainability of the sites. Thus, Nepal needs to carefully make decisions about expanding BEmONC and CEmONC service sites, considering both the population served and the sites where people travel to receive care, along with strengthening the referral systems. The quality improvement systems must regularly monitor these sites to ensure structural components and standards of care are met for achieving maternal survival.

This case study of Nepal provides important learnings for other LMICs that are working toward reducing maternal mortality. The key challenges facing LMICs are similar and rooted in weak and vulnerable health systems. Although the program or intervention strategies might differ from country to country, the key strategy to ensure maternal mortality reductions is the provision of uninterrupted, high-quality obstetric services to women through strategic expansion of EmONC sites, strengthening referral systems, improving service readiness, and periodically assessing service quality.

Acknowledgments

The authors would like to acknowledge the Demographic and Health Survey Program for providing public access to the 2015 and 2021 Nepal Health Facility Survey data set. The authors would also like to thank the health facility, service providers, and the women who consented to participate in these surveys.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

References

Ahmed, T., Rahman, A. E., Amole, T. G., Galadanci, H., Matjila, M., Soma-Pillay, P., Gillespie, B., Arifeen, S. E., & Anumba, D. (2021). The effect of COVID-19 on maternal newborn and child health (MNCH) services in Bangladesh, Nigeria and South

Africa: Call for a contextualised pandemic response in LMICs. *International Journal for Equity in Health*, *20*(1), 77. https://doi.org/10.1186/s12939-021-01414-5

Aranda, Z., Binde, T., Tashman, K., Tadikonda, A., Mawindo, B., Maweu, D., Boley, E. J., Mphande, I., Dumbuya, I., Montaño, M., Clisbee, M., Mvula, M. G., Ndayizigiye, M., Casella Jean-Baptiste, M., Varney, P. F., Anyango, S., Grépin, K. A., Law, M. R., Mugunga, J. C., Hedt-Gauthier, B., … Fulcher, I. R. (2022). Disruptions in maternal health service use during the COVID-19 pandemic in 2020: Experiences from 37 health facilities in low-income and middle-income countries. *BMJ Global Health*, *7*(1), e007247. https://doi.org/10.1136/bmjgh-2021-007247

Bell, G., Macarayan, E. K., Ratcliffe, H., Kim, J. H., Otupiri, E., Lipsitz, S., Hirschhorn, L., Awoonor-Williams, J. K., Nimako, B. A., Ofosu, A., Leslie, H., Bitton, A., & Schwarz, D. (2020). Assessment of bypass of the nearest primary health care facility among women in Ghana. *JAMA Network Open*, *3*(8), e2012552. https://doi.org/10.1001/jamanetworkopen.2020.12552

Bhutta, Z. A., Ali, S., Cousens, S., Ali, T. M., Haider, B. A., Rizvi, A., Okong, P., Bhutta, S. Z., & Black, R. E. (2008). Alma-Ata: Rebirth and Revision 6 Interventions to address maternal, newborn, and child survival: What difference can integrated primary health care strategies make? *Lancet (London, England)*, *372*(9642), 972–989. https://doi.org/10.1016/S0140-6736(08)61407-5

Department of Health Services (DOHS). (2023). *Annual Report 2021-2022*. Integrated Health Management Information System. Management Division, Department of Health Services, Ministry of Health and Population, Teku, Kathmandu Nepal.

Darmstadt, G. L., Bhutta, Z. A., Cousens, S., Adam, T., Walker, N., & de Bernis, L. (2005). Evidence-based, cost-effective interventions: How many newborn babies can we save? *Lancet (London, England)*, *365*(9463), 977–988. https://doi.org/10.1016/S0140-6736(05)71088-6

Family Welfare Division (FWD). (2019). Nepal *safe motherhood and newborn health road map* 2030. Family Welfare Division, Teku, Kathmandu, Nepal.

Family Welfare Division (FWD) & World Health Organization (WHO). (2023). Maternal and Perinatal Death Surveillance and Response (MPDSR) (pp. 1–4). Government of Nepal, Ministry of Health and Population, Department of Health Services, Family Welfare Division, Nepal.

Gausman, J., Pingray, V., Adanu, R., Bandoh, D. A. B., Berrueta, M., Blossom, J., Chakraborty, S., Dotse-Gborgbortsi, W., Kenu, E., Khan, N., Langer, A., Nigri, C., Odikro, M. A., Ramesh, S., Saggurti, N., Vázquez, P., Williams, C. R., & Jolivet, R. R. (2023). Validating indicators for monitoring availability and geographic distribution of emergency obstetric and newborn care (EmoNC) facilities: A study triangulating health system, facility, and geospatial data. *PloS One*, *18*(9), e0287904. https://doi.org/10.1371/journal.pone.0287904

Karkee, R., Lee, A. H., & Pokharel, P. K. (2014). Women's perception of quality of maternity services: A longitudinal survey in Nepal. *BMC Pregnancy and Childbirth*, *14*(1), 45. https://doi.org/10.1186/1471-2393-14-45

Kc, A., Gurung, R., Kinney, M. V., Sunny, A. K., Moinuddin, M., Basnet, O., Paudel, P., Bhattarai, P., Subedi, K., Shrestha, M. P., Lawn, J. E., & Målqvist, M. (2020). Effect of the COVID-19 pandemic response on intrapartum care, stillbirth, and neonatal mortality outcomes in Nepal: A prospective observational study. *The Lancet Global Health*, *8*(10), e1273–e1281. https://doi.org/10.1016/s2214-109x(20)30345-4

Lee, A. C., Cousens, S., Darmstadt, G. L., Blencowe, H., Pattinson, R., Moran, N. F., Hofmeyr, G., Haws, R. A., Bhutta, S., & Lawn, J. E. (2011). Care during labor and birth for the prevention of intrapartum-related neonatal deaths: A systematic review

and Delphi estimation of mortality effect. *BMC Public Health*, *11*(Suppl 3), S10. https://doi.org/10.1186/1471-2458-11-S3-S10

Management Division (MD). (2021). Assess impact of COVID-19 pandemic in selected health services with estimation of 'excess maternal deaths'. Government of Nepal Ministry of Health and Population Department of Health Service Management Division Integrated Health Information Management Section Kathmandu.

Ministry of Health and Population (MOHP), New ERA, & ICF. (2022). *Nepal health facility survey final report 2021*. Ministry of Health and Population, Nepal.

Ministry of Health and Population (MOHP), New ERA, & ICF. (2023). *Nepal demographic and health survey final report 2022*. Ministry of Health and Population, Nepal.

Ministry of Health and Population (MOHP), & National Statistics Office (NSO). (2023). *National population and housing census 2021: Nepal maternal mortality study 2021*. Ministry of Health and Population, Nepal.

Ministry of Health (MOH), New ERA, NHSSP, & ICF. (2016). *Nepal health facility survey final report 2015*. Ministry of Health, Nepal.

Montagu, D., Sudhinaraset, M., Diamond-Smith, N., Campbell, O., Gabrysch, S., Freedman, L., Kruk, M. E., & Donnay, F. (2017). Where women go to deliver: Understanding the changing landscape of childbirth in Africa and Asia. *Health Policy and Planning*, *32*(8), 1146–1152. https://doi.org/10.1093/heapol/czx060

Pasha, O., Goldenberg, R. L., McClure, E. M., Saleem, S., Goudar, S. S., Althabe, F., Patel, A., Esamai, F., Garces, A., Chomba, E., Mazariegos, M., Kodkany, B., Belizan, J. M., Derman, R. J., Hibberd, P. L., Carlo, W. A., Liechty, E. A., Hambidge, K. M., Buekens, P., … Wright, L. L. (2010). Communities, birth attendants and health facilities: A continuum of emergency maternal and newborn care (the global network's EmONC trial). *BMC Pregnancy and Childbirth*, *10*(1), 82. https://doi.org/10.1186/1471-2393-10-82

Pattinson, R., Kerber, K., Buchmann, E., Friberg, I. K., Belizan, M., Lansky, S., Weissman, E., Mathai, M., Rudan, I., Walker, N., & Lawn, J. E. (2011). Stillbirths: How can health systems deliver for mothers and babies? *Lancet (London, England)*, *377*(9777), 1610–1623. https://doi.org/10.1016/S0140-6736(10)62306-9

Roy, L., Biswas, T. K., & Chowdhury, M. E. (2017). Emergency obstetric and newborn care signal functions in public and private facilities in Bangladesh. *PloS One*, *12*(11), e0187238. https://doi.org/10.1371/journal.pone.0187238

Shah, R. (2016). Bypassing birthing centres for childbirth: A community-based study in rural Chitwan Nepal. *BMC Health Services Research*, *16*(1), 6–7. https://doi.org/10.1186/s12913-016-1848-x

Salazar, M., Vora, K., & Costa, A. D. (2016). Bypassing health facilities for childbirth: A multilevel study in three districts of Gujarat, India. *Global Health Action*, *9*(1), 32178. https://doi.org/10.3402/gha.v9.32178

World Health Organization (WHO). (2009). *Monitoring emergency obstetric care: A handbook*. World Health Organization.

World Health Organization (WHO). (2023). *Trends in maternal mortality 2000 to 2020: Estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division*. World Health Organization.

Yeshiwas, A., & Eskinder, K. (2021). Trends in operative delivery in Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia: A 5 years. Retrospective review. *Ethiopian Journal of Health Sciences*, *31*(6), 1199. https://doi.org/10.4314/ejhs.v31i6.15

BMC Pregnancy and Childbirth

RESEARCH

Open Access

Standards of care and determinants of women's satisfaction with delivery services in Nepal: a multi-perspective analysis using data from a health facility-based survey

Sabita Tuladhar[1,2*], Maria Delius[3], Matthias Siebeck[4], Cornelia Oberhauser[5,6], Deepak Paudel[7†] and Eva Rehfuess[5,6†]

Abstract

Background Compliance with standards of care is required for sustained improvement in the quality of delivery services. It thus represents a key challenge to improving maternal survival and meeting the Sustainable Development Goal (SDG) target of reducing the maternal mortality ratio to 70 deaths per 100,000 live births. This study examines the extent to which normal low-risk health facility deliveries in Nepal meet the standards of quality of care and assesses the effect of the standards of quality of care and various contextual factors on women's satisfaction with the services they receive.

Methods Drawing on the 2021 Nepal Health Facility Survey, the sample comprised 320 women who used health facilities for normal, low-risk delivery services. A weighted one-sample t-test was applied to examine the proportion of deliveries meeting the eight standards of care. Women's overall satisfaction level was computed from seven satisfaction variables measured on a Likert scale, using principal component analysis. The composite measure was then dichotomized. Binary logistic regression was used to analyze the determinants of women's satisfaction with delivery care services.

Results Deliveries complying with the eight standards of care and its 53 indicators varied widely; output indicators were more frequently met than input indicators. Of the eight standards of care, the "functional referral system" performed highest (92.0%), while "competent, motivated human resources" performed the least (52.4%). Women who were attended by a provider when they called for support (AOR: 5.29; CI: 1.18, 23.64), who delivered in health facilities that displayed health statistics (AOR 3.16; CI: 1.87, 5.33), who experienced caring behaviors from providers (AOR: 2.59; CI: 1.06, 6.30) and who enjoyed audio-visual privacy (AOR 2.13; CI: 1.04, 4.38) had higher satisfaction levels compared to their counterparts. The implementation of the Maternity Incentive Scheme and presence of a maternal waiting room in health facilities, however, were associated with lower satisfaction levels.

Conclusions Nepal performed moderately well in meeting the standards of care for normal, low-risk deliveries. To meet the SDG target Nepal must accelerate progress. It needs to focus on people-centered quality improvement

†Deepak Paudel and Eva Rehfuess shared last authorship.

*Correspondence:
Sabita Tuladhar
Sabita.Tuladhar@lrz.uni-muenchen.de
Full list of author information is available at the end of the article

© The Author(s) 2024. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/. The Creative Commons Public Domain Dedication waiver (http://creativecommons.org/publicdomain/zero/1.0/) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

to routinely assess the standards of care, mobilize available resources, improve coordination among the three tiers of government, and implement high-impact programs.

Keywords Maternal health, Maternal mortality, Standards of care, Quality of care, Health facility survey, Delivery care, Quality, Low- and middle-income country

Background

Maternal survival has been a global priority for more than three decades, as illustrated by United Nations (UN) Millennium Development Goal (MDG) 5, which aimed to reduce maternal mortality by three-quarters between 1990 and 2015, and Sustainable Development Goal (SDG) 3.1, which seeks to reduce the maternal mortality ratio (MMR) to 70 deaths per 100,000 live births by 2030 [1]. Despite efforts to improve access to skilled birth attendance and health facility (HF)-based interventions, most low- and middle-income countries (LMICs) did not meet MDG 5 [2] and are challenged to achieve the SDG 3.1 target.

Nepal was close to meeting MDG 5 [3], and over the past two and a half decades the country has made significant progress in improving access to HF-based delivery services, as demonstrated by an increase in HF births from 8.0 to 79.3% between 1996 and 2022 [4]. However, an increase in access to HF-based delivery services does not always translate to high-quality obstetric care and better maternal survival. With nearly 650,000 Nepalese women getting pregnant annually [5], about half of the total HFs offering normal low-risk delivery services in 2021 [6], and 79.3% of pregnant women giving birth at a HF in 2022 [4], Nepal still faces the challenge of a high MMR of 151 deaths per 100,000 live births in 2021, with 57.0% of these deaths occurring at HFs [7]. Of the total deceased women, 56.0, 38.0, and 3.0% had normal low-risk, caesarean, and assisted deliveries, respectively, while the mode of delivery of 3.0% of the women was unknown [7]. To meet the SDG 2030 3.1 target, Nepal needs to reduce the MMR by around 9.0% every year, which requires significant improvements in the quality of HF-based delivery services along with implementing evidence-based and effective maternal health interventions, in addition to ensuring that all women in Nepal have access to such services.

Quality of care (QoC) is multi-dimensional, contextual, and subjective, which makes it challenging to define and measure this construct. The QoC framework developed by the World Health Organization (WHO) builds on previous QoC models and identifies eight domains of QoC: i) evidence-based practices for routine care and management of complications; ii) actionable information systems; iii) functional referral systems; iv) effective communication; v) respect and preservation of dignity; vi) emotional support; vii) competent, motivated human resources; and viii) essential physical resources; these domains need to be regularly monitored and improved [8]. The framework recognizes the differences between the provision of care and the experience of care, as well as the interlinkages between the two, and takes account of the structure, processes, and outcomes of care. Corresponding to the eight domains of the QoC framework, WHO formulated eight standards of care which are further detailed as quality statements and quality measures [9]. These standards of care explicitly define what is required to achieve high-quality care around the time of childbirth. They also account for the critical role of communities and clients and their needs and preferences with regards to managing their own health, in addition to the care provided in distinct HFs [9].

Nepal's political transition in 2017 from a unitary government system to a federalized system with three tiers of government – federal, provincial, and local – presents a novel opportunity for the 753 local governments to re-focus on the provision of high-quality basic healthcare services free of cost, as mandated by the constitution. However, several challenges exist when trying to meet this constitutional mandate, largely due to unclear roles and responsibilities of the three tiers of government, among them poor budget allocation processes and limited human resource capacity at local levels directly affect the provision of health services and their quality [10]. Moreover, the coronavirus disease-19 (COVID-19) pandemic that hit Nepal in 2020 put the health system under significant pressure. Several health indicators were impacted negatively, including those relating to maternal health [11].

To fulfill the MDG 5 commitment, Nepal prioritized maternal health and developed and implemented several strategies and programs for providing safe motherhood services to women. The Maternity Incentive Scheme (*Aama Surakshya Karyakram*) implemented across the country since 2009 has been foundational in addressing critical barriers to HF-based births where pregnant women receive delivery services free of cost, are entitled to receive a transportation allowance for completing antenatal visits at HFs in the fourth, sixth, eighth, and ninth months of pregnancy, and for giving birth at a HF, while the HFs are reimbursed for the cost of every delivery. The transportation allowance for women varies

between plain, hill and mountain regions of the country while the reimbursement for a delivery varies by the type of delivery: normal-low risk deliveries, deliveries with complications, and cesarean deliveries [12]. The gradual scale-up of the Maternal and Perinatal Deaths Surveillance and Response System reached 95 out of a total of 561 hospitals in 2020 (i.e., 16.9%), and has been key in identifying gaps in QoC and implementing actions to address these gaps [5]. However, efforts to date have not resulted in adequate and sustained improvements in QoC. The results of the national-level HF-based surveys, the routine implementation of the HF-based Minimum Service Standards (MSS) readiness assessment tools, and other studies have consistently shown low compliance with standard processes, as well as low job motivation among service providers [6]. A recent HF-based study comparing data of 2015 and 2021 identified slow progress in HF readiness, including a lack of delivery care guidelines and basic equipment, high stock-outs of essential medicines, as well as low training among the delivery attendants in both public and private HFs [13]. Improving QoC has been a strategic focus of previous health strategic plans, as well as the recently launched Nepal Health Sector-Strategic Plan (NHS-SP) for the years 2023–2030. The importance of QoC has also been reflected in several national strategies and action plans, notably the Nepal Safe Motherhood and Newborn Health Road Map 2030. The National Medical Standard (NMS) for Maternal and Newborn Care Volume III in 2007, revised in 2009 and 2020, defines operating procedures for maternal and newborn service delivery in Nepal and is aligned with WHO recommended standards of care [14].

In view of the strategic focus on reducing maternal mortality and meeting the standards of care of normal-low risk delivery services for improving the overall quality of delivery services in Nepal, this study has the following two objectives. Firstly, it examines the extent to which normal low-risk HF deliveries in Nepal meet the standards of QoC. Secondly, it assesses the effect of the standards of QoC and various contextual factors on women's satisfaction with the services they receive.

