

Learning Management Software for Medical Institutions Implementing Competency-based Medical Education: An Untapped Opportunity!

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ABSTRACT

The gaps in competency-based medical education (CBME) implementation in Indian medical colleges are caused by multiple factors, such as training, structural, and system-based limitations. Stakeholders believe that using learning management system (LMS)-based solutions could be a good way to make the CBME process more efficient, but this must be supported by targeted training for faculty, better IT infrastructure, and strong institutional governance. A strategic, step-by-step approach to adopting LMS tools could make CBME more effective and sustainable, especially in colleges with limited resources.

Keywords: Digital health, Education, Global poverty trends, Health, India, Living standards, Nutrition, Social protection.

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INTRODUCTION

In India, the National Medical Commission (NMC) introduced competency-based medical education (CBME) with the aim of cultivating medical graduates who are not only technically skilled but also ethically grounded and attuned to the health needs of their communities. Competency-based medical education marks a significant transformation in how medical training is structured, shifting the focus from traditional, time-bound curricula to an approach that centers around observable skills and outcomes. This model prioritizes the development of competencies—such as clinical skills, ethical decision-making, and community responsiveness—through learner-centered strategies. Competency-based medical education is regarded as a potent solution for many of the shortcomings found in the conventional method of medical education in the country. Competency-based medical education is not simply about adding competencies to the existing curriculum; rather, it involves a comprehensive approach that includes tailored instruction, effective assessment, and continuous, hands-on training.

Studies have shown that the successful implementation of CBME relies heavily on the use of faculty development programs (FDPs) to provide regular and ongoing training on the CBME modules. For CBME to be implemented effectively, a coordinated effort involving all stakeholders—such as medical educators, students, and policymakers—is essential.^{1–9}

Implementation Challenges of CBME

However, even with detailed guidelines and national-level initiatives, the move from traditional teaching methods to CBME has been difficult at the institutional level. Research from various medical colleges indicates that while the concept of CBME is broadly accepted, its implementation is often inconsistent and fragmented. Educators commonly face confusion around mapping competencies, developing assessment strategies, and maintaining documentation processes.^{10–17}

Faculty Perspectives toward CBME

From the perspective of faculty, several challenges arise from cumbersome paper-based administrative systems, increased

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workloads, and inefficiencies that complicate the CBME process. Many studies from the past decade have highlighted these challenges. While there is growing literature on the challenges of implementing CBME, there is a lack of research on how these challenges can be addressed through contextualized evaluations of CBME. One study noted that while some members of medical education units feel competent in certain aspects of CBME, continuous training and workshops are necessary for better understanding and implementation.

One of the most frequently reported issues in the implementation of CBME is the large amount of documentation required, such as logbooks, internal assessments, workplace-based assessments, and feedback records. These tasks often compete with regular teaching, clinical responsibilities, and research activities, leading to faculty exhaustion and resistance. Insufficient FDPs and inconsistent institutional support further widen the gap between CBME policy and practice.

Students' Perspectives toward CBME

From the student point of view, the CBME curriculum has generally been well-received, with newer batches showing a greater appreciation for self-directed and integrated learning approaches.

However, logistical and educational barriers such as logbook management and understanding the assessment structure

remain, indicating the need for ongoing improvements to the curriculum.^{18–23}

Learning Management Software: A Ray of Hope!

Learning management systems (LMSs) have the potential to support CBME by integrating features like competency tracking, assessment documentation, feedback mechanisms, and academic analytics into a single digital platform.

However, the practicality and acceptance of LMSs in Indian medical colleges, especially in government institutions that often have limited resources, require further study. Although some research has indicated that LMS has gained popularity in medical education for both undergraduate and postgraduate programs, the extent of its use and its effectiveness in this context are not well understood. Studies have shown that e-learning plays a crucial role in enhancing the implementation of CBME in Indian settings. The need of the hour is to recognize the benefits of e-learning and to develop strategies that facilitate its integration, creating a more streamlined and effective CBME process. While Indian literature on CBME has largely focused on the perceptions and early experiences of faculty, there is a lack of empirical data regarding the operational challenges and digital preparedness of institutions for CBME. Digital tools, particularly LMS software, have been proposed as a way to make CBME processes more efficient. This study, therefore, aims to identify the key factors that contribute to gaps in CBME implementation and to evaluate stakeholder views on the effectiveness of LMS software as a digital support tool in Indian medical colleges, making this study unique in its approach and focus.^{24–35}

CONCLUSION

The implementation gaps in CBME across Indian medical colleges arise from a combination of training deficiencies, infrastructural challenges, and systemic constraints. Stakeholders perceive LMS-based solutions as a promising approach to enhance efficiency; however, their success depends on adequate faculty training, improved IT infrastructure, and robust institutional support. Adopting LMS tools through a well-planned, phased strategy can significantly strengthen the effectiveness and long-term sustainability of CBME, particularly in resource-constrained settings.³⁶

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Determinants of Anemia among Women of Reproductive Age in Assam India

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ABSTRACT

Anemia prevalence is significantly higher among females than males across most regions, with stark disparities observed in Central Asia and high-income Asia Pacific. Anemia is a global health concern, affecting over half a billion women of reproductive age-group. According to the National Family Health Survey (NFHS-5), approximately 57% of women in the reproductive age-group in India are anemic. This study focuses on the prevalence of mild and moderate anemia among women of reproductive age-group (15–49 years) in Assam. Prevalence of anemia among women was analyzed with relation to age, alcohol consumption, body mass index (BMI), education, marital status, source of drinking water, caste, wealth, contraceptive method, and pulse consumption among women. The analysis is based on data obtained from NFHS-5 (2020–2021), encompassing 34,979 women of reproductive age. Bivariate and multinomial regression statistical techniques were applied to analyze the data. The study shows that women with no formal education had 21% higher odds of moderate anemia. Belonging to the scheduled tribe (ST) and other backward class (OBC) groups was found significantly associated with a 17.4 and 41.6% increase in the odds of moderate anemia, respectively, whereas 17.1% higher odds of mild anemia were noticed in the OBC group. Underweight women exhibited higher odds of moderate anemia ($OR = 1.833, p < 0.001$), whereas contraceptive use [pills and intrauterine devices (IUDs)] and alcohol abstinence were linked to reduced anemia risk. Addressing BMI, education, community, and lifestyle disparities is essential for mitigating anemia and improving women's health outcomes in the state.

Keywords: Anemia, Assam, National Family Health Survey, Reproductive age, Women.

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INTRODUCTION

Anemia, is characterized by reduced red blood cell count that decrease the body's ability to supply sufficient oxygen to tissues, which affecting approximately 1.76 billion people worldwide.^{1,2} Anemia significantly impacts women of reproductive age and child health, contributing to increased morbidity, maternal mortality, and hindering socio-economic development.^{3,4} An estimation by World Health Organization (WHO, 2019) about 30% of women of reproductive age (15–49 years) worldwide, amounting to over half a billion, are estimated to be anemic, and most of them suffers due to iron deficiency among them.⁵

Central Asia and high-income Asia Pacific regions showed stark disparities, with largest differences between males and females, with a much higher frequency of anemia presence among females than males. South Asia is the region with the maximum prevalence of anemia among developing countries, and India in particular bears a very high burden of iron-deficiency anemia.^{4–7} World Health Organization states that the highest weight of anemia is borne by individuals from low and lower-middle income countries, and the highest prevalence of the disease is seen in rural populations, economically vulnerable households and individuals without any formal educational background. Worldwide, anemia is estimated to impact 40% of children aged 6–59 months, 37% of pregnant women, and 30% of women aged 15–49 years.

According to the National Family Health Surveys (NFHS), Assam consistently recorded the highest prevalence of anemia among all Indian states, particularly among women aged between 15 and 49 years.^{8,9} A spatial meta-analysis further substantiated this finding, reporting that Assam had the highest pooled prevalence of anemia, with 83.9% of women affected, surpassing the national burden.¹⁰ More recent evidence from NFHS-5 indicates a worsening trend, showing an increase in anemia level among women in

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the state, with rural populations and women with lower levels of education being disproportionately affected.¹¹ According to NFHS-5, approximately 57% of women in the reproductive age-group in India are anemic, underscoring a critical public health challenge. This heightened prevalence among Indian women highlights their social and biological vulnerabilities within both societal and household contexts.^{3,12} A review of existing literature reveals that, among other important determinants younger age, lower education status, lesser empowerment, poor economic status, inadequate intake of food and higher fertility are major contributors of anemia among women.^{13–18} On the other hand, contrasting evidence indicates that lower consumption of alcohol and contraceptive methods could exert protective effects on the risk of anemia.^{19,20}

Studies indicate that women from lower castes—scheduled caste (SC), scheduled tribe (ST), and other backward caste (OBC)—are more prone to anemia due to limited autonomy in decisions related to health, education, and nutrition, reflecting their socio-economic disadvantage and the persistent impact of traditional social stratification in India, where over 60% of the

population belongs to these marginalized groups.¹⁸ This study seeks to examine the prevalence of anemia and explore the associated physiological and socio-demographic determinants among women of reproductive age in Assam.

MATERIALS AND METHODS

This study has adopted a quantitative, cross-sectional design with the help of multi nominal logistic regression using fifth round of the NFHS-5, to examine the relationship between factors associated with the status anemia and socio demographic variables of women in reproductive age-group in Assam. The NFHS is a large-scale, multi-round survey data conducted in a proportionate sample of households across India, providing essential data on population, health, and nutrition indicators. The NFHS-5 survey offers comprehensive data, making it a valuable resource for analysing demographic and health trends in India. For this study, a total of 34,979 women in the reproductive age-group (15–49 years) from the state of Assam were considered.

Study Population

The study emphasizes on women of reproductive age (15–49 years) residing in Assam, India. To ensure data reliability, women with incomplete information on anemia status and essential covariates such as place of residence, employment status, etc., were excluded from the analysis. The sample size for Assam was finalized at 34,979 women. For contextual comparison, this subset is part of the total national sample surveyed under NFHS-5. The primary focus of this research is how the socio-economic conditions influence or are associated with anemia level among the reproductive-age-group of women in Assam.

Dependent Variable

The level of anemia is taken as the dependent variable in this study. The NFHS-5 classifies anemia into three categories based on hemoglobin (Hb) levels: Mild anemia (10.0–11.9 gm/dL), moderate anemia (7.0–9.9 gm/dL), and severe anemia (below 7.0 gm/dL). For analytical clarity and due to sample size limitations, the moderate and severe anemia categories were combined into a single category referred to as “moderate anemia,” while the mild anemia category was retained separately. This classification ensures improved statistical robustness in the final analysis.

Independent Variables

The selection of predictor variables was guided by reviewing of existing literature on anemia risk factors in India.^{3,4,21} The independent variables encompass demographic, economic, and behavioural factors such as age, marital status, contraceptive use, wealth quintile, body mass index (BMI), dietary intake, drinking water sources, and alcohol consumption. Variables like pregnancy status and place of residence were excluded from the analysis due to insufficient sample representation. This methodological framework ensures a comprehensive examination of socio-economic determinants influencing anemia prevalence among women in Assam, facilitating meaningful insights for policy interventions and public health strategies.

RESULTS

The analysis from the Table 1, reveals key patterns in anemia prevalence across various socio-demographic factors. Age-wise, there is little variation, though individuals above 35 years have the

Table 1: Socio-economic determinants and anemia status in women of reproductive age

Background characteristics	Anemia level			Total
	Moderate (in %)	Mild (in %)	Not anemic (in %)	
Age-group				
15–24	36.3	29.5	34.2	10,876
25–34	36.1	28.5	35.4	10,709
<35	37.9	28.6	33.5	12,258
Educational status				
No education	40.6***	28.1	31.3	6,326
Primary	36.6	28.9	34.5	4,586
Secondary and higher	35.8	29.0	35.1	22,931
Caste				
SC	36.2	29.0	34.8	4,184
ST	39.1***	27.6	33.3	6,097
OBC	41.9***	28.9***	29.2	9,110
Others	35.2	29.5	35.3	3,857
Marital status				
Never married	36.5	30.1	33.4	7,379
Married	36.7	28.5	34.8	25,021
Formerly married	40.9	28.8	30.3	1,443
Contraceptive method				
Not using	37.6	29.1	33.3	17,980
Pill and IUD	32.2***	28.5***	39.3	7,859
Female sterilization	41.6	28.7	29.7	2,372
Others	38.9	28.4	32.7	5,632
BMI				
Under weight	44.2***	28.0***	27.8	5,705
Normal	35.7***	29.3***	35.1	23,143
Obese	33.7	27.8	38.5	4,926
Pulse consumption				
Occasionally	35.8***	29.0	35.2	11,771
Daily	37.4	28.8	33.8	22,072
Source of drinking water				
Improved source	36.9***	29.1***	34.0	28,220
Non improved source	36.2	27.6	36.2	5,353
Alcohol consumption				
No	36.5***	28.9	34.6	31,298
Yes	41.3	27.5	31.2	2,545
Wealth quintile				
Poor	28.9	36.9	34.2	24,042
Middle	28.7	36.5	34.8	5,750
Rich	28.8	36.6	34.5	4,051
Total	9,761	12,462	11,620	33,843

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. BMI, body mass index; OBC, other backward caste; SC, scheduled castes; ST, scheduled tribes

highest prevalence of moderate anemia (37.9%). Education shows a notable role; higher levels of education are significantly associated with a reduced risk of moderate anemia and a greater likelihood of being non-anemic. Those with no education shows a moderate anemia prevalence of 40.6%, which decreases to 35.8% in individuals with secondary or higher education. Caste differences are evident, with the OBC group recording the highest percentage of moderate anemia (41.9%), followed by ST population (39.1%). Marital status



Table 2: Socio-economic variables associated with mild and moderate anemia among women of reproductive age

Variable	Category	Moderate anemia					Mild anemia				
		B	Sig.	Exp (B)	CI lower	CI upper	B	Sig.	Exp (B)	CI lower	CI upper
Age	15–24	–0.059	0.140	0.943	0.872	1.019	–0.034	0.425	0.967	0.890	1.050
	25–34	–0.028	0.397	0.973	0.912	1.037	–0.029	0.406	0.971	0.907	1.040
	<35 ^R	–	–	–	–	–	–	–	–	–	–
Educational status	No education	0.191	0.000	1.210	1.126	1.300	0.070	0.076	1.072	0.993	1.159
	Primary	0.036	0.363	1.037	0.959	1.121	0.022	0.602	1.022	0.941	1.110
	Secondary and higher ^R	–	–	–	–	–	–	–	–	–	–
Caste	SC	0.040	0.451	1.041	0.937	1.157	–0.006	0.914	0.994	0.890	1.110
	ST	0.160	0.001	1.174	1.064	1.296	–0.008	0.881	0.992	0.893	1.102
	OBC	0.348	0.000	1.416	1.292	1.551	0.158	0.001	1.171	1.063	1.290
	Others ^R	–	–	–	–	–	–	–	–	–	–
Marital status	Never married	–0.143	0.058	0.867	0.748	1.005	–0.027	0.739	0.973	0.831	1.140
	Married	–0.112	0.099	0.894	0.782	1.021	–0.086	0.240	0.917	0.794	1.059
	Formerly married ^R	–	–	–	–	–	–	–	–	–	–
Contraceptive method	Not using	–0.063	0.117	0.939	0.867	1.016	–0.035	0.422	0.966	0.887	1.051
	Pill and IUD	–0.374	0.000	0.688	0.634	0.747	–0.186	0.000	0.830	0.761	0.906
	Female sterilization	0.091	0.131	1.095	0.973	1.231	0.078	0.227	1.082	0.952	1.228
	Others ^R	–	–	–	–	–	–	–	–	–	–
Pulses consumption	Occasionally	–0.104	0.000	0.901	0.854	0.951	–0.044	0.126	0.957	0.904	1.013
	Daily ^R	–	–	–	–	–	–	–	–	–	–
BMI	Underweight	0.606	0.000	1.833	1.667	2.016	0.148	0.000	1.160	1.073	1.254
	Normal	0.169	0.000	1.184	1.100	1.276	0.321	0.000	1.378	1.244	1.526
	Obese ^R	–	–	–	–	–	–	–	–	–	–
Wealth quantile	Poor	0.117	0.024	1.125	1.015	1.245	0.102	0.068	1.107	0.993	1.235
	Middle	0.047	0.415	1.048	0.936	1.172	0.048	0.433	1.049	0.930	1.183
	Rich ^R	–	–	–	–	–	–	–	–	–	–
Drinks alcohol	No	–0.182	0.000	0.834	0.756	0.920	–0.038	0.486	0.963	0.864	1.072
	Yes ^R	–	–	–	–	–	–	–	–	–	–
Sources of drinking water	Improved source	0.188	0.000	1.207	1.113	1.310	0.172	0.000	1.187	1.087	1.297
	Non improved source ^R	–	–	–	–	–	–	–	–	–	–

BMI, body mass index; OBC, other backward caste; SC, scheduled castes; ST, scheduled tribe

also influences anemia levels, with formerly married individuals showing the highest moderate anemia rate (40.9%). Contraceptive methods appear to impact anemia prevalence, women with pill and intrauterine device (IUD) shows lower proportion of moderate anemia (32.2%), while female sterilization users exhibit the highest moderate anemia rate (41.6%). Body mass index has a strong association with anemia; underweight individuals show the highest moderate anemia rate (44.2%), while obese individuals have the lowest moderate anemia rate (33.7%) and the highest proportion of non-anemic individuals (38.5%). Alcohol consumption is linked to poorer anemia outcomes, with drinkers showing higher moderate anemia rates (41.3%) compared to non-drinkers. Overall, education, BMI, and lifestyle factors like alcohol consumption significantly influence anemia prevalence, highlighting the need for targeted interventions among vulnerable groups.

Table 2 shows the BMI in women is significantly correlated with an increased likelihood of anemia. Compared to the obese, underweight women are more likely to be moderately anemic, with 83.3% improved odds of anemia (OR = 1.833, $p < 0.001$), and

the result is statistically significant. However, normal BMI also shows increased risk but to a lesser extent (OR = 1.184, $p < 0.001$) which is 18.4% as compared to the obese category. For mildly anemic women, BMI was again a significant factor. Underweight women are 1.16 times and normal-weight women are 1.37 times more likely to be mildly anemic, compared to the obese category. This suggests that both underweight and normal-weight women are vulnerable to mild anemia, and underweight women are particularly vulnerable. These findings highlight the critical role of BMI in anemia risk.

Educational attainment is another significant predictor of anemia. Women with no education has 21% higher odds of being moderately anemic compared to women having higher education and the result is statistically significant, suggesting that lack of formal education substantially increases anemia risk. Similarly, women who had completed only primary education, still exhibits an elevated risk but through a lesser extent with insignificant association (OR = 1.037, $p > 0.001$). The results underscore the importance of education as a protective factor against anemia,

with higher educational attainment potentially mitigating the risk. The multinomial logistic regression highlights the significant role of community classification in anemia risk among women. Scheduled tribe and OBC groups show increased odds of moderate anemia ($OR = 1.174, p = 0.001$; $OR = 1.416, p < 0.001$), possibly linked to socioeconomic and dietary disparities. Women from the OBC community demonstrate the highest likelihood of both moderate ($OR = 1.416$) and mild ($OR = 1.171$) anemia, indicating a particularly vulnerable group in terms of anemia prevalence. Women from the ST community also show an elevated risk for moderate anemia ($OR = 1.174$), though they do not exhibit a significant association with mild anemia. Whereas, women from the SC community do not show significant associations with either moderate or mild anemia, indicating that anemia risk in this group may not be as pronounced. These findings show the importance of addressing community-based disparities in anemia prevalence, particularly in the OBC and ST communities, to reduce anemia rates and improve women's health outcomes.

Marital status also played an important role in anemia risk. The result suggests that the likelihood of being moderately anemic is lower compared to those who were formerly married for never married women, but the result is not statistically significant at 5% level. However, age and marital status do not show statistically significant differences in the risk of moderate and mild anemia relative to their respective reference categories. These findings suggest that marital status influences anemia risk, though the association is stronger for the moderately anemic category. The results indicate that those women who abstained from alcohol were significantly less likely to be moderately and mildly anemic. Non-drinkers are significantly less likely to have moderate anemia, with an odds ratio (OR) of 0.834 and a highly significant p -value (< 0.001). However, alcohol consumption did not show a significant impact on the likelihood of mild anemia. This suggesting lifestyle factors like alcohol avoidance may reduce anemia risk.

Among the significant predictors of mild anemia, the source of drinking water emerged as notable; women who consumed water from improved sources exhibited a higher likelihood of being mildly anemic ($B = 0.172, p < 0.001, OR = 1.187$) compared to those relying on non-improved sources. These findings highlight the role of socio-economic factors in determining anemia risk, alongside physiological factors such as BMI.

DISCUSSION

The focus of this study was to determine the prevalence of anemia among women of reproductive age in Assam, India by taking into consideration a wide-range of socio-demographic factors. The study found that, women having no education had higher prevalence of mild and moderate anemia compared to women with primary and higher education. These findings are consistent with other studies indicating that women with limited or no education are at a higher risk of anemia.^{22–25} Lack of education can be linked to lower socioeconomic status which limits access to iron rich food, it may also be associated with early marriage and multiple pregnancies among women which increase the risk of anemia. In relation to dietary habits, women who consumed pulses occasionally were less likely to be anemic. This finding contradicts earlier research from Andhra Pradesh, which indicated that women who consumed pulses daily were less likely to be anemic (mildly, moderately, or severely) than those who consumed

pulses only intermittently.³ This study identified a significant association between BMI and anemia, indicating that women with lower body mass are at increased risk of developing anemia. There is a less likelihood of anemia among overweight women compared to women with lower and normal BMI. The plausible explanation could be the diets of overweight and obese women that include iron-rich foods, which may lead to reduce risk of anemia among women with higher BMI.^{26,27} These findings are in line with the findings of other studies, where women with lower BMI had higher risk of developing anemia.^{19,28} Women in reproductive age who do not consume alcohol were found to have lower risk of being mildly and moderately anemic. However, this finding is contradictory to the findings of previous studies where consumption of alcohol were found have positive effects on the iron concentration.^{3,29} Women using pill and IUD contraceptive method showed lower risk of being anemic. In terms of caste and wealth, women from lower caste and lower wealth quantile showed higher likelihood of both moderate and mild anemia, while ST and SC showed higher likelihood of moderate anemia compared to women from other categories. Women from both poor and middle wealth quantile are found to be anemic, with poor quantile showing greater risk of anemia. Socio-economic factors, such as, caste and wealth quantile were found to have significant association with anemia in previous studies, with STs and SCs and lower wealth quantile showing greater risk of anemia.^{4,30}

Limitations

The findings of this study should be interpreted in light of certain methodological constraints. The cross-sectional nature of the secondary data precludes stronger causality inference. Additionally, focusing solely on socio-economic variables omits critical predictors of anemia, such as dietary intake, existing comorbidities, and reproductive history. Future research should apply longitudinal cohort designs to establish temporal precedence and incorporate comprehensive biological and behavioural assessments to provide a holistic understanding of anemia prevalence.

CONCLUSION

This study of anemia among women in Assam reveals socio-economic variables as key predictors of anemia risk. Underweight and normal BMI women are particularly prone to mild and moderate anemia, while low education and certain marital statuses further increase vulnerability. Targeted interventions to improve nutritional status and education could significantly reduce anemia prevalence. Further research should explore additional socio-economic and behavioural factors, including alcohol consumption. Addressing anemia requires an integrated approach that combines public health education, improved nutritional access, and systemic healthcare reforms.

Data Availability

The specific datasets and variables used in this analysis are available from the corresponding author upon reasonable request.

AI Disclosure

The authors declare that ChatGPT 4.1 was used to assist with grammatical editing and language refinement of the manuscript. All AI-generated content was thoroughly reviewed and edited by the authors, who take full responsibility for the final manuscript.



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AUTHORS' CONTRIBUTIONS

Reshab Debnath conceptualized the overall study, data analysis, and served as the lead author of the manuscript. Sanswarg Basumatary assisted in data analysis, contributed to the discussion, and supported the preparation of the original draft. Both authors reviewed, edited, and approved the final version of the manuscript for submission.

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Effect of Addiction to Smartphone Usage on Neck Flexor Muscle Endurance among Apparently Healthy College Students – A Cross-sectional Study

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ABSTRACT

Aim and background: With the growing prevalence of smartphone use among young adults, it becomes essential to examine the adverse consequences of excessive usage. Existing literature has established a connection between excessive smartphone usage and neck dysfunction. Therefore, this research aimed to clinically investigate early-stage impairments by evaluating how smartphone addiction influences the endurance of deep neck flexor muscles in subclinical university students.

Materials and methods: A total of 100 college students participated in the study. Based on their scores from the Smartphone Addiction Scale-Short Version (SAS-SV), they were categorized into two groups: Addicted and non-addicted. Both groups underwent assessments of neck flexor muscle endurance using the neck flexion endurance test (NFET) and the cranio-cervical flexion test (CCFT). An unpaired *t*-test was employed to determine statistical significance.

Results: The endurance of deep neck flexor muscles was significantly lower ($p < 0.05$) in the group identified as smartphone-addicted. Additionally, this group showed reduced activation scores and performance indices for these muscles.

Conclusion: The findings offer clinical evidence of early impairments in deep neck flexor endurance and activation among subclinical individuals with smartphone addiction.

Clinical significance: These results suggest that intervention and awareness programs for this demographic should prioritize exercises that activate and strengthen deep neck flexor muscles.

Keywords: Cross-sectional study, Community health, Deep neck flexor endurance, Health promotion, Neck dysfunction, Physical activity, Smartphone addiction.

