Counting every mother: Strengthening maternal mortality data in Nepal- A narrative review article

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ABSTRACT

Introduction: Maternal mortality remains a major public health concern in Nepal, and accurate measurement is vital for evidence-based policymaking and achieving Sustainable Development Goal 3.1, which targets a reduction in maternal deaths. This study reviews methodologies used to measure maternal mortality and evaluates the quality of related data across four dimensions- completeness, accuracy, timeliness, and consistency. **Methods:** A narrative review was conducted using national data sources such as the National Population and Housing Census, Demographic and Health Surveys, and Maternal Mortality and Morbidity Studies. Relevant WHO and UN guidelines were reviewed to assess the extent to which Nepal's methodologies align with global standards. **Results:** The Demographic and Health Surveys provides standardized maternal death information but is limited by small sample sizes, recall bias, and the absence of cause-of-death data. The national census offers comprehensive coverage and regional disaggregation, yet data accuracy is affected by cultural barriers, underreporting, and reliance on household reporting. While Demographic and Health Surveys ensures methodological consistency across survey rounds, the decennial census restricts trend analysis due to infrequent data collection. Demographic and Health Surveys produces relatively timely data, but the census suffers from delayed reporting and limited inclusion of mobile populations. Overall, both data sources contribute valuable insights but demonstrate gaps in completeness, accuracy, and timeliness. **Conclusions:** Strengthening Nepal's maternal mortality data requires adopting WHO-recommended standards, integrating International Classification of Disease-Maternal Mortality classifications, enhancing statistical validation, and leveraging digital data systems. Reliable, timely, and consistent data are essential for effective maternal health planning and achieving national and global maternal mortality targets.

Keywords: Data quality, maternal mortality measures, Maternal Mortality Ratio, Nepal, WHO standards.

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INTRODUCTION

Maternal mortality continues to pose a significant public health challenge in Nepal, despite ongoing national and global efforts to improve maternal health outcomes. According to the World Health Organization (WHO), maternal death is defined as the death of a woman while pregnant or within 42 days of the termination of pregnancy, from any cause related to or aggravated by the pregnancy or its management, excluding accidental or incidental causes.[1,2] Accurate measurement of maternal mortality is essential for tracking progress towards Sustainable Development Goal (SDG) 3.1 and for informing policies aimed at reducing maternal mortality.[3]Various methods have been employed globally to measure maternal mortality, including civil registration and vital statistics (CRVS), household surveys, and census-based estimates, each with distinct advantages and limitations.[4] In Nepal, maternal mortality measurement largely relies on periodic censuses, national demographic health surveys, and sample surveys.

Although census-based measurement is cost-effective and

provides nationwide coverage, it is often hindered by underreporting, misclassification of causes of death, and recall bias.[4]Previous studies have highlighted the limitations of data derived from censuses, particularly when deaths and live births within households are not fully reported.[5,2]While surveys such as the Nepal Demographic and Health Survey (NDHS) and Maternal Mortality and Morbidity Study (MMMS) offer detailed data, they are expensive and face statistical limitations due to the rarity of maternal deaths. Vital registration systems, though ideal for continuous tracking, still face implementation challenges in Nepal, especially regarding timely and accurate cause-of-death reporting.[6] Consequently, post-enumeration surveys and verbal autopsies have been used to complement census data and improve classification and verification of maternal deaths.[7] Despite recent improvements, inconsistencies remain in estimating the Maternal Mortality Ratio (MMR), particularly at subnational levels, calling into question the reliability and comparability of these figures across sources and over time.[8]

The primary objective of this study was to assess the methodology and quality of maternal mortality measurement in Nepal, evaluating its alignment with WHO-recommended standards. Specifically, it examines the completeness, accuracy, timeliness, and consistency of existing data and the methods used to generate them. By evaluating the strengths and limitations of current data sources including the national census, demographic surveys, and maternal mortality studies this review seeks to identify critical gaps and propose actionable strategies to improve data quality. Accurate measurement of MMR is vital for guiding evidence-based maternal health policies and ensuring Nepal's progress toward maternal mortality reduction goals.

METHODS

This review study is a component of a broader funded research project titled "Quality of Data for Policy and Planning in Nepal: Examination Based on Post Enumeration Survey." While the broader study received ethical approval and funding support, the present narrative review represents an independent scholarly output focusing specifically on the data quality dimension of maternal mortality measures in Nepal. The objective, methods, and analytical scope of this paper are distinct from those of the main project. It does not duplicate or fragment the original research findings; rather, it provides a focused synthesis of existing literature relevant to maternal mortality data quality.