Methods

Study design and population

This cross-sectional study used publicly available data from the 2021 Nepal Health Facility Survey (NHFS) retrieved from https://dhsprogram.com/Data/. It utilized four types of data from the multi-component NHFS: (i) direct observation of labor and delivery services provided to women; (ii) post-partum exit interviews with women as they were discharged from the HF; (iii) HF inventory assessments; and (iv) interviews with the service providers attending labour and delivery. The sample size was determined by the women for whom both components (i) and (ii) could be undertaken; information from components (iii) and (iv) was then linked to these data to complement the analysis. The study thus analyzed data from 320 women whose labor and delivery procedures were observed at HFs and who were then interviewed post-delivery as they were discharged from the HF regarding their experience of care and satisfaction with the services they received.

Sampling

The 2021 NHFS assessed 1576 HFs in Nepal, of which 804 reported providing normal low-risk delivery services. Normal low-risk deliveries are those that are spontaneous in onset, low risk at the beginning of labor, and remain that way throughout labor and delivery; the infant is born naturally out of the vertex position between 37 and 42 weeks of pregnancy; and after birth, both the mother and the infant are in good health [15]. Details of the 2021 NHFS sampling strategy are reported elsewhere [6]. With regards to this study, the following information is relevant:

Observation of women during labour and delivery

The data collectors spent 2 days at each HF to observe women during labour and delivery in all HFs where normal low-risk delivery services were available. Observations could be made in 125 HFs where the data collectors attempted to observe as many women as possible. A total of 457 women were observed during labour and delivery.

Exit interviews with post-partum women

The exit interviews were undertaken as the women were discharged from the HF, with the aim to interview all women who were observed for labour and delivery. However, out of the 457 women observed, only 320 in 94 HFs were interviewed. The remaining 137 women could not be interviewed for various reasons, such as that they suffered complications, were referred to another HF, refused to be interviewed, or remained in the same HF for a prolonged period of time.

HF inventory assessment

Inventory assessments for normal low-risk delivery services were conducted for all 804 HFs that reported providing normal low-risk delivery services.

Interviews with the service providers attending labour and delivery

Interviews with 2,742 providers were undertaken for all 804 HFs that reported providing normal low-risk delivery services.

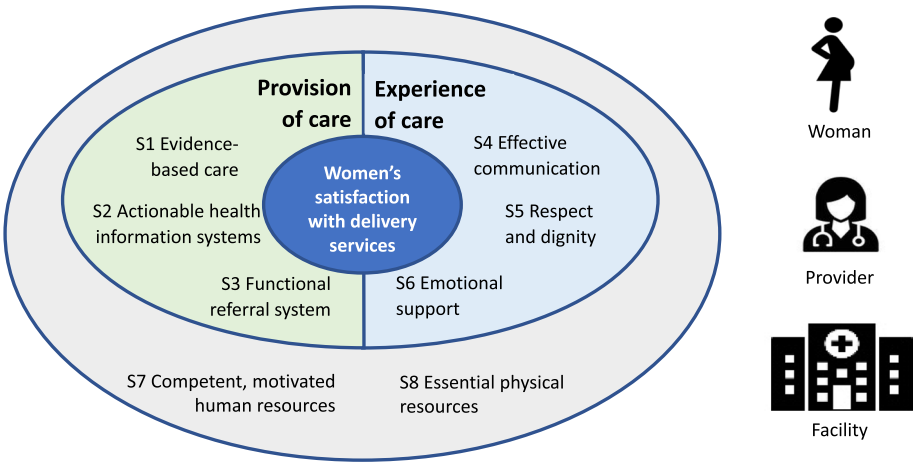

Fig. 1 Conceptual framework linking the eight WHO standards for improving maternal care with women's satisfaction with normal low-risk delivery services in health facilities

Data collection

A validated comprehensive checklist was used for every woman observed during labor and delivery to capture whether the service providers correctly performed key evidence-based interventions during each stage, including the initial client assessment, the first stage of labor, the second and third stages of labor, and the immediate care of the mother and newborn after birth. The exit interview employed a pre-tested questionnaire consisting of questions related to accessing care and decision-making, knowledge of the Maternity Incentive Scheme, perceptions of care, and satisfaction with delivery services. The inventory encompassed a complete review of HF infrastructure, the availability of necessary equipment and medicines for routine deliveries, services offered, basic amenities, infection prevention, and waste disposal practices. The provider interview included pre-tested questions on training, duration of work, work environment, and motivation.

Four weeks of training were provided to nine medical doctors and one nurse with a master's degree in nursing, who supervised a pool of 135 data collectors who had bachelor of science in nursing, bachelor of nursing, or bachelor in public health degrees. The data collectors received 4 weeks of training. Data on labor and delivery services were collected by the nurses, who were all females. HF inventory, service provider interviews, and exit interviews were conducted by the trained nurses and the public health graduates. Data was collected between January and September 2021 with breaks in May through July due to the COVID-19 imposed lockdown.

Conceptual framework

Figure 1 presents the conceptual framework of this study, adapted from the WHO Framework for the quality of maternal and newborn health care [8]. Each of the eight standards of care corresponds to the respective domains of the WHO QoC framework. These standards of care capture the provision of care, the experience of care, and the immediate physical environment in which the care is offered; they assess each of the standards of care at the input, output and outcome levels of the results chain using a defined set of indicators. This conceptual framework visualizes the standards of care as two concentric ovals. At the center of the framework is the outcome of interest, i.e., women's satisfaction with normal low-risk delivery services, which is influenced by the two ovals. The first oval comprises both the provision of care and the experience of care, covering six of the eight standards of care, while the second oval represents the immediate external environment, covering the remaining two standards of care. Three types of contextual factors influencing the outcome of interest – characteristics of women, characteristics of service providers, and characteristics of the HF – are presented in the outer box.

Unit of analysis

Women, whose labour and delivery were observed and who were then interviewed as they were discharged from the HF, represented the unit of analysis. As described above, data from the HF inventory, the exit interviews and the provider interviews were then linked to these data.

Study variables

Outcome variable

This study used women's satisfaction with normal low-risk delivery services as the outcome variable. During the exit interviews women were asked about seven aspects of QoC they experienced during their stay on the labour and delivery ward. These aspects were measured on a Likert scale from 1 to 5, where 1 represents the highest satisfaction and 5 represents the lowest satisfaction. These aspects referred to i) waiting time, ii) information received from the service provider, iii) skill of the service provider, iv) politeness and empathy of HF staff, v) cleanliness of the HF, vi) privacy, and vii) care received at the HF. The responses to these seven aspects were aggregated into a composite measure of satisfaction using Principal Component Analysis (PCA). Variable loadings on the first principal component that resulted from the PCA were used to compute a composite measure of women's satisfaction. The variable was then made dichotomous, using the median level to distinguish between higher satisfaction and lower satisfaction.

Standards of care variables

As shown in Table 1, a total of 53 variables were used to measure standards of QoC, distinguishing between input (29 indicators) and output (24 indicators) and using the relevant indicators from the 2021 NHFS facility inventory, service provider interviews, observations of labor and delivery, and client exit interviews. The "input indicators" measure the service readiness elements of the standards of care, and the "output indicators" measure the process of labour and delivery care, or the experience of women after any clinical procedure was performed. The number of indicators analyzed within each of the eight standards of care ranged from two for standard S3 "functional referral systems" to 15 for standard S1 "evidence-based practices"; there was no output indicator for standard S3 "functional referral systems". Although WHO suggests using the same indicator to measure multiple standards of care, this study used each indicator once, only for the most relevant standard of care, to avoid giving undue weight to selected indicators. All indicators were binary variables.

Contextual variables

Table 2 presents the 12 contextual variables related to the characteristics of women, service providers, and HFs analyzed in this study. The selection of the indicators was informed by a literature review, as well as the variables available in the 2021 NHFS data set. Of the 12 variables analyzed, six were categorical and six were binary.

Statistical analysis

Sample characteristics

For contextual variables, weighted frequencies and proportions were presented to show the characteristics of women, providers and HFs.

Standards of care for normal low-risk health facility deliveries (objective 1)

To examine the proportion of normal low-risk deliveries that meet the standards of care, a weighted one-sample t-test (with a p-value = 0.05) was applied. The weighted means of the deliveries that meet each of the individual input and output indicators of the standards of care were calculated, together with their weighted 95% confidence interval (CI). A weighted average score of each of the standards of care was also calculated, which ranged from 0 to 100%.

Standards of care, contextual factors, and women's satisfaction with delivery services (objective 2)

For the seven original satisfaction variables as well as the composite, dichotomized variable on women's satisfaction with normal low-risk delivery services, weighted proportions were used to describe the satisfaction of women with the delivery services received. To examine the effect of the standards of care and contextual factors on women's satisfaction with delivery care services, this study applied weighted binomial logistic regression. Initially, the multi-collinearity tests of tolerance and variation inflation factor (VIF) tests were carried out to identify and exclude the highly correlated covariates. In the next step, bivariate logistic regression was carried out to examine the independent effect of each of the covariates on the outcome variable, and odds ratios (OR) were calculated. Finally, the multivariate regression model examined the overall influence of the covariates that were significant in the bivariate regression on the outcome variable, and the adjusted odds ratios (AOR) were calculated. A 95% CI and a p-value of 0.05 were assumed.

All analyses were weighted to account for the complex, clustered sample design of the 2021 NHFS. The data analysis was conducted using SPSS (IBM SPSS Statistics 25).

Ethical approval

The 2021 NHFS received ethical approval from the Nepal Health Research Council (NHRC) and obtained written consent from the HF authority, while oral consent was obtained from all participating service providers, and clients or their next of kin before their participation in the survey. NHRC and the

Table 1 Standards of care variables

Standards	Results	Indicators measured as availability of equipment or performance of a service
S1 Evidence-based practices (15)	**Input (7)**	(i) Health facility with at least one functioning unit of each of seven basic equipment and supplies for mothers: delivery pack, partograph, examination light, blood pressure apparatus, latex gloves, sterilization equipment, delivery bed
		(ii) Health facility with any delivery care guidelines
		(iii) Health facility with at least one provider trained on delivery care
		(iv) Health facility with five essential medicines for mothers: magnesium sulfate, uterotonics, antibiotics, intravenous solution, skin antiseptics
		(v) Health facility with two types of equipment for an assisted delivery: vacuum aspirator, manual vacuum extractor
		(vi) Health facility with three basic types of equipment for newborns: suction apparatus, bag and mask, infant weighing scale
		(vii) Health facility with five essential medicines for newborns: gentamycin, chlorhexidine, tetracycline, amoxicillin, ceftriaxone powder
	Output (8)	(i) Provider monitored the mother's vital signs
		(ii) Provider administered immediate postpartum uterotonic
		(iii) Provider dried, covered, and cleaned the newborn
		(iv) Provider delivered the newborn to the mother's abdomen
		(v) Provider supported the initiation of early breastfeeding
		(vi) Provider checked newborn breathing and crying
		(vii) Provider helped mother to initiate skin-to-skin contact
		(viii) Provider counseled on postpartum family planning
S2 Actionable health information systems (5)	**Input (4)**	(i) Health facility with Maternal and Newborn Health Service Register
		(ii) Health facility with Health Management Information System monthly reports
		(iii) Health facility that displayed health statistics
		(iv) Health facility with Quality Assurance Action Plans
	Output (1)	(i) Women who had a completed discharge slip
S3 Functional referral systems (2)	**Input (2)**	(i) Health facility with at least one unit of functioning ambulance or emergency transport
		(ii) Health facility with at least one type of communication equipment
	Output (0)	None
S4 Effective communication (6)	**Input (3)**	(i) Health facility with at least one unit of information materials on maternal care
		(ii) Health facility that received at least one external supervision from federal, provincial, or local authorities in the last 12-month-period before data collection
		(iii) Health facility which had a 24-hour on-call service
	Output (3)	(i) Women received postnatal counseling before discharge
		(ii) Provider explained to women about the delivery procedures
		(iii) Provider completed a partograph
S5 Respect and preservation of dignity (8)	**Input (2)**	(i) Health facility with physical environment that allows privacy
		(ii) Health facility with a system for collecting clients' opinions
	Output (6)	(i) Woman did not experience use of physical force or abrasive behavior from the provider
		(ii) Woman experienced caring and appropriate behavior from the provider
		(iii) Woman felt comfortable with visual and auditory privacy
		(iv) Woman did not experience discriminatory behavior from the provider
		(v) Woman was attended to by a provider when she called
		(vi) Woman was not scolded by any provider

Table 1 (continued)

Standards	Results	Indicators measured as availability of equipment or performance of a service
S6 Emotional support (3)	**Input (1)**	(i) Health facility with a maternity waiting room
	Output (2)	(i) Woman who was allowed a companion to join her when requested
		(ii) Provider who provided emotional support and reassurance to the woman
S7 Competent, motivated human resources (5)	**Input (4)**	(i) Provider received supervision in the last 12 months
		(ii) Health facility that implemented quality assurance activities routinely
		(iii) Provider reported having a written job description
		(iv) Provider reported opportunities for staff promotion
	Output (1)	(i) Provider who was experienced (worked more than 1 year)
S8 Essential physical resources (9)	**Input (6)**	(i) Health facility with regular source of electricity
		(ii) Health facility with basic water supply in maternity care areas
		(iii) Health facility with one functioning unit of the six-infection prevention and control equipment (surgical masks, waste receptacle, disinfectant, sterilization equipment, aprons/gowns, latex gloves)
		(iv) Health facility with health-care waste management system
		(v) Health facility with a toilet for female clients
		(vi) Health facility with a newborn corner
	Output (3)	(i) Women who reported access to drinking water
		(ii) Women who reported access to a toilet
		(iii) Women who reported getting a maternity bed on time
Total (53)	**Input (29); Output (24)**	

The number in parenthesis indicates the number of indicators. These indicators were selected from the 2021 Nepal Health Facility Survey data set. The selection of indicators was guided by WHO's "Standards for Improving the Quality of Maternal and Newborn Care in Health Facilities 2016"

Table 2 Contextual variables

Characteristics	Indicators
Women (6)	i) Age: less than 20 years, 20–34 years, and 35 or more years
	ii) Caste: advantaged which includes Brahmin/Chhetri, and disadvantaged which includes Terai castes, Dalits, Janajatis, and others.
	iii) Education: ever went to school, never went to school
	iv) The number of pregnancies: one, two, three or more
	v) Experience of complications (during current pregnancy): yes, no
	vi) Experience of stillbirths (during previous pregnancies): yes, no
Provider (2)	i) Type of provider: doctor, nurse, auxiliary nurse midwife
	ii) Sex of the provider assisting birth: female, male
Health facility (4)	i) Type of health facility: public hospital, other public health facility, private hospital
	ii) Health facility that implemented the Maternity Incentive Scheme: yes, no
	iii) Type of site: emergency obstetric and neonatal care (EmONC), basic emergency obstetric and neonatal care (BEmONC), comprehensive emergency obstetric and neonatal care (CEmONC), other
	iv) Distance to health facility: proximal (< 30 minutes' walking distance from women's place of residence), semi-proximal (30–60 minutes' walking distance from women's place of residence), distal (> 60 minutes' walking distance)
Total (12)	

The number in parenthesis indicates the number of indicators

Ludwig-Maximilians-Universität (LMU) Ethics Commission, Munich, Germany approved the current study in June 2021.

Results

Characteristics of women, service providers, and health facilities

The women's age ranged from 18 to 36 years, with 7.8%

Table 3 Characteristics of the women included in the study (weighted)

Characteristics of women	Number	Percent
Age		
Less than 20 years	25	7.8
20–34 years	282	88.1
35 years and above	13	4.1
Caste		
Advantaged	78	24.4
Disadvantaged[a]	242	75.6
Education		
Ever went to school	269	84.2
Never went to school	51	15.8
Number of pregnancies[b]		
One	141	44.1
Two	101	31.5
Three or more	77	24.4
Experience of complications	46	14.3
Experience of stillbirths	23	7.1
Total women	**320**	**100.0**

[a] Terai castes: 29.6%; Janajati: 27.3%, Dalits: 11.8%; Others: 6.9%

[b] One missing case

being younger than 20 years (Table 3). Almost one quarter (24.4%) of women belonged to the advantaged caste group, 84.2% had attended school, 44.1 and 31.5% of women were experiencing their first and second pregnancy, respectively, while 24.4% were higher multiparous. 14.3% had experienced complications during their current pregnancy, and 7.1% of women had previously experienced a stillbirth.

As shown in Table 4, more than half of the births (56.2%) were assisted by a nurse, 36.9% by an auxiliary nurse midwife, and 6.9% by a medical doctor. Almost all birth attendants (96.9%) were female. Seven out of 10 women gave birth in a public hospital; a large majority of 85.6% of women delivered at comprehensive emergency obstetric and neonatal service sites; and nearly two-thirds (64.4%) of the women lived within 30 minutes' walking distance from a HF.

Standards of care of normal low-risk health facility deliveries (objective 1)

The weighted percentage of deliveries meeting each of the 53 input and output indicators of the standards of care are reported in Additional file 1: Table S1 (with its 95% CI) and Additional file 2: Fig. S1. Standard S1 "evidence-based practice", which measures the structural components of services around childbirth, is the most comprehensive of the eight standards. Findings show

Table 4 Characteristics of service providers and health facilities (weighted)

Characteristics of service providers and health facilities	Number	Percent
Type of provider		
Doctor	22	6.9
Nurse	180	56.2
Auxiliary Nurse Midwife	118	36.9
Sex of the provider assisting the birth		
Female	310	96.9
Male	10	3.1
Type of health facility		
Public hospital	228	71.3
Other public health facility	24	7.3
Private hospital	68	21.4
Implementation of Maternity Incentive Scheme	269	83.9
Type of site		
Emergency obstetric and neonatal care (EmONC)	25	7.7
Basic emergency obstetric and neonatal care (BEmONC)	8	2.4
Comprehensive emergency obstetric and neonatal care (CEmONC)	274	85.6
Other	14	4.3
Distance to health facility		
Proximal, within 30 minutes' walking distance	206	64.4
Semi-proximal, 30–60 minutes' walking distance	114	35.6
Total women	**320**	**100.0**

In the "Type of provider" variable, one Health Assistant has been merged with the Auxiliary Nurse Midwife category

that most deliveries meet essential equipment for mothers and newborns and essential medicines for mothers, and subsequently most mothers received uterotonics, and most newborns received essential newborn care after birth. However, delivery care guidelines and newborn medicines were lacking. Display of health statistics in HFs and presence of quality assurance action plans, the two indicators of S2 "actionable health information systems" was not met for most deliveries. The availability of transportation and communication equipment, a component of S3 "functional referral system" was near-universal. S4 "effective communication" performed moderately well for individual indicators; S5 "respect and preservation of dignity" performed well, for example, 95.7% of women did not experience any discriminatory behavior from the provider, and 93.9% of women were attended to by a provider when called. S6 "emotional support" also performed well: providers allowed most women to have their companion present when requested and offered emotional support and reassurance to them. For most deliveries, compliance with S7 "human resources", and S8 "physical environment" was poor. Providers did not have a clear job description, and infection prevention and control (IPC) supplies were missing for many deliveries.

The radar diagram (Fig. 2) shows variation in the weighted average score of all deliveries for the eight standards of care. The bigger the shape of the polygon, the better the standards of care received by the women at HFs. The average score of deliveries was highest (92.0%) for S3 "functional referral system", and lowest (52.4%) for S7 "competent, motivated human resources".

Standards of care, contextual factors, and women's satisfaction with delivery services (objective 2)

In this study, 46.0% of women were very satisfied, 37.9% fairly satisfied, and 12.2% were neutral with the delivery services they received from the HFs; less than 5 % of the women were very or fairly dissatisfied. With regards to individual aspects of satisfaction, as shown in Fig. 3, a relatively higher proportion of women was very satisfied with waiting time (55.4%), provider's skill (54.8%), and politeness of the provider (49.3%). Care received, cleanliness, and privacy were the three areas where a relatively higher proportion of respondents, 4 out of 10 women, were fairly satisfied.

Figure 4 shows the composite satisfaction level, dichotomized as higher satisfaction vs. lower satisfaction, in total and according to the women's characteristics. By design, in total 50.0% reported higher satisfaction and 50.0% reported lower satisfaction. Young women, women who had experienced stillbirths in their previous pregnancies, or who had experienced complications during the current pregnancy reported higher levels of satisfaction compared to their counterparts.

The multi-collinearity test did not find a strong correlation among the 65 covariates (53 standards of care and 12 contextual factors) selected for analysis. The bivariate logistic regression analyses carried out for each of the 65 covariates and the outcome variable, reported in Additional file 1: Table S2, found eight variables significantly associated with women's satisfaction levels. As reported in Table 5, women who delivered at HFs implementing the Maternity Incentive Scheme, having maternity

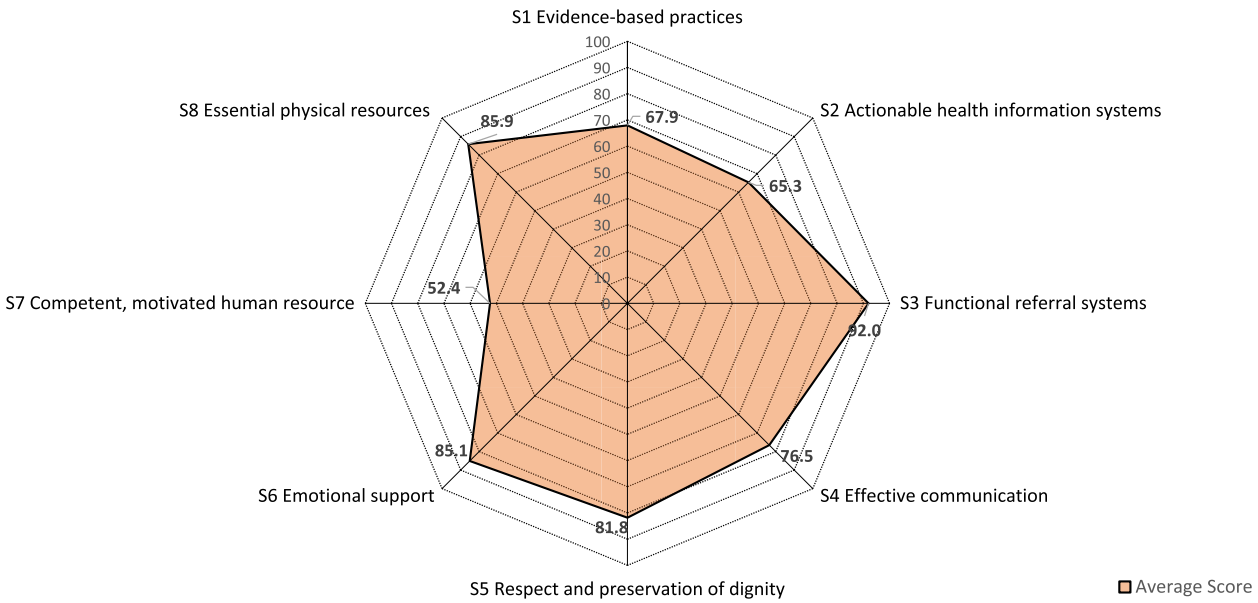

Fig. 2 Weighted average score for each of the standards of care of all normal low risk deliveries at health facilities in Nepal

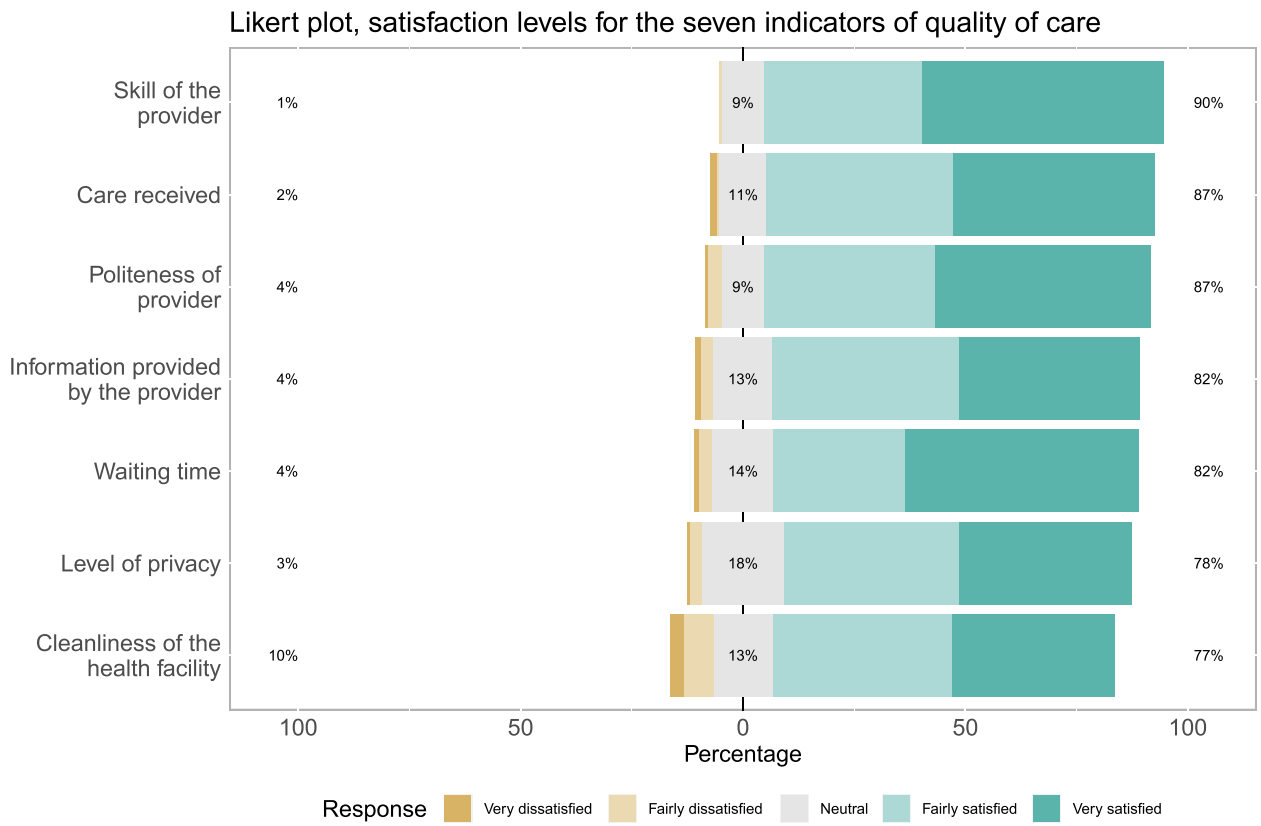

Fig. 3 Satisfaction levels of women who had normal low-risk deliveries on the seven indicators of quality of care. Women's satisfaction was measured on a 5-point Likert Scale, from very dissatisfied to very satisfied

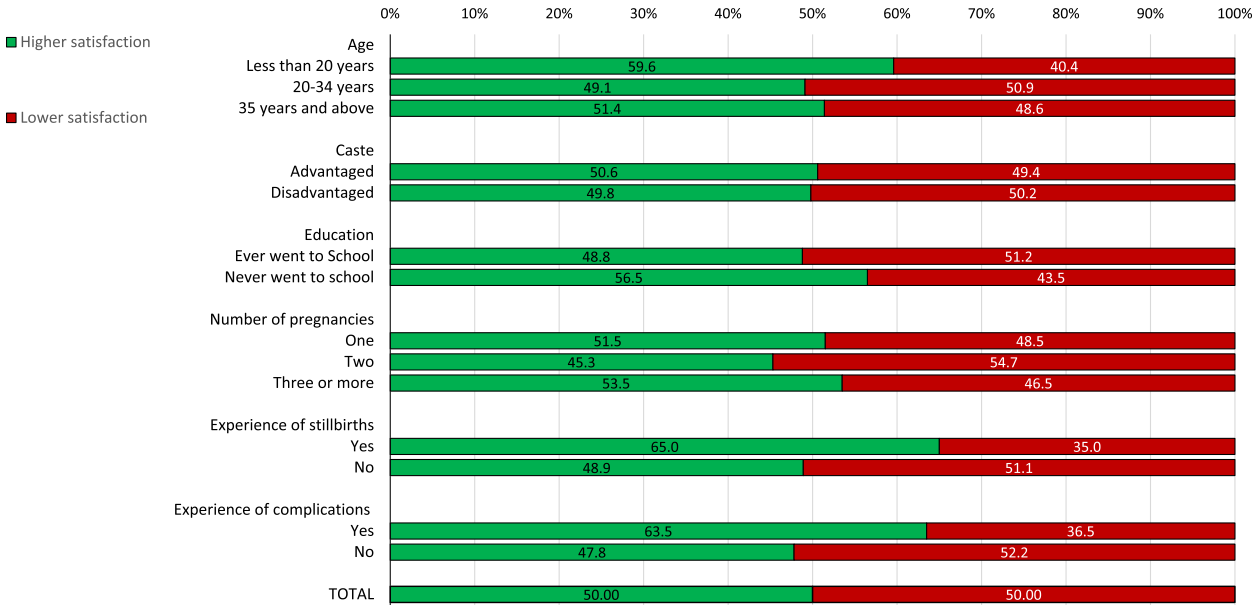

Fig. 4 Weighted proportion of women's satisfaction level with delivery services, in total and by characteristics of women

Table 5 (Weighted) bivariate and multivariate logistic regression for assessing standards of care and contextual factors associated with women's satisfaction with normal low-risk delivery services

Independent variables: deliveries meeting the following criteria at health facilities	Bivariate logistic regression				Multivariate logistic regression			
	OR	95% CI for OR		*p*-value	AOR	95% CI for AOR		*p*-value
		Lower	Upper			Lower	Upper	
Contextual variables								
Health facility that implemented the Maternity Incentive Scheme	0.34	0.18	0.65	0.0010**	0.27	0.13	0.55	0.0004*
Standards of care variables								
Health facility with any delivery care guidelines	2.07	1.12	3.84	0.0210*	1.97	0.98	3.96	0.0575
Health facility that displayed health statistics	2.15	1.37	3.38	0.0010*	3.16	1.87	5.33	< 0.0001*
Health facility with at least one unit of information materials on maternal care	0.54	0.33	0.86	0.0100*	0.57	0.33	0.97	0.0393*
Health facility with a maternity waiting room	0.36	0.16	0.82	0.0140*	0.35	0.15	0.82	0.0156*
Woman experienced caring and appropriate behavior from the provider	2.67	1.19	5.99	0.0170*	2.59	1.06	6.30	0.0359*
Woman felt comfortable with visual and auditory privacy	2.41	1.28	4.55	0.0070**	2.13	1.04	4.38	0.0399*
Woman was attended to by a provider when she called	8.13	2.04	32.35	0.0030**	5.29	1.18	23.64	0.0292*

*Statistically significant $p < 0.05$

OR odds ratio, *AOR* adjusted odds ratio, *CI* confidence interval

waiting rooms, and having information material had lower odds of being in the higher satisfaction category compared to women who delivered at HFs that did not feature these characteristics. Women who were attended by a service provider when they called for support, who experienced caring behavior from providers and good levels of audio-visual privacy, who delivered in HFs that displayed health statistics and that had delivery care guidelines had higher odds of being in the higher satisfaction category compared to their counterparts. In the multivariate logistic regression model, all but one of these eight variables (i.e., delivery care guidelines) retained their significance. For the Maternity Incentive Scheme, the influence increased in the multivariate model compared to the bivariate model. The influence also increased among HFs displaying health statistics, and for the maternity waiting room, although only minimally.

Discussion

Key findings and locating them in the literature

Health facilities' compliance with standards of care

Compliance with the eight standards of care for normal low-risk deliveries in HFs in Nepal varied and was inconsistent across the 53 indicators analyzed. A few indicators, such as the provider completing the discharge slip, the provider administering uterotonics, and the provider cleaning and drying the newborn, were met for all or almost all deliveries. Several other indicators were met for a considerable proportion of the deliveries, but some indicators were only met for a small proportion of deliveries. The output indicators of the standards of care performed marginally better than the input indicators, reflecting the wide gaps in the structural components of care, which block pathways to meeting the standards of both the process of care and the experience of care. Some of the input indicators, such as the availability of client feedback systems and delivery care guidelines at HFs and the availability of job descriptions with providers, scored very low, which lowered the overall performance of the input indicators. Of the eight standards of care, S1 "evidence-based practice" showed mixed results. While essential equipment and medicines for mothers and equipment for newborns were frequently available for most deliveries, the delivery care guidelines, trained providers, and essential medicines for newborns were unavailable for many deliveries. Gaps in structural factors of QoC are common across LMICs; for example, in Ethiopia, one-third of HFs assessed in 2022 had low readiness to provide routine labor and delivery care, with only 52.2% of the hospitals having essential medicines, equipment, and supplies [16]. While the average score for S2 "actionable health information systems" was 65.3%, S3 "functional referral system" was almost universally achieved. For example, a functional ambulance service was available for 94.5% of deliveries. This contrasts with much lower scores in Madagascar in 2016, where this ranged from 3.1% for basic health centers to 83.3% for university (referral) hospitals [17], and in Nigeria, where none of the 60 primary health care centers assessed in 2020 had a functional ambulance [18]. The higher availability of functional equipment for referral in Nepal, however, does not guarantee a functional referral system as shown in a 2021 study reporting that 33.2% of maternal

deaths in Nepal are attributable to delays in reaching the HF [7].

S4 "effective communication" performed moderately well; for example, the availability of a 24-hour on-call service was met for nine out of 10 deliveries in Nepal, much higher than in Tanzania, where only 28.3% of HFs met this standard in 2019 [19]. Most deliveries met the indicators of S5 "respect and preservation of dignity", indicating that women giving birth in HFs in Nepal generally experience kind, considerate, and appropriate behaviors from providers. However, most HFs lacked a system to gather client feedback. In this study, nine out of 10 women did not experience any discriminatory behavior from their providers, which supports the findings from another recent nationally representative survey reporting that during their most recent birth only 3.8 and 13.8% of women experienced physical and verbal abuse, respectively [4]. Provider misbehavior in Nepal is much lower compared to India, where a systematic review published in 2020 found that 25.7, 16.9, and 14.7% of women experienced verbal abuse, physical abuse, and discrimination, respectively [20]. Similarly, in Ethiopia 36.0% of women experienced mistreatment by the provider during childbirth, according to a cross-sectional study published in 2017 [21].

With regards to S6 "emotional support", most providers were empathetic, 94.0% allowed women to have their companion present when requested, and 71.0% provided them with emotional support and reassurance. Compliance with emotional support is higher in Nepal compared to other LMICs; for example, a 2019 study from Uttar Pradesh, India, showed that nearly a quarter of women interviewed were not allowed to have a companion close to them during labour and delivery [22]. Compliance with the five indicators of S7 "competent, motivated human resources" varied, with most providers attending the deliveries not having a clear job description, but nine out of 10 HFs having routine quality assurance activities. Similarly, most deliveries met eight out of nine indicators of S8 "essential physical resources". The indicator on IPC was met for only six out of 10 deliveries. Studies from LMICs often show important gaps in physical resources, such as toilets, for clients [23].

Standards of care as determinants of women's satisfaction with delivery services

Six of the 53 standards of care indicators analyzed in this study were found to be statistically significant in influencing women's satisfaction with delivery services. Standards of care related to the inter-personal communication of providers with clients—the caring behavior—were associated with higher satisfaction levels among women. This finding aligns with the findings of a cross-sectional study carried out in Iraq in 2019, where the provider's good behavior during delivery was related to women's satisfaction with the services [24]. Women's experiences of privacy during labour and delivery were also related to higher satisfaction levels in Nepal. This is consistent with studies carried out in other LMICs. A systematic review from 2015 shows that women treated with dignity, respect, and courtesy were more satisfied [25], while another systematic review focused on Ethiopia reports that two-thirds of Ethiopian women were satisfied with skilled delivery care, which was correlated with privacy and short waiting times [26]. Studies show notable differences in the factors influencing satisfaction among Asian and African women, where Asian women preferred providers' behavior over their technical competence, but African women preferred providers' confidence and competence over their behavior [25]. In view of the high reported compliance with dignified and respectful delivery care for women, the findings of this study suggest that providers in Nepal are more empathetic compared to many other LMICs. This could be due to cultural factors, with Nepalese women tending to highly value health providers and therefore responding positively. Similarly, Nepalese women may not be aware of the standards of care and have relatively low expectations.

The display of health statistics at the HF, where women delivered, emerged as a strong predictor of higher satisfaction; surprisingly, the availability of information materials on maternal care at the HF emerged as a predictor of lower satisfaction. Most of the women in this study were relatively educated, and it may be that the health statistics displayed at HFs attracted the women who could read them, thereby contributing to higher satisfaction levels. In Nepal, displaying health statistics is an approach pursued for promoting evidence-based management of health programs. Although the information materials were available in the HF, women's access to them could have been low, or the materials were not attractive. Another explanation could be that displaying health statistics might have been perceived as more modern or a means of quality control and assurance, and the availability of information materials might have been perceived as more old-fashioned.

Similarly, nine out of 10 deliveries in this study took place in HFs that had maternity waiting rooms, and most of the women benefiting from these had lower satisfaction levels than women in HFs without maternity waiting rooms. Although this study did not analyze the comfort and quality of the maternity waiting rooms, it is possible that just having a room is not adequate. Comfort and physical facilities are important for satisfaction; for example, a recent Ethiopian study found that providing secure and comfortable waiting rooms can reduce the desire for

home delivery and improve client satisfaction [27]. An alternative explanation may be that HFs that have a waiting room tend to be larger and often overcrowded and may thus keep women in the waiting room for prolonged periods of time, with little or no attention and support from providers.

Contextual factors as determinants of women's satisfaction with delivery services

Of the 12 contextual factors analyzed, only the Maternity Incentive Scheme showed a statistically significant association with women's satisfaction with delivery services. Most deliveries in this study took place in public hospitals that implemented the Maternity Incentive Scheme, which was associated with lower satisfaction among women. Although this scheme has been key to addressing the financial barriers to accessing HFs across Nepal, operational challenges such as appropriate monitoring of women's antenatal visits, delays in providing the transportation incentives to women and stockouts of essential medicines and supplies at HFs [28] are likely to decrease levels of satisfaction. A study published in 2018 found that only 43% of women delivering in public hospitals in Nepal were very satisfied with the transportation incentives [29], while a study published in 2021 showed that less than two-thirds of women delivering at a HF knew about the scheme [6].

Policy, program and research implications

Compliance with the standards of care at HFs and several other factors determine women's satisfaction levels, and these in turn affect how often they and their family members, friends and other acquaintances use HFs to give birth. In Nepal, a people-centered approach to service provision that monitors the process of care, and the experience of care has been emphasized. Using client satisfaction as a measure of QoC is necessary but often incomplete and contentious as clients in LMICs often have low expectations of the healthcare they receive [30]. Relying solely on client satisfaction as a measure of the QoC may yield high levels of satisfaction despite HFs not meeting the standards of care and objectives for quality improvement. Hence, to understand QoC holistically, Nepal must complement the indicators of client satisfaction with other indicators that gauge the level of adherence to the standards of care, and such data needs to be collected and reported more frequently. For example, in addition to the MSS, Nepal needs to contextualize and use the globally available quality improvement tools that monitor the knowledge and skills of providers. A pool of mentors and coaches who can visit the HFs, assess provider knowledge and skills, and provide feedback, needs to be developed at the local level. Compliance with standards of care varied for different indicators in Nepal, but the results are encouraging. With the improving policy environment, QoC has received greater attention in the newly endorsed Nepal Health Sector Strategic Plan (NHS-SP) 2023–2030. With the implementation of the various quality improvement initiatives, such as the MSS and Maternal and Perinatal Death Surveillance and Response, progress in compliance with standards of care and improvements in QoC can be expected. The WHO's standards of care for maternal and newborn care during childbirth are exceedingly comprehensive; therefore, full compliance with these standards is a challenge for LMICs, and Nepal is no exception. Nepal needs to contextualize these standards of care and integrate its monitoring into the routine information management systems. In the new federalized context, resources are available at all three tiers of government, which must be rationally allocated and well-coordinated for developing human resource capacity to implement quality improvement initiatives, monitor compliance with the standards of care and use data to feed into the planning and quality improvement cycle.

In this study, nine out of 10 births occurred at hospitals, which indicates low utilization of the other peripheral public HFs that offer normal, low-risk delivery services. Several of the birthing HFs in Nepal are not strategically located and, therefore, do not attract clients, resulting in clients bypassing the local HFs and using big referral hospitals for normal, low-risk delivery services [31]. This tendency has an enormous impact on the functionality of the HFs and on their adherence to the standards of care. Bigger hospitals are often overwhelmed due to client overcrowding, as well as medicines and supplies often being stocked out, and the providers cannot take good care of the clients, resulting in low or no client satisfaction. Moving forward, it is critically important to rationalize the establishment of new HFs and ensure appropriate quality of care of the existing HFs to build trust and attract more women to use HFs for delivery services. Client and community education is equally important to increase the uptake of normal low-risk delivery services at peripheral public HFs. In the new federal system of government, the local governments have an important role in improving the management of normal low-risk delivery services. The Nepal government is committed to providing free maternal health care services to women. In this purview, it is important to review the operational challenges of the Maternity Incentive Scheme to create demand for HF-based maternal health services, gain trust from the community, and improve service quality and women's satisfaction.

Strengths and limitations of the study

This study is the first of its kind conducted in Nepal and provides multiple perspectives on the standards of care for normal, low-risk deliveries using the WHO framework for the quality of maternal and newborn health care. This study has several strengths and some limitations.

Study design

This study used a conceptual framework-led approach informed by the WHO framework and assessed standards of care from multiple perspectives. It used data from the recent nationally representative NHFS that included all public HF types and private hospitals, comprising inventory assessments, provider interviews, observations of labor and delivery and client exit interviews. The NHFS, was, however not specifically designed for the research question addressed in this study. As a result, several variables of interest were missing. Moreover, while the HFs included in this study were nationally representative, observations of women giving birth were not. In fact, relying on only 2 days of observations of women's labour and delivery per HF may have created sampling bias, potentially leading to more large facilities represented in our sample.

Data collection

Validated, standardized, and pre-tested tools were used in accordance with the quality standards of the NHFS [6]. Data were collected by trained nurses, medical officers, and public health professionals; a computer-based data collection system employing various data checks ensured high quality data. Limitations include the low number of cases observed at lower-level HFs and private hospitals, which limited informative analyses for different types of HFs. Women were observed at different stages of labor; therefore, complete information on labour and delivery was not available for all women analyzed.

Data analysis

Study variables were carefully selected from the large data set following a largely a priori approach in line with the conceptual framework of the study. Various composite measures were developed to reduce the large number of variables, allowing for more meaningful analyses and avoiding power limitations; collinearity checks were carried out. The study focused on maternal care-specific indicators and did not focus on newborn-specific indicators, as recommended by the WHO.

Conclusions

The learnings from the first half of the SDG-relevant period imply that Nepal needs to urgently accelerate and sustain the quality improvement efforts to meet target 3.1 of reducing MMR to 70 deaths per 100,000 live births. Improving coverage of maternal health services and meeting standards of care are the prerequisites for achieving this target. Although Nepal is performing moderately well with regards to meeting the standards of normal low-risk delivery care, gaps exist in critical components such as human resource capacity, strengthened supply chain systems, a supportive environment for provider motivation, and quality improvement systems to collect and address client feedback. These gaps are challenging the implementation of the Maternity Incentive Scheme, a key intervention for Nepal to improve maternal survival. Moving forward, all three tiers of government—federal, provincial, and local—should strengthen collaboration, tap into and mobilize available resources, and implement high-impact integrated programs. Measuring compliance with standards of care should be integral to routine information management systems to assess and track progress.

Abbreviations

AOR	Adjusted odds ratio
BEmONC	Basic emergency obstetric and neonatal care
CEmONC	Comprehensive emergency obstetric and neonatal care
CI	Confidence interval
COVID	Coronavirus disease
EmONC	Emergency obstetric and neonatal care
HF	Health facility
IBM	International business machines corporation
IPC	Infection prevention and control
LMU	Ludwig-maximilians-universität
LMIC	Low and middle-income countries
MDG	Millennium development goals
MMR	Maternal mortality ratio
MSS	Minimum service standards
NHS-SP	Nepal health sector - strategic plan
NHFS	Nepal health facility survey
NHRC	Nepal health research council
OR	Odds ratio
PCA	Principal component analysis
QoC	Quality of care
S	Standard
SDG	Sustainable development goal
SPSS	Statistical package for the social sciences
UN	United nations
VIF	Variation inflation factor
WHO	World health organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-024-06301-9.

Additional file 1: Table S1. Weighted number and proportion of deliveries (including 95% CI) meeting the input, output, and all indicators by the standards of care, and the average score by the standards of care among

all women observed and interviewed ($n=320$). **Table S2.** (Weighted) bivariate logistic regression for assessing the factors associated with women's satisfaction with normal low-risk delivery services (with Odds Ratio (OR) and 95% CI for OR).

Additional file 2: Fig. S1. Weighted proportion of deliveries meeting the 53 indicators among all women observed and interviewed arranged in descending order ($n=320$).

Acknowledgements
The authors would like to acknowledge the Demographic and Health Survey Program for providing public access to the 2021 Nepal Health Facility Survey data set. The authors would also like to thank the health facility, service providers, and the women who consented to participate in the survey.

Authors' contributions
S.T. conceptualized and designed the study, performed statistical analysis, and developed the manuscript. D.P., M.D., E.R., and M.S. supervised S.T., reviewed, and edited the manuscript. C.O. provided advice on statistical analysis and reviewed for interpretation of data. All authors read and approved the final manuscript.

Funding
The authors have not declared a specific grant for this study from any funding agency.

Availability of data and materials
The data used in the study is publicly available at the DHS Program website: https://dhsprogram.com/Data/

Declarations

Ethics approval and consent to participate
The 2021 Nepal Health Facility Survey received ethical approval from the Nepal Health Research Council (NHRC) and obtained written consent from the HF authority, while oral consent was obtained from all participating service providers, and clients or their next of kin before their participation in the survey. NHRC and the Ludwig-Maximilians-Universität (LMU) Ethics Commission, Munich, Germany approved this study in June 2021.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Teaching & Training Unit, Division of Infectious Diseases and Tropical Medicine, University Hospital, LMU, Munich, Germany. [2]Center for International Health, LMU, Munich, Germany. [3]Department of Obstetrics and Gynecology, University Hospital, LMU, Munich, Germany. [4]Institute of Medical Education, LMU University Hospital, LMU, Munich, Germany. [5]Institute for Medical Information Processing, Biometry, and Epidemiology, LMU, Munich, Germany. [6]Pettenkofer School of Public Health, Munich, Germany. [7]Save the Children, Kathmandu, Nepal.

Received: 23 September 2023 Accepted: 29 January 2024
Published online: 13 February 2024

References

1. Trends in maternal mortality 2000 to 2020: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division. Geneva: World Health Organization; 2023. Licence: CC BY-NC-SA 3.0 IGO. Page xiii.
2. Countdown Case Study Collaboration Group, Moucheraud C, Owen H, Singh NS, Ng CK, Requejo J, et al. Countdown to 2015 country case studies: what have we learned about processes and progress towards MDGs 4 and 5? BMC Public Health. 2016;16(S2):794.
3. National Planning Commission, The Millennium Development Goals, Final Status Report, 2000–2015. Government of Nepal. Kathmandu: National Planning Commission; 2016 p. 76.
4. Ministry of Health and Population [Nepal], New ERA, and ICF. Nepal demographic and health survey 2022. Kathmandu, Nepal: Ministry of Health and Population [Nepal]; 2023. p. 186.
5. Annual Report: Department of Health Services 2078/79 (2021/2022). Department of Health Services Government of Nepal Ministry of Health and Population Kathmandu; 2023 p. 28. http://dohs.gov.np/annual-report-2078-79/.
6. Ministry of Health and Population, Nepal; New ERA, Nepal; and ICF. Nepal Health Facility Survey 2021 Final Report. Kathmandu, Nepal: Ministry of Health and Population, Kathmandu; New ERA, Nepal; and ICF, Rockville, Maryland, USA; 2022. p. 189.
7. Ministry of Health and Population, National Statistics Office. National Population and housing census 2021: Nepal maternal mortality study 2021. Kathmandu: Ministry of Health and Population; National Statistics Office; 2022. p. 13.
8. World Health Organization. Quality of Care for Maternal and Newborn Health: a monitoring framework for network countries. Genève, Switzerland: Department of Maternal, newborn, child and adolescent health (MCA), World Health Organization HQ avenue Appia 20, 1211; 2019.
9. World Health Organization. Standards for improving quality of maternal and newborn Care in Health Facilities. Geneva 27, Switzerland: WHO Press, World Health Organization, 20 Avenue Appia, 1211; 2016.
10. Thapa R, Bam K, Tiwari P, Sinha TK, Dahal S. Implementing federalism in the health system of Nepal: opportunities and challenges. Int J Health Policy Manag. 2018;8(4):195–8.
11. Kc A, Gurung R, Kinney MV, Sunny AK, Moinuddin M, Basnet O, et al. Effect of the COVID-19 pandemic response on intrapartum care, stillbirth, and neonatal mortality outcomes in Nepal: a prospective observational study. Lancet Glob Health. 2020;8(10):e1273–81.
12. Family Welfare Division. Aama guidelines 2021. Teku, Kathmandu: Government of Nepal, Ministry of Health and population, Department of Health Services, family welfare division; 2022.
13. Tuladhar S, Paudel D, Rehfuess E, Siebeck M, Cornelia Oberhauser C, Delius M. Changes in health facility readiness for obstetric and neonatal care services in Nepal: An analysis of cross-sectional health facility survey data in 2015 and 2021. Submitted to a Journal for Publication; 2023.
14. National Medical Standard for Maternal and Newborn Care Volume III. 3rd ed. Ministry of Health and Population; 2020. p. 5–6. https://fwd.gov.np/wp-content/uploads/2022/10/NMS-Vol-III.pdf.
15. World Health Organization (WHO). Care in Normal Birth: a practical guide. In: Report of a Technical Working Group. WHO, Geneva: Reproductive Health and Research; 1996. https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2413/2014/08/WHO_FRH_MSM_96.24.pdf. Accessed 10 Sept 2023.
16. Bayou NB, Grant L, Riley SC, Bradley EH. Structural quality of labor and delivery care in government hospitals of Ethiopia: a descriptive analysis. BMC Pregnancy Childbirth. 2022;22(1):523.
17. Andriantsimietry SH, Rakotomanga R, Rakotovao JP, Ramiandrison E, Razakariasy MER, Favero R, et al. Service availability and readiness assessment of maternal, newborn and child health Services at Public Health Facilities in Madagascar. Afr J Reprod Health / La Revue Africaine de la Santé Reproductive. 2016;20(3):149–58.
18. Ekenna A, Itanyi IU, Nwokoro U, Hirschhorn LR, Uzochukwu B. How ready is the system to deliver primary healthcare? Results of a primary health facility assessment in Enugu state, Nigeria. Health Policy Plan. 2020;35(Supplement_1):i97-106.
19. Ansari H, Yeravdekar R. Respectful maternity care during childbirth in India: a systematic review and meta-analysis. J Postgrad Med. 2020;66(3):133–40.
20. Bintabara D, Ernest A, Mpondo B. Health facility service availability and readiness to provide basic emergency obstetric and newborn care in a low-resource setting: evidence from a Tanzania National Survey. BMJ Open. 2019;9(2):e020608.
21. Sheferaw ED, Bazant E, Gibson H, Fenta HB, Ayalew F, Belay TB, et al. Respectful maternity care in Ethiopian public health facilities. Reprod Health. 2017;14(1):60.
22. Sharma G, Penn-Kekana L, Halder K, Filippi V. An investigation into mistreatment of women during labour and childbirth in maternity care

facilities in Uttar Pradesh, India: a mixed methods study. Reprod Health. 2019;16(1):7.
23. Manu A, Zaka N, Bianchessi C, Maswanya E, Williams J, Arifeen SE. Respectful maternity care delivered within health facilities in Bangladesh, Ghana and Tanzania: a cross-sectional assessment preceding a quality improvement intervention. BMJ Open. 2021;11(1):e039616.
24. Ahmed HM. Role of verbal and non-verbal communication of health care providers in general satisfaction with birth care: a cross-sectional study in government health settings of Erbil City, Iraq. Reprod Health. 2020;17(1):35.
25. Srivastava A, Avan BI, Rajbangshi P, Bhattacharyya S. Determinants of women's satisfaction with maternal health care: a review of literature from developing countries. BMC Pregnancy Childbirth. 2015;15(1):97.
26. Bishaw KA, Temesgen H, Amha H, Desta M, Bazezew Y, Ayenew T, et al. A systematic review and meta-analysis of women's satisfaction with skilled delivery care and the associated factors in Ethiopia. SAGE Open Med. 2022;10:205031212110682.
27. Eziawdres D, Worku W, Taye M. Maternal satisfaction with delivery services and its associated factors among mothers who gave birth at public health centers in Yeka Sub City, Addis Ababa, Ethiopia. Health Serv Insights. 2021;14:117863292110507.
28. Family welfare division (FWD, Department of Health Services (DOHS), Ministry of Health and population (MOHP) Nepal. Report on rapid assessment of Aama Surakshya Programme: round XI. 2018. Chrome-Extension://Efaidnbmnnnibpcajp-cglclefindmkaj/Https://WwwNhsspOrgNp/Resources/PPFM/Rapid_Assessment_of_Aama_Programme_RoundXI_2018Pdf.
29. Panth A, Kafle P. Maternal satisfaction on delivery service among postnatal mothers in a government hospital. Mid-Western Nepal Obstet Gynecol Int. 2018;2018:4530161.
30. Rishard M, Fahmy FF, Senanayake H, Ranaweera AKP, Armocida B, Mariani I, et al. Correlation among experience of person-centered maternity care, provision of care and women's satisfaction: cross sectional study in Colombo, Sri Lanka. PLoS One. 2021;16(4):e0249265.
31. Karkee R, Lee AH, Binns CW. Bypassing birth centres for childbirth: an analysis of data from a community-based prospective cohort study in Nepal. Health Policy Plan. 2015;30(1):1–7.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.