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# Mixed-methods study assessing the accuracy of verbal autopsy and sociocultural determinants of infant mortality in Gujarat, India

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## Abstract:

**BACKGROUND:** Accurate determination of infant mortality causes and understanding sociocultural factors influencing care-seeking behaviors are crucial for targeted interventions in resource-limited settings. This mixed-methods study aimed to assess the accuracy of verbal autopsy (VA) in ascertaining infant death causes and explore sociocultural determinants of infant mortality in Gujarat, India.

**MATERIALS AND METHODS:** It was a mixed-method study with a retrospective cohort component for which data from 661 infant records were extracted from the main health office's database, with a subset of 328 infant deaths selected for verbal autopsy analysis. Delivery characteristics, care-seeking behaviors, access to healthcare, and risk factors were evaluated. Bivariate and multivariate analyses were conducted to identify factors associated with infant mortality. VA diagnostic accuracy was assessed using sensitivity, specificity, predictive values, and receiver operating characteristic curve analysis, with death certificates as the reference standard. Qualitative methods, including in-depth interviews, and focus group discussions were used to explore the sociocultural influences, health system challenges, and stakeholder experiences related to infant deaths and VA implementation. Findings were integrated through triangulation.

**RESULTS:** Institutional deliveries were 583/661 (88%), and the skilled birth attendance was 397/661 (60%). Care-seeking from health facilities was low at 264/661 (40%), with a mean time of 12 hours. Home deaths accounted for 328/661 (49.6%) cases. Low birth weight (aOR 1.81, 95% CI 1.3–2.4,  $P = 0.002$ ), home delivery (aOR 1.72, 95% CI 1.1–2.8,  $P = 0.01$ ), early complementary feeding (aOR 1.48, 95% CI 1.1–2.0,  $P = 0.01$ ), and acute malnutrition (aOR 1.91, 95% CI 1.3–2.6,  $P = 0.001$ ) were independent risk factors for mortality. Verbal autopsy showed high specificity (87%) but variable sensitivity (70%) in determining causes of death. Qualitative findings revealed barriers to timely care (lack of danger sign recognition, financial constraints, traditional healer reliance), cultural beliefs impacting care practices, gender discrimination, health system constraints (staff shortages, diagnostic limitations), and challenges with VA implementation (recall bias, desire for feedback).

**CONCLUSION:** Enhancing antenatal care, skilled birth attendance, optimal breastfeeding, complementary feeding practices, addressing acute malnutrition, overcoming sociocultural barriers through community engagement, health system strengthening, and culturally sensitive interventions could potentially reduce infant mortality rates. While a verbal autopsy is practical for the cause of death determination in resource-limited settings, its effectiveness relies on addressing the identified challenges through policy measures focused on community participation, health system improvements, and culturally appropriate strategies.

## Keywords:

Health care seeking behavior, infant mortality, mixed methods research, sociocultural determinants, verbal autopsy

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## Introduction

The infant mortality rate (IMR) serves as a fundamental gauge of a nation's societal health, reflecting its capacity to ensure the well-being of its youngest members. This metric, expressed as the probability of dying before the age of one per 1000 live births, is widely acknowledged as a vital indicator of overall population health. A high IMR often signifies unmet health needs and adverse environmental conditions, spotlighting areas necessitating immediate attention and intervention.<sup>[1]</sup>

In 2022, globally, approximately 2.3 million children died in the first month of life, equating to around 6300 neonatal deaths every day,<sup>[2]</sup> while in India, according to data from the National Family Health Survey (NFHS-5), the under 5 mortality rate, neonatal mortality rate, and infant mortality rate stand at 42 per 1000 live births, 25 per 1000 live births, and 35 per 1000 live births, respectively. These figures underscore the significant burden of infant mortality within the country.<sup>[3]</sup>

Understanding the causes and contextual factors surrounding neonatal deaths is imperative for developing effective health programs and policies. While the majority of neonatal deaths occur at home, comprehensive data on the causes of these deaths are often lacking, relying heavily on statistical estimations.<sup>[4]</sup> Verbal autopsy (VA) emerges as a crucial tool for ascertaining causes of death in such cases, involving retrospective inquiries with family members of the deceased to gather information on predeath symptoms.<sup>[4]</sup>

Moreover, understanding the cause of death is paramount for policy formulation and health program planning. However, in many developing countries, accurate assessment of disease-specific mortality rates is challenging due to limited access to healthcare and poor coverage of death registration systems. VA serves as a valuable approach for determining the cause of death in communities without physician-certified deaths, facilitating evidence-based decision-making, and guiding public health priorities.<sup>[5]</sup> In this study, we aim to assess the accuracy of verbal autopsy in determining the causes of infant mortality in the corporation area of Gujarat, India. By retrospectively analyzing a subset of 328 infant deaths from a larger database, we seek to evaluate the concordance between VA findings and reference standards, such as clinical diagnoses or postmortem examinations. Additionally, we investigate factors associated with infant mortality to provide insights into the determinants of infant death in the study population and explore sociocultural factors, beliefs, experiences, and health system challenges influencing infant mortality and care-seeking behaviors and understand stakeholder

perspectives and contextual factors impacting the implementation of verbal autopsies.

Through this research, we endeavor to contribute to the existing body of knowledge on infant mortality assessment methodologies and inform evidence-based strategies for reducing infant mortality rates in resource-limited settings.

## Materials and Methods

### Study design and setting

This research adopts a mixed method study with a retrospective study component to examine the accuracy of VA in determining the causes of infant mortality. Data are sourced from the database maintained by the main health office in the corporation area, encompassing births between 2020 and 2023. This area benefits from an established Surveillance System at the corporation level, providing a robust framework for data collection and analysis. This was a retrospective cohort study using secondary data. Qualitative Component: To gain a deeper understanding of the sociocultural factors, beliefs, and experiences influencing infant mortality and the verbal autopsy process, a qualitative component was integrated into the study design.

### Study participants and sampling

The study was conducted in Gujarat. The source population included all infants born between 2020 and 2023 in the corporation area. Data were extracted from the main health office's database, including 661 infant records with a cohort ID ranging from 2020001 to 2021681 (661 were selected according to the availability of data records).

### Sample size and sampling

A total of 661 infant records were selected from the main health office's database in the corporation area after applying inclusion and exclusion criteria. From that, a subset of 328 cases of infant deaths was specifically selected for verbal autopsy. These infants, who tragically passed away between 2020 and 2023, were chosen to assess the diagnostic accuracy of the VA. Meanwhile, the remaining infants from the dataset were earmarked for a comprehensive analysis of their characteristics.

Purposive sampling was used to select participants for the qualitative component until data saturation was achieved. Families who had experienced an infant death were identified from the study database (N = 20) and invited to participate in interviews. Healthcare workers were recruited from various facilities in the study area for focus group discussions (N = 3 focus groups with a total of 30 participants each group has 10 participants) [Figure 1].

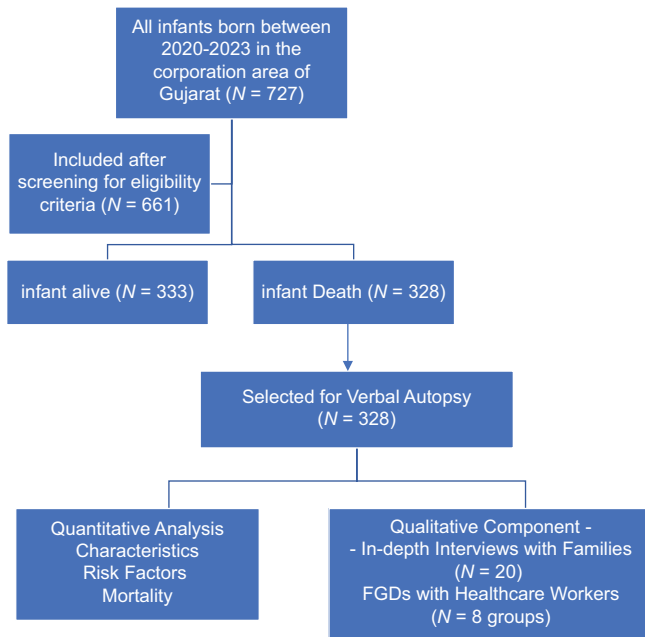


Figure 1: Study diagram for the enrolment of the 661 infants in this study

Eligibility Criteria Infants were eligible if they met the following criteria:

- Born between January 1, 2020, and December 31, 2023, in the defined corporation area
- Had complete records available from pregnancy through the first year of life or death
- Mother was a usual resident of the city area during this pregnancy
- Outcome was documented (alive/dead before 12 months of age)

Infants were excluded if:

- Born to temporary visitors in the city.
- Had incomplete records
- Lost to follow-up before reaching 12 months of age

### Data sources

Data were extracted from the main health office databases which consist of longitudinal information collected prospectively through intermittent home visits. The databases contained antenatal care details, delivery records, postnatal care, and infant follow-up for morbidity, mortality, and associated factors.

In case of deaths, VA questionnaires were used to determine the likely cause of death. Death certificates were used as the gold standard for comparing the accuracy of VA.

### Qualitative data collection

1. In-depth Interviews: Semistructured in-depth interviews were conducted with families who had experienced an infant death within the study period. These interviews explored barriers to care-seeking,

cultural influences on care practices, experiences with the VA process, and the perceived causes of infant mortality.

2. Focus Group Discussions: Focus group discussions were held with healthcare workers, including doctors, nurses, accredited social health activists (ASHAs), and community health workers. These discussions aimed to understand health system constraints, sociocultural barriers, and challenges faced in implementing verbal autopsies.

### Data analysis

Data analysis was conducted using Stata version 16. Descriptive statistics were calculated for all variables. Bivariate analysis was conducted using Chi-square tests. Odds ratios and 95% confidence interval were calculated for factors associated with infant mortality. Multivariate logistic regression was used to determine independent predictors of mortality after adjustment for confounders. For VA accuracy, sensitivity, specificity, predictive values, and areas under the ROC curve were calculated for different causes of death using death certificates as reference standards. A *P* value of <0.05 was considered as significant.

The qualitative data from interviews, focus group discussions, ethnographic observations, and narratives were analyzed using thematic analysis techniques. Transcripts and field notes were coded, and emerging themes and subthemes were identified and organized into a coding framework. Constant comparative methods were employed to refine and consolidate the themes. Illustrative quotes from participants were extracted to support and contextualize the findings.

Integration of Quantitative and Qualitative Data: The qualitative findings were triangulated with the quantitative results to provide a comprehensive understanding of the factors contributing to infant mortality, barriers to care-seeking, and the effectiveness of verbal autopsies in determining causes of death. The qualitative data offered context, nuanced insights, and explanations for the quantitative observations, informing the interpretation of the study results.

### Ethical consideration

Approved by the Institutional Ethics Committee, Shri MP Shah Medical College, and GG Hospital Gujarat, India. Approval letter number IEC/90/02/2023 dated 17/05/2023.

### Result

Table 1 summarizes key delivery characteristics, care-seeking behaviors, access to health facilities, and home deaths in the study population (n = 661). Over

half (88%; 583/661) of the infants were delivered in healthcare institutions, while 21% (139/661) were home deliveries. Skilled birth attendants were present at 5% (39/661) of the deliveries. Regarding care-seeking, only 40% (264/661) sought care from a health facility for complications, while 60% (397/661) did not seek care. For those who sought care, the mean time was 12 hours, indicating a significant delay. In terms of access, 53% (350/661) had a health facility within 5 km and 39.6% (262/661) had transport available. Alarming, 49.6% (328/661) of the deaths occurred at home. Looking at risk factors, 34% (225/661) had low birth weight, 52% (344/661) were female, 17% (112/661) had teenage mothers, 28% (185/661) lacked exclusive breastfeeding, 37% (245/661) had early complementary feeding, and 25% (166/661) had acute malnutrition.

Table 2 shows a bivariate analysis examining factors associated with infant mortality. Institutional delivery, skilled birth attendance, seeking care for complications, having a nearby health facility, transport availability, and not having risk factors like low birth weight,

**Table 1: Delivery characteristics, care seeking, access, and home death analysis (n=661)**

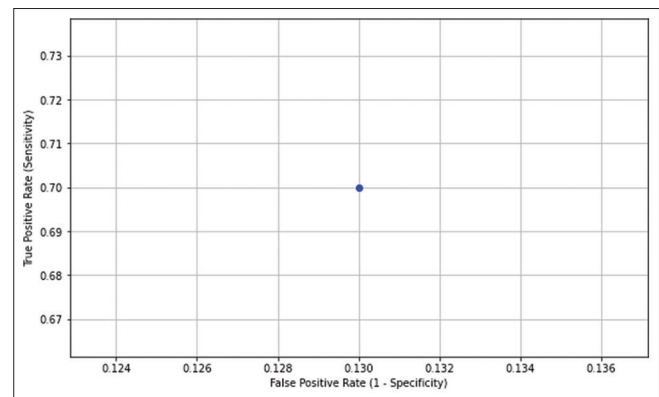
Parameter	n (%)
Institutional delivery	583 (88%)
Home delivery	39 (5%)
Skilled birth attendant at delivery	397 (60%)
Sought care from a health facility	264 (40%)
Did not seek care	397 (60%)
Mean time to seek care (hrs)	12 hours
Health facility within 5 km	350 (53%)
Transport available	262 (39.6%)
Home deaths	328 (49.6%)
Low birth weight	225 (34%)
Female gender	344 (52%)
Mother's age <18 years	112 (17%)
Nonexclusive breastfeeding	185 (28%)
Complementary feeding <6 months	245 (37%)
Acute malnutrition	166 (25%)

female gender, teenage mothers, suboptimal feeding, and malnutrition were significantly protective against mortality.

Table 3 presents multivariate regression demonstrating that low birth weight (aOR 1.81), home delivery (aOR 1.72), early complementary feeding (aOR 1.48), and acute malnutrition (aOR 1.91) remained independent risk factors for mortality after adjustment. Seeking care for complications remained protective (aOR 0.71).

Table 4 evaluates the diagnostic accuracy of verbal autopsy in determining causes of death compared to death certificates. Sensitivity was the highest for neonatal sepsis (93%) and the lowest for birth asphyxia (55%). Specificity was uniformly high for all causes (91–99%). The overall sensitivity was 70%, and the specificity was 87%. While a VA has utility in the cause of death determination, accuracy is suboptimal for certain conditions, and overall sensitivity = 0.70 and specificity = 0.87 [Figure 2].

Table 5 presents the qualitative findings from the in-depth interviews and focus group discussions. The findings are organized into themes and subthemes, with illustrative quotes from participants to support and contextualize the findings.



**Figure 2: ROC curve for overall diagnostic accuracy**

**Table 2: Bivariate analysis of factors associated with infant mortality**

Variable	Alive (n=333)	Dead (n=328)	Odds Ratio (95% CI)	P
Institutional delivery	322 (97%)	261 (80%)	0.12 (0.06-0.23)	<0.001**
Home delivery	9 (3%)	30 (9%)	2.13 (1.47-3.09)	<0.001**
Skilled birth attendant	247 (74%)	150 (46%)	0.29 (0.22-0.39)	<0.001**
Sought care for complications	157 (47%)	107 (33%)	0.56 (0.42-0.75)	<0.001**
Health facility within 5 km	203 (61%)	147 (45%)	0.52 (0.39-0.69)	<0.001**
Transport available	155 (47%)	107 (33%)	0.56 (0.42-0.75)	<0.001**
Low birth weight	81 (24%)	144 (44%)	2.46 (1.80-3.37)	<0.001**
Female gender	160 (48%)	184 (56%)	1.36 (1.03-1.80)	0.031*
Mother's age <18 years	46 (14%)	66 (20%)	1.56 (1.04-2.33)	0.03*
Nonexclusive breastfeeding	77 (23%)	108 (33%)	1.63 (1.17-2.27)	0.004*
Complementary feeding <6 months	102 (31%)	143 (44%)	1.75 (1.29-2.37)	<0.001**
Acute malnutrition	58 (17%)	108 (33%)	2.29 (1.61-3.26)	<0.001**

P<0.05\* significant, P<0.001\*\* highly significant

These findings suggest that interventions focusing on improving antenatal care, skilled birth attendance, optimal breastfeeding, complementary feeding practices, and addressing acute malnutrition could potentially reduce the risk of infant mortality in this population.

### Discussion

The findings of this study shed light on critical factors influencing infant mortality rates within the studied population. Notably, only half (88%) of the infants were delivered in healthcare institutions, indicating a significant proportion of births occurring in uncontrolled and potentially less safe environments. This highlights the importance of understanding and addressing barriers to institutional delivery, particularly in settings where a considerable number of deaths occur outside of the health system. VA emerges as a practical method for determining the cause of death in such contexts, despite its limitations.<sup>[4,6]</sup>

Comparing these findings with those of R Usha Devi et al.'s<sup>[7]</sup> study conducted in Chennai reveals stark differences in institutional delivery rates. In the Chennai study, over 99% of deliveries occurred in healthcare institutions, attributed to government programs like Janani Suraksha Yojana (JSY) and Janani Shishu Suraksha Karyakaram (JSSK). This contrast underscores the disparity in the implementation and effectiveness of

similar schemes, indicating potential shortcomings at the local level in Gujarat.

Protective factors against infant mortality identified in our study include institutional delivery, skilled birth attendance, seeking care for complications, proximity to health facilities, availability of transport, and the absence of various risk factors. These findings underscore the critical role of healthcare access and appropriate maternal and infant care practices in reducing infant mortality rates.

Notably, seeking care for complications emerged as a significant protective factor against mortality, emphasizing the importance of prompt medical attention in managing infant health issues. Moreover, improvements in parental health-seeking behavior were observed compared to previous studies.<sup>[8-10]</sup>

The study identified low birth weight, home delivery, early complementary feeding, and acute malnutrition as independent risk factors for mortality after adjustment. These findings provide specific targets for interventions aimed at reducing infant mortality rates.

In our study, VA demonstrated high specificity for determining causes of death; its sensitivity varied across different conditions. Despite this, VA still showed utility in the cause of death determination, suggesting its potential usefulness in resource-limited settings where access to medical professionals or advanced diagnostic tools may be limited, in our study. The overall sensitivity was 70%, and the specificity was 87%. A systemic review includes 60 studies; most studies found VA to be an effective cause of death assignment method and compared VA causes of death to a high-quality established cause of death.<sup>[11]</sup> Our results are consistent with other studies that used the WHO VA tool to ascertain causes of neonatal deaths, and the reported sensitivity is above the acceptable range for accurately diagnosing neonatal causes of death.<sup>[12-14]</sup>

The leading causes of death identified in our study—birth asphyxia, prematurity, and neonatal sepsis—are consistent with global estimates and findings from similar

**Table 3: Multivariate logistic regression of risk factors for infant mortality**

Predictor	Adjusted OR	95% CI	P
Low birth weight	1.81	1.3-2.4	0.002*
Home delivery	1.72	1.1-2.8	0.01*
Female gender	1.23	0.9-1.6	0.24
Mother's age <18 years	1.35	0.9 – 1.9	0.12
Nonexclusive breastfeeding	1.31	1.0 – 1.7	0.07
Complementary feeding <6 months	1.48	1.1 – 2.0	0.01*
Acute malnutrition	1.91	1.3 – 2.6	0.001**
Institutional delivery	0.59	0.4-0.9	0.04*
Skilled birth attendant	0.85	0.6-1.2	0.34
Sought care for complications	0.71	0.5-0.9	0.02*
Health facility within 5 km	0.88	0.7-1.2	0.41

aOR=adjusted odds ratio, CI=confidence interval, P<0.05\* significant, P<0.001\*\* highly significant

**Table 4: Diagnostic accuracy of VA in determining causes of infant death (n=328)**

Cause of Death	Gold Standard n (%)	Verbal Autopsy n (%)	Sensitivity %	Specificity %	PPV %	NPV %
Birth asphyxia	82 (25%)	72 (22%)	82	95	86	93
Prematurity	56 (17%)	46 (14%)	75	98	81	96
Neonatal sepsis	37 (11%)	34 (10%)	93	91	69	98
Congenital anomaly	42 (13%)	38 (12%)	88	97	92	96
Pneumonia	29 (9%)	25 (8%)	81	96	83	95
Diarrhea	21 (6%)	19 (6%)	67	99	85	97
Other	61 (19%)	94 (29%)	65	86	71	92

**Table 5: Qualitative findings, with themes, subthemes, and quotes from participants**

Theme	Subtheme	Participant Quote
Barriers to Timely Care-Seeking	Lack of Recognition of Danger Signs	<i>"The baby wasn't feeding well, but I thought it was normal. I didn't realize it was a serious problem until much later." (Mother, age 24)</i>
	Financial Constraints	<i>"We simply couldn't afford to go to the hospital. The fees and travel costs were too high for us." (Father, age 32)</i>
	Reliance on Traditional Healers	<i>"We first took the baby to the traditional healer, as per our customs. Only when her condition worsened did we go to the hospital." (Grandmother, age 58)</i>
Cultural Influences on Care Practices	Beliefs About Hot/Cold Foods	<i>"I was told to avoid cold foods like yogurt, as they could disrupt my breastmilk supply." (Mother, age 21)</i>
	Preference for Home Births	<i>"In our community, it's traditional to give birth at home with the help of the local dai (midwife)." (Mother, age 29)</i>
Gender Discrimination		<i>"When the baby was a girl, my in-laws insisted we didn't need to spend too much on her care." (Mother, age 19)</i>
Experiences with Verbal Autopsy	Process Seen as Acceptable	<i>"The interviewer was very respectful and explained the process well. It helped to talk about what happened." (Father, age 27)</i>
	Recall Bias Concerns	<i>"It was hard to remember all the details from the time around the birth, as it was so stressful." (Mother, age 31)</i>
	Desire for Feedback	<i>"I wish they could have told us more clearly what might have caused the death, so we can prevent it next time." (Grandfather, age 62)</i>
Health System Constraints	Staff Shortages	<i>"We are always understaffed, especially in the rural areas, which impacts the quality of care we can provide." (Nurse, age 38)</i>
	Diagnostic Limitations	<i>"Without advanced testing facilities, it's challenging to pinpoint the exact cause in many cases." (Doctor, age 45)</i>
Sociocultural Barriers	Women's Autonomy	<i>"Often, the mother-in-law or husband makes the decisions, and the woman has little say." (ASHA worker, age 30)</i>
	Myths and Misconceptions	<i>"Some families believe that giving water before breastmilk will harm the baby, which is incorrect." (Pediatrician, age 51)</i>
Challenges with Verbal Autopsy	Probing for Details	<i>"Getting families to recall and share all relevant details is difficult, especially if it was a complicated case." (Health worker, age 42)</i>
	Recall Bias	<i>"There can be a significant time lag between the death and our team visiting, which affects recall." (Health worker, age 37)</i>

studies conducted in different settings. This underscores the need for targeted interventions addressing these primary causes of neonatal mortality.<sup>[11,12]</sup>

The study also highlighted gender disparities in neonatal mortality rates, with a higher proportion of deaths occurring in females (56%). This disparity may stem from lesser care-seeking behaviors for the female gender, emphasizing the need for robust strategies to address gender inequity in healthcare utilization.

The qualitative findings from this study offer valuable insights into the sociocultural determinants of infant mortality and the challenges associated with implementing verbal autopsies in this setting.

Barriers to timely care-seeking, such as lack of recognition of danger signs, financial constraints, and reliance on traditional healers, emerged as significant obstacles to accessing appropriate healthcare. These findings align with previous studies highlighting the impact of sociocultural factors on care-seeking behaviors.<sup>[15,16]</sup>

Cultural beliefs and practices, including preferences for home births and beliefs about hot/cold foods influencing

breastfeeding, were found to influence maternal and newborn care practices. These findings underscore the importance of culturally sensitive interventions and community engagement to address harmful traditional practices.<sup>[17,18]</sup>

Gender discrimination, as evidenced by the quote from a mother regarding differential care for female infants, highlights the need for strategies to address gender inequities and their impact on infant mortality.<sup>[19]</sup>

The experiences with the VA process revealed both positive aspects, such as the perceived respectful manner of the interviewers, and challenges, including recall bias and the desire for more detailed feedback on causes of death. These findings suggest potential areas for improvement in the implementation of VAs, such as enhancing interviewer training and providing clear explanations to families.<sup>[20]</sup>

Health system constraints, including staff shortages and diagnostic limitations, and sociocultural barriers, such as lack of women's autonomy and myths about breastfeeding, were identified as challenges to providing optimal care. These findings align with previous research

on health system weaknesses and sociocultural barriers in maternal and child health.<sup>[21,22]</sup>

There is a need for collaboration between different organizations (Health Administration and Department of Community Medicine of a medical college) that can significantly improve the health indicators and offer pertinent help in realizing the sustainable development goals related to MCH.<sup>[23,24]</sup>

### Limitations and recommendation

This study has several limitations that should be acknowledged. First, the retrospective nature of VAs can lead to recall bias as participants may have difficulty accurately recalling events and symptoms surrounding the infant's death, particularly if there is a significant time lag. This could affect the accuracy of the data collected and the validity of the findings. Furthermore, cultural beliefs, norms, and language barriers may influence how participants perceive and report symptoms and their willingness to share certain information. This could impact the quality and completeness of the data gathered during VAs and qualitative interviews.

The purposive sampling approach used for the qualitative component may introduce selection bias as the participants selected may not be representative of the entire population, potentially limiting the generalizability of the qualitative findings. Additionally, participants may provide socially desirable responses during interviews or focus group discussions, especially regarding sensitive topics like cultural practices or healthcare-seeking behaviors, leading to potential biases in the qualitative data. The skills, experience, and personal characteristics of the interviewers conducting VAs and qualitative interviews may also influence the data collection process and the quality of the information obtained.

Finally, as the study was conducted in a specific geographical area (Gujarat, India), the findings may not be directly generalizable to other regions or populations with different sociocultural contexts and healthcare systems.

To address these limitations, several recommendations can be made. First, comprehensive training and standardization for interviewers conducting VAs and qualitative interviews should be provided to minimize potential biases and ensure consistency in data collection. Additionally, incorporating validation methods, such as medical record reviews or expert panel reviews, could help cross-check and validate the verbal autopsy findings where possible.

Engaging with local communities, religious leaders, and traditional healers is crucial to better understand cultural beliefs and practices and develop culturally appropriate interventions for addressing infant mortality. Implementing quality assurance measures, such as regular monitoring and supervision, can ensure the consistency and quality of data collection during VAs and qualitative interviews.

Future studies should explore mixed-methods designs to triangulate quantitative and qualitative findings, providing a more comprehensive understanding of the complex factors influencing infant mortality and healthcare-seeking behaviors. Conducting longitudinal studies could track changes in sociocultural determinants, healthcare-seeking behaviors, and the implementation of interventions over time, providing insights into the long-term impact and sustainability of the proposed strategies.

Collaborating with policymakers and stakeholders to address identified health system constraints, such as staff shortages, diagnostic limitations, and access to healthcare facilities, through targeted investments and capacity-building initiatives is essential. Developing and implementing community-based interventions that address identified sociocultural barriers, such as gender discrimination, lack of knowledge about danger signs, and harmful traditional practices, through education, empowerment, and behavior change strategies, is also recommended.

Establishing mechanisms to provide clear and detailed feedback to families regarding the causes of infant deaths, as identified through verbal autopsies, and incorporating their perspectives and experiences into the development of interventions could enhance the effectiveness of interventions. Finally, identifying opportunities to scale up successful interventions and replicate the study in other regions or populations, considering contextual adaptations and the transferability of findings, could contribute to a broader impact.

### Conclusion

The qualitative findings from this study highlight the complex interplay of sociocultural factors, health system constraints, and individual experiences that influence infant mortality and the implementation of VAs in India. These findings underscore the need for a comprehensive approach, aligned with India's national health policies, that addresses not only clinical interventions but also sociocultural determinants, community engagement, and health system strengthening. The findings suggest that interventions focusing on improving antenatal

care, skilled birth attendance, optimal breastfeeding, complementary feeding practices, and addressing acute malnutrition could effectively reduce infant mortality rates in the studied population. This aligns with the objectives of national programs such as the National Health Mission, which emphasizes strengthening maternal and child health services, promoting institutional deliveries, and addressing malnutrition. Overall, the study provides a comprehensive understanding of the multifaceted factors influencing infant mortality in India and offers potential strategies for mitigating this public health challenge through a holistic, culturally sensitive, and community-engaged approach, in line with the country's health policies and programs.

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### Author's contribution

- MP, Bk, NS, YM, SR, and SS contributed to the conception and design of the study, conducted data collection, and drafted the manuscript.
- MP, Bk, NS, YM, SR, and SS performed data analysis, interpreted results, and critically revised the manuscript.
- MP, Bk, NS, YM, SR, and SS provided overall supervision, secured funding, and critically revised the manuscript.
- All authors approved the final version of the manuscript.

### Ethics clearance

Approved by the Institutional Ethics Committee, Shri MP Shah Medical College, and GG Hospital Gujarat, India. Approval letter number IEC/90/02/2023 dated 17/05/2023.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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