This study employed a narrative review to assess the quality of maternal mortality data in Nepal and evaluate the alignment of national measurement practices with international standards. The review focused on four key data quality dimensions recommended by the WHO–completeness, accuracy, timeliness, and consistency. A comprehensive search was conducted between June and November 2024 using Google Scholar and official websites of key institutions, including the WHO, United Nations (UN), Ministry of Health and Population (MoHP) of Nepal, and Central Bureau of Statistics (CBS), Nepal. The search included keywords such as "maternal mortality measures," "data quality in MMR," and "maternal mortality ratio calculation." Literature published from 1991 to November 30, 2024, was considered.

Literature review process: Documents including national census and surveys that reported MMR since 1991 were studied i.e,: Report on Maternal Mortality–part of National Population and Housing Census (NPHC)2021,[9] Nepal Demographic Health Survey2016 and 2006;[10,11] Nepal Maternal Mortality and Morbidity Study 2009;[12] Nepal Family Health Survey(NFHS)1996;[13] and Population Monograph of Nepal 2014.[14]Additionally, publications were identified through the literature search. After screening for relevance and quality, total 20documentsi.e. peer-reviewed articles, WHO/UN reports, and USAID guidelines including the national census and surveys were included in the final review. Each data source reporting MMR were assessed against the following criteria:

Completeness: Evaluated the extent to which data captured maternal deaths across different geographic and socio-demographic groups, including sub-national i.e., province and local level, rural and urban, and marginalized populations.

Accuracy: Examined reported maternal deaths against age distribution patterns, consistency with hospital and civil registration data, and potential misclassification or recall bias. Methods such as enumerator training, self-reporting practices, and cause-of-death determination methods (e.g., verbal autopsy) were reviewed.

Timeliness: Assessed the reporting timelines in census and DHS surveys, including any delays between data collection and dissemination, and the impact on policy utility.

Consistency: Analyzed whether definitions, methods, and classifications used in data collection were uniform across sources and over time. Regional variations in reporting practices and changes in indicators were also reviewed.

The review further explored the policy implications of these findings, focusing on how data quality affects maternal health programming, resource allocation, and progress toward Sustainable Development Goal (SDG) 3.1. Gaps in methodology identified were used to propose recommendations for improving maternal mortality surveillance in Nepal. This methodological approach ensured a comprehensive synthesis of available national evidence while situating Nepal's maternal mortality measurement practices within the broader global context.

RESULTS

Over the period of time, Nepal has employed various data sources to monitor maternal mortality. Nepal Fertility, Family Planning and Health Survey (NFFPHS) and NDHS provides nearly complete data on sibling deaths, a critical component for estimating adult and maternal mortality. The NDHS provided MMR estimates in alternate survey rounds whereas the national census provided MMR in 10 years starting from 2011.

Table 1: Summary of data on MMR from different national level surveys and census at Nepal

S.N.	Source	Study conducted by	Year of data collection	Reference period	Study sites	Indicator	MMR per 100,000	95 % CI/ Uncertainty bounds	Method	Deaths captured
1	NFFPHS 1991	MoH	1991	1997-1981	Cluster	PRMR	515	Na	Indirect sisterhood	613
2	NFHS 1996	MoH	1996	1989-1995	Cluster	PRMR	539	392-686	Direct sisterhood	87
3	MMMS 1998	MoH	1998		3 districts	MMR	596-683		Calculation by MMR formula	
4	NDHS 2006	MoHP	2006	1999-2005	Cluster	PRMR	281	178-384	Direct sisterhood	39
5	MMMS 2008	MoHP	2009	13 Apr 2008-13 Apr 2009	8 districts	MMR	229	153-301 (lowest and highest range by district)	Calculation by MMR formula	
6	NPHC 2011	MoHP	2011		Census	PRMR	480		Calculation by PRMR formula	
7	NDHS 2016	MoH	2016		Cluster	MMR	239	134-345	Direct sisterhood	
8	NPHC 2021	MoHP NSO	2021	2020-2021	Census	MMR	151		Calculation by MMR formula	

Table 1 summarizes key studies that have measured maternal mortality in Nepal using different methods over the time. It highlights how data sources ranging from early family health surveys to national censuses and Demographic and Health Surveys vary in their reference periods, geographical coverage, and measurement techniques. Earlier surveys (1991–2006) primarily used the pregnancy-related mortality ratio (PRMR) based on the sisterhood method, which relies on respondents reporting deaths of their sisters. This method often yields wide uncertainty bounds due to recall bias and small numbers of captured deaths.

Later studies, including the NDHS 2016 and NPHC 2021, shifted toward producing MMR based on more direct reporting of maternal deaths. The table also shows considerable variation in MMR estimates across years from 515 in 1991 to 151 in 2021, reflecting both possible real declines and methodological inconsistencies.

Prior to 1996, vital registration data and small-scale, hospital-based studies both of which have significant limitations were the foundation for national estimates.[13] The DHS employed the sisterhood methods, including the direct sisterhood method variant in NFFPHS 1991, NFHS 1996 and NDHS 2006for Nepal.[10,13,14] The variation in maternal mortality reported by DHS surveys conducted using various methodologies between 1996 and 2006 is not accurate for those years; rather, it more reliably pertains to the years 1989 to 1999, both of which were prior to the Millennium Declaration. Understanding the non-sampling and sampling mistakes that impact these estimates is crucial when assessing the maternal mortality indicators derived from sibling data (direct or indirect technique).[15] In the homes tested for the 2006 NDHS, history of pregnancy was obtained from all eligible women between the ages of 15 and 49. The NDHS 2006 recorded 39 maternal fatalities, indicating a 50% decrease over a ten-year period. The estimated MMR was 281 per 100,000 live births, down from 539 in 1996. Nonetheless, substantial uncertainty is indicated by broad confidence intervals, which range from 392 to 686 in 1996 and 178 to 384 in 2006.[17]

Specifically focused on maternal deaths, the NDHS 2016 was the first in Nepal to give MMR estimates (239 per 100,000 live births).[11] Prior to adopting the WHO's updated definition of maternal mortality in 2016, the NDHS employed the sisterhood method and found pregnancy-related fatalities instead of maternal deaths. Maternal fatalities were tallied, divided by the number of woman-years of exposure, and then adjusted using the General Fertility Rate (GFR) in order to calculate MMR. The transition to WHO's direct method, requiring larger sample sizes, provided more accurate estimates by distinguishing maternal deaths from pregnancy-related deaths. NDHS 2016, used six questionnaires– one for fieldworkers, one for households, one for women, one for men, one for biomarkers, and one for verbal autopsy for neonatal fatalities. These were authorized by the ICF Institutional Review Board and the Nepal Health Research Council (NHRC) after being modified from the DHS-7 model.[16]

Since 1911, Nepal's census has been carried out every ten years.[9]The 2011 NPHC provided Nepal's first estimate of the Pregnancy-Related Mortality Ratio (PRMR), which was

480 deaths per 100,000 live births. Although Nepal's MMR has improved, previous studies have not fully explored the causes behind maternal deaths. To address this, the 2021 NPHC included household death records from the past year and maternal mortality-specific questions covering age, cause, place of death, and demographic details.[9]It combined verbal autopsy with maternal mortality estimation for the first time.[9]

The 2021 Maternal Mortality Study, conducted after the national census, used verbal autopsy to identify and classify maternal deaths at federal, provincial, and local levels. This approach enabled detailed estimation of MMR and PRMR, differentiating deaths by age, timing, and causes.[9,17,18] In the first phase, pregnancy-related deaths were recorded through death notification forms, which were verified by local health workers during the post-census phase through verbal autopsies. Data on live births and deaths of women of reproductive age in the 12 months prior to the census were collected using structured questionnaires. Key census questions included whether anyone in the household died in the last 12 months, their name, gender, age at death, main cause of death, and if the deceased woman (aged 15-49) was pregnant, in delivery, or within six weeks postpartum.[9] The MMR, PRMR, causes of death, and other relevant estimates at the federal, provincial, and local levels given by census 2021 supports to prioritize and provide new information that will support the review of Nepal's current maternal health policies and the development of new strategies for further improvement and towards reaching the Sustainable Development Goals (SDG) target by 2030.[17]

Nepal conducted two MMMS in 1998 and in 2008to understand maternal mortality.[12] The 1998 study, conducted in three districts (Okhaldhunga, Rupandehi, Kailali), lacked live birth data, preventing MMR estimation. In contrast, the 2008/09 study covered eight districts, representing 12% of Nepal's population, and estimated an MMR of 229 per 100,000 live births. This study employed qualitative and quantitative methods, including community surveillance, maternal death reviews, emergency obstetric care morbidity monitoring, facility and staff assessments, and stakeholder interviews. The study identified maternal deaths, conducted verbal autopsies, and analyzed emergency obstetric care data over a one-year period (April 2008-April 2009). Findings showed district-level MMR variations (153-301 per 100,000 live births), aligning with the 2006 NDHS estimate (281 per 100,000) but differing from WHO's unpublished 2005 estimate (670 per 100,000). Maternal deaths accounted for 11% of all deaths among women of reproductive age, lower than the 2006 NDHS national estimate 18%, with age-specific variations highlighting the context-specific nature of maternal mortality.[12]

Comparing all aforementioned measures of MMR calculation in Nepal, it is clear that Nepal has been experimenting various methods till date. However, Nepal continues to face challenges in ensuring data quality and lack adherence to WHO standards. The primary issues include:**1) Inconsistency in methodologies:** Different surveys and censuses have used varying approaches, making direct comparisons difficult, **2) Irregular measurement intervals:** The gaps between major maternal mortality surveys, including NDHS and NPHC, prevent continuous monitoring and trend analysis, **3) Uncertainty in estimates:** Large confidence intervals and methodological limitations contribute to uncertainty in reported figures. Despite minor omissions, particularly among older siblings, the NFHS data are largely reliable due to the high level of completeness in age and date-of-death information. NDHS uses computer-assisted personal interviewing and multilingual questionnaires to enhance data accuracy. Fieldwork is rigorously monitored through weekly reports and quality checks using CS Pro software, ensuring timely and accurate data collection. The MMMS of 1998 and 2008/09 offered valuable insights but had limitations. The 1998 study, for instance, did not collect data on live births, preventing the calculation of maternal mortality ratios (MMR).

The 2021 census integrated maternal mortality questions, verbal autopsies, and multiple validation mechanisms, including post-enumeration surveys and field checklists. Although it aligns with WHO standards in several areas, gaps remain in evaluating the completeness of birth and death recordings using WHO-recommended methodologies. Census 2021 adhered closely to WHO guidelines. It included verbal autopsies, used multiple data sources, and followed the International Classification of Disease- Maternal Mortality (ICD-MM) classification. In recent census the data on age and sex were collected, yet the report did not specify if checks for age heaping and sex ratio distortions were performed. Complete recording of deaths was done using verbal autopsy to improve completeness. The census recorded birth history but did not use Brass P/F ratios or synthetic cohort methods, limiting comprehensive evaluation. Maternal deaths were classified using ICD-MM and validated through verbal autopsy and expert review, aligning strongly with WHO recommendations.

The further analysis is structured around four key

dimensions: completeness, accuracy, timeliness, and consistency.

Completeness: DHS data has strengths such as capturing maternal death details and following international standards, but faces limitations such as small sample sizes, recall bias, and lack of cause-of-death data. The national census excels in providing comprehensive nationwide coverage, regional disaggregation, and a wider reach, but suffers from cultural biases, missing data, and methodological constraints in determining causes of death.[18] **Accuracy:** DHS data benefits from a direct sisterhood method for estimating maternal mortality, with efforts to mitigate recall bias and misclassification. However, challenges include misclassification errors in distinguishing maternal deaths from other causes. The census aligns with global definitions of maternal mortality ratio and uses a Post enumeration survey (PES) for validation, but faces limitations like misclassification bias and reliance on household reports without medical verification.[18] **Consistency:** DHS data is consistent with historical trends, with its sisterhood method being applied consistently over time, though the data is not collected every year. The census data is aligned with global standards, but due to the infrequency of its occurrence (every 10 years), trend analysis is limited. Timeliness: DHS data is timely enough to enable trend analysis but lacks contextual data essential for targeted interventions. The census, while providing data every ten years, suffers from delayed reporting and limited inclusion of migrant and displaced populations, reducing its utility for real-time health interventions and progress tracking.

DISCUSSION

This narrative review examined the methodologies used to measure maternal mortality in Nepal and evaluated the quality of data across completeness, accuracy, consistency, and timeliness. Overall, the literatures show substantial progress in maternal mortality measurement over the last three decades, yet persistent methodological inconsistencies continue to affect data reliability. Key findings highlight the transition from indirect sisterhood methods toward more direct and standardized measurement approaches, the increasing integration of verbal autopsy, and the gradual alignment of national data systems with WHO recommendations.[19]

The reviewed evidence shows that earlier surveys such as the NFFPHS 1991, NFHS 1996, and NDHS 2006relied on the indirect and direct sisterhood methods, generating PRMR that were prone to recall bias and wide uncertainty intervals.[10,13,15] Later surveys, notably NDHS 2016, adopted WHO's updated definition of maternal mortality and improved data collection procedures, producing more precise MMR estimates.[7,11,20] Similarly, national censuses progressed from basic household death reporting in 2011 to incorporating maternal mortality specific modules and verbal autopsy in 2021, improving classification and cause-of-death ascertainment.[9] The census 2021 further strengthened data quality by integrating ICD-MM classifications and multi-level estimation techniques.[1,9] Despite these advancements, significant differences in methodological approaches across surveys, censuses, and maternal mortality studies contribute to variation in MMR estimates over time.[18]

Findings from this review show that methodological variation is a major source of inconsistency in maternal mortality estimates in Nepal. Surveys using sisterhood methods tend to produce higher uncertainty due to small numbers of captured deaths, misclassification of maternal versus pregnancy-related deaths, and reliance on long-term recall.[15,21] In contrast, NDHS 2016 and NPHC 2021, which followed updated WHO guidelines, generated estimates more aligned with global standards, reflecting improvements in data accuracy and classification.[7,9,11,22] The census-based estimates also demonstrate progress, although reliance on household reporting without medical verification introduces the risk of misclassification, especially in rural areas where medical certification of deaths remains limited.[9,23] Conflicting results across sources such as differences between NDHS and census-based MMR likely reflect variations in data completeness, sampling design, reference periods, and inclusion or exclusion of late maternal deaths. Additionally, infrequent data collection (10-year census intervals) limits the ability to track short-term trends.[9,24] These discrepancies underscore the need for harmonized methods and continuous surveillance.

Accurate maternal mortality measurement is fundamental to designing effective maternal health programs, allocating resources, and tracking progress toward SDG 3.1.[15,17] The findings of this review highlight the urgent need for Nepal to establish a unified, standardized maternal mortality surveillance system. Improving the quality of death reporting, integrating verbal autopsy into routine systems, applying ICD-MM consistently, and strengthening data validation mechanisms would enhance both the precision and comparability of MMR estimates. The review also underscores the value of multi-source data triangulation combining census, survey, and facility-based information to inform policy decisions and identify high-risk populations more effectively.

However, this narrative review is limited by variations in

the methodological quality of the included studies and by differences in reference periods, sample sizes, and data completeness across data sources. The review also depends on secondary analyses, which may reflect bias from original studies. Additionally, because maternal deaths are rare events, many surveys lack sufficient sample sizes for precise estimation.

Hence, future research should prioritize standardized implementation of ICD-MM nationwide, allowing accurate classification of direct, indirect, and late maternal deaths; and methodological harmonization across surveys and censuses to reduce variability in estimates. Strengthening these areas will enhance data quality and support Nepal in achieving its maternal mortality reduction targets.

CONCLUSIONS

This review shows that Nepal has advanced in measuring maternal mortality through the 2021 census's Maternal Mortality Study, which follow several WHO-recommended practices. However, persistent issues such as underreporting, misclassification, and recall bias continue to affect the completeness and accuracy of estimates.[9,18] The census provides nationwide coverage but lacks timeliness, limiting its precision for policy planning.

To strengthen maternal mortality measurement, Nepal must integrate census findings with continuous surveillance, improve CRVS systems, and consistently apply ICD-MM classifications.[1,7,9] Investment in technical capacity and digital reporting tools is essential for producing timely and reliable data.[24] High-quality maternal mortality data will be critical for guiding evidence-based interventions and achieving the SDG 3.1 target of reducing maternal deaths.

RECOMMENDATIONS

Nepal should strengthen its CRVS system by integrating census findings with routine surveillance and ensuring consistent application of WHO-recommended methods, including ICD-MM classification. This would reduce misclassification, enhance completeness of reporting, and generate more accurate estimates of maternal mortality. Improving data quality requires sustained investment in training for health workers and enumerators, particularly in areas of cause-of-death attribution and use of verbal autopsy tools. Strengthening technical capacity will help address recurrent issues such as recall bias, underreporting, and inconsistencies across data sources. Together, these measures will enhance the reliability of maternal mortality estimates and support evidence-based policymaking toward achieving Nepal's maternal health goals.

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AUTHORS' CONTRIBUTIONS

SA designed the study, performed narrative review and analysis, and prepared the first draft of the manuscript. The draft of the manuscript was reviewed by BS and PPK. Further SA, BS and PPK contributed to finalize it as per the journal's requirement. All authors read and approved the manuscript.

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