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INTRODUCTION

Technological innovation has led to a rapid increase in smartphone usage across various domains.^{1–5} These devices are continuously being enhanced to be more engaging and efficient. However, excessive use can lead to both physical and psychological issues, including anxiety, depression, reduced focus, and impaired work performance.⁶ Alarming, this trend spans all age groups—from children to the elderly—raising concerns about behavioral patterns resembling addiction, especially among university students in their 20s.⁵

Traditionally, addiction refers to repeated and excessive use of substances. Today, the term also encompasses behavioral addictions, including compulsive use of smartphones, gambling, and internet dependency.¹ Research using the smartphone addiction scale has shown that overuse can result in symptoms like craving, withdrawal, tolerance, and disruption of daily routines.¹

Numerous studies have confirmed a correlation between prolonged smartphone use and musculoskeletal discomfort.² Specifically, smartphone overuse has been associated with neck muscle fatigue and reduced upper limb function. Studies suggest that the prevalence of neck pain among smartphone users ranges from 17.3 to 67.8%, with a lifetime occurrence of approximately 55.8%.⁶

When the head is in a normal position, it typically applies a force of 10–12 pounds on the cervical spine. However, forward

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head posture—commonly adopted during extended smartphone use—can significantly increase this load. For example, a 15-degree tilt adds 27 pounds of pressure, while a 60-degree tilt can exert up to 60 pounds.⁶ If left unaddressed, this condition—often referred to as “text neck”—can lead to chronic injuries similar to repetitive strain disorders.⁷

Over time, untreated text neck may cause inflammation in the neck’s muscles, ligaments, and nerves, potentially altering spinal curvature. While existing research highlights long-term neck issues, there is limited clinical evidence identifying the earliest impairments that precede these conditions. A study in 2021 attempted to bridge this gap by comparing grip strength, pinch

strength, and neck muscle endurance in smartphone-addicted versus non-addicted asymptomatic individuals.⁸ They found a significant difference in neck flexor endurance but not in other parameters.

Building on these findings, this study aims to further explore the effect of smartphone addiction on deep neck flexor (DNF) endurance using two distinct tests that assess different cervical spine segments in subclinical individuals.

Aim

To evaluate the influence of smartphone addiction on the endurance of neck flexor muscles in apparently healthy college students.

OBJECTIVES

- To classify college students as smartphone-addicted or non-addicted using the Smartphone Addiction Scale-short Version (SAS-SV).
- To measure DNF endurance using the neck flexor endurance test (NFET) and cranio-cervical flexion test (CCFT).
- To compare endurance test scores between addicted and non-addicted students to identify early impairments in asymptomatic individuals.

MATERIALS AND METHODS

Research design—It is a prospective cross-sectional study.

Study duration—6 months.

Participants—Undergraduate physiotherapy students.

Sample size—100.

Inclusion criteria—Students aged 18–27 who regularly use smartphones.

Exclusion criteria—Individuals with current or past neck pain (with or without radiating symptoms), congenital deformities, diagnosed neurological, musculoskeletal, rheumatic, or cardiopulmonary conditions, or a history of neck/upper limb surgeries.

Assessment Tools—SAS-SV.²

NFET.³

CCFT.⁴

Procedure

The study protocol received approval from the Institutional Ethics Committee (Approval No.: DYPUSOP/2294(a)2022). A total of 100 physiotherapy students who met the defined inclusion and exclusion criteria were enrolled. Data regarding smartphone addiction was collected using a convenience sampling approach, involving an offline survey. Participants were briefed thoroughly about the study and provided informed consent. Since the sample was drawn from a physiotherapy college, the majority of participants were female, which may introduce bias and limit the generalizability of the findings.

Based on scores from the SAS-SV, participants were categorized into two groups: Those identified as addicted (group A) and those classified as non-addicted (group B). Both groups underwent evaluation of DNF endurance using NFET and CCFT. The detailed assessment sheet is attached at the end of the article as Supplementary Appendix A.

Outcome Measures

SAS-SV

The SAS-SV comprises 10 items that evaluate five key behavioral dimensions: (i) disruption of daily life, (ii) withdrawal symptoms, (iii) relationships centered around cyberspace, (iv) excessive use, and (v) tolerance. Participants respond using a six-point Likert scale, from “strongly disagree” (1) to “strongly agree” (6), with a maximum score of 60. Participants scoring above 30 were considered excessive users, while those scoring 30 or below were categorized as non-excessive users. The SAS-SV has demonstrated strong internal consistency (Cronbach’s $\alpha = 0.911$), with a sensitivity of 0.87 and a specificity of 0.89.²

NFET

The participant was positioned supine with the knees bent and hands placed on the abdomen. He/she was instructed to perform a maximal chin tuck and lift the head approximately 2.5 cm from the surface. This position was held isometrically, and the duration was recorded until either the neck skin folds separated or the head contacted the investigator’s hand placed under the occiput. This test demonstrates moderate inter-rater reliability, with an intraclass correlation coefficient (ICC) value of 0.66.^{3,9}

CCFT

Designed to assess the selective activation of the deep neck flexors (longus capitis and longus colli) while minimizing engagement of superficial muscles (e.g., sternocleidomastoid and anterior scalene), this test uses a pressure biofeedback device. Participants were placed in a crook-lying posture with the head in a neutral alignment and instructed to perform subtle nodding actions. The goal was to reach five incremental pressure targets (22–30 mm Hg) without compensatory strategies. The test comprises two stages: stage I evaluates the ability to achieve and briefly hold each pressure level correctly; stage II measures the ability to maintain each level for 10 seconds across 10 repetitions. High intertester reliability for the CCFT has been confirmed through Bland and Altman’s agreement analysis.^{4,10}

Data Analysis and Interpretation

The sample consisted of 100 students, evenly split between smartphone-addicted (group A) and non-addicted (group B) groups based on SAS-SV scores. No participants dropped out, and as the study was cross-sectional, no follow-up was required. Participant demographics and test outcomes were documented in Excel and evaluated using descriptive statistical methods, including visual graphs, percentage distributions, and unpaired *t*-tests. *p*-value of less than 0.05 was considered as statistically significant, with the confidence level set at 95%.

DISCUSSION

Given the widespread use of smartphones, it is essential to investigate the adverse effects of excessive usage [Tables 1 and 2](#). This study aimed to assess the impact of smartphone addiction on neck flexor endurance and activation in a subclinical population of young adults ([Fig. 1](#)). This study found that NFET endurance time was significantly lower in the addicted group ($p < 0.05$, [Table 3](#)), aligning with findings from a previous study.⁸

Table 1: Age distribution

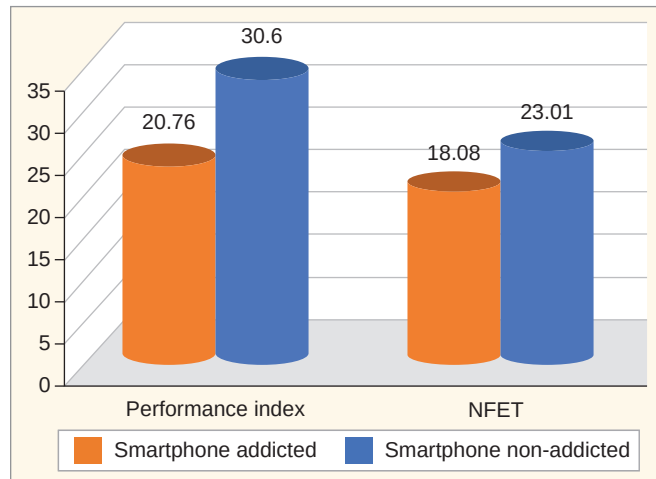
Group A		Group B	
Age	No. of participants	Age	No. of participants
18	0 (0%)	18	1 (2%)
19	7 (14%)	19	4 (8%)
20	2 (4%)	20	10 (20%)
21	8 (16%)	21	5 (10%)
22	17 (34%)	22	10 (20%)
23	8 (16%)	23	10 (20%)
24	3 (6%)	24	4 (8%)
25	1 (2%)	25	4 (8%)
26	4 (8%)	26	2 (4%)
Mean age: 22	Total: 50 (100%)	Mean age: 22	Total: 50 (100%)

Inference: The above table shows that the maximum percentage of the population in the study belongs to the age of 22 years in both the addicted (34%) and non-addicted (20%) groups

Table 2: Gender distribution

Gender	Group A	Group B
Female	42 (84%)	40 (80%)
Male	8 (16%)	10 (20%)
Total	50 (100%)	50 (100%)

Inference: The above table shows that the maximum percentage of study subjects is females in both the addicted (84%) and non-addicted (80%) groups

**Fig. 1:** Comparison of the neck flexor muscle endurance scores

Isolating the function of deep cervical flexors from superficial neck muscles presents a clinical challenge [Table 1](#). These deep muscles—longus capitis, longus colli, rectus capitis anterior, and lateralis—play a key role in cervical spine stabilization. Although the sternocleidomastoid (SCM) is the primary contributor to neck flexion, electromyographic (EMG) studies show that the DNFs are active during both dynamic and static cervical flexion.¹¹ Electromyographic activity in the longus colli and longus capitis muscles intensifies with progressive flexion, while signals from SCM and anterior scalene remained relatively constant.¹¹ This supports

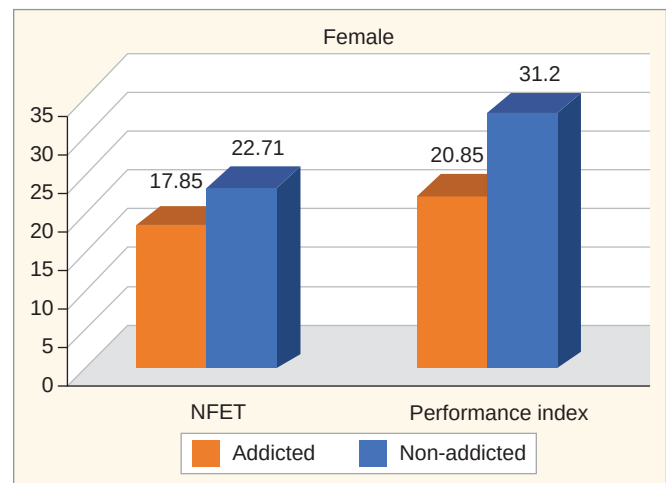
Table 3: Comparison of the neck flexor muscle endurance score

Test	Group A	Group B	T-score	p-value
	Mean $\pm$ SD	Mean $\pm$ SD		
NFET	18.08 $\pm$ 6.73	23.01 $\pm$ 9.65	-2.9659	0.003
CCFT performance index	20.76 $\pm$ 10.78	30.6 $\pm$ 21.11	-2.9350	0.004

Inference: The above graph shows that NFET score and CCFT performance index score are significantly reduced ($p < 0.01$) in the addicted group when compared to the non-addicted group

Table 4: Comparison of NFET and CCFT performance index between the two groups in female

Test	Group A	Group B	T-score	p-value
	Mean $\pm$ SD	Mean $\pm$ SD		
NFET	17.85 $\pm$ 6.32	22.71 $\pm$ 9.44	-2.721	0.008
Performance index	20.85 $\pm$ 10.81	31.2 $\pm$ 22.28	-2.65308	0.01

**Fig. 2:** Comparison of NFET and CCFT performance index between the two groups in female

the use of chin-tuck-based endurance tests to isolate DNF activity [Table 2](#).

In this study, both the NFET and the CCFT were used to assess DNF function. The CCFT provided insight into muscle activation and performance across graded flexion levels.¹²

Gender-based analysis of the CCFT performance revealed a significant ($p < 0.05$, [Table 4](#)) reduction in endurance scores among addicted females as depicted by the graph in [Figure 2](#), but in the male subgroup, though the reduction in CCFT performance in addicted subgroup is clearly seen in [Figure 3](#), it was not statistically significant ($p > 0.05$, [Table 5](#))—likely due to the smaller sample size. However, Cohen's d analysis ([Table 5](#)) indicated a moderate effect size in males, suggesting practical relevance.

Scatter plots ([Figs 4 and 5](#)) comparing NFET scores, CCFT activation scores, and CCFT performance indices across both groups revealed a consistent reduction in the addicted group. These findings indicate that the smartphone-addicted individuals have difficulty sustaining inner-range cranio-cervical flexion, reflecting

compromised endurance in DNFs. This impairment in DNF muscle endurance contributes to neck pain, forward head posture, and increased cervical lordosis.^{7,8}

Research has explored the impact of prolonged smartphone use on spinal flexion angles and cervical repositioning accuracy. Findings revealed notable increases in both spinal flexion and repositioning errors following five minutes of continuous smartphone activity, indicating postural and proprioceptive changes.¹³

In conclusion, this study corroborates previous findings that smartphone addiction is associated with reduced DNF endurance,

even in asymptomatic individuals. The diminished CCFT scores highlight the DNFs as the primary site of impairment, offering clinical evidence for the early pathophysiological changes linked to neck dysfunction in smartphone-addicted populations.

CONCLUSION

- The present study provides statistical evidence that smartphone addiction has a significant negative impact on neck flexor endurance, as assessed by NFET and CCFT, in young, seemingly healthy college students ($p < 0.05$).
- When compared to non-addicted females, addicted females have significantly lower neck endurance ($p < 0.05$). Owing to limited male representation, statistical significance was not achieved in this subgroup ($p > 0.05$), however, the effect size was found to be moderate, implying a noticeable practical difference in scores of both tests.
- Collective results from NFET and CCFT metrics suggest that deep cervical flexors are the primary site of functional impairment in sub-clinical smartphone-addicted young adults.

Limitations of the Study

- As the sample comprised predominantly female university students, the generalizability of the results may be constrained.
- Additional variables influencing neck endurance, such as posture, physical activity, and visual health, were not examined in this study.
- While the SAS can help identify people who are at risk of smartphone addiction, it cannot provide a clinical diagnosis of smartphone addiction. This should be considered when deciphering any SAS score insights.

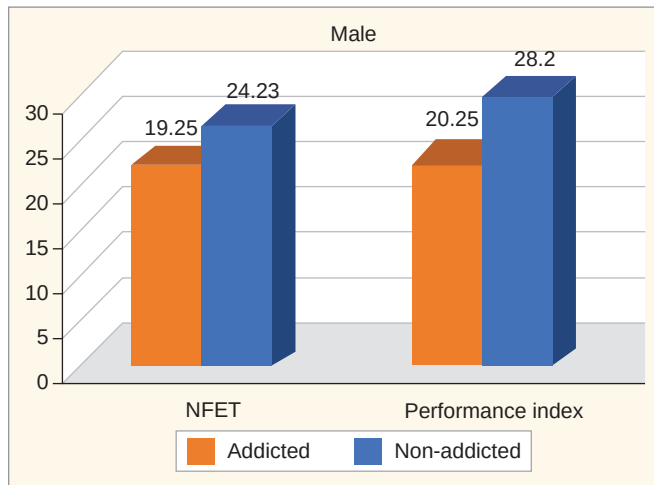


Fig. 3: Comparison of NFET and CCFT performance index between the two groups in male

Table 5: Comparison of NFET and CCFT performance index between the two groups in male

Test	Group A	Group B	T-score	p-value	Cohen's d
	Mean $\pm$ SD	Mean $\pm$ SD			
NFET	19.25 $\pm$ 8.99	24.23 $\pm$ 10.9	-1.063	0.3034	-0.49
Performance index	20.25 $\pm$ 11.33	28.2 $\pm$ 16.34	-1.2156	0.2417	-0.55

Inference: The above graphs show that deep neck flexor endurance is significantly reduced in smartphone-addicted females ($p < 0.05$), but there is no significant difference in deep neck flexor endurance in males. But the effect size, as indicated by Cohen's d , is moderate, implying a noticeable practical difference in means

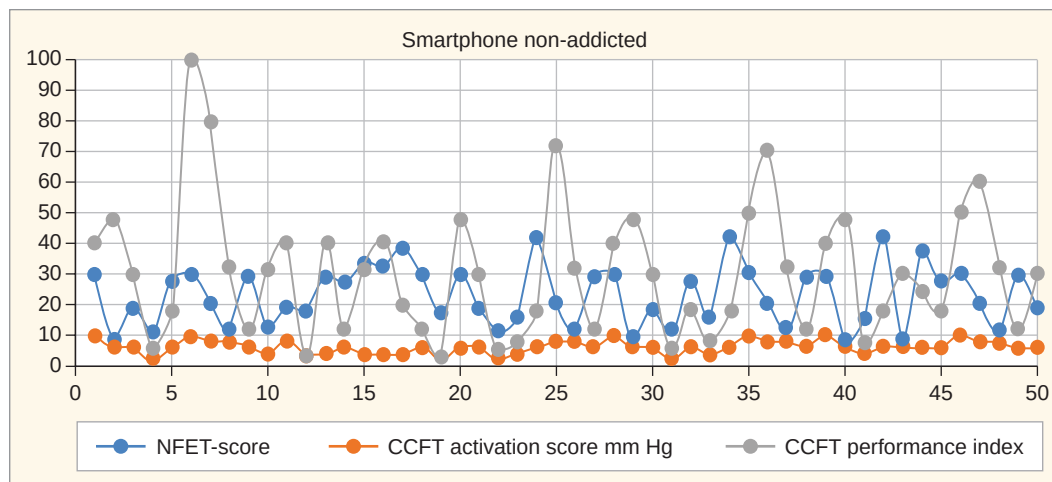


Fig. 4: Scatter plot depicting NFET score, CCFT activation score, and CCFT performance score in smartphone non-addicted subjects (group B)

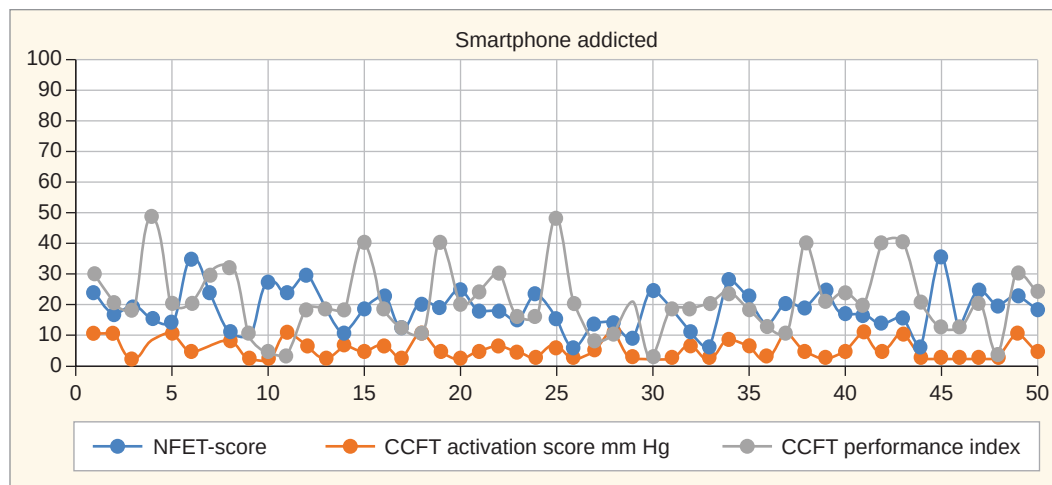


Fig. 5: Scatter plot depicting NEFT score, CCFT activation score, and CCFT performance score in smartphone addicted subjects (group A)

Inference: Comparison of the two scatter graphs clearly shows that all neck muscle endurance test scores (NFET score, CCFT activation score, and CCFT performance score) are clearly reduced in most of the smartphone-addicted subjects as compared to the smartphone non-addicted subjects

Clinical Significance

This study concluded that long-term smartphone use and addiction can lead to the development of muscle imbalance, as deep neck muscles become weak in activation and in endurance. Such muscular imbalance may disrupt biomechanical function and contribute to progressive cervical dysfunction. Thus, this study identifies the deep neck flexors as the site of the primary impairment and implies that Intervention strategies and educational efforts should emphasize targeted activation and reinforcement of deep cervical flexor musculature.

Future Scope of Research

- Future research should involve a more diverse and balanced participant pool to validate these findings.
- A similar study can be carried out in individuals involved in other screen-based occupations.
- Subsequent studies may investigate additional contributors such as visual function, exercise habits, and postural alignment, to isolate the impact of smartphone overuse from the above-mentioned factors as a cause for the neck disability.

DECLARATIONS

Data Availability

All the data relevant to this research is available in the article itself and the raw data is available with the corresponding author, and can be accessed upon a reasonable request.

Artificial Intelligence (AI) Disclosure

No AI assisted technologies were used for any part of this research, its writing and publication process. The authors take the full responsibility for the accuracy and integrity of the final outcome of this research work.

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SUPPLEMENTARY MATERIALS

All the supplementary materials are available on its journal website www.hppi.in

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Geographical Variation and Covariates of Growth Failure among Under-five Children in India: Evidence from National Family Health Survey-5 (2019–2021)

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ABSTRACT

Background: Growth failure in children (GFC) is a condition where a child's weight and height growth are delayed compared to healthy children of the same age. It is a major public health challenge with significant health and socioeconomic implications. Variations across regions, socioeconomic status, and maternal and child health highlight the difficulty in achieving uniform improvements.

Objectives: To identify spatial variation and examine determinants of GFC, including child, maternal, household, community, and spatial factors using NFHS-5 data.

Methods: Spatial analysis was conducted using Global Moran's I statistics and Local Indicator of Spatial Association (LISA) maps. Logistic regression models were used to assess explanatory factors.

Results: Significant regional disparities were observed. Stunting is highest in eastern India, while wasting and underweight are more prevalent in western India. Hotspot districts include West Bengal, Maharashtra, Gujarat, Assam, Telangana, and Bihar. Higher GFC is associated with male gender, higher birth order, early maternal marriage, short stature, low BMI, poor breastfeeding duration, and inadequate ANC visits.

Conclusion: Growth failure in children shows marked spatial variation and is influenced by multiple child, maternal, and healthcare-related factors.

Keywords: Growth failure in children, Malnutrition, National Family Health Survey, Stunting, Underweight, Wasting.

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INTRODUCTION

Growth failure in children (GFC) refers to a condition in which a child's physical development, particularly in terms of weight and height, is delayed or retarded compared to healthy peers of the same age.¹ It is termed wasting, stunting, and underweight, which results from acute and chronic diseases (infection) and malnutrition.² These are characterized by low weight-for-height, low height-for-age, and low weight-for-age.³ However, it is not, in itself, a disease; rather, it is a common sign or symptom of a wide variety of disorders.⁴ In 2022, it was estimated that around 45 million children under five were wasted, 149 million were stunted, and 390 million were underweight, with the majority of these cases occurring in low- and middle-income countries.³ As reported in the Global Hunger Index (2022), India accounts for the highest number of malnourished children globally, with nearly one-third of the world's stunted children residing in the country.⁵ India ranks 105th out of 127 countries, reflecting a serious hunger level.⁶ This underscores the persistent challenges of child malnutrition, particularly stunting, which remains a critical public health issue.

Empirical evidence from prior studies has highlighted a significant multilevel association between child growth outcomes and several determinants, including child-specific characteristics, maternal educational attainment, household wealth status, and other underlying socioeconomic factors.^{7,8} Several studies have documented that factors such as poor living conditions, inadequate household sanitation, poor maternal nutritional status, large family size, higher birth order, low maternal literacy levels, early maternal age at marriage, and maternal health indicators such as body mass index (BMI), child's dietary intake and physical activity, inadequate

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access to healthcare services, place of delivery, and antenatal care (ANC), along with breastfeeding initiation and frequency, are essential factors influencing maternal characteristics and health status, which in turn directly or indirectly impact child growth.^{8–15}

India, home to diverse states with large populations, encompasses districts that vary significantly in ecology, demography, and economic conditions, each impacting child health outcomes. Studies highlight those environmental factors, including regional climate and agricultural practices, influence nutritional availability and child health.¹⁶ Additionally, demographic factors, such as urban vs rural residency, correlate with differing access to health and sanitation facilities, which are critical for child development.¹⁷ Economic disparities across states and districts further affect access to nutritious food and healthcare, contributing to malnutrition and

health inequities.¹⁸ Therefore, to address the persistent burden of child undernutrition and improve maternal health outcomes, the Government of India has implemented several nutrition and welfare programs over the decades. Among them are the National Prophylaxis Programme 1970, the Integrated Child Development Services (ICDS, 1975), the Targeted Public Distribution System (TPDS, 1997), the National Food Security Act (NFSA, 2013), and the PM POSHAN Abhiyaan (2018). The ICDS program focuses on providing nutritional support, health services, and early childhood education for mothers and young children. The TPDS ensures access to subsidized food grains for economically disadvantaged households, while the NFSA reinforces a rights-based framework for food security across the nation. More recently, the PM POSHAN Abhiyaan has been launched to enhance nutritional outcomes among children, adolescent girls, and mothers through the convergence of various government schemes and improved service delivery.

However, India's multiethnic composition and geographic diversity, combined with vast economic disparities, contribute to the uneven progress in reducing GFC across the country.¹⁹ Ethnic and cultural factors often influence childcare norms, dietary practices, and access to health services, all linked to child growth outcomes.²⁰ The economic divide among states and communities also affects healthcare access and nutrition security, impacting child health and growth.²¹ These regional disparities underscore the challenges in achieving uniform improvements in child growth and health.

According to the NFHS-5 (2019–2021) report, the prevalence of GFC is alarmingly high, with 19% of under-five children being wasted, 36% stunted, and 32% experiencing underweight.²² Although India reports a high prevalence of growth failure among children, considerable variation exists across regions and states. Such disparities can be attributed to differences in population size, ecological conditions, demographic patterns, and economic status, all of which influence child health outcomes. Furthermore, the NFHS-5 report highlights that the hotspot areas with undernutrition are concentrated in several states, including Bihar, Chhattisgarh, Jharkhand, Gujarat, Rajasthan, Madhya Pradesh, and West Bengal.²³ Marked geographical disparities in child malnutrition persist across Indian states with particularly high prevalence observed in parts of the eastern and central regions.²⁴ Most of these states have a poor wealth index. Therefore, it is important to accurately assess the patterns of GFC in geographically diverse areas at the district level. This study aims to identify spatial variation and investigate various determinants, including child, maternal, household, community, and spatial factors, affecting GFC.

METHODS

Data and Study Population

This study is based on data from a cross-sectional, nationally representative survey conducted under the National Family Health Survey (NFHS-5) between 2019 and 2021 by the Ministry of Health and Family Welfare, Government of India (available at <https://www.dhsprogram.com/data/available-datasets.cfm>). Initially, exploratory data assessment was carried out to identify outliers, missing, and consistency. Subsequently, the final analytic sample of 1,29,394 out of 2,32,920 surveyed children aged 0–59 months was taken after exclusion of flagged or missing information. A detailed procedure for deriving the final analytical sample is presented in Table 1. All statistical analyses were weighted for sampling probabilities using the weighting factor in the NFHS data to account for the survey's complex sampling design.

Table 1: Selection of study population

<i>Selection of analytical sample</i>	<i>N</i>
Overall survey sample	2,32,920
Excluded cases due to missing or flagged anthropometric data of the child	34,118
Excluded cases due to missing or flagged data of child, maternal, household, and community characteristics	69,408
Final analytical sample	1,29,394

Outcome Variable

For outcome variables, three indicators of GFC based on height, age, and weight measures (i.e., wasting, stunting, and underweight) are considered. Wasting was identified when the weight-for-height z-score fell below -2 standard deviation (SD), stunting when the height-for-age z-score was below -2 SD, and underweight when the weight-for-age z-score was less than -2 SD, which are according to the WHO child growth reference standards (WHO, 2006). They are dichotomized: Children who had no growth failure were categorized as “no” (code 0), and otherwise were categorized as “yes” (code 1).

Explanatory Variables

Multiple explanatory indicators related to the child, maternal, household, community, and spatial were considered based on previous literature. Child characteristics comprise the child's sex, age, birth order, breastfeeding initiation, and current breastfeeding. Maternal characteristics comprise maternal education, height, BMI, ANC visit during pregnancy, and age at marriage. Household characteristics include the use of cooking fuel, drinking water sources, and household wealth quintile. Caste, religion, and facility for the child's place of delivery are included in community characteristics. Additionally, the places of residence and regions in India based on the NFHS survey classification are in spatial characteristics.

Statistical Analysis

To determine the prevalence of GFC, this study considered child, maternal, household, community, and spatial characteristics. District-wise choropleth maps were created to visualize the spatial distribution of GFC rates. To assess spatial autocorrelation, Local Indicator of Spatial Association (LISA) maps and univariate Global Moran's I statistics have been estimated. To evaluate potential predictors of GFC, a series of logistic regression analyses was conducted. All selected covariates were included simultaneously in an adjusted model. The associations were presented as odds ratios (ORs), with corresponding 95% confidence intervals (CIs), and statistical significance was determined at $p < 0.05$. To account for the complex, multistage, stratified sampling design of the NFHS, adjustments were made for sampling weights, stratification, and clustering to ensure national and sub-national representativeness. These adjustments help compensate for disparities in sample size and variability across states and districts, thereby enhancing the accuracy and reliability of the estimates.

FINDINGS

Distribution of Child Growth Failure (CGF)

Table 2 shows the distribution of CGF. These forms of CGF are not evenly distributed but instead vary based on individual child characteristics, maternal characteristics, household, community

Table 2: Percentage distribution of wasting, stunting, and underweight children under five in India

Variables	Total (N)	Wasting (%)	Stunting (%)	Underweight (%)
Child's age (in months)				
0–9	25,529	25.2	23.3	23.8
10–19	27,640	20.9	36.2	28.1
20–29	24,152	19.6	39.5	31.4
30–39	19,582	18.3	38.2	33.3
40–49	16,964	17.3	37.1	32.8
50–59	15,527	17.4	32.6	31.5
Child's gender				
Male	69,175	20.9	35.6	30.8
Female	60,219	19.5	32.8	28.5
Order of birth				
First	41,799	19.5	29.5	25.2
Second	46,265	19.8	33.0	28.6
Third or more	41,330	21.5	41.0	35.9
Maternal education				
No schooling	26,549	23.7	44.8	40.1
Primary	16,021	21.5	40.4	35.7
Secondary	67,713	19.6	32.7	28.1
Higher	19,111	17.0	22.4	18.2
Maternal height (in cm)				
<145 cm	14,515	22.1	52.4	45.0
145–149.9 cm	32,970	22.2	41.0	35.4
150–154.9 cm	43,957	20.1	31.8	27.6
155–159.9 cm	26,678	18.3	25.3	22.1
160 + cm	11,274	17.0	20.9	18.1
Mother's BMI (in kg/m ²)				
<18.5	23,945	25.8	42.4	41.5
18.5–24.9	80,895	20.7	34.2	29.5
25.0+	24,554	13.5	26.8	19.3
Initiation of breastfeeding				
≤1 hr of birth	58,828	20.2	33.8	29.3
≥1 hr of birth	70,566	20.3	34.6	30.0
Currently breastfeeding				
No	46,731	16.9	33.1	28.4
Yes	82,663	22.2	35.0	30.5
ANC visit				
Less than four times	53,421	20.9	37.7	33.0
At least four times	75,973	19.8	32.0	27.5
Maternal marriage age				
Age at marriage <18	38,964	21.6	39.7	35.0
Age at marriage ≥18	90,430	19.6	31.7	27.2
Cooking fuel				
Clean	60,653	18.5	29.9	25.2
Not clean	68,741	22.1	39.1	34.7
Drinking water source				
Improved	1,18,565	20.2	34.4	29.7
Not improved	10,829	21.3	33.1	30.1

(Contd...)

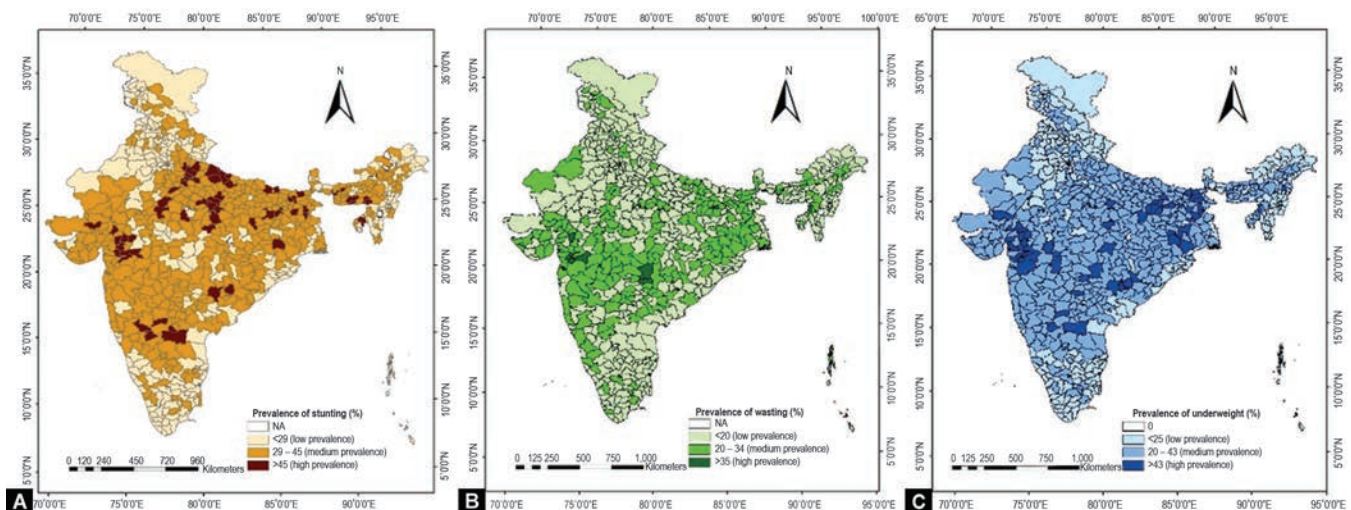
Table 2: (Contd...)

Variables	Total (N)	Wasting (%)	Stunting (%)	Underweight (%)
Area of residence				
Urban	27,464	19.0	29.3	24.7
Rural	1,01,930	20.7	36.2	31.6
Household wealth quintile				
Poorest	32,479	24.9	45.0	41.7
Poorer	29,482	21.4	39.1	34.2
Middle	25,446	19.1	33.6	28.2
Richer	23,026	18.2	27.8	23.5
Richest	18,961	16.3	22.7	17.7
Place of childbirth				
Public sector	84,283	20.8	35.9	31.3
Private medical sector	29,446	18.0	27.2	22.8
At home	15,665	23.0	44.1	39.2
Caste category				
SC	27,036	20.6	37.9	32.8
ST	27,717	24.6	39.4	36.8
OBC	51,580	20.0	33.9	29.0
Others	23,061	18.1	28.2	23.9
Religion category				
Hindu	98,367	20.2	34.3	29.9
Muslim	14,492	21.2	35.5	30.2
Christian	11,078	18.3	31.5	24.7
Others	5,457	16.2	29.4	24.8
Region				
South	16,496	17.4	29.9	24.9
North	24,776	15.1	28.9	21.9
Central	32,990	19.3	36.7	29.9
East	25,082	23.2	36.9	35.1
West	11,900	26.0	36.1	34.7
Northeast	18,150	18.6	32.4	24.3
Total	1,29,394	20.2	34.3	29.7

BMI, body mass index; Note: All percentages are presented in weighted cases. ANC, antenatal care

Source: NFHS-5 (authors have calculated)

conditions, and geographical regions. The results indicate that, in terms of child characteristics, the peak occurrence of stunting arises between the age group of 20–29 months, wasting is most common in the youngest age group, and underweight is highest in children aged 30–39 months. Growth failure in children is more prevalent among male children, those with a birth order of three or more, children whose breastfeeding was initiated later than one hour after birth, those still being breastfed, and those delivered at home. Regarding maternal characteristics, the menace of GFC is notably complex among mothers with no schooling, mothers with a height of less than 145 cm, those with a BMI below 18.5 kg/m², mothers who received fewer than four ANC visits, and those who married before the age of 18. Characteristics of the household are also important. Households that use dirty cooking fuel, live in rural areas, and are in the lowest wealth quintile have the highest prevalence of GFC. Stunting is most prevalent in households with improved drinking water facilities, while wasting and underweight



Figs 1A to C: Prevalence of (A) Stunting, (B) Wasting, and (C) Underweight among under-five children in different districts of India, 2019–2020

Source: Map created by author based on data from NFHS-5

are more common in households without improved water sources. Furthermore, children from the scheduled tribes (STs) and the Muslim community show a higher incidence of GFC. Regionally, wasting is more common in the western states, whereas stunting and underweight are more common in the eastern states.

Spatial Variations of GFC of India at the District Level

Figure 1 shows the prevalence of GFC in children under five in various Indian districts. The highest rate of stunting among Indian districts is found in West Singhbhum, Jharkhand (60.7%), followed by West Khasi Hills, Meghalaya (59.0%), Yadgir, Karnataka (57.8%), Dohad, Gujarat (55.6%), and Sitamarhi, Bihar (54.2%). On the other hand, the lowest rates of stunting are found in Jagatsinghapur, Odisha (13.1%), Puri (13.7%), and the Lower Dibang Valley, Arunachal Pradesh (14.3%).

In Assam, districts like Hojai (12.9%), Majuli (14.2%), and Jorhat (15.4%) have lower rates of wasting than Sribhumi district (formerly known as Karimganj), which has the highest prevalence at 48%. Districts such as Dang (40.6%) in Gujarat, Dhule (39%) in Maharashtra, and Jehanabad (36.9%) in Bihar also exhibit high wasting rates. The north district of Delhi has the lowest rate of wasting (4.5%), followed by Ludhiana (5.9%) in Punjab and Bhiwani (6.1%) in Haryana.

Pashchimi Singhbhum (62.5%) in Jharkhand has the highest prevalence of underweight children, followed by Nandurbar (57.2%) in Maharashtra and Dohad (53.5%) in Gujarat. In contrast, Jharkhand districts like Dhanbad (25.2%), Koderma (31.7%), and Hazaribagh (32.5%) report lower rates. The South district of Delhi has the lowest prevalence of underweight children (7.2%), followed by lower Subansiri (8.1%) and Siang (8.9%) in Arunachal Pradesh.

Spatial Autocorrelation of Stunting, Wasting, and Underweight among Under-five Children

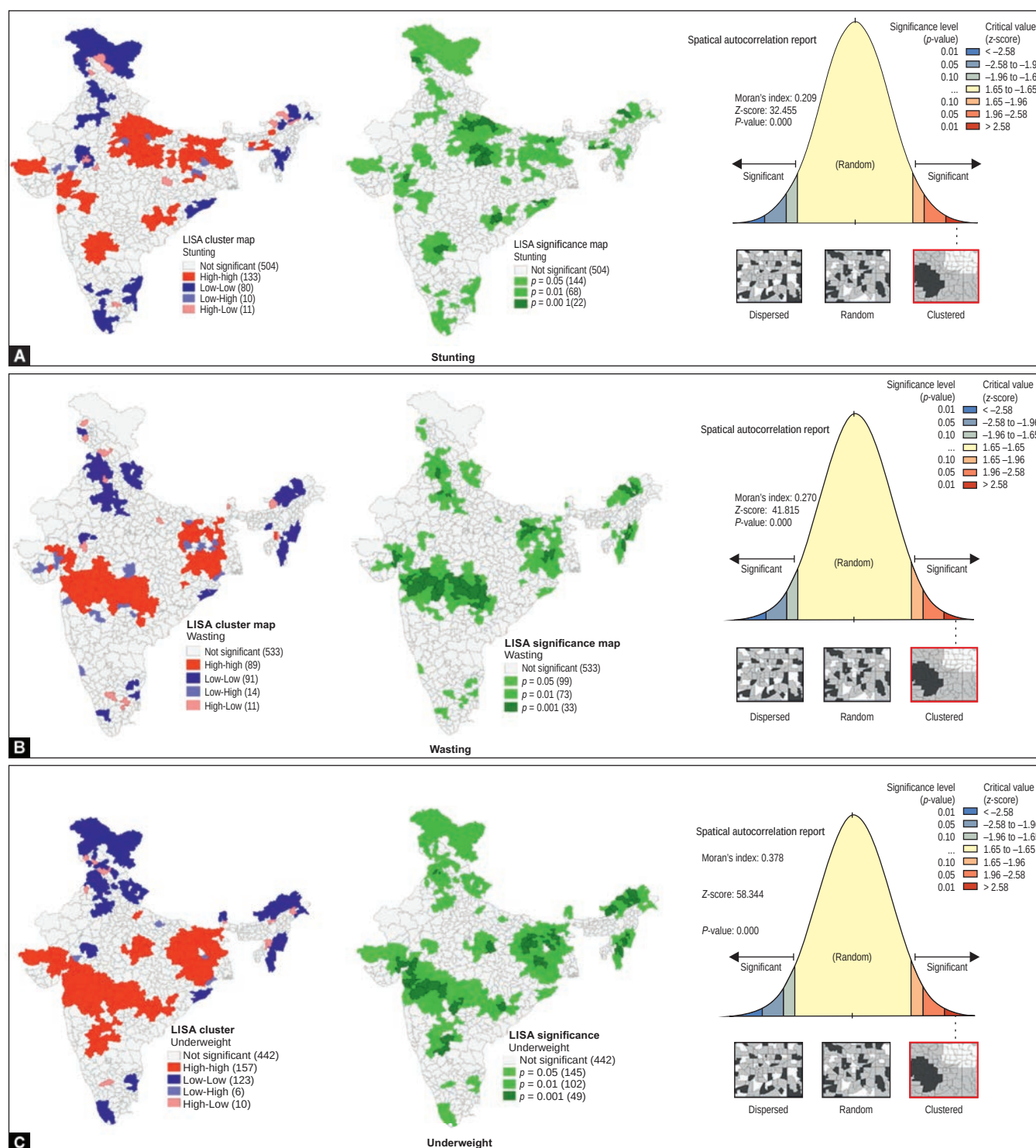
Figure 2 illustrates the spatial autocorrelation report and univariate LISA maps for the prevalence of GFC. Significant clustering for stunting, wasting, and underweight in children under five is indicated by the Global Moran's I values of 0.209, 0.270, and 0.378, respectively. The LISA cluster maps reveal that 133 districts (stunting), 89 districts (wasting), and 157 districts (underweight)

are hotspots, indicating that these districts have high rates of stunting, wasting, and underweight, along with similarly affected neighboring districts. West Bengal, Meghalaya, Karnataka, Gujarat, Bihar, Chhattisgarh, Uttar Pradesh, and Jharkhand are the districts with the highest rates of stunting. Likewise, districts in Assam, Gujarat, Maharashtra, Bihar, and Telangana have been identified as hotspots for wasting.

For underweight, hotspot regions are concentrated in West Bengal, Maharashtra, Gujarat, Bihar, Assam, Telangana, and Jharkhand. For instance, hotspot regions are primarily clustered in states with poorer socioeconomic indicators, whereas cold spots are aligned with states that have better health infrastructure, higher economic development, and improved living conditions. The LISA significance map also shows that the geographical clustering of these indicators shows high statistical significance (p -value < 0.001) for 22 districts (stunting), 33 districts (wasting), and 49 districts (underweight). This suggests that these districts are strongly linked to high rates of stunting, wasting, and underweight. Furthermore, with p -values less than 0.001, the spatial autocorrelation reports verify that there are notable clustering patterns in the distribution of stunting, wasting, and underweight among children under five.

Multivariate Analysis

Binary logistic regression models (Table 3) were employed to examine the prevalence of GFC among children under five in India. The results of the regression analysis revealed significant associations between GFC and various factors, including children's profiles, maternal characteristics, household, and other socioeconomic conditions. Upon adjusting for a number of variables, the findings showed a strong correlation between GFC and a number of attributes pertaining to the mother, the child, the home, the neighborhood, and the area. According to the chosen child characteristics, older children were more likely to be stunted and underweight than children under 10 months, and children under 10 months were more likely to be wasting. Furthermore, it was discovered that male children were more likely to suffer from growth failure. Moreover, children currently breastfeeding exhibited a higher likelihood of experiencing GFC; however, no



Figs 2A to C: Univariate LISA maps and spatial autocorrelation report depicting the prevalence of (A) Stunting, (B) Wasting, and (C) Underweight
Source: Map created by the author based on data from NFHS-5

significant correlation was found between the commencement of breastfeeding and GFC.

Regarding maternal characteristics, children of mothers with higher educational attainment exhibited a markedly reduced likelihood of experiencing growth failure compared to those

whose mothers lacked formal education. Maternal height and BMI exhibited significant negative correlations with GFC, suggesting that mothers with reduced height or lower BMI were at an increased risk of having children with growth failure. Moreover, an increased frequency of ANC visits substantially reduced the probability of

Table 3: Binary logistic regression model of GFC under-5 with background characteristics of India, 2019–2021

Variables	Wasting		Stunting		Underweight	
	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value
Child's age (in months)						
Below 10*	–	–	–	–	–	–
10–18	0.774 (0.730–0.822)	0.000 –	1.960 (1.850–2.077)	0.000 –	1.263 (1.194–1.337)	0.000 –
20–29	0.743 (0.698–0.791)	0.000 –	2.454 (2.312–2.604)	0.000 –	1.636 (1.544–1.734)	0.000 –
30–39	0.720 (0.668–0.777)	0.000 –	2.470 (2.311–2.640)	0.000 –	1.968 (1.824–2.123)	0.000 –
40–49	0.697 (0.644–0.755)	0.000 –	2.418 (2.243–2.606)	0.000 –	2.025 (1.877–2.184)	0.000 –
50–59	0.729 (0.667–0.797)	0.000 –	2.013 (1.861–2.178)	0.000 –	1.986 (1.838–2.147)	0.000 –
Child's gender						
Male*	–	–	–	–	–	–
Female	0.902 (0.869–0.937)	0.000 –	0.888 (0.859–0.918)	0.000 –	0.907 (0.876–0.940)	0.000 –
Order of birth						
First*	–	–	–	–	–	–
Second	1.055 (1.002–1.111)	0.042 –	1.086 (1.040–1.134)	0.000 –	1.095 (1.048–1.143)	0.000 –
Third or more	1.042 (0.987–1.101)	0.137 –	1.187 (1.134–1.244)	0.000 –	1.188 (1.133–1.245)	0.000 –
Maternal education						
No education*	–	–	–	–	–	–
Primary	0.926 (0.869–0.988)	0.020 –	0.935 (0.884–0.990)	0.022 –	0.946 (0.892–1.002)	0.060 –
Secondary	0.884 (0.837–0.932)	0.000 –	0.841 (0.803–0.881)	0.000 –	0.838 (0.799–0.878)	0.000 –
Higher	0.896 (0.809–0.993)	0.035 –	0.720 (0.671–0.772)	0.000 –	0.728 (0.671–0.790)	0.000 –
Maternal height (in cm)						
>145 cm*	–	–	–	–	–	–
145–149.9 cm	1.032 (0.967–1.102)	0.345 –	0.644 (0.611–0.680)	0.000 –	0.689 (0.651–0.729)	0.000 –
150–154.9 cm	0.957 (0.898–1.020)	0.173 –	0.447 (0.423–0.471)	0.000 –	0.508 (0.480–0.538)	0.000 –
155–159.9 cm	0.891 (0.826–0.961)	0.003 –	0.336 (0.316–0.357)	0.000 –	0.398 (0.373–0.425)	0.000 –
160 + cm	0.853 (0.777–0.935)	0.001 –	0.275 (0.253–0.298)	0.000 –	0.328 (0.301–0.358)	0.000 –
Mother's BMI (in kg/m ²)						
Below 18.5 kg/m ² *	–	–	–	–	–	–
18.5–24.9 kg/m ²	0.811 (0.771–0.854)	0.000 –	0.761 (0.730–0.792)	0.000 –	0.638 (0.612–0.666)	0.000 –
25.0+ kg/m ²	0.533 (0.492–0.578)	0.000 –	0.613 (0.580–0.649)	0.000 –	0.415 (0.388–0.443)	0.000 –
Initiation of breastfeeding						
Less than 1 hr of birth*	–	–	–	–	–	–
≥1 hour of birth	1.009 (0.958–1.062)	0.742 –	0.998 (0.963–1.034)	0.911 –	1.016 (0.978–1.055)	0.407 –

(Contd...)

Table 3: (Contd...)

Variables	Wasting		Stunting		Underweight	
	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value
Currently breastfeeding						
No ^o	–	–	–	–	–	–
Yes	1.170 (1.102–1.241)	0.000 –	1.217 (1.166–1.271)	0.000 –	1.279 (1.219–1.342)	0.000 –
ANC visit						
Less than four times ^o	–	–	–	–	–	–
At least four times	1.009 (0.961–1.060)	0.719 –	0.946 (0.912–0.982)	0.003 –	0.944 (0.910–0.979)	0.002 –
Maternal marriage age						
Age at marriage ≤18 ^o	–	–	–	–	–	–
Age at marriage ≥18	1.000 (0.957–1.044)	0.988 –	0.936 (0.902–0.971)	0.000 –	0.964 (0.928–1.001)	0.056 –
Cooking fuel						
Clean ^o	–	–	–	–	–	–
Not clean	1.036 (0.983–1.092)	0.185 –	1.007 (0.965–1.051)	0.739 –	0.996 (0.953–1.042)	0.874 –
Drinking water source						
Improved ^o	–	–	–	–	–	–
Not improved	1.010 (0.936–1.090)	0.798 –	0.859 (0.804–0.918)	0.000 –	0.916 (0.859–0.977)	0.008 –
Area of residence						
Urban ^o	–	–	–	–	–	–
Rural	0.905 (0.836–0.979)	0.013 –	0.983 (0.933–1.035)	0.507 –	0.943 (0.892–0.997)	0.039 –
Household wealth quintile						
Poorest ^o	–	–	–	–	–	–
Poorer	0.914 (0.864–0.967)	0.002 –	0.887 (0.846–0.930)	0.000 –	0.847 (0.808–0.889)	0.000 –
Middle	0.853 (0.797–0.913)	0.000 –	0.785 (0.741–0.831)	0.000 –	0.727 (0.685–0.771)	0.000 –
Richer	0.859 (0.786–0.939)	0.001 –	0.662 (0.618–0.708)	0.000 –	0.638 (0.595–0.684)	0.000 –
Richest	0.842 (0.760–0.933)	0.001 –	0.610 (0.559–0.665)	0.000 –	0.557 (0.509–0.610)	0.000 –
Place of childbirth						
Public medical sector ^o	–	–	–	–	–	–
Private medical sector	0.929 (0.880–0.981)	0.008 –	0.888 (0.846–0.931)	0.000 –	0.877 (0.836–0.920)	0.000 –
At home	0.997 (0.935–1.063)	0.920 –	1.100 (1.044–1.160)	0.000 –	1.054 (0.998–1.113)	0.059 –
Caste category						
SC ^o	–	–	–	–	–	–
ST	1.104 (1.029–1.185)	0.006 –	0.953 (0.899–1.011)	0.110 –	1.029 (0.969–1.092)	0.350 –
OBC	0.989 (0.938–1.042)	0.677 –	0.957 (0.915–1.000)	0.049 –	0.954 (0.912–0.998)	0.039 –
Others	0.902 (0.842–0.965)	0.003 –	0.836 (0.788–0.887)	0.000 –	0.837 (0.784–0.893)	0.000 –

(Contd...)



Table 3: (Contd...)

Variables	Wasting		Stunting		Underweight	
	Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value
Religion category						
Hindu*	–	–	–	–	–	–
Muslim	1.134 (1.061–1.211)	0.000 –	1.183 (1.117–1.254)	0.000 –	1.167 (1.103–1.235)	0.000 –
Christian	0.955 (0.824–1.106)	0.536 –	1.059 (0.938–1.195)	0.357 –	0.958 (0.839–1.094)	0.527 –
Others	0.875 (0.765–1.000)	0.050 –	0.968 (0.864–1.084)	0.572 –	0.977 (0.870–1.098)	0.699 –
Region						
South*	–	–	–	–	–	–
North	0.789 (0.728–0.855)	0.000 –	0.961 (0.898–1.028)	0.250 –	0.801 (0.746–0.860)	0.000 –
Central	0.921 (0.856–0.992)	0.029 –	0.923 (0.870–0.980)	0.008 –	0.824 (0.773–0.877)	0.000 –
East	1.087 (1.007–1.175)	0.034 –	0.747 (0.701–0.797)	0.000 –	0.848 (0.793–0.907)	0.000 –
West	1.553 (1.373–1.757)	0.000 –	1.218 (1.128–1.314)	0.000 –	1.407 (1.296–1.527)	0.000 –
Northeast	0.879 (0.795–0.973)	0.013 –	0.704 (0.649–0.764)	0.000 –	0.569 (0.520–0.622)	0.000 –
Constant	0.493 (0.425–0.571)	0.000 –	1.108 (0.979–1.255)	0.104 –	1.216 (1.065–1.390)	0.004 –
Observations	1,29,394	–	1,29,394	–	1,29,394	–
CI in parentheses	–	–	–	–	–	–

*Reference; Note: Constant estimates baseline odds

Source: NFHS-5

stunting (OR: 0.946) and being underweight (OR: 0.944). It was also found that mothers who married after the age of 18 were much less likely to have children who were stunted.

When looking at household characteristics, it was surprising to find that the chances of wasting and being underweight are 0.859 and 0.798 times lower in households with drinking water sources that have not been improved compared to those that have. Kids who lived in cities were more likely to be underweight and wasting. Additionally, children from households in higher wealth quintiles exhibited a markedly reduced probability of GFC in comparison with those from the lowest wealth quintiles. Regarding the child's place of delivery, private medical sector delivery significantly decreased the likelihood of GFC compared to public sector delivery. In terms of community factors, compared to Hindu communities, children from Muslim were found to have a higher likelihood of GFC. Finally, the results of the regional comparisons showed that the OR was still significantly lower in the northern, central, and northeastern regions compared to the southern region. On the other hand, the western region had a higher OR of GFC.

DISCUSSION

Growth failure in children has a multifactorial etiology, based on the child's profile, maternal characteristics, household conditions, and nutritional status, in addition to other factors (Table 2). Among children in specific age groups, stunting and underweight are positively correlated, while wasting is negatively associated.

This variation indicates that age-related factors and nutritional deficiencies influence each growth metric differently. The disparities are likely influenced by socioeconomic and regional factors across India.²⁵

This study shows that male children are more prone to GFC biologically, and males are more vulnerable to infections and illnesses in early childhood, contributing to growth failure.²⁶ Socially, while families may prioritize resources for boys, the quality of care, including breastfeeding and attentive feeding practices, does not always reflect this preference.²⁷ Research highlights that male children may be weaned earlier, with the introduction of supplementary foods that often lack sufficient nutrients, contributing to higher levels of stunting and underweight as they grow older.^{27,28} Moreover, a positive relation has been observed between birth order and GFC, with higher birth orders linked to an increased risk of stunting and underweight. Firstborn children often receive better nutrition and healthcare, while subsequent children may receive less attention, contributing to growth disparities.²⁹ Other studies indicate that larger family sizes lead to resource competition, affecting children's nutritional status.^{30,31}

The findings of this study indicate a negative association between maternal education and GFC, suggesting that children of mothers with no formal education are at a higher risk of experiencing wasting, stunting, or underweight. This association may be attributed to the fact that educated mothers tend to possess greater awareness regarding nutrition, hygiene, and health

practices, leading to improved childcare practices and a healthier household environment supporting better growth outcomes.¹¹ Furthermore, maternal height was found to be significantly associated with both stunting and underweight, where shorter mothers were more likely to have children exhibiting these conditions. Similarly, BMI demonstrated a significant and negative correlation with stunting, wasting, and underweight, implying that mothers with higher BMI, i.e., better nutritional and health status, are more likely to have children with improved growth outcomes.³²

Current breastfeeding status is positively linked to GFC in India, potentially due to insufficient attention to supplementary dietary needs for these children. Earlier studies suggest that longer breastfeeding duration is linked to better growth outcomes.^{13,28} Antenatal care visits are negatively correlated with stunting and underweight in children, which might be due to regular ANC visits improving maternal and child health access, leading to better birth outcomes that lower the risk of GFC.¹³ This study shows that higher maternal age at marriage lowers childhood stunting. Older mothers often have higher education levels, improving their knowledge of nutrition and child-rearing, leading to better healthcare use. Conversely, early marriages and adolescent pregnancies are linked to anemia and malnutrition, increasing stunting rates in children.³¹

Surprisingly, this study differs from those of earlier research where they found that access to improved drinking water positively influences child growth outcomes.^{33,34} In contrast, the present analysis does not provide sufficient evidence to establish a clear relationship between drinking water sources and GFC. Moreover, the results indicate that urban children are more likely to experience wasting and underweight, possibly because low-income urban households often face challenges such as unemployment, high living costs, and limited access to nutritious foods. For instance, urban areas often experience higher food insecurity due to rising living costs and limited access to affordable, nutritious food.³⁵ The study further reveals a negative association between household wealth quintile and GFC, suggesting that children from economically disadvantaged families are more vulnerable to malnutrition due to restricted food access and lower dietary quality.¹² Limited financial resources also hinder access to quality healthcare services, including preventive care and immunization, thereby increasing the risk of untreated illnesses that exacerbate growth problems.³⁶ Additionally, low-income families typically live in inadequate housing with poor sanitation and hygiene, contributing further to child malnutrition.

The place of delivery plays a crucial role in influencing child nutritional outcomes in India. Findings indicate that home births are associated with a higher likelihood of stunting compared to deliveries in healthcare facilities. In contrast, children born in private healthcare institutions show a greater tendency toward wasting and underweight than those delivered in public hospitals. Limited access to postnatal care, vaccinations, and nutritional counseling among home deliveries may explain the elevated risk of malnutrition. Additionally, mothers delivering at home often lack adequate maternal healthcare support, which may adversely affect their own nutrition and, consequently, the growth of their children. Meanwhile, public health facilities, though more accessible, may experience overcrowding and resource constraints, potentially diminishing the quality of care and contributing to malnutrition among children.

Significant disparities in GFC are also evident across caste groups. Children belonging to SC exhibit higher rates of stunting,

whereas those from ST are more vulnerable to wasting and underweight. These differences may be driven by long-standing socioeconomic inequalities, limited healthcare access, and nutritional inadequacies among marginalized communities. Religious affiliation also demonstrates an association with child nutritional outcomes. Muslim children show relatively higher rates of GFC compared to their Hindu counterparts, which may be partially explained by lower maternal educational levels, suboptimal feeding practices, and reduced utilization of healthcare services among Muslim households. Moreover, the study identifies marked regional disparities in GFC across India. Variations in geographical conditions, economic development, and infrastructure influence regional nutritional outcomes. Areas characterized by arid climates, low agricultural productivity, and food insecurity face greater challenges in ensuring adequate child nutrition. These ecological and socioeconomic differences contribute to the spatial concentration of growth failure in specific parts of the country.

CONCLUSION

This study underscores the complex interplay of demographic, maternal, household, and regional factors influencing CGF in India. The prevalence of wasting, stunting, and underweight remains high among children under five, with notable spatial and demographic heterogeneity. The findings reveal that older children, boys, and those of higher birth orders face a greater risk of CGF. Maternal characteristics, including limited education, short stature, low BMI, early marriage, and inadequate ANC, emerge as critical determinants. At the household level, rural residence, use of unclean cooking fuel, and low wealth status significantly elevate the likelihood of CGF. Regional hotspots, particularly in Jharkhand, Gujarat, and Bihar, highlight persistent geographic disparities. Interestingly, the analysis also found that access to improved drinking water was unexpectedly linked with higher odds of wasting and underweight, warranting further investigation into contextual factors. The spatial autocorrelation analysis confirms significant clustering of CGF in economically and socially disadvantaged regions, suggesting that localized interventions are essential. Policy strategies should therefore prioritize maternal education, nutrition-sensitive healthcare, and targeted economic support for vulnerable communities. Strengthening antenatal and postnatal care, improving household living conditions, and addressing regional inequalities are key to reducing CGF and promoting equitable child health and nutrition outcomes across India.

DECLARATIONS

Ethics Approval and Consent to Participate

This study is based entirely on secondary data from the DHS, which is publicly accessible and anonymized. As no direct interaction with human participants was involved, ethical approval and informed consent were not required. Detailed information regarding the DHS data collection procedures and ethical protocols is available at (<http://www.dhsprogram.com>).

Data Availability Statement

The data used in this study were obtained from Demographic and Health Surveys (DHS), which is publicly available through the DHS Program website at (<http://www.dhsprogram.com/data/available-datasets.cfm>).



AI Disclosure

The authors declare that no AI tools were used in the preparation of this manuscript, and authors take responsibility for all AI-generated text.

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AUTHORS' CONTRIBUTIONS

Conceptualization and study design: Both authors contributed equally.

Data acquisition, analysis, and interpretation: Both authors contributed equally.

Manuscript drafting and critical revision for important intellectual content: Both authors contributed equally.

Statistical analysis: Both authors contributed equally.

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Different Occupational Mortality Risks of Assam Government Employees during Service Period

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ABSTRACT

Government workers' illnesses and deaths during their employment can result in significant and permanent financial losses, which can be difficult for the impacted families and have an effect on society as a whole. Depending on their line of work, employees have varying mortality risks. Analyzing the disparate mortality risks linked to occupation type, age of service entry, and duration of service sub-intervals is the goal of this study. The study data came from pension payment orders (PPOs) of government employees who were employed in the Assam government service between 1984 and 2020. Three treasury offices—the Dispur Pension Office (Dispur), the Chandmari Treasury Office, and the Guwahati Metro Treasury Office (Panbazar)—provided the PPO records. The entire 40 years service term was split into eight sub-intervals for analytical purposes: 0–5, 5–10, 10–15, 15–20, 20–25, 25–30, 30–35, and 35–40 years. Police service (PS) and other than police service (OTPS) were the two groups into which the personnel were divided. There were 1,292 recorded deaths among workers who began working between the ages of 18 and 32. Based on occupational type and length of service, death rates, absolute mortality counts, and relative risks (RRs) of mortality were computed. With a mortality ratio of 0.1903 for PS personnel and 0.1847 for OTPS employees, the highest mortality rate was noted during the 16–20 years service interval. Additionally, PS personnel who began their service between the ages of 18 and 32 had a 1.22 RR of mortality, while their OTPS counterparts had a 0.93 related risk. This study provides significant insight into the risks of occupational mortality for government workers, emphasizing the necessity of focused initiatives to enhance workplace safety and health regulations, especially for high-risk service categories.

Keywords: Differential mortality risk, Government employees in service, Occupational health and safety, Relative risk.

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INTRODUCTION

Entry into the world of work can be defined as a socio-economic event called employment. Paid work in a government organization that has the character of an occupation may be referred to here as “work.” Employment or work is considered the main source of income in our society. Workers have a fixed retirement age called the superannuation age, and normally all employees, once in service, can continue in service until superannuation age in an organized sector, particularly in the Indian government organization and in most developing countries.^{1,2} Although most government workers retire at superannuation age, occupational and lifestyle factors continue to raise concerns about premature in-service death.^{3,4}

The very vital and crucial force for the development of any country or the society is the working force constituted by the adults of aged 18–60 years as they are economically productive, biologically reproductive, and responsible for the support of the children and elderly population. The age of the government employees also usually ranges from 18 to 60 years of age. Thus, a major subgroup of the adult population in the country is the government employees. Moreover, it is considered one of the most important subgroups of the adult population as far as their education, income, and regenerative abilities are concerned. The ill health and mortality may cause impairment to the government employees, which in turn can cause great loss and irreparable financial hardship to the concerned family in particular and to the society as a whole, as adults' ill health and mortality can directly affect production, earnings, investment, consumption, and the health of the other members of the household. The premature death of an adult member in a family, especially when he/she is the principal income earner, creates many problems for

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the surviving members, including serious financial hardship to the family. The excess risk of premature deaths of adult middle-aged male employees due to variations in occupations was observed in a comparative study in Western Europe in the 1980s.⁵

The vital and crucial force for the development of any country or society is the workforce made up of adults between the ages of 18 and 60, as they are economically productive, biologically reproductive, and responsible for supporting the infant and elderly population. The age of civil servants also tends to fluctuate between 18 and 60. Therefore, an important sub-group of the country's adult population is made up of civil servants. Furthermore, it is considered one of the most important subgroups of the adult population in terms of education, income, and regenerative abilities. The ill health and mortality can cause harm to civil servants, which in turn can cause great losses and irreparable financial hardship for the affected family in particular

and for society as a whole, as ill health and adult mortality can affect directly production, income, investments, consumption, and the health of other family members. The premature death of an adult member of a family, especially when it is the main income generator, creates many problems for surviving members, including severe financial hardship for the family. The excess risk of premature death of middle-aged adult male employees due to changes in occupations was observed in a comparative study in Western Europe in the 1980s.

LITERATURE REVIEW

A large number of studies have been conducted on adult mortality rates on both a national and global scale. The following lists a few of the studies:

Bogaert et al. underscore a notable deficiency in national-level statistics regarding the federal public health staff prior to 2014. Previous studies examined workforce concerns at the organizational level. The initiation of the public health workforce interests and needs survey (PH WINS) in 2014 established a vital resource, facilitating nationally representative comparisons among individual respondents. This signified a transformation in the examination of the public health workforce, rectifying a significant constraint in prior studies. Public health sectors have seen similar changes in the demographics of their employees.⁶

Jacobs and Forst examined the relationship between occupational safety and health (OSH) and healthy housing (HH), highlighting that the residential construction sector, characterized by high risk, frequently neglects worker safety.⁵ Hazards such as falls, equipment-related injuries, and toxic exposures pose risks to workers, whereas HH emphasizes resident health by prioritizing ventilation and the use of non-toxic materials. The integration of OSH and HH may mitigate risks for both sectors, with enhanced regulations promoting safer work environments. In Assam, the elevated mortality risks associated with occupational roles such as policing indicate potential broader applications for safeguarding government employees across various sectors. It has been suggested that workplace safety and healthy housing efforts be more widely integrated.⁷

Fox and Adelstein examined the influence of workplace conditions vs lifestyle factors on occupational mortality, utilizing data from the UK (occupational mortality).⁴ Two methods were employed: Comparing the mortality rates of men in specific occupations with those of their wives and applying social class standardization. The research indicates that occupational hazards and socio-economic factors both play a role in mortality, exhibiting different levels of impact depending on the profession. This important study establishes a fundamental framework for analyzing the intricate relationship between work and lifestyle in the field of occupational health research. The impact of lifestyle and occupation on mortality is still up for debate.⁸

Kusi et al. investigated work-related stress among academic personnel at the University of Education, Winneba, Ghana. The research identifies high workloads, administrative pressures, and insufficient support as significant stressors that contribute to mental health challenges. The authors advocate for the implementation of stress management programs and institutional reforms to enhance staff well-being. This study emphasizes the significance of addressing occupational stress within academia, a field frequently neglected in health and safety discourse. Stress at work has an

impact on non-communicable disease-related morbidity trends as well.⁹

Lennings conducted a review of violence related to occupational duties among police officers, synthesizing evidence regarding the prevalence and causes of these incidents.⁷ The research highlights high-risk scenarios, including encounters with suspects, and psychological stressors as critical factors. Recommendations involve the implementation of improved training and support systems aimed at decreasing exposure to violence. This study enhances comprehension of the specific occupational hazards encountered by law enforcement, with implications for international policing policies. In order to reduce exposure to violence, early studies emphasized the need for improved training.¹⁰

Loo performed a meta-analysis on police suicide rates, examining factors such as job stress, trauma exposure, and organizational culture.⁸ The research indicates increased suicide risks among officers relative to the general population, underscoring the necessity for mental health interventions. The author advocates for the implementation of proactive counseling and stress reduction programs. This study highlights the worldwide issue of managing mental health in high-stress professions such as policing. Increased suicide risks in law enforcement are supported by meta-analytic studies.¹¹

Mayhew examined the occupational health and safety risks encountered by police officers. This study identifies physical injuries, stress, and violence as primary concerns, influenced by the unpredictable nature of police work. Recommendations encompass enhanced safety protocols and comprehensive risk assessments. This work provides a comprehensive overview of police occupational hazards, relevant to global law enforcement agencies. For law enforcement, thorough risk evaluations are still essential.¹²

Samaei et al. examined the impact of mental workload on occupational accidents in nurses in Kerman, Iran.¹⁰ The research indicates that elevated mental demands are associated with increased errors and injuries, thereby intensifying workplace risks. The authors suggest strategies for workload management and training aimed at improving safety. This study emphasizes the international concern of mental health within the healthcare sector, with significant implications for nurse safety globally. The effects of mental workload extend to other occupations with high demand.¹³

Schulte et al. conducted a review of insights gained from scientific meetings regarding the expansion of the focus on OSH.¹¹ The study advocates for broader frameworks that include emerging risks like climate change and technological advancements. Results highlight the importance of interdisciplinary collaboration in addressing emerging workplace hazards. This study presents a prospective analysis of global priorities in occupational health. Multidisciplinary approaches are necessary to address emerging hazards.¹⁴

Sigler et al. conducted a comparison of stress levels between police officers and teachers, focusing on both workplace and home environments. The research indicates that police officers encounter elevated levels of occupational stress attributable to job demands, which affects their professional and personal lives. Recommendations involve implementing stress management interventions specifically designed for high-risk professions. This study enhances the comprehension of stress dynamics across various occupations worldwide.



Koneti present a comprehensive analysis of the difficulties encountered by solid waste workers in India amid the COVID-19 pandemic. The research emphasizes the essential function of these workers in upholding public health via efficient waste management, while also noting their insufficient recognition and vulnerability to considerable health hazards, such as infectious diseases and physical injuries. The pandemic increased these vulnerabilities, leading to heightened waste volumes and insufficient protective measures. The authors propose enhancements in working conditions, increased availability of personal protective equipment, and improved health monitoring to protect these essential workers. This research holds significant implications for policymakers focused on mitigating occupational health disparities within India's informal sector.

Oza et al. performed a systematic review and meta-analysis regarding occupational health outcomes in sanitation workers, identifying a significant prevalence of health issues, including respiratory infections, musculoskeletal disorders, and chemical exposures.¹³ This study integrates data from various sources to quantify risks, highlighting that sanitation workers encounter distinct hazards due to extended exposure to harmful substances and physically strenuous activities. The authors advocate for specific interventions, such as ergonomic enhancements and health assessments, to reduce these risks. This research significantly enhances the global discourse on occupational health by presenting evidence pertinent to a critical yet underexplored workforce in India. These results are consistent with more general concerns over high-exposure and informal jobs.¹⁵

Rajbongshi et al. investigated occupational mortality risks among pensioners in Assam during the period from 1985 to 1995.¹ This study examines mortality differentials following retirement, indicating that occupational exposures throughout working years may exert long-term health effects. Research demonstrates elevated mortality rates in specific occupational categories, possibly associated with workplace hazards and socio-economic influences. The authors advocate for longitudinal studies to enhance understanding of these associations and to guide retirement health policies. This study offers a historical analysis of occupational health in India, emphasizing the necessity for ongoing health monitoring beyond periods of active employment. Long-term work-related exposures also affect outcomes after retirement.¹⁶

Ruchi et al. examined the prevalence and risk factors associated with hypertension in bank employees located in Davangere City, Karnataka.¹⁵ The research identifies occupational stress, sedentary behavior, and irregular work hours as key factors contributing to increased blood pressure. The authors conducted a cross-sectional analysis revealing a significant prevalence of hypertension, highlighting the necessity for workplace wellness programs. Recommendations encompass stress management initiatives and routine health assessments to mitigate cardiovascular risks. This study emphasizes the increasing prevalence of non-communicable diseases among white-collar workers in India. The risk of non-communicable diseases is also increasing in sedentary white-collar jobs.¹⁷

Saharia and Kalita investigated the occupational mortality risks faced by retired government employees in Assam.² This study identifies variations in mortality rates among various job roles, indicating that occupational exposures and socio-economic conditions post-retirement contribute to these differences. The authors highlight the significance of customized health

interventions for retirees, especially those originating from high-risk professions. This study contributes to the sparse literature on post-retirement health outcomes in India, emphasizing the need for policies that promote long-term worker well-being. In certain situations, post-retirement disparities reflect in-service trends.¹⁸

Seikh examined differential mortality risks among government employees in Nagaland throughout their service period. The research emphasizes the role of occupational stressors and workplace conditions in influencing mortality rates among different job categories. Research indicates that employees in specific positions encounter increased risks associated with environmental exposures and insufficient safety protocols. The author advocates for enhanced occupational health policies to mitigate these disparities. This study offers important insights into the health challenges encountered by public sector employees in India's northeastern region.

Thayyil et al. conducted a review of occupational health issues faced by municipal solid waste workers in India.¹⁶ The research identifies various health issues, such as skin infections, respiratory problems, and injuries, associated with inadequate working conditions and insufficient protective equipment. The authors propose enhanced training, improved access to safety equipment, and the implementation of health surveillance programs to safeguard these workers. This study highlights the critical necessity for occupational health interventions within India's waste management sector, thereby contributing to the wider discussion on worker safety. Workers in waste management continue to encounter occupational illnesses.¹⁹

OBJECTIVES

- Examine whether variations in length of service in a profession affect mortality risks. Specifically, to determine the relative significance of specific mortality risks for a given service length in a given occupation.
- To study whether the mortality pattern varies due to the occupational difference, i.e., to observe the differential occupational mortality risks among employees prior to reaching retirement age in Guwahati City.
- To study whether the mortality pattern varies due to variation in age at the time of entry into service.

DATA AND METHODOLOGY

Data

Pension payment order (PPO) of the living pensioner and also family pensions are issued by the office of the Accountant General that is situated at every district of a state in India. The data were collected from the pension payment orders (PPO) available from three treasury offices: Guwahati metro Treasury Office (Panbazar), Chandmari Treasury Office (Chandmari), and Dispur Pension Office (Dispur) for those employees who were appointed to the Assam government service in the period 2010–2020.

Pension payment order provides information on name, address, gender, date of birth, date of appointment, and date of death of employees who died during the period of service before attaining the superannuation age.

Table 1 displays the distribution of employees by age at entry into police service (PS), other than police service (OTPS), and all services combined. The data collected from PPOs showed that, between 1984 and 2020, 94.37% of all employees joined the Assam

government between the ages of 18 and 32, whereas only 5.63% joined after that age (Table 1).

This shows that the majority of employees joined the Assam government between the ages of 18 and 32. As a result, employees who joined the government during this time frame were taken into consideration for analysis, with an assumption that the removal of the remaining employees would not have an impact on our findings.

Table 2 shows the death rate of employees who died after serving for 40 years. Therefore, this service period is considered as the total length of the service period to study the differential risks of occupational mortality in service. The full service period of 40 years is divided into eight sub-ranges (0–5), (5–10), (10–15), (15–20), (20–25), (25–30), (30–35), and (35–40), each having 5 years of length.

From the PPOs of family pensioners, out of 1,708 total death, 1,292 deaths occurred to employees who entered service in the age range of 18–32 years, and the rest of the deaths occurred to employees who joined the service beyond the age-group 18–32 years (Table 1). For this reason, we censor the deaths that occurred in employees who entered government service after 18–32 years of age. This censoring was necessary since the risk of mortality increases with age, and therefore, the employees who have joined the government services in or after age 33 may have a higher risk of mortality while on duty due to older age compared to those who signed up between 18 and 32 years. Furthermore, in terms of the incidence of death, the smaller age range of 18–32 years is fairly uniform in age.

Table 1: Distribution of employees who joined service during 1984–2020

Age at entry (in years)	PS	OTPS	All services together
18–20	551	1,115	1,650
21–23	267	1,073	1,331
24–26	161	633	791
27–29	64	374	439
30–32	41	165	211
33–34	16	130	160
35–37	11	62	76
38–40	5	18	28
Total	1,116	3,570	4,686

Source: PPOs issued by Accountant General Office, Assam

From Table 3, it is seen that there is a very small amount of absolute deviation from the percentage of the total number of employees who joined the government service on censoring the age at entry into service (only 0.72% for employees in PS and 0.76% for OTPS). The corresponding amount of absolute deviation of the percentage of total deaths of employees who entered the government service on censoring the age of entry into service was also very low (2.84% in PS as well as in OTPS). This may also state that the censoring of age at the time of entry into service had a negligible effect on resolving the analysis. Therefore, 1,292 deaths were considered for the final analysis.

People have a common belief that the risk of mortality of an employee is higher in the PS than in any other service. Police personnel are at high risk of death and homicide. Also, the percentage of deaths occurring in the initial stage of the service in the PS can be higher than in any other service such as the teaching service, the engineering service, the medical service, etc. Therefore, the services are classified into two groups: Police service and OTPS. Here, the group includes all other services except PS, such as teaching service, medical and family care services, engineering service, agriculture department services, etc.

We assume that the number of employees in service is reduced only due to death. Cases of superannuation retirement are not considered here. Factors such as the transfer in and out, if any, may be very small in proportion and therefore neglected.

METHODOLOGY

To analyze the data, we will use the proportion of deaths, death rates, and death ratios. Death rates will provide us with a process of comparing the severity of death risk for a given sub-range of the service period in a particular occupation. On the other hand, the death rates will provide us with a comparison of deaths per thousand in a given period of time for one population with another population. The methods are given below.

The proportion of deaths or, death ratio, is obtained by:

$${}_nP_x = \frac{{}_nd_x}{d} \text{-----(i)}$$

Table 2: Distribution of observed number of deaths who joined in service during 1984–2020

Length of service (in years)	PS		OTPS		All services together	
	Number of deaths	Percent of total	Number of deaths	Percent of total	Number of death	Percent of total
0–5	42	9.292035398	79	6.289808917	121	7.084309133
5–10	69	15.26548673	155	12.34076433	224	13.1147541
10–15	66	14.60176991	189	15.0477707	255	14.92974239
15–20	86	19.02654867	232	18.47133758	318	18.61826698
20–25	77	17.03539823	199	15.84394904	276	16.15925059
25–30	52	11.50442478	221	17.5955414	273	15.98360656
30–35	46	10.17699115	142	11.30573248	188	11.00702576
35–40	14	3.097345133	39	3.105095541	53	3.103044496
Total	452	100	1,256	100	1,708	100

Source: PPOs issued by Accountant General Office, Assam



Table 3: Distribution of no. of employees and deaths who joined service during 1984–2020

Occupation	No. of employees joined (% of total)			No. of deaths occurred to those who joined service (% of total)		
	At any age	18–32 years of age (on censoring)	Absolute percent deviation on censoring	At any age	18–32 years of age (on censoring)	Absolute percent deviation on censoring
PS	1,116 (23.81)	1,084 (24.53)	0.72	452 (26.46)	368 (28.48)	2.84
OTPS	3,570 (76.18)	3,360 (75.42)	0.76	1,256 (73.53)	924 (71.51)	2.84
All	4,686 (100)	4,444 (100)		1,708 (100)	1,292 (100)	

where, ${}_n d_x$ = number of observed deaths of those employees who died during the service period ($x, x + n$) years; $x = 0, 1, 2, \dots, 35$ and $n = 5$ years,
 d = total number of observed deaths occurred at any time in the service period.

The death rates are obtained by the following formula,

$${}_n M_x = \frac{{}_n d_x}{{}_x p_n} \times 1,000 \text{ -----(ii)}$$

where, ${}_n d_x$ = number of observed deaths of those employees who died during the service period ($x, x + n$) years,
 ${}_n p_x$ = person year lived by those employees who were at the risk of death at the beginning of the service period ($x, x + n$).
 Persons year lived is calculated by the following formula:

$$\begin{aligned} {}_n p_x &= (N_x - {}_n D_x) \times n + \left(\frac{{}_n D_x}{2} \right) \times n \\ &= \left(N_x - \frac{{}_n D_x}{2} \right) \times n \end{aligned}$$

where, N_x = number of employees who are at the risk of death at the beginning of the service period ($x, x + n$) years,
 n = number of years in the service period ($x, x + n$) years.

Also, since our population consists of adults between the ages of 18 and 60 years, deaths are assumed to be uniformly distributed over small intervals of time, i.e., mortality rates are considered linear in small age intervals.

The conventional denominator for a mortality rate is an estimate of the person years lived during the period in which deaths are recorded. Here, to estimate the person years lived, we have considered all those employees who have joined the service to be at risk of death from the moment of joining their service.

Now, finally, the relative risk (RR) of mortality is calculated by,

$$\begin{aligned} \text{RR of } i^{\text{th}} \text{ occupation} &= \frac{{}_n M_x \text{ of } i^{\text{th}} \text{ occupation}}{{}_n M_x \text{ for all}}; \\ (i = \text{PS} = 1 \text{ and } i = \text{OTPS} = 2) \end{aligned}$$

where, PS stands for PS and OTPS stands for other than PS.

If RR for a particular occupation > 1 , then that occupation bears more risk of mortality and vice-versa.

RESULTS

The following Table 4 shows the death distribution and death ratios of employees who joined service in 18–32 years of age.

From Table 4 and Figure 1 it is clear that within PS, the highest mortality ratio (0.1903) occurred in 15–20 years of service. On the

Table 4: Death distribution and death ratios of employees who joined service in 18–32 years of age

Length of service (in years)	PS		OTPS		All	
	Number	Death ratio	Number	Death ratio	Number	Death ratio
0–5	31	0.0929	47	0.0629	78	0.0708
5–10	59	0.1527	111	0.1234	170	0.1311
10–15	52	0.1460	136	0.1505	188	0.1493
15–20	72	0.1903	191	0.1847	263	0.1861
20–25	64	0.1704	143	0.1584	207	0.1616
25–30	39	0.115	174	0.1759	213	0.1598
30–35	35	0.1018	92	0.1131	127	0.1101
35–40	16	0.031	30	0.0311	46	0.031
Total	368	1	924	1	1,292	1

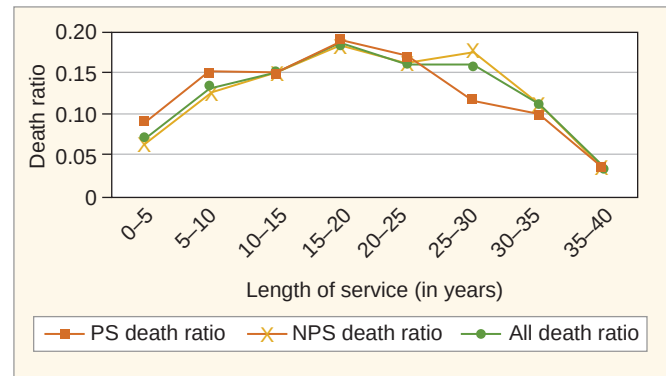


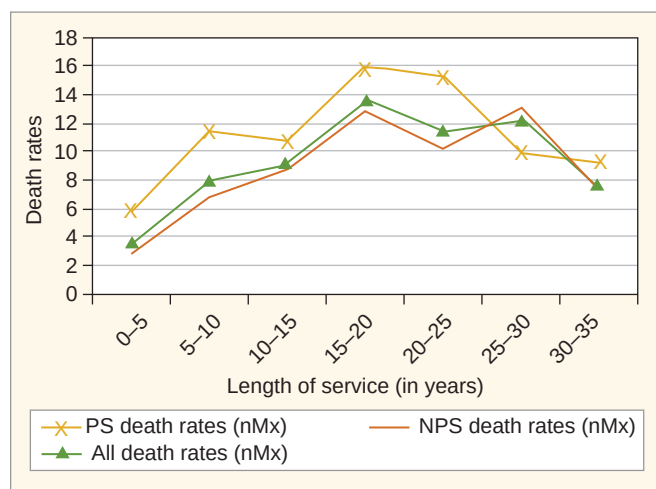
Fig. 1: Graph showing death ratios by occupation and length of service of all employees who joined service in 18–32 years of age

other hand, the highest death ratio (0.1759) for OTPS occurred in 25–30 years of service. Considering together a few sub-intervals, it can be seen that the mortality rates of employees in PS are higher in the intermediate parts (i.e., 5–10, 10–15, 15–20, 20–25, and 25–30 years) than in the first (i.e., 0–5 years), and subsequent parts (i.e., 30–35 and 35–40 years) of their services. On the other hand, OTPS employee death ratios are higher in the age-groups 10–15, 15–20, 20–25, and 25–30 years of their service. The death ratio increases almost uniformly during the period of service, except in the last years of service for employees in OTPS (Fig. 1).

Table 5 shows that the death rates among PS employees rise steadily until they reach 25 years of service, at which point rates begin to fall. On the other hand, the death rates for OTPS employees continue to rise for up to 30 years of service. When all employees are taken into account, it comes to light that the death rate peaks between the ages of 15 and 20, suggesting that this is the most vulnerable time in terms of mortality during the service duration.

Table 5: Death rates of employees who joined service in 18–32 years of age during 1984–2020

Length of service (in years)	PS				OTPS				All			
	No. exposed to the risk of death	No. of deaths	Person years lived (nPx)	Death rates (nMx)	No. exposed to the risk of death	No. of deaths	Person years lived (nPx)	Death rates (nMx)	No. exposed to the risk of death	No. of deaths	Person years lived (nPx)	Death rates (nMx)
0–5	1,084	31	5,343	5.80	3,360	47	16,683	2.82	4,444	78	22,025	3.54
5–10	1,053	59	5,118	11.53	3,313	111	16,288	6.82	4,366	170	21,405	7.94
10–15	994	52	4,840	10.74	3,202	136	15,670	8.68	4,196	188	20,510	9.17
15–20	942	72	4,530	15.89	3,066	191	14,853	12.86	4,008	263	19,383	13.57
20–25	870	64	4,190	15.27	2,875	143	14,018	10.20	3,745	207	18,208	11.37
25–30	806	39	3,933	9.92	2,732	174	13,225	13.16	3,538	213	17,158	12.41
30–35	767	35	3,748	9.34	2,558	92	12,560	7.32	3,325	127	16,308	7.79
35–40	732	16	3,620	4.42	2,466	30	12,255	2.45	3,198	46	15,875	2.90

**Fig. 2:** Graph showing death rates by occupation and length of service of all employees who joined service in 18–32 years of age

Following the peak period, there is a minor decline in the death rate, indicating a reduction in the risk of mortality. After completing 30 years of service, the OTPS death rate significantly decreases.

The graph (Fig. 2) shows the pattern of death rates (nMx) for varying lengths of service (in years) for three categories—PS, OTPS, and all services combined. For all groups, death rates rise between 15 and 20 years of service after a significant rise in the first few years. The highest death rates are found in the PS, especially during peak hours, indicating increased occupational hazards. Death rates in all categories start to gradually decrease after 20 years, with the lowest rates seen in the 30–35 years range.

It was found that the total death rate for PS employees who were recruited between the ages of 18 and 32 was higher (10.72 per 1,000) than for other than PS (OTPS) employees (8.46 per 1,000). Consequently, the RR for PS employees (1.192) was greater than that of other than PS (OTPS) employees (0.940) (Table 6).

The above Table 7 shows that for employees who started their service in the 18–20 age range, the death rates are higher for PS compared to OTPS in the first five service period subintervals, each lasting 5 years, and in the sixth and seventh service period subintervals, death rates higher for OTPS compared to PS, which are 26–30, 31–35, and 35–40 years of service for the same group of employees. However, the death rates for PS employees are greater

Table 6: Relative risk of death of employees who joined service in 18–32 years of age

Occupation	No. of employees	No. of deaths	Death rates (nMx)	Relative risk (RR) of death
PS	1,084	368	10.72	1.192
OTPS	3,360	924	8.46	0.940
All	4,444	1,292	9.00	1.000

than those for OTPS employees in all service period sub-intervals for those who started the service in the age-groups of 21–23, 24–26, 27–29, and 30–32 (Table 7). As an exception, for the age-group 21–23 in the service period 25–30, it is seen that OTPS death rate is higher than the PS death rate.

When compared to OTPS employees, the table demonstrates a consistent pattern of higher death rates among PS employees across all age-groups and sub-intervals. The overall pattern suggests that PS jobs have a large impact on mortality risks, even if the magnitude of this disparity varies by age-group.

From the above Table 8 and Figure 3 it is clear that, employees who started the service in the 18–20 age range, the RR of deaths is greater in PS than in OTPS for each of the first five sub-intervals of the 5 year service period. In other words, up to 25 years of employment, the RR of mortality for this group of employees is higher in PS than in OTPS. However, in the sixth and seventh service period subintervals, i.e., 25–30 and 30–35 years of service, the RR of mortality is higher in OTPS than PS (Table 8). However, the RR of death is higher for PS employees than for OTPS employees in all sub-intervals of employment for those who joined between the ages of 21–23, 24–26, and 27–29 (Table 8 and Figs 4 to 6, respectively). Therefore, it is evident that RR for PS employees is higher than that of OTPS employees in nearly every sub-interval of the service term for those who entered the government between the ages of 18 and 22 between 1984 and 2020. However, employees who began their service between the ages of 30–32 have a distinct pattern across their 10–20 year service periods. For these two service periods (i.e., 10–15 and 15–20), it is observed that the RR of OTPS employees is higher than that of PS employees (Table 8 and Fig. 7).

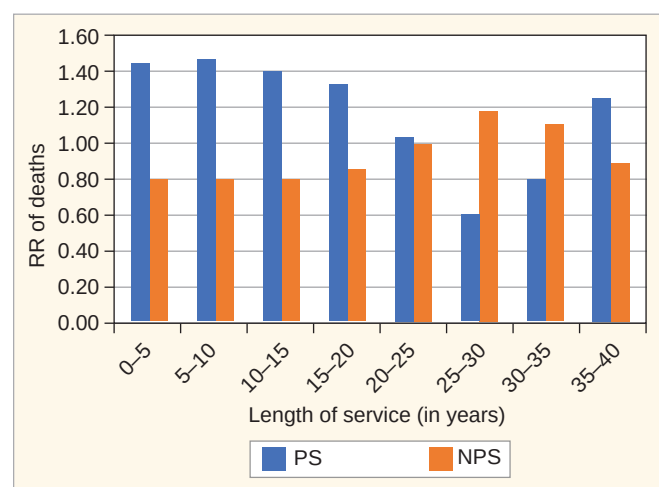
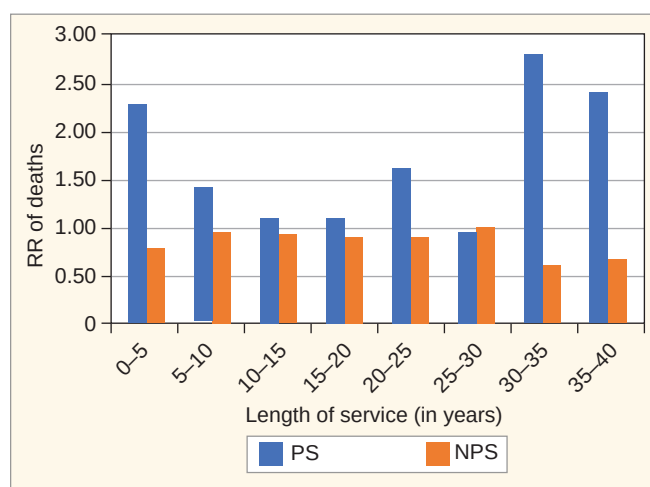
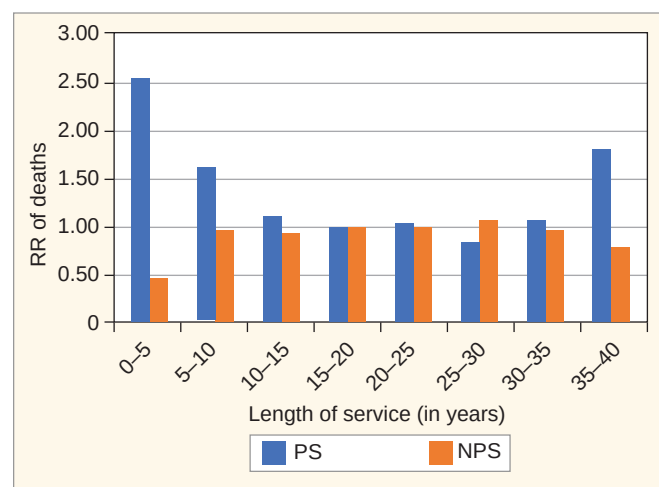
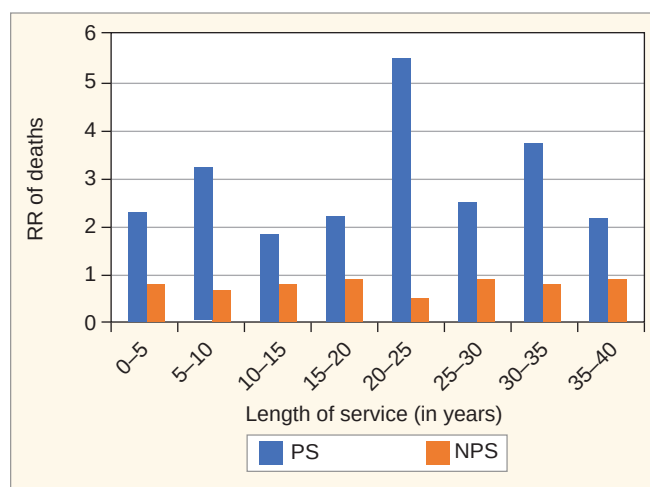
The above table (Table 9 and Fig. 8) makes it evident that, for all employees who joined service between the ages of 18–20, 21–23, 24–26, 27–29, and 30–32, the RR of mortality are higher among PS employees than OTPS. Additionally, it can be observed from the table that PS has a substantially higher RR of death than OTPS

Table 7: Death rates per 1,000 employees during 1984–2020 by service period sub-interval, occupation and age at entry into Assam government service

Age at entry	Length of service	Police service (PS)				Other than police service (OTPS)				All			
		No. of emp. in the beginning of the interval	No. of deaths	Persons year lived	Death rate	No. of emp. in the beginning of the interval	No. of deaths	Persons year lived	Death rate	No. of emp. in the beginning of the interval	No. of deaths	Persons year lived	Death rate
18–20	0–5	551	10	2,730	3.66	1,115	11	5,548	1.98	1,666	21	8,278	2.54
	5–10	541	22	2,650	8.30	1,104	24	5,460	4.40	1,645	46	8,110	5.67
	10–15	519	25	2,533	9.87	1,080	30	5,325	5.63	1,599	55	7,858	7.00
	15–20	494	37	2,378	15.56	1,050	51	5,123	9.96	1,544	88	7,500	11.73
	20–25	457	28	2,215	12.64	999	59	4,848	12.17	1,456	87	7,063	12.32
	25–30	429	15	2,108	7.12	940	62	4,545	13.64	1,369	77	6,653	11.57
	30–35	414	13	2,038	6.38	878	37	4,298	8.61	1,292	50	6,335	7.89
	35–40	401	6	1,990	3.02	841	9	4,183	2.15	1,242	15	6,173	2.43
21–23	0–5	267	9	1,313	6.86	1,073	10	5,340	1.87	1,340	19	6,653	2.86
	5–10	258	14	1,255	11.16	1,063	32	5,235	6.11	1,321	46	6,490	7.09
	10–15	244	12	1,190	10.08	1,031	45	5,043	8.92	1,275	57	6,233	9.15
	15–20	232	13	1,128	11.53	986	55	4,793	11.48	1,218	68	5,920	11.49
	20–25	219	12	1,065	11.27	931	49	4,533	10.81	1,150	61	5,598	10.90
	25–30	207	8	1,015	7.88	882	47	4,293	10.95	1,089	55	5,308	10.36
	30–35	199	9	973	9.25	835	36	4,085	8.81	1,034	45	5,058	8.90
	35–40	190	4	940	4.26	799	8	3,975	2.01	989	12	4,915	2.44
24–26	0–5	161	6	790	7.59	633	11	3,138	3.51	794	17	3,928	4.33
	5–10	155	10	750	13.33	622	26	3,045	8.54	777	36	3,795	9.49
	10–15	145	7	708	9.89	596	25	2,918	8.57	741	32	3,625	8.83
	15–20	138	11	663	16.60	571	40	2,755	14.52	709	51	3,418	14.92
	20–25	127	11	608	18.11	531	24	2,595	9.25	658	35	3,203	10.93
	25–30	116	7	563	12.44	507	32	2,455	13.03	623	39	3,018	12.92
	30–35	109	6	530	11.32	475	6	2,360	2.54	584	12	2,890	4.15
	35–40	103	3	508	5.91	469	4	2,335	1.71	572	7	2,843	2.46
27–29	0–5	64	4	310	12.90	374	8	1,850	4.32	438	12	2,160	5.56
	5–10	60	8	280	28.57	366	11	1,803	6.10	426	19	2,083	9.12
	10–15	52	5	248	20.20	355	16	1,735	9.22	407	21	1,983	10.59
	15–20	47	6	220	27.27	339	17	1,653	10.29	386	23	1,873	12.28
	20–25	41	8	185	43.24	322	6	1,595	3.76	363	14	1,780	7.87
	25–30	33	5	153	32.79	316	17	1,538	11.06	349	22	1,690	13.02
	30–35	28	4	130	30.77	299	9	1,473	6.11	327	13	1,603	8.11
	35–40	24	1	118	8.51	290	5	1,438	3.48	314	6	1,555	3.86
30–32	0–5	41	2	200	10.00	165	7	808	8.67	206	9	1,008	8.93
	5–10	39	5	183	27.40	158	18	745	24.16	197	23	928	24.80
	10–15	34	3	163	18.46	140	20	650	30.77	174	23	813	28.31
	15–20	31	5	143	35.09	120	28	530	52.83	151	33	673	49.07
	20–25	26	5	118	42.55	92	5	448	11.17	118	10	565	17.70
	25–30	21	4	95	42.11	87	16	395	40.51	108	20	490	40.82
	30–35	17	3	78	38.71	71	4	345	11.59	88	7	423	16.57
	35–40	14	2	65	30.77	67	4	325	12.31	81	6	390	15.38

Table 8: Relative risks of deaths of Assam government employees during 1984–2020

Length of service (in years)	Age (in years) at entry into service and occupation														
	18–20			21–23			24–26			27–29			30–32		
	PS	OTPS	All	PS	OTPS	All	PS	OTPS	All	PS	OTPS	All	PS	OTPS	All
0–5	1.44	0.78	1.00	2.40	0.66	1.00	1.75	0.81	1.00	2.32	0.78	1.00	1.12	0.97	1.00
5–10	1.46	0.77	1.00	1.57	0.86	1.00	1.41	0.90	1.00	3.13	0.67	1.00	1.10	0.97	1.00
10–15	1.41	0.80	1.00	1.10	0.98	1.00	1.12	0.97	1.00	1.91	0.87	1.00	0.65	1.09	1.00
15–20	1.33	0.85	1.00	1.00	1.00	1.00	1.11	0.97	1.00	2.22	0.84	1.00	0.72	1.08	1.00
20–25	1.03	0.99	1.00	1.03	0.99	1.00	1.66	0.85	1.00	5.50	0.48	1.00	2.40	0.63	1.00
25–30	0.61	1.18	1.00	0.76	1.06	1.00	0.96	1.01	1.00	2.52	0.85	1.00	1.03	0.99	1.00
30–35	0.81	1.09	1.00	1.04	0.99	1.00	2.73	0.61	1.00	3.79	0.75	1.00	2.34	0.70	1.00
35–40	1.24	0.89	1.00	1.74	0.82	1.00	2.40	0.70	1.00	2.21	0.90	1.00	2.00	0.80	1.00

**Fig. 3:** Multiple bar diagram showing RR of deaths by occupation and length of service of Assam government employees who joined service in 18–20 years of age**Fig. 5:** Multiple bar diagram showing RR of deaths by occupation and length of service of Assam government employees who joined service in 24–26 years of age**Fig. 4:** Multiple bar diagram showing RR of deaths by occupation and length of service of Assam government employees who joined service in 21–23 years of age**Fig. 6:** Multiple bar diagram showing RR of deaths by occupation and length of service of Assam government employees who joined service in 27–29 years of age

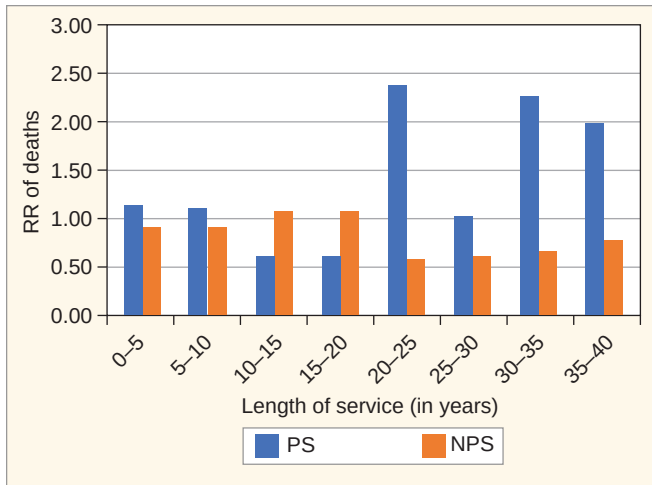


Fig. 7: Multiple bar diagram showing RR of deaths by occupation and length of service of Assam government employees who joined service in 30–32 years of age

Table 9: Relative risks of deaths of Assam government employees according to their age at entry into service

Occupation	Age at entry (in years)					
	18–20	21–23	24–26	27–29	30–32	18–32
PS	1.11	1.16	1.4	2.82	1.12	1.22
OTPS	0.95	0.96	0.91	0.77	0.97	0.93
Total	1	1	1	1	1	1

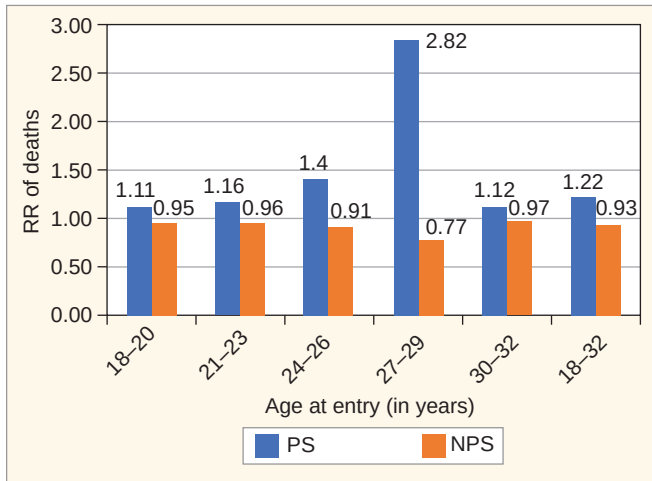


Fig. 8: Multiple bar diagram showing RR of deaths by occupation and age at entry into Assam government jobs

at ages 27–29. In other words, regardless of age at entry into the government service, the mortality risk is higher in PS than in OTPS.

Distribution of Deaths Associated with Length of Service

Regression Analysis

As shown in the Table 10, there is a statistically significant relationship between the length of service and the changes in death rates. The data indicated that the death rates for PS employees

Table 10: Analysis of variance (ANOVA) table of employees in police service (PS) for death rates by length of service

ANOVA					
	Sum of squares	df	Mean square	F	Sig.
Regression	97.254	3	32.418	7.941	0.037*
Residual	16.330	4	4.082		
Total	113.584	7			

The independent variable is length of service in years. *Indicates that the value is significant at 5% level of significance (Source: SPSS)

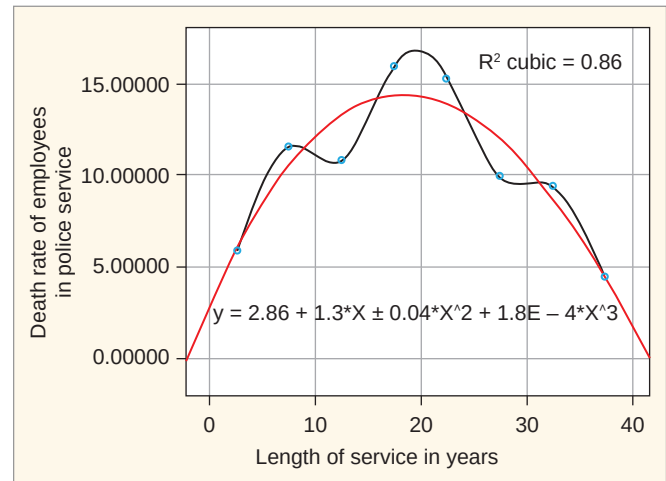


Fig. 9: Death rates trend of employees in police service by length of service in years

Table 11: Analysis of variance table of employees in OTPS for death rates by length of service

ANOVA					
	Sum of squares	df	Mean square	F	Sig.
Regression	104.021	3	34.674	12.604	0.017*
Residual	11.004	4	2.751		
Total	115.025	7			

The independent variable is length of service in years. *Indicates that the value is significant at 5% level of significance (Source: SPSS)

followed an increasing pattern up until 18 years of service, and then a decreasing trend towards the end of their service (Fig. 9). With a large enough coefficient of determination ($R^2 = 0.86$), as shown in this figure, a cubic degree polynomial fits the data well; this means that the duration of service accounts for 86% of the variability in death rates.

Table 11 shows that the variations in death rates are statistically significant with length of service for the employees in OTPS. Figure 10 indicates the correlation between “length of service in years” and “death rate of employees in other than PS” is complex and non-linear. Death rates rise with service duration initially, peak at around 20 years, fall sharply, and then rise again at extremely long service lengths, according to the observed data shown by the black line. The death rate does not appear to follow a straightforward linear trend, but rather exhibits a more complex pattern impacted by the length of employment, according to a cubic regression model (red line) that offers a good fit. This model explains 90.4% of the variance ($R^2 = 0.904$).

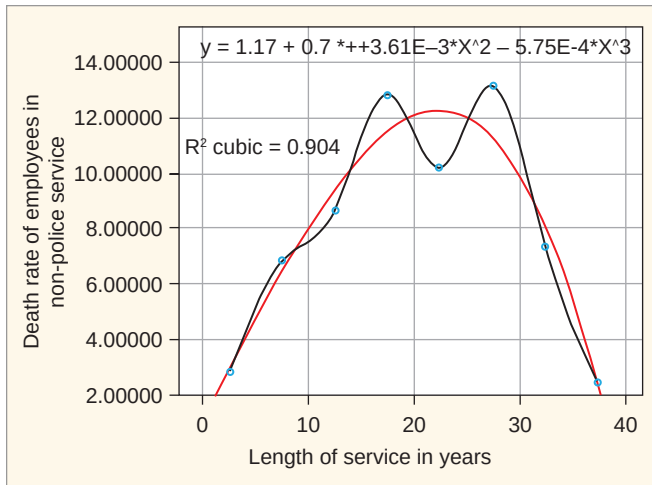


Fig. 10: Death rates trend of employees in OTPS by length of service in years

Table 12: Analysis of variance table of all employees for death rates by length of service

ANOVA					
	Sum of squares	df	Mean square	F	Sig.
Regression	100.004	3	33.335	20.851	0.007*
Residual	6.395	4	1.599		
Total	106.399	7			

The independent variable is length of service in years. (*Indicates that the value is significant at 1% level of significance) (Source: SPSS)

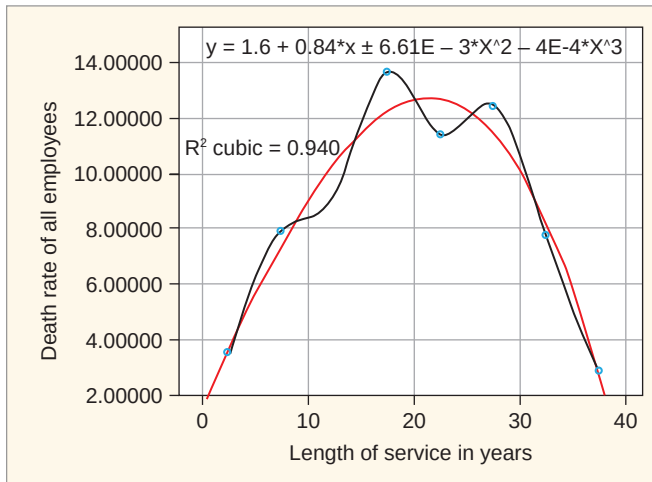


Fig. 11: Death rates trend of all employees by length of service in years

Table 12 shows that the variations in death rates are statistically highly significant with length of service for all employees. The graph displays a non-linear cubic trend in the association between the death rate of all employees and the length of service (in years) (Fig. 11). After a slow but steady increase as service year's increase, the death rate peaks at about 20 years, then falls significantly as service year's approach 40. Employee mortality risk rises with tenure up to a certain point (possibly due to cumulative occupational exposures or age), but then falls for those with the longest service (possibly reflecting a "healthy worker effect" where

only the healthiest employees remain the longest), according to the fitted cubic regression equation (with a R^2 value of 0.940, indicating a strong fit).

DISCUSSION

It is observed that the death ratio and death rate (DR) of PS employees are higher in the central part of their service than in the initial and subsequent parts (Tables 4 and 5). This is likely due to the fact that in most field activities, such as operations against gangs of armed robbers, kidnappers, drug traffickers, capturing members of prohibited armed organizations, etc., the middle-aged police personnel who are experienced but young and energetic might be deployed to lead. Police service employees' increased death rates during service years 15–20 may be mostly explained by their degree of expertise and physical stamina at this point. Many of them are now in the late 25–35 or early 30–40 age range, which is typical of people who entered the police force between the ages 18–32. Instead of being allocated to regular tasks like office work, traffic control, or security guarding, they are more likely to be placed in operational responsibilities. Additionally, as previously said, it usually takes a few first years for just hired law enforcement officers to acquire the expertise required for direct field assignments. On the other hand, police employees with the help of promotions try to get more office duties than fieldwork in the later part of their services. Police personnel at the upper levels are mostly occupied with administrative duties. This can be seen in the postings of SP/DSP in the districts. Therefore, the risks of death at work for very young police personnel early in their career and older police personnel later in their careers are lower than for young but energetic and experienced police personnel in the middle part of their career. However, mortality ratios and mortality rates of OTPS employees increase more or less uniformly during the service period as the service period increases (Tables 4 and 5). Obviously, age can be the main cause, as the risk of death increases with each increase in the age of adults. The risks of being affected by non-communicable diseases such as cardiovascular disease, cancer, diabetes, etc. increase for the adult population with increasing age.^{20–22}

The employees in PS face higher risks of deaths compared to employees in other than PS. The higher risks of deaths and injuries in PS may be due to many operations such as fighting insurgency, unlawful elements, bombing, etc. which are absent in case of other than PS. The police personnel face high risks of deaths and homicides. Homicide is more common for United States personnel doing undercover work, making arrests, conducting drug raids, attending domestic disputes or pursuing speeding motorists.²³ A few personnel in the United States have been killed off-duty, most commonly after intervening in robberies, or when on-duty police mistook them for gang members. Some died through unintentional firearm discharges, typically when personnel ignored firearms safety rules while offenders.²⁴

The employees in PSs experience higher levels of stress than other occupational groups. This was supported in an earlier study where a strong relationship was discovered between on-the-job stress and type of stressors, with police stress found to be more closely related to job stressors than was teacher stress. Stress for police officer is related to their work experiences and that different levels of stress exist in different management environments. The police personnel suffer stress through constant exposure to danger, traumatic events, prisoner threats, conflicting task demands,

short staffed stations, court appearances (often requiring detailed recollection of events from years earlier), departmental inquiries and work in isolated rural areas.^{25,26}

Stress levels among police officers are higher than those of other occupational categories. This was supported by a prior study that discovered a high correlation between the type of stressors and workplace stress, with police stress being more closely linked to employment stresses than teacher stress. Constant risk, traumatic experiences, threats from inmates, conflicting job requests, understaffed stations, court, departmental surveys, and working in remote rural locations are all sources of stress for police officers.

When investigating crimes, doing searches, collecting samples, or apprehending suspects, police officers are susceptible to contracting infectious infections. A puncture wound from secreted needles that could be tainted with HIV, hepatitis B, or another crippling virus or bacteria is always a possibility when searching the body of a suspected drug user or his or her property.

Employees of the PS are more likely to die than those of non-police organizations. Numerous operations that are not present in the other than PS, such as combating insurgency, criminal elements, bomb assaults, etc., may be the cause of the higher danger of death and injury in the PS.²⁷ Officers are particularly vulnerable to murder and death. As they look into crimes, perform research, collect samples, or apprehend suspects, they are probably going to get injected with contagious diseases. The possibility of a puncture wound from discharged needles containing HIV, hepatitis B, or other crippling viruses or germs is always present while searching the body of a suspected drug addict or its facility. Other work-related ailments that police officers experience include hypertension and jumping fences during pursuits. Workers who investigate fraud, arson, and bombings may be exposed to explosives, hazardous structures, and toxic chemicals and gases.²⁸

Other service workers experience stress as well. For instance, relationships with coworkers, administrative personnel, and students, the need for complex communication regarding the diverse range of student abilities and assignments, dealing with inattentive students, talking with students about disciplinary measures, and listening to their personal and academic concerns are just a few of the many factors that cause stress for teachers. Expectations regarding job performance are inconsistent for teachers. They are supposed to carry out their responsibilities with little assistance. However, the level of stress in teaching is lower than in the police force, which may be why teaching services, one of the OTPS's components, have a lower impact on mortality.²⁹ The unique pressures in law enforcement are further highlighted by historical assessments of workplace violence and police suicide.³⁰

FUTURE SCOPE OF STUDY

This research has the potential for expansion in several significant areas. Comparative analyses of mortality risks may be performed across various occupational sectors within the government workforce. This entails analyzing employees in sectors including academia, engineering, agriculture, and industry to identify occupational hazards and mortality risks that differ from those found in PS personnel. This approach, which classifies employees according to lifestyle factors and occupational exposures, is likely to provide deeper insights into the relationship between occupational characteristics and worker well-being. The results of these analyses may guide the creation of targeted interventions and

evidence-based policies designed to enhance the safety and health of workers in various professions. Additionally, future research may gain from incorporating analyses of cause-specific and occupational mortality. This entails utilizing advanced statistical models to enhance mortality risk predictions, considering specific causes of death across various occupational groups. Longitudinal studies in Assam that examines the effects of lifestyle and environmental factors on worker health could greatly improve the development of interventions. Future research could clarify the long-term effects of these factors, thereby aiding in the formulation of policies that address both immediate and latent health risks encountered by government employees.

CONSENT FOR PUBLICATION

I, Parag Saharia, corresponding author of the research paper "Different Occupational Mortality Risks of Assam Government Employees During Service Period" giving my full consent to publish my research paper by the Journal "BMC Psychology" if the paper is accepted.

Availability of Data and Materials

Data will be made available on request.

Study Design and Ethics approval

The research utilizes retrospective, cross-sectional study design based on the secondary administrative records. Formal ethical approval was not required for this study as it relied exclusively on the secondary analysis of administrative records (Pension Payment Orders) and did not involve direct interaction with human subjects.

AI Disclosure Statement

During the preparation of the manuscript, authors used Grammarly and Quillbot apps to improve language, grammar, and readability. After using these tools, authors reviewed and edited the content as needed and takes full for final content of the publication.

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AUTHORS' CONTRIBUTIONS

Data for this research is collected by the corresponding author and the co-author (guide) helped in interpreting the results

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Demographic Divides in Fertility and Child Mortality in a Northeastern Tribal Group (India)

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ABSTRACT

Background: With socio-economic status being a major contributor in impacting the demographic structure, tribal communities, especially in rural India, seemed to be majorly affected. These factors are not studied explicitly among tribal populations in India.

Objectives: The present study aims to describe the demographic characteristics and to understand the differential rates of fertility and mortality of the Mishing tribe of Assam.

Methodology: Data were collected from 255 married Mishing women aged 15–49 years from 226 households. Data on demographic and socio-economic parameters were collected using interview schedules. Student's *t*-test, Chi-square test, and ANOVA were used for statistical analyses. Statistical significance level was set at a probability level of 5%.

Results: The sex ratio of the Mishing community was 105.2 females per 100 males. The mean age at marriage and first child birth is higher in males than in females. Furthermore, the number of live births tends to increase with age in this community, with the age-specific fertility rate peaking between 20 and 24 years. On the other hand, mortality indicators revealed a 4.66% prevalence of reproductive wastages (abortions and stillbirths) in this tribal population. Education and income significantly influenced fertility, whereas only income level significantly influenced child mortality.

Conclusion: Higher age, better education, and higher income were found to be key indicators influencing the fertility and mortality in this community. Hence, improvement in socio-economic conditions may improve maternal and child health in such tribal populations.

Keywords: Assam, Child mortality, Demography, Fertility, Mishing tribe, Reproductive wastage.

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INTRODUCTION

Demography is the empirical and statistical study of human populations, concerned with social and biological processes related to population trends, composition, and distribution. It understands the composition of human populations on five major processes viz., fertility, mortality, marriage, migration, and social mobility.¹ Both biological and social factors are reported to affect a population's fertility and mortality patterns. Age at marriage, age at first childbirth, age at first conception and number of conceptions, live births, and surviving children are some of the biological factors that determine fertility and mortality.^{2,3} On the contrary, educational status, occupation, household income, family type, use of contraception, and adoption of family planning are some of the social factors that affect fertility and mortality patterns in a population.^{4,5}

Fertility and mortality patterns are associated with women's education and occupation, which are further related to family planning measures. Numerous studies in India have also revealed that education, especially female education, is a crucial factor in influencing the fertility rate.^{6–9} Additionally, mortality rates are influenced by education, occupation, literacy, and health services.^{10–12} Also, lower age at marriage and age at first conception are important predictors of fertility and mortality rate.^{13,14} Maternal age is associated with a high frequency of anomalies, while both extreme ages are associated with a higher risk of birth trauma.^{15,16}

India's marked cultural diversity may account for the differential fertility and mortality indicators across different populations.³ Factors such as early age at marriage, age at first conception, preference for male child, socio-demographic, and economic status

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vary across Indian states and their population. The demographic indicators of fertility and mortality, such as age at marriage, age at first childbirth, number of live births and surviving children, infant mortality rate, child and juvenile mortality rate, and number of abortions, are quite different for tribal populations compared to non-tribal populations. Fertility factors such as mean age at marriage among Garo tribe (21 years) is higher compared to Gujar caste population (17 years), similarly mean age at first childbirth is also higher among Khasi tribe (20 years) than the Gujar caste (19 years), whereas, mortality factors such as infant mortality rates show higher among tribal populations compared to non-tribals.^{17,18} Such differences could be attributed to education, health services, and cultural factors.¹⁹

Despite the obvious differences in the prevalence of demographic indicators among tribal and non-tribal populations, these factors are not studied explicitly among the tribal population

in India. Furthermore, the northeast populations have largely been unexplored in terms of understanding the fertility and mortality patterns. Specifically, very recent studies on the Mishing community have mostly concentrated on the morphological and health domains.^{20–23} Therefore, the present study attempts to describe the demographic structure and understand the differential fertility and mortality rates among the Mishing community of Dhemaji district, Assam.

METHODOLOGY

The Mishings

The tribe Mishing, also listed as Miri in the Indian constitution, is one of the major tribal groups of Assam in northeast India. The Mishings, as they would like to be addressed, belong to the Mongoloid ancestry.²⁴ They are one of the prominent tribal communities in Northeast India and the second largest tribal group in Assam. According to the Census of India, their population in Assam stands at 6,80,424, comprising 3,45,786 males and 3,34,638 females.²⁵ Historically, the Mishings are believed to be a hill tribe from the Himalayan region of Northeast India who migrated from Arunachal Pradesh and settled along the banks of the Brahmaputra River and its tributaries. Today, they predominantly inhabit the plains and are distributed across various districts in Assam, including North Lakhimpur, Dhemaji, Dibrugarh, Sivasagar, Golaghat, Sonitpur, and Tinsukia.²⁶ Like many other communities in the region, their main occupation is agriculture. They have good skills in livelihood techniques like farming, fishing, and weaving.

Fieldwork and Data Collection

The present study is a cross-sectional study conducted in two villages of Dhemaji district in the state of Assam. A total of 226 households were surveyed and 255 married Mishing tribal women aged between 15 and 49 years were interviewed for the study. Data was collected from January to February in 2022. Data on socio-economic variables included age at marriage, household composition, family size, educational level of mothers, household income, household expenditure, occupation, etc. Data were collected through detailed interviews using structured interview schedules. The information on demographic characteristics was collected from the head of the family or, in his/her absence, from an elderly member who could provide the relevant information.

Data on fertility and mortality variables were collected by obtaining information on the number of conceptions, number of live births, birth order, age, sex, marital status of each offspring, number of dead children, age at death, causes of death (if any), and reproductive wastage (abortions and stillbirths) from each of the married women. Data on types of marriage, marital distance, i.e., the distance between birthplaces of spouses, clan exogamy, village endogamy, and exogamy were also collected. Age estimation among illiterates was done concerning important life events such as the age of first childbirth/last child, marriage, historical events, and the known age of some individuals of the same age-group. The nature and objectives of the study were carefully narrated to the participants.

Data Categorization

Mortality was divided into three groups as follows:

- Infant mortality: Number of deaths before 1 year.
- Child mortality: Number of deaths between 1 and 4 years.
- Juvenile mortality: Number of deaths between 4 and 14 years.

Educational level was categorized as follows:

- Illiterate: Unable to read and write.
- Lower primary (LP): I–V.
- Upper primary and secondary (UP and Sec.): VI–XII.
- XII and above: 12+.

Household income was categorized following the percentile method as follows:²⁷

- High-income group (HIG): 75th Percentile and above.
- Middle-income group (MIG): 50th percentile to 75th percentile.
- Low-income group (LIG): Below the 50th percentile.

Statistical Analysis

Statistical analyses were done using SPSS (version 26.0) for Windows. The differences between two means for continuous variables were tested using the Student's *t*-test. Whereas, the difference between two occurrence frequencies for categorical variables was tested using the Chi-square test. Furthermore, ANOVA was used to assess the variation between more than two means for continuous variables. Statistical significance level was set at $p < 0.05$.

RESULTS

Demographic Characteristics

The distribution of age, sex, and marital status of the Mishings of Borola and Uriamguri villages is shown in Table 1. It was found that 31.78, 54.79, and 13.43% of the total population belong to the age-groups 0–14, 15–49, and 50+ years, respectively. The population pyramid (Fig. 1) of the total population shows the base (0–4 years) to be constricted compared to (5–14 years), indicating a decline in the fertility rate.

Sex Ratio, Age at Marriage, and Age at First Child Birth

In this study, out of the total population of 1,221 individuals, 595 (48.70%) were males, and 626 (51.27%) were females. Thus, the overall sex ratio was 105.2 females per 100 males. The sex ratio in terms of the number of females per males is higher among the younger generations, specifically lesser than 50 years age-groups (Fig. 2). Furthermore, the mean age at marriage and age at first childbirth is significantly ($p < 0.001$) higher in males than in females (Table 2).

Fertility

In the present study, fertility rates were measured regarding child–woman ratio, completed family sizes, live births, surviving children to mothers of all ages, and age-specific rates. Table 3 shows the fertility ratio of the Mishing mothers. It was found that the number of women aged 15–49 years was 350, and the fertility ratio among these groups is 36.29 per 100 women.

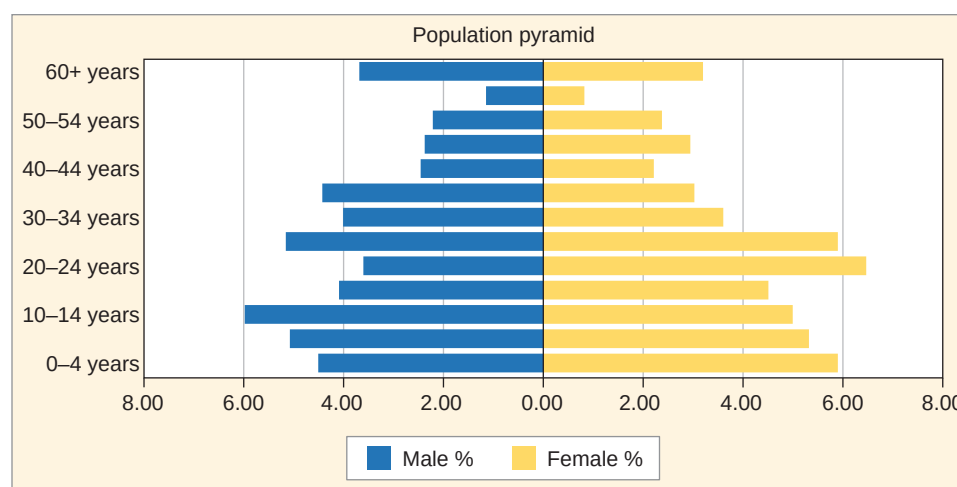
The mean number of live births per married woman in different age-groups is shown in Table 4. The mean number of live births per mother of all ages was 2.99. Furthermore, the mean number of live births and the mean number of surviving children per mother tends to hike with an increase in the age of the mothers. It was found that the mean number of surviving children for mothers of all ages was 2.73. The age-specific fertility rate reaches its peak when the mothers are aged 20–24 years of age (Fig. 3). Thereafter, it tends to decline with the increasing age of the mothers. The total fertility rate (TFR), which was the total of age-specific fertility rates, is 4.07 in the present population.



Table 1: Population distribution by age, sex, and marital status

Age-group (years)	Unmarried		Married		DSW		Total		Total person	p-values
	M	F	M	F	M	F	M	F		
0–4	55	72	0	0	0	0	55	72	127	0.19
5–9	62	65	0	0	0	0	62	65	127	
10–14	73	61	0	0	0	0	73	61	134	
Total (0–14%)	190 (15.56)	198 (16.23)	0	0	0	0	190 (15.56)	198 (16.23)	388 (31.78)	
15–19	49	49	1	6	0	0	50	55	105	0.03*
20–24	24	19	20	60	0	0	44	79	123	
25–29	7	10	56	62	0	0	63	72	135	
30–34	8	2	41	41	0	1	49	44	93	
35–39	0	2	54	35	0	0	54	37	91	
40–44	1	25	29	2	0	0	30	27	57	
45–49	0	0	29	30	0	6	29	36	65	
Total (15–49%)	89 (7.29)	107 (8.76)	230 (18.84)	236 (19.33)	0	7 (0.57)	319 (26.13)	350 (28.67)	669 (54.79)	
50–54	0	0	25	24	2	5	27	29	56	0.68
55–59	0	0	12	8	2	2	14	10	24	
60+	0	0	36	18	9	21	45	39	84	
Total (50–60+%)	0 (0.0)	0 (0)	73 (5.98)	50 (4.10)	13 (1.00)	28 (2.29)	86 (7.04)	78 (6.39)	164 (13.43)	
Total (0–60+%)	279 (22.85)	305 (24.98)	303 (24.8)	286 (23.42)	13 (1.00)	35 (2.87)	595 (48.73)	626 (51.27)	1221 (100)	

* $p < 0.05$; DSW, divorced, separated, widowed; F, female; M, male

**Fig. 1:** Population pyramid of the Mishig community

Mortality and Reproduction Wastage

Table 5 shows the frequency of infant, juvenile, and child mortality, and the reproductive wastage rates of the Mishig population. Out of 752 live births to mothers of all ages, 38 live births died before the age of 1 year, 20 live births died before the age of 1–4 years, and 12 live births died before the age of 15 years. So, the frequencies of infant, child, and juvenile mortality rates were 5.05, 2.66, and 1.60%, respectively. It was also seen that the frequency of abortion in total pregnancies was 3.8%, while the frequency of stillbirths in total pregnancies was 0.86%. The overall rate of reproductive

wastage (abortion and stillbirths) out of the total pregnancies is 4.66%. In the present study, abortion included both induced and spontaneous abortion, with 10 cases of induced abortions out of 21 cases reported.

Association of Age at Marriage, Income, and Education with Fertility

Table 6 shows the fertility rate according to age at marriage, economic condition, and educational level of mothers. Results of the present study indicate that the mean number of live births was

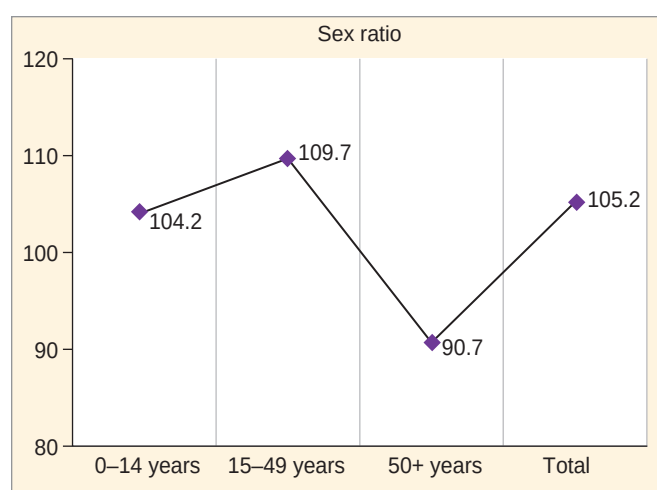


Fig. 2: Sex ratio of the Mishig community

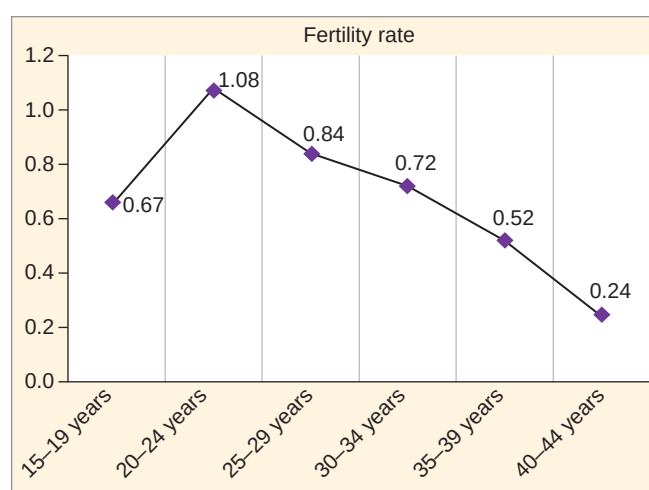


Fig. 3: Age-specific fertility rates of the Mishig community

Table 2: Mean age at marriage and mean age at first childbirth among the Mishings

Variables	Statistics	Male	Female	p-value
Mean age at marriage	N	241	255	<0.001*
	Mean $\pm$ SE	23.69 $\pm$ 0.33	19.16 $\pm$ 0.3	
Mean age at first childbirth	N	238	253	<0.001*
	Mean $\pm$ SE	24.82 $\pm$ 0.34	21.03 $\pm$ 0.83	

* $p < 0.001$ **Table 3:** Child–women ratio (fertility ratio) among the Mishings

Number of women aged 15–49 years	Number of children below 5 years	Fertility ratio (per 100 women)
350	127	36.29

Table 4: Live births and surviving children by present age-groups of all married Mishings women

Age-group (years)	Number of mother	Mean number of live births $\pm$ SE	Mean number of surviving children $\pm$ SE
≤ 24	48	1.35 $\pm$ 0.10	1.33 $\pm$ 0.96
25–29	48	2.19 $\pm$ 0.13	2.04 $\pm$ 0.11
30–34	41	2.44 $\pm$ 0.14	2.34 $\pm$ 0.13
35–39	32	3.03 $\pm$ 0.19	2.84 $\pm$ 0.16
40–44	21	3.57 $\pm$ 0.28	3.24 $\pm$ 0.23
45+	65	4.77 $\pm$ 0.29	4.31 $\pm$ 0.23
Total	255	2.99 $\pm$ 0.12	2.73 $\pm$ 0.10

higher in women who had a higher age at marriage, especially for women who were married above 25 years of age, compared to women below 25 years of age. However, no statistical significance was observed between the groups.

The relationship between economic conditions and fertility rates was assessed in terms of household per capita monthly income. The mean number of live births was 3.05, 3.10, and 2.55 in

Table 5: Mortality indicators in the study population

Parameters	Frequency
Number of mothers of all ages, <i>N</i>	255
Number of live births, <i>N</i>	752
Infant mortality rate, <i>N</i> (%)	38 (5.05%)
Child mortality rate, <i>N</i> (%)	20 (2.66%)
Juvenile mortality rate, <i>N</i> (%)	12 (1.60%)
Number of pregnancies, <i>N</i>	815
Number of abortion, <i>N</i> (%)	31 (3.80%)
Number of stillbirths, <i>N</i> (%)	7 (0.86%)
Total no. of reproductive wastage, <i>N</i> (%)	38 (4.66%)

the LIG, MIG, and HIG, respectively. The mean number of live births per mother was the highest among the MIG and lowest among the HIG. Significant variation in terms of the mean number of live births between LIG and MIG was observed ($p < 0.05$).

The mean number of live births according to the mothers' educational level is illustrated in Table 6. It was seen that the mean number of live births tends to decrease significantly with the rise in the educational level of mothers. It was found that the mean number of live births is 4.32, 2.90, 2.40, and 1.90, respectively, in the illiterate, LP, upper primary, and secondary and 12+ groups. Comparison between different levels of education depicts that higher education level significantly impacted the number of live births, except between 12+ and UP and Sec. in which the difference was insignificant ($p > 0.05$).

Association of Age at Marriage, Income, and Education with Mortality

Table 7 illustrates the relationship of age at marriage, income level, and education with mortality. The mortality rate of infants born to mothers who married ≤ 20 years is 4.01%, while mothers who married after 20 years showed 6.60% of infant mortality. Our results, however, did not show statistical significance between the two groups ($p > 0.05$).

Table 6: Fertility rates by age at marriage, income, and educational status of Mishings mothers

Variables	Number of mothers	Number of live births	Mean number of live births $\pm$ SE	p-values
Age at marriage (years)				
≤19	161	449	2.79 $\pm$ 0.33	p1 = 0.720
20–24	70	208	2.97 $\pm$ 0.23	p2 = 0.120
≥25	24	95	3.96 $\pm$ 0.59	p3 = 0.059
Total	255	752	9.72 $\pm$ 0.59	-
Income groups				
LIG	120	379	3.05 $\pm$ 0.18	p4 = 0.002*
MIG	70	217	3.10 $\pm$ 0.23	p5 = 0.101
HIG	65	156	2.55 $\pm$ 0.20	p6 = 0.080
Total	255	752	8.70 $\pm$ 0.61	-
Education level				
Ill.	69	298	4.32 $\pm$ 0.30	p7 = 0.0003*
LP	78	226	2.90 $\pm$ 0.20	p8 = 0.0001**
UP and Sec.	48	114	2.40 $\pm$ 0.16	p9 = 0.0001**
12+	60	114	1.9 $\pm$ 0.13	p10 = 0.100
Total	255	752	11.52 $\pm$ 0.79	p11 = 0.0001** p12 = 0.010*

* $p < 0.05$, ** $p < 0.001$; HIG, high-income group; Ill., illiterate; LIG, low-income group; LP, lower primary; MIG, middle-income group; p₁, ≤19 vs 20–24; p₁₀, 12+ vs UP and Sec.; p₁₁, Ill. vs 12+; p₁₂, Ill. vs UP and Sec.; p₂, 20–24 vs ≥25; p₃, ≤19 vs ≥25; p₄, LIG vs MIG; p₅, MIG vs HIG; p₆, LIG vs HIG; p₇, Ill. vs LP; p₈, LP vs UP and Sec.; p₉, UP and Sec. vs 12+; Sec., secondary; UP, upper primary

Table 7: Infant mortality rates by age at marriage, income, and educational status of Mishing mothers

Variables	Number of mothers	Number of live births	Infant mortality (<1 year)	Mortality (%)	χ^2 p-values
Age at marriage (years)					
≤20	161	449	18	4.01	0.131
>20	94	303	20	6.60	
Total	255	752	38	10.61	
Income groups					
LIG	124	379	27	7.12	0.017*
HIG	131	373	11	2.95	
Total	255	752	38	10.07	
Education level					
Illiterate	69	298	14	4.70	0.110
Literate	186	454	24	5.29	
Total	255	752	38	9.99	

* $p < 0.05$; HIG, high-income group; LIG, low-income group

It was seen that the infant mortality rate was significantly higher in the LIG (7.12%) when compared to the mothers of HIG (2.95%) ($p < 0.05$). The mortality rate according to mothers' educational level reveals that infant mortality was higher among the literate mothers (5.29%) compared to those of illiterate mothers (4.70%). However, the variation between the two groups was found to be insignificant ($p > 0.05$).

DISCUSSION

The present study attempted to describe the demographic characteristics of the Mishing tribe of Assam with special emphasis on understanding the socio-demographic correlates of fertility and mortality. The overall sex ratio in the presently population was seen to be welcoming as it was higher than the national sex-ratio (102 females per 100 males) and Assam state (101.2 females per 100 males).¹⁹

Both the mean age at marriage and the mean age at first childbirth were significantly higher in males than in females, suggesting an earlier age at marriage among females than males.

Such a trend of gender variation in age at marriage is common in India and was also witnessed among tribal groups of northeast India, such as the Pnars and Sakacheps and Garos of Meghalaya.^{14,28}

The child–women ratio was much lower in the present population when compared to populations similar to the presently studied population, such as Pnars and War Khasi.²⁹ This indicates that the fertility rate, in terms of child–women ratio, was moderately low in the present population. This may be due to the reason that fertility based on child–women ratio was considered on the number of live births and/or children to all mothers who married only once and lived continuously in wedlock till attainment of the age 45. Age-specific fertility rate reached its peak when the mothers were aged 20–24 years of age. Thereafter, it tends to decline with the increasing age of the mothers, which tends to be a general trend in all populations. The TFR of the presently studied population (4.07 TFR) was double than the average TFR of Assam, which recorded 2.3 TFR.³⁰ However, other tribal communities in the region have reported similar TFRs as reported in the present investigation.^{14,31}

The mean number of live births and number of surviving children was seen to be directly proportional with the increase in age. This improvement in live births and surviving children can be attributed to the general notion of experiences in terms prenatal care, infant care, child rearing, and parenting. Similarly, the positive impact of advancing age with average live births and surviving children has also been reported in numerous related studies.^{11,31,32}

Mortality indicators and reproductive wastage of the Mishing mothers were observed in the population. The infant mortality rate of the population was higher than that of India's infant mortality rate, whereas, child mortality rate was exceptionally low compared to the country's child mortality rate.^{19,33} This is probably due to a lack of medical facilities and proper delivery facilities. Also, this was contrary to the general expectation that the high fertility rate in a population was associated with a high mortality rate.³⁴ It was also observed that there were a greater number of abortions than stillbirths out of the total pregnancies among the Mishing mothers. A study conducted by Sharma and Jyoti³⁵ among the same population revealed that 79.61% of the mothers opted for home delivery instead of availing professional help. This can be an important factor for higher incidences of stillbirths in this community. However, the rate of abortion or pregnancy wastage in this community is relatively lesser than the non-tribals in urban settings, as seen in related literatures.^{36,37} This is true even in northeast India, as evinced from a study conducted in Manipur, where tribal mothers reported lesser cases of abortion than their non-tribal counterparts.¹⁸

Furthermore, the factors affecting fertility and mortality were understood. Age at marriage was not seen to affect fertility rate in the present population, which contradicts with recent studies in the northeast region, where the relationship of age at marriage with fertility was seen to be significantly associated.^{14,31,38} However, with respect to income, higher income was associated with both low fertility and mortality. Similar trends have been reported among other populations of northeast India viz., the Bishnupriyas of Manipur,³² the Garos of Meghalaya,¹⁴ and the Muslims of Assam.³⁸ Furthermore, educational status was reported to influence fertility and mortality. More specifically, fertility was seen to decrease with a higher educational level of Mishing mothers. On the other side, the mortality rate was higher among literate mothers when compared to illiterate mothers, albeit with insignificant results. This association of education and mortality could not be seen in other studies, and the reason for this need to be explored further. However, the impact of education on fertility among the Mishings is consistent with a previous finding from the same population reported by Mahanta.³⁹

CONCLUSION

The results of the present study hint towards the need for better medical facilities and awareness among Mishing mothers to opt for institutional deliveries for the reduction of mortality indicators. Furthermore, an improvement in education and socio-economic conditions of the mother may prove to be vital for boosting maternal-child health in such tribal populations.

DECLARATIONS

Data Availability Statement

Data that supports the current study is available upon reasonable request to the corresponding author.

Ethical Statement

Consent for participation and publication was obtained from all the participants. This study was approved by the Department of Anthropology, North-Eastern Hill University, Shillong (India).

Artificial Intelligence (AI) Use Declaration

No artificial assisted AI technologies were used.

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AUTHORS' CONTRIBUTIONS

Study design (KCJCL). Data acquisition (KCJCL). Data analysis (KCJCL and VT). Literature review (KCJCL and VT). Manuscript writing (KCJCL and VT). Manuscript review (VT). Manuscript communication (VT). Both the authors have read and approved the final manuscript.

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Effectiveness of Health Empowerment Education on Self-efficacy and Self-management in Patients with Chronic Liver Disease: A Quasi-experimental Study

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ABSTRACT

Background: Chronic liver disease (CLD) is a progressive, debilitating condition. Enhancing self-efficacy and self-management skills is essential for improving health outcomes and health empowerment education (HEE) plays a key role in strengthening these patient capacities.

Objectives: To evaluate the effect of HEE on self-efficacy and self-management in patients with CLD.

Materials and methods: Using a quasi-experimental, pre- and post-test, control group design, 60 patients with CLD were purposively selected and then randomly allocated using the flip of coin method into experimental and control groups. The experimental group received the HEE intervention, while the control group received standard care. Post-test assessments were conducted on the 7th day. Data were collected using standardized and validated tools.

Results: Baseline scores for both groups were comparable ($p > 0.05$). In the experimental group, self-efficacy significantly improved from 38.8 ± 6.28 to 51.3 ± 3.7 ($p < 0.001$), and self-management increased from 48.43 ± 3.9 to 76.2 ± 9.0 ($p < 0.001$). Post-test comparisons showed significantly higher scores in the experimental group for both self-efficacy ($MD = 16.7$; $p < 0.001$) and self-management ($MD = 27.9$; $p < 0.001$), with a strong positive correlation between self-efficacy and self-management ($r = 0.78$, $p < 0.001$).

Conclusion: Health empowerment education is an effective approach, and its integration into the routine care of patients with CLD can enhance patient engagement, disease management, and health outcomes.

Keywords: Chronic liver disease, Health empowerment education, Patient, Self-efficacy, Self-management.

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INTRODUCTION

Chronic liver disease (CLD) is a progressive condition characterized by long-standing hepatic injury leading to fibrosis, cirrhosis, and significant functional decline. Globally, CLD accounts for more than 1.5 million deaths annually, with rising trends driven by metabolic dysfunction-associated steatotic liver disease (MASLD), alcohol-associated liver disease, and chronic viral hepatitis (HBV and HCV).^{1–3} India has witnessed a steady increase in CLD prevalence due to changing lifestyles, high alcohol consumption, and escalating metabolic risk factors such as obesity and diabetes.⁴

Patients with CLD face substantial challenges in daily self-care, including symptom burden, fatigue, dietary restrictions, complex medication schedules, and psychosocial distress. These factors reduce autonomy and hinder effective disease control. Empowerment-based educational interventions have shown significant benefits in improving self-care, treatment adherence, and self-efficacy across chronic diseases.^{5,6} Although such interventions have been well established in diabetes, heart failure, and chronic respiratory disease, their systematic application in CLD populations remains limited. Recent evidence highlights substantial gaps in self-management support for individuals with CLD. A 2024 scoping review showed that self-management interventions for cirrhosis remain limited, heterogeneous, and insufficiently standardized to address the complex needs of this population.⁷ Patients consistently report significant unmet informational needs, with qualitative studies demonstrating that inadequate disease knowledge directly

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impairs their ability to manage symptoms, adhere to treatment, and make informed lifestyle decisions.⁸ Although isolated initiatives, such as a structured teaching program in India, have demonstrated improvements in patients' understanding of cirrhosis prevention and disease care, such programs remain rare, fragmented, and not widely integrated into routine hepatology practice.⁹ Collectively, these findings emphasize the need for structured, patient-centered empowerment and education strategies tailored to the CLD population, particularly in resource-constrained settings. Identifying this research gap, the present study intended to assess

the effect of health empowerment education (HEE) on self-efficacy and self-management among patients with CLD.

Objective

To evaluate the effectiveness of HEE on self-efficacy and self-management among patients with CLD and to explore associations with demographic and clinical factors.

Null Hypothesis

There is no significant effect of HEE on self-efficacy and self-management among patients with CLD, and there are no associations between these outcomes and any demographic or clinical variables.

MATERIALS AND METHODS

Study Design

This study employed a quasi-experimental, pre- and post-test, control group design, where experimental group that received the HEE and a control group that received standard care. The data was collected from 15 September to 15 October 2025 for a duration of one month.

Sampling Size and Technique

A total of 60 participants were selected using a convenience sampling method and subsequently randomized into experimental and control groups using the coin-flip method. Eligibility criteria included patients aged 18 years and above diagnosed with CLD, admitted to general wards, conscious and able to respond to the questionnaire, and willing to participate by providing informed consent. Patients were excluded if they were diagnosed with hepatic encephalopathy or had altered sensorium, were critically ill or on ventilator support, or were discharged before the 7 days follow-up period. The 7 days period for the follow-up was decided based on available evidence wherein it has produced its effects within a week.¹⁰⁻¹²

The primary endpoint for sample size estimation was the expected difference in post-test outcome scores between the experimental and control groups. The sample size was calculated based on a similar study conducted by Royani et al. (2013), which reported post-test scores of 62.12 (SD = 1.72) in the experimental group and 52.93 (SD = 15.42) in the control group. Considering a 5% alpha error, 90% power, and a 10% anticipated dropout rate, the required sample size was determined using the formula below:

$$N = \frac{2S_p^2(Z_\alpha + Z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

$$S_p^2 = \frac{(S_1^2 + S_2^2)}{2}$$

where,

S_1^2 : Standard deviation (SD) in the first group.

S_2^2 : SD in the second group.

μ_1 : Mean difference between the samples.

α : Significant level.

$1-\beta$: Power.

Pooled variance

$$S_p^2 = \frac{1.72^2 + 15.42^2}{2} = \frac{2.9584 + 237.7764}{2} = 120.3674$$

Compute ($Z_\alpha + Z_{1-\beta}$)

$$Z_\alpha + Z_{1-\beta} = 1.96 + 1.2816 = 3.2416$$

Substituting all the values into the formula:

$$N = \frac{2 \times 120.3674 \times (3.2416)^2}{(62.12 - 52.93)^2} = \frac{2 \times 120.3674 \times 10.510}{(9.19)^2} \approx 29.95$$

Hence, 30 samples in each group were selected.

Tools Used in the Study

Data were collected using four tools, including a structured sociodemographic and clinical data sheet. All the tools were assessed for their preliminary reliability (using the test-retest method) and validity (using a selected panel of experts). The self-efficacy for managing chronic disease (SEMCD) was measured using a standardized six-item instrument developed by Lorig et al., demonstrating strong reported reliability ($\alpha = 0.87$). Each item was rated from 1 (not at all confident) to 10 (totally confident), with scores interpreted as follows: >80% indicating high self-efficacy, 60–80% indicating moderate self-efficacy, and <60% indicating low self-efficacy. The third tool was the self-management scale for CLD, a researcher-developed, 24-item instrument using a four-point Likert response format (1 = rarely, 2 = sometimes, 3 = most of the time, 4 = always), covering four domains: Dietary habits, lifestyle modification, medication adherence, and illness monitoring. Scores ranged from 24 to 96, with higher scores reflecting greater self-management ability. The tool demonstrated acceptable psychometric properties when pilot tested among 10 patients with CLD (Cronbach's $\alpha = 0.84$; content validity index = 0.93). The fourth instrument was a structured Patient Satisfaction Questionnaire, developed by the researcher, consisting of 14 items rated on a five-point Likert scale (1 = very dissatisfied to 5 = very satisfied), with a possible score range of 7–35 for each section. All instruments were translated into Hindi, and linguistic validation was carried out by an expert fluent in both Hindi and English. No modifications were made to the standardized self-efficacy tool to maintain its original construct validity. However, the remaining tools were developed and culturally adapted to align with the study objectives, target population, and contextual relevance.

Intervention

Health empowerment education consisted of a structured education program lasting for one hour and delivered using PowerPoint, demonstration, and discussion with active engagement from the patient focusing on areas such as his understanding of CLD and its progression, the importance of diet, lifestyle modification, medication adherence, symptom monitoring, areas where to seek support, patient activation, and motivation. The content validity index of HEE was computed to quantify the degree of agreement among the experts and was obtained as 0.94. The researcher had past experience working with patients with CLD and was trained

in giving health education. The intervention was carried out at the patient's bedside where it was quiet and the patient was comfortable. The control group received standard care, which comprised routine clinical management, regular monitoring, and day-to-day interaction with the nursing staff and treating physicians. Participants were provided with incidental or need-based health education as deemed appropriate during routine care, without any structured educational or capacity-building intervention.

Theoretical Framework Applied for the Study

An integrated theoretical framework combining Bandura's self-efficacy theory and Lorig's self-management model was adopted to explain how an empowerment-based education intervention can influence health outcomes among patients with CLD.^{5,13} According to Bandura, a person's belief in their capability to execute behaviors (self-efficacy) determines their motivation, effort, and persistence in performing those behaviors. In the context of chronic illness, higher self-efficacy increases the likelihood that patients will engage in the continuous, complex, and self-regulated tasks required for disease management. Lorig's model further elaborates that effective self-management encompasses not only medical tasks (e.g., medication adherence and symptom monitoring) but also role management (maintaining life activities) and emotional management (coping with stress and emotional burden). Empowerment education serves as the crucial precursor in this framework: By providing knowledge, fostering self-awareness, supporting goal-setting, encouraging problem-solving, and promoting autonomy, empowerment education enhances patients' sense of competence and control — thereby strengthening self-efficacy. Elevated self-efficacy then facilitates the adoption and maintenance of self-management behaviors (medical, lifestyle, and emotional) prescribed for CLD. Ultimately, this chain of influence—from empowerment education → increased self-efficacy → enhanced self-management — is expected to lead to improved health outcomes, better quality of life, and possibly reduced complications or healthcare utilization among CLD patients. Thus, the theoretical framework posits that empowerment education is not an end in itself but a mechanism to activate internal motivation and capability, which, mediated through self-efficacy, translates into sustained self-management behavior as per Lorig's conceptualization.

Statistical Analysis

Data were analyzed using SPSS (version 20) at the $p < 0.05$ level of significance. The distribution of the data was found to be homogenous and normal in distribution, hence, parametric tests such as the Chi-square test, paired t -test, one-way ANOVA, and independent t -test were used. The paired and independent Cohen's d was also calculated to determine effect size. There were no missing data in the study due to closely monitored face-to-face administration of the tools. The analysis of the data was based on the per-protocol method, in which only participants who completed the full intervention and both pre- and post-test assessments were included in the final analysis.

Ethical Consideration

Ethical clearance was obtained from the Institutional Ethics Committee of ILBS (CONEC/ILBS/MS/01/24/008). Written informed consent was obtained from all participants. Confidentiality and anonymity of participants were maintained throughout the study. Participation was voluntary, and participants had the right to

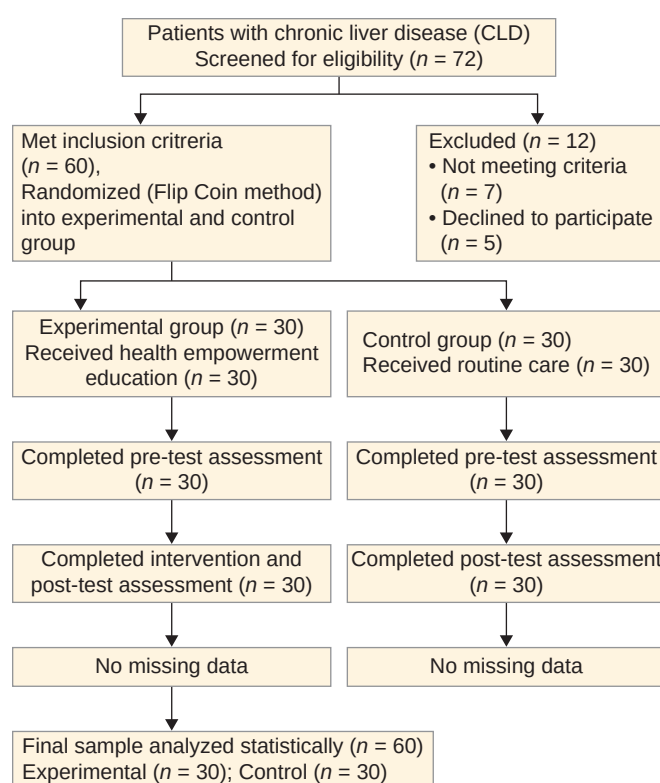


Fig. 1: Consort flow diagram for inclusion of patients with CLD

withdraw at any stage without affecting their treatment. All the principles as per the Declaration of Helsinki were followed.

RESULTS

A total of 72 patients were screened, out of which a total of 60 patients meeting the inclusion criteria were recruited. They were then randomized using the flip of coin method equally (30 each) into the intervention and control group (Fig. 1).

Baseline Comparability of Participants in the Experimental and Control Group

Both the groups were found comparable with respect to sociodemographic and outcome variables (Table 1).

As shown in Table 2, within-group comparisons using the paired t -test reveal that the experimental group demonstrated a marked and highly significant improvement in both self-efficacy and self-management post-intervention. Mean self-efficacy scores increased substantially from 38.8 to 51.3 ($MD = 12.5, p < 0.001$) and self-management scores improved from 48.43 to 76.2 ($MD = 27.7, p < 0.001$).

As shown in Table 3, between-group comparisons using the independent t -test reveal that the experimental group demonstrated a marked and highly significant improvement in both self-efficacy and self-management post-intervention, with improvement in self-efficacy by 16.7 points and self-management by 27.9 points, both with $p < 0.001$. Both paired (within-group) and independent (between-group) effect comparisons as shown in Tables 2 and 3 above indicated a high magnitude of change attributable to the intervention.

The association between self-efficacy and self-management scores with selected sociodemographic and clinical variables



Table 1: Frequency and percentage distribution of sociodemographic and outcome variables at baseline

Variables	n1 f (%)	n2 f (%)	χ^2/t	df	p-value
Age					
18–33	01 (3.3)	1 (3.3)	0.622	3	0.891
34–49	15 (50)	15 (50)			
50–65	10 (33.3)	8 (26.7)			
66–81	4 (13.3)	6 (20)			
Gender					
Male	22 (73.3)	26 (86.7)	1.667	1	0.197
Female	8 (26.7)	4 (13.3)			
Marital status					
Married	28 (93.3)	28 (93.3)	1.33	2	0.513
Unmarried	0	1 (3.3)			
Widowed	2 (6.7)	1 (3.3)			
Religion					
Hindu	28 (93.3)	26 (86.7)	2.074	3	0.557
Muslim	2 (6.7)	2 (6.7)			
Sikh	0	1 (3.3)			
Christian	0	1 (3.3)			
Month family income (Rs.)	f (%)	f (%)			
>70,000	6 (20)	2 (6.7)	5.886	4	0.208
50,001–70,000	8 (26.7)	6 (20)			
30,001–50,000	13 (43.3)	13 (43.3)			
<30,000	3 (10)	7 (23.3)			
	0	2 (6.7)			
Employment type					
Full time	14 (46.7)	13 (43.3)	0.067	1	0.795
Unemployed	16 (53.3)	17 (56.7)			
Area of residence					
Urban	22 (73.3)	28 (93.3)	4.320	1	0.38
Rural	8 (26.6)	2 (6.7)			
Education level	f (%)	f (%)			
No formal education	2 (6.7)	0	3.496	6	0.745
Primary school middle school	1 (3.3)	1 (3.3)			
High school	2 (6.7)	2 (6.7)			
Intermediate	6 (20)	5 (16.7)			
Graduation	9 (30)	10 (33.3)			
Post-graduation or higher	8 (26.7)	7 (23.3)			
	2 (6.7)	5 (16.7)			
Baseline pretest scores	(Mean $\pm$ SD)	(Mean $\pm$ SD)			
Self-efficacy (6–60)	38.8 $\pm$ 6.28	38.6 $\pm$ 4.46	1.16		0.88
Self-management (24–96)	48.4 $\pm$ 3.98	48.4 $\pm$ 3.98			

n1 + n2 = 30 + 30; $p \geq 0.05$; not significant

was analyzed using one-way ANOVA and the independent *t*-test. No significant associations were observed, indicating that the effectiveness of the intervention was consistent across participant subgroups (Table 4). As multiple univariate comparisons were performed, these findings should be interpreted cautiously. Future analysis using multivariable regression could better account for covariates simultaneously and reduce type-I error inflation.

Figure 2 shows a strong positive correlation between the post test scores the self-efficacy vs self-management, indicating that as self-efficacy increases, the self-management behavior of the patient is also increased.

As shown in Table 5, the mean scores of both sections of the patient satisfaction questionnaire for HEE are towards the higher end of the possible score range (high satisfaction), range

Table 2: Mean, SD, mean difference, and paired *t*-test value of pre- and post-test scores of self-efficacy and self-management in the experimental and control group

Variables	Group n1 and n2	Pre-test score Mean $\pm$ SD	Post-test score Mean $\pm$ SD	MD	SEMD	t-value	p-value	95% CI for MD	Paired Cohen's d value
Self-efficacy (6–60)	n1 = 30	38.8 $\pm$ 6.28	51.3 $\pm$ 3.7	12.5	1.22	12.06	<0.001**	10.11–14.89	1.87
	n2 = 30	34.6 $\pm$ 5.1	34.9 $\pm$ 5.3	0.3	0.17	1.90	0.06	10.11–14.89	0.32
Self-management (24–96)	n1 = 30	48.43 $\pm$ 3.9	76.2 $\pm$ 9.0	27.7	1.49	18.5	<0.001**	24.78–30.62	3.39
	n2 = 30	76.2 $\pm$ 9.0	48.3 $\pm$ 5.2	13–21	27.9	1.20	22.1	25.55–30.25	0.17

n1 + n2 = 30 + 30; n1 = experimental group; n2 = control group; **p* $\leq$ 0.05; significant; ***p* $\leq$ 0.01; highly significant; Bold values indicated that large Cohen's d effect sizes (*d* $\geq$ 0.8); for the experimental group indicate that the intervention had a strong practical impact on improving self-efficacy and self-management

Table 3: Mean, SD, and mean difference of post-test scores of self-efficacy and self-management among experimental and control groups

Variable	Post-test score								Independent Cohens d
	(n1 = 30) Mean $\pm$ SD	(n2 = 30) Mean $\pm$ SD	Range	MD	SEMD	t-value	p-value	95% CI for MD	
Self-efficacy (6–60)	51.3 $\pm$ 3.7	34.6 $\pm$ 4.4	15–22	16.7	1.08	10.2	<0.001**	14.58–18.82	4.11
Self-management (24–96)	76.2 $\pm$ 9.0	48.3 $\pm$ 5.2	13–21	27.9	1.20	22.1	<0.001**	25.55–30.25	3.80

n1 + n2 = 30 + 30; n1 = experimental group; n2 = control group; **p* $\leq$ 0.05; significant; ***p* $\leq$ 0.01; highly significant; Bold values indicated that large Cohen's d effect sizes (*d* $\geq$ 0.8); for the experimental group indicate that the intervention had a strong practical impact on improving self-efficacy and self-management

Table 4: One-way ANOVA and independent *t*-test showing association between self-efficacy or self-management in experimental group with selected socio demographic variables

Variables	Self-efficacy (mean $\pm$ SD)	Self-management (mean $\pm$ SD)	f/t value	df	p-value
Age					
18–33	44.5 $\pm$ 14.8	54 $\pm$ 19.7	0.355/0.87	59	0.78/0.46
34–49	43.07 $\pm$ 8.9	62.3 $\pm$ 13.8			
50–65	44.33 $\pm$ 9.0	64.7 $\pm$ 14.5			
66–81	40.60 $\pm$ 10.5	57.1 $\pm$ 12.4			
Gender					
Male	42.06 $\pm$ 3.7	31.6 $\pm$ 2.07	1.743/0.463	58	0.69/0.35
Female	47.17 $\pm$ 3.8	32 $\pm$ 2.3			
Education level					
No schooling	51 $\pm$ 5.6	78.5 $\pm$ 2.2	0.51/0.64	59	0.79/0.69
Primary	44.5 $\pm$ 12.01	58.5 $\pm$ 13.4			
Middle school	46.5 $\pm$ 10.4	64 $\pm$ 16.8			
High school	43.09 $\pm$ 11.4	61.9 $\pm$ 14.7			
Intermediate	43.9 $\pm$ 8.5	62.1 $\pm$ 11.7			
Graduation	41.9 $\pm$ 9.03	61.8 $\pm$ 16.2			
$\geq$ Post-graduation	39.7 $\pm$ 8.95	56.7 $\pm$ 14.4			
Etiology					
Alcohol	43.1 $\pm$ 9.08	63.0 $\pm$ 13.7	0.64/0.73	59	0.69/0.60
Viral-B/C	40.5 $\pm$ 8.16	60.3 $\pm$ 13.01			
α 1-antitrypsin def	52 $\pm$ 1.4	74 $\pm$ 2.8			
Autoimmune	45.7 $\pm$ 10.7	60.5 $\pm$ 16.6			
NASH	44.6 $\pm$ 12.4	63.3 $\pm$ 15.6			
Cystic fibrosis	41.4 $\pm$ 8.26	54.3 $\pm$ 15.1			
Duration of illness					
1–3 months	44.9 $\pm$ 8.7	64.6 $\pm$ 12.06	1.96/1.33	59	0.13/0.27
4–6 months	40.5 $\pm$ 9.5	59.5 $\pm$ 15.1			
7–9 months	35.7 $\pm$ 3.4	51.2 $\pm$ 5.9			
10–12 months	45.2 $\pm$ 9.6	63.4 $\pm$ 15.6			

n = 30; **p* $\leq$ 0.05; significant; ***p* $\leq$ 0.01; highly significant



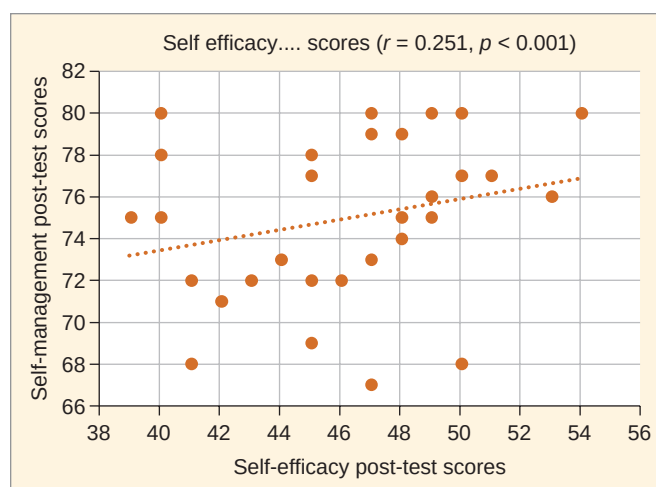


Fig. 2: Scatter plot of post test scores of self-efficacy vs self-management

Table 5: Descriptive statistics of scores as per patient satisfaction questionnaire for HEE sections among the experimental group ($n = 30$)

Sections of patient satisfaction questionnaire	Range	Mean $\pm$ SD
Section I – Content-related satisfaction	7–35	31.7 $\pm$ 2.1
Section II – Perceived usefulness of HEE	7–35	31.0 $\pm$ 2.5

suggesting overall positive acceptance and perceived relevance of this intervention among the patients with CLD.

DISCUSSION

This study evaluated the effect of HEE on self-efficacy and self-management among patients with CLD. The findings revealed a statistically significant improvement in both within the experimental group, indicating that the intervention was effective in enhancing patients' confidence and ability to manage their condition. Post-intervention analysis demonstrated a marked increase in self-efficacy ($MD = 12.5; p < 0.001$), suggesting that participants became more confident in handling daily care demands, medication routines, and lifestyle modifications. These outcomes align with Bandura's self-efficacy framework and Lorig's self-management framework, which state that structured learning experiences, guided support, and reinforcement provide the mastery and confidence required for sustained behavioral change.^{5,13} Correspondingly, self-management behaviors improved substantially ($MD = 27.7; p < 0.001$), indicating that empowerment-driven education successfully translated into practical behavioral application.

The study's results are consistent with a growing body of evidence endorsing structured patient education interventions. Systematic reviews, including that of Kim and Lee, report that self-management-focused educational programs improve treatment adherence and quality of life among chronic illness populations.¹⁴ Similar outcomes were demonstrated in a trial conducted in China among liver transplant recipients, where empowerment-based education led to significant improvements in self-efficacy and self-management over a prolonged duration, whereas the control group showed a decline at later follow-up.¹⁵ Further supportive evidence comes from studies in stroke and ulcerative colitis populations, wherein educational interventions yielded significant gains in self-efficacy, health behaviors, and overall well-being.^{16,17}

These parallels reinforce the robustness of the present findings and underline the role of empowerment-oriented education in chronic disease care. A slight increase in post-test self-efficacy scores in the control group ($MD = 0.3; p = 0.06$) may be explained by routine clinical interactions, spontaneous learning during hospitalization, or possible information contamination between participants. Additionally, the possibility of a Hawthorne effect cannot be excluded, as participants aware of being observed may have modified their behavior.

Despite its positive implications, the study has notable limitations. The relatively small sample size and the non-probability sampling technique limit the generalizability of the study. The single-center setting and short follow-up period restrict generalizability and limit conclusions regarding long-term behavioral sustainability. As blinding was not feasible during the intervention, the possibility of performance and measurement bias cannot be fully excluded. In addition, although efforts were made to minimize interaction between participants, contamination of information across groups may have occurred, potentially influencing the intervention effect. The study also relied primarily on self-reported measures rather than objective clinical endpoints, which may be subject to reporting inaccuracies, recall bias, or social desirability effects. Future research using probability sampling, blinded outcome assessment, stricter contamination control, and the incorporation of clinical biomarkers is recommended to strengthen internal and external validity. Improvements in self-efficacy and self-management may be more accurately captured through extended follow-up or multi-site studies with larger cohorts. Future research should explore longer-duration interventions, evaluate the maintenance of gains over time, and examine the potential scalability and feasibility of delivering HEE through outpatient or telehealth platforms.

Overall, the intervention demonstrated meaningful benefits and provides a foundation for integrating empowerment-based education into CLD management pathways. Further large-scale and longitudinal studies are warranted to establish durable outcomes and inform policy and clinical practice.

CONCLUSION AND RECOMMENDATIONS

The findings highlight the value of structured HEE in strengthening patients' self-efficacy and supporting self-directed management of CLD. By equipping individuals with disease-specific knowledge and practical coping strategies, HEE enhances treatment adherence, encourages lifestyle modification, and promotes greater autonomy—elements that contribute to better clinical stability and improved quality of life. The integration of structured HEE into standard CLD management pathways can potentially enhance adherence and self-care behaviors. Future multi-center studies with longer follow-up are warranted.

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the first author on reasonable request.

Artificial Intelligence (AI) Disclosure

All the authors hereby declare that no AI-assisted technologies were used for writing the manuscript and the authors reviewed, edited the manuscript. The standard tools were used in the manuscripts, for which permissions were obtained and for the content of the manuscript the authors take the entire responsibility.

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AUTHORS' CONTRIBUTION

Mr Dil Raj contributed to designing the study, collection of data, coding and analysis of the study. Dr Sunita Srivastava contributed in designing the study, analysis and interpretation and writing the final manuscript and Dr Shashtry contributed in critiquing the manuscript and guidance in methodology of the study. All the authors read and approved the final manuscript.

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Prevalence and Predictors of Non-adherence to Treatment in Patients with Hypertension: A Cross-sectional Study

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ABSTRACT

Aims and background: Non-adherence to antihypertensive therapy remains a major global barrier to optimal blood pressure (BP) control and is associated with increased cardiovascular morbidity and mortality. Understanding the prevalence and determinants of non-adherence is crucial for designing effective interventions. This study aimed to determine the prevalence of treatment non-adherence among hypertensive patients in a tertiary care hospital and to assess the associated sociodemographic and clinical characteristics, as well as the underlying reasons for non-adherence.

Materials and methods: A prospective observational study was conducted among 100 hypertensive patients attending the General Medicine Department at King Koti Hospital, Hyderabad. Data were collected using structured questionnaires covering sociodemographic variables, clinical profiles, hypertension management practices, and medication adherence patterns. Blood pressure measurements were recorded, and adherence was assessed by patient self-report. Descriptive statistical methods were applied to analyze the collected data.

Results: Of the 100 patients studied, 56% were female and 44% were male, with a mean age of 52.9 years (standard deviation = 10.7). The majority were urban residents (78%) and married (79%). Uncontrolled hypertension ($\geq 140/\geq 90$ mm Hg) was present in 72% of participants. Comorbid conditions were reported by half of the cohort, with type 2 diabetes mellitus (T2DM) being the most common (48%). Pharmacological therapy consisted of single-drug regimens (54%) and combination therapy (46%). Adherence to lifestyle modifications was suboptimal, with only 44% following dietary salt restrictions and 11% engaging in regular physical exercise. In contrast, 82% regularly monitored their BP and 75% attended routine doctor follow-ups. Medication adherence was reported by 82%; forgetfulness and carelessness emerged as the primary causes of non-adherence. Financial constraints and polypharmacy were noted to have minimal influence.

Conclusion: Although medication adherence among the study population was relatively high, adherence to non-pharmacological lifestyle measures remained inadequate. Addressing behavioral factors, particularly forgetfulness, through targeted patient education and individualized intervention strategies is essential to improving overall treatment adherence and achieving better hypertension control.

Clinical significance: This study highlights the need for comprehensive adherence-enhancing strategies within clinical practice. While pharmacological adherence is generally satisfactory, poor adherence to lifestyle modifications continues to hinder optimal BP control. Clinicians should prioritize behavioral counselling, incorporate adherence-support tools such as reminders, and promote sustained lifestyle changes to reduce long-term cardiovascular risks in hypertensive patients.

Keywords: Blood pressure control, Hypertension, Lifestyle modification, Medication adherence, Non-adherence, Secondary care.

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INTRODUCTION

Non-adherence to antihypertensive treatment continues to pose a substantial challenge to the effective management of hypertension. This condition affects over one billion adults globally and remains a leading cause of cardiovascular morbidity and mortality. Recent evidence indicates a high prevalence of non-adherence, ranging from 27% to over 40% worldwide, with particularly elevated rates in low- and middle-income countries (LMICs).

Lee et al. reported that such non-adherence significantly contributes to poor blood pressure (BP) control and increases the risk of cardiovascular complications.¹ Systematic reviews and meta-analyses reinforce this link, demonstrating that poor adherence to antihypertensive therapy is associated with increased all-cause mortality [hazard ratio (HR) = 1.32] and cardiovascular mortality (HR = 1.61).²

Several recent studies have identified multifactorial predictors of non-adherence, including socioeconomic status, medication burden, healthcare access, and patient-related behavioral factors. For example, Kim et al. found that medication adherence below 50% correlated with worse cardiovascular outcomes and higher hospitalization rates.³ Additionally, biochemical adherence testing

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revealed that higher BP levels and greater medication complexity are associated with poorer adherence, whereas older age tends to be associated with better compliance.⁴ Regional analyses, such as the meta-analysis from sub-Saharan Africa by Aminde et al., indicate

a rising trend in non-adherence rates, emphasizing the urgent need for targeted intervention strategies.⁵

Given these findings, understanding the prevalence and predictors of non-adherence in hypertensive patients is critical for designing effective policies and interventions aimed at improving medication adherence, enhancing BP control, and ultimately reducing the burden of hypertension-related complications globally.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of General Medicine at King Koti Hospital, Hyderabad. One hundred hypertensive patients were randomly selected from patients attending the General Medicine Department. Data were collected between March 2025 and September 2025, ensuring a representative sample of the outpatient hypertensive population.

Inclusion and Exclusion Criteria

Patients eligible for inclusion were those with a prior clinical diagnosis of hypertension, aged 18 years or older, willing to participate, capable of providing informed consent, and able to comprehend and complete the questionnaire. Patients who were critically ill, cognitively impaired, or unwilling to participate were excluded.

Data Collection

Data were collected using a structured questionnaire developed specifically for this study, which consisted of two components. The first component captured sociodemographic characteristics, including age, gender, marital status, education level, occupation, and residence. The second component explored treatment adherence behaviors related to antihypertensive medications, dietary restrictions (such as salt intake), physical activity, and reasons for non-adherence for each management strategy. The questionnaire also recorded clinical data, including patient history, family history of hypertension, comorbidities, hypertension complications, and prescribed medications (with details on dose, duration, and administration route).

The questionnaire was pilot-tested with 10 hypertensive patients to evaluate face validity, comprehensibility, and clarity; no modifications were required following the pilot test. The questionnaire was administered via face-to-face interviews by the principal investigator, ensuring data completeness and accuracy.

Ethical Considerations

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Ethics Committee (IEC) of Anwarul Uloom College of Pharmacy, Hyderabad, prior to the commencement of the study (Ethics Committee Approval number: AUCP/IEC/24-25/M. Pharm/03/02, Dated - 29/03/2025). Written informed consent was obtained from all participants after a full explanation of the study aims and procedures. Confidentiality and anonymity were strictly maintained by assigning each participant a unique ID. Participants were assured of their right to withdraw at any time without affecting their medical care.

Statistical Analysis

Data collected through the questionnaires were entered into Microsoft Excel and analyzed using descriptive statistics.

Table 1: Sociodemographic and clinical characteristics of participants (N = 100)

Variables	Frequency	Percentage (%)
Gender		
Male	44	44
Female	56	56
Age (years)		
Mean (SD)	52.9 (10.7)	
<49	35	35
49–59	37	37
60–71	24	24
≥72	4	4
Place of residence		
Urban	78	78
Rural	22	22
Marital status		
Single	14	14
Married	79	79
Widowed	7	7

Continuous variables (such as age and duration of hypertension) were summarized using means and standard deviations (SDs), while categorical variables (including gender, adherence status, and presence of comorbidities) were presented as frequencies and percentages. The prevalence of treatment non-adherence and the distribution of associated sociodemographic and clinical predictors were described to provide a clear understanding of adherence behavior in the study population.

RESULTS

A total of 100 participants were included in the study. The sociodemographic, clinical, and treatment-related characteristics are presented below.

Sociodemographic and Clinical Characteristics

Among the participants, 44% were male and 56% were female. The mean age was 52.9 years (SD = 10.7), with most participants falling within the 49–59 years (37%) and <49 years (35%) age-groups. A majority (78%) resided in urban areas, while 22% were from rural settings. With respect to marital status, 79% were married, 14% were single, and 7% were widowed (Table 1).

Employment Status and Lifestyle Risk Factors

Nearly half of the participants were housewives (49%), followed by employed/self-employed individuals (29%), retired individuals (14%), and students or unemployed (8%). A family history of hypertension was reported in 68% of participants. Regarding lifestyle factors, 23% consumed alcohol, and 20% were smokers, whereas the majority abstained from alcohol (77%) and smoking (80%) (Table 2).

BP, Duration of Hypertension, and Comorbid Conditions

Most participants (72%) had uncontrolled hypertension with BP readings $\geq 140/\geq 90$ mm Hg. Only 3% had optimal BP ($<120/<80$ mm Hg), and 7% had values within the elevated category ($120\text{--}129/<80$ mm Hg). The mean duration of hypertension was 4.67



Table 2: Employment status and lifestyle risk factors (N = 100)

Variables	Frequency	Percentage (%)
Employment status		
Housewife	49	49
Employed/self-employed	29	29
Retired	14	14
Unemployed/student	8	8
Family history of hypertension		
Present	68	68
Absent	32	32
Alcohol consumption		
Yes	23	23
No	77	77
Smoking status		
Yes	20	20
No	80	80

Table 3: Blood pressure levels, duration of hypertension, and comorbidities (N = 100)

Variables	Frequency	Percentage (%)
BP (mm Hg)		
<120/<80	3	3
120–129/<80	7	7
130–139/80–89	18	18
≥140/≥90	72	72
Duration of hypertension		
0–5 years	70	70
6–10 years	22	22
≥11 years	8	8
Mean (SD)	4.67 (3.2)	
Comorbid conditions		
None	50	50
Present	50	50
T2DM	48	48
Dyslipidemia	6	6
CKD	4	4
Heart disease	1	1

years (SD = 3.2), with the majority (70%) diagnosed within the past 0–5 years, followed by 22% with 6–10 years and 8% with ≥11 years duration.

Comorbidities were present in half (50%) of the study population. Among these, T2DM was the most common (48%), followed by dyslipidemia (6%), chronic kidney disease (CKD) (4%), and heart disease (1%) (Table 3).

Pharmacological and Lifestyle Management

Regarding pharmacological management, 54% of patients were on single-drug therapy, 42% on dual-drug therapy, and 4% on triple-drug therapy. Non-pharmacological practices were suboptimal: 44% reported following a salt-restricted diet, while the majority (56%) did not adhere to dietary advice. Only 11% of patients practiced regular physical exercise, with 89% reporting no regular exercise (Table 4).

Table 4: Pharmacological and lifestyle management practices (N = 100)

Variables	Frequency	Percentage (%)
Pharmacological treatment		
Single drug therapy	54	54
Dual drug therapy	42	42
Triple drug therapy	4	4
Non-pharmacological treatment		
Following salt-restricted diet	44	44
Not following diet advice	56	56
Regular exercise practice	11	11
No regular exercise	89	89

Table 5: Blood pressure monitoring and follow-up practices (N = 100)

Variables	Frequency	Percentage (%)
Monitor BP regularly		
Yes	82	82
No	18	18
Regular doctor visits		
Yes	75	75
No	25	25
Reasons for missing doctor visits		
Cost of fees	1	1
Perceived no need	7	7
Forgetfulness	7	7
Travel costs	5	5
Cost of treatment	1	1

BP Monitoring and Follow-up

The majority (82%) monitored their BP regularly, and 75% attended regular follow-up consultations with physicians. However, 25% of patients missed follow-up visits, with the most common reasons including a perceived lack of need (7%), forgetfulness (7%), and travel costs (5%). A smaller proportion reported the cost of treatment (1%) and consultation fees (1%) as barriers (Table 5).

Medication Adherence

Medication adherence was relatively high, with 82% adherent and 18% non-adherent. The primary reasons for non-adherence were attributed to carelessness (6%) and forgetfulness (4%). Other reasons included financial constraints (1%), polypharmacy (1%), and perceived lack of necessity (1%). Notably, no participants cited side effects, drug unavailability, or long duration of therapy as reasons for non-adherence (Table 6).

DISCUSSION

The current study found an adherence rate of 82% among hypertensive patients, which is encouraging compared with reported global figures, where adherence often ranges between 27 and 55%.^{6,7} This higher adherence may be attributed to regular healthcare follow-up, with 75% of participants attending physician visits routinely, consistent with findings that regular care engagement supports better medication-taking behavior.³

However, non-pharmacological management practices such as salt restriction and physical activity were markedly suboptimal, aligning with the literature that emphasizes the challenge of lifestyle adherence in hypertensive populations.⁸

Table 6: Medication adherence and reasons for non-adherence (N = 100)

Variables	Frequency	Percentage (%)
Medication adherence status		
Adherent	82	82
Non-adherent	18	18
Reasons for non-adherence		
No response	87	87
Carelessness	6	6
Financial constraints	1	1
Polypharmacy (too many drugs)	1	1
Forgetfulness	4	4
Perceived lack of necessity	1	1
Side effects	0	0
Long duration of therapy	0	0
Drug unavailability	0	0

The predominance of uncontrolled hypertension (72%) despite high medication adherence echoes global concerns of suboptimal BP control, which may relate to factors beyond adherence, including pharmacological regimen adequacy and comorbidities.⁹ Comorbid diabetes was prevalent, underscoring the complex clinical profiles that often challenge hypertension management.¹⁰

Forgetfulness and carelessness were the leading reported reasons for non-adherence, consistent with previous studies highlighting cognitive and behavioral barriers as primary obstacles.^{8,11}

Financial constraints and side effects were rarely cited, which might reflect the socioeconomic profile of the study population or effective medication counselling. Polypharmacy appeared to have a minimal impact on adherence here, although international evidence suggests the contrary, indicating that an increased medication burden generally predicts poorer adherence.⁸

The high urban representation (78%) and family history of hypertension (68%) align with findings that urban living and genetic predisposition may influence hypertension prevalence and management challenges.⁵

Additionally, the majority being female (56%) and housewives (49%) might reflect demographic tendencies in healthcare-seeking behavior and warrant consideration in tailored intervention strategies.⁷

Overall, the findings support the need for multifaceted interventions that address medication adherence and place a robust emphasis on lifestyle modifications. Interventions such as patient education, reminder systems, and simplifying medication regimens could mitigate non-adherence due to forgetfulness.¹⁰ Given the association between poor adherence and adverse cardiovascular outcomes, enhancing adherence remains a public health priority.³

CONCLUSION

This study highlights relatively high medication adherence among hypertensive patients attending a secondary care hospital in Hyderabad, juxtaposed with inadequate lifestyle adherence and a substantial burden of uncontrolled hypertension. Behavioral factors, such as forgetfulness, are primary barriers to adherence, and multifaceted strategies tailored to patient demographics are essential. Strengthening patient education, implementing

regular follow-up, and establishing support systems are crucial to enhancing adherence rates and optimizing hypertension control, ultimately reducing cardiovascular morbidity and mortality.

Clinical Significance

The study highlights that despite relatively high medication adherence, a substantial proportion of hypertensive patients continue to exhibit uncontrolled BP, emphasizing gaps in comprehensive hypertension management. Identifying forgetfulness and behavioral lapses as key contributors to non-adherence provides clinicians with actionable targets for designing low-cost, patient-centered interventions. Improving adherence to lifestyle modifications such as salt restriction and physical activity may significantly enhance BP control. These findings reinforce the need for integrated behavioral support within routine hypertension care to reduce long-term cardiovascular risk.

DECLARATIONS

Data Availability

The data used in this study are available from the corresponding author upon reasonable request.

AI Disclosure

Grammarly was used to assist with language editing. The authors reviewed and take full responsibility for the content.

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AUTHOR'S CONTRIBUTIONS

Deena Sunayani Peters: Protocol writing and paper writing.

Kanchana Dussa: Protocol writing, data collection, result calculation and paper writing.

Md Idris Ghori: Protocol writing, data collection, data entry into excel sheet and result calculations.

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Mental Health and Psychological Well-being: A Comparative Analysis of Special Educators and Regular Teachers in Delhi NCR

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ABSTRACT

Background: Mental health and psychological well-being of special and regular teachers in Delhi NCR are important yet underexplored in inclusive education.

Objective: To compare mental health and psychological well-being between special educators and regular teachers.

Methods: A cross-sectional study was conducted on 100 teachers (50 special educators and 50 regular teachers) using the Mental Health Inventory (MHI) and Friedman Psychological Well-Being Scales (FWPS).

Results: Special educators had significantly higher depression, loss of behavioral control, and psychological distress ($p < 0.001$), along with higher psychological well-being, including self-esteem, job satisfaction, environmental satisfaction, and happiness ($p < 0.05$).

Conclusion: Special educators show higher psychological distress but also greater psychological well-being than regular teachers, indicating a complex mental health profile.

Keywords: Comparative study, Mental health, Psychological well-being, Regular teachers, Special educators.

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INTRODUCTION

Mental health and psychological well-being are fundamental aspects of an individual's overall health.¹ Mental health pertains to emotional, psychological, and social well-being, enabling individuals to effectively manage life's normal stressors, maintain productivity, and positively contribute to their community. It encompasses the absence of mental disorders as well as the presence of positive traits such as resilience and effective coping mechanisms.²

Psychological well-being encompasses an individual's general quality of life and positive functioning. It entails experiencing positive emotions, actively engaging in life, having a sense of purpose and meaning, nurturing healthy relationships, and realizing personal potential. It reflects an individual's subjective assessment of their own life in terms of psychological functioning and contentment.³ Psychological well-being is closely intertwined with mental health, encompassing positive functioning in a life characterized by purpose, engagement, and positive relationships.⁴ These aspects are particularly crucial in professions with significant interpersonal interactions and responsibilities, such as teaching.⁵

In the realm of education, the mental well-being and psychological health of educators play a pivotal role in shaping academic outcomes.⁶ Teachers, as the backbone of the education system, influence students' academic and personal development.⁷ Their well-being is essential not only for their professional performance but also for the learning environment they create.⁸ As per Spiel et al., education is highly valued, and teachers are seen as key figures in societal progress. Thus, understanding the mental health and psychological well-being of teachers is crucial.⁹

The Indian education system is undergoing significant transformations, with a growing emphasis on inclusive education.

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This shift aims to integrate children with special needs into mainstream classrooms, fostering an inclusive society.¹⁰ However, this progressive step presents unique challenges for educators, particularly special educators who work directly with children requiring specialized attention and mainstream teachers who are now tasked with accommodating diverse learning needs in their classrooms.^{11,12}

Special educators in India face considerable challenges. They are responsible for developing individualized education plans, addressing varied learning disabilities, and managing behavioral issues, often with limited resources and support. A study by Kaur revealed that occupational stress and burnout were significantly more prevalent among special educators working in schools for children with intellectual disabilities compared to those teaching children with hearing and visual impairments.¹³ The study further highlighted significant economic disparities among educators,

revealing that approximately 70% of special educators reported earning salaries ranging from Rs 2,000 to Rs 6,000. Such socioeconomic disparities in regions like Delhi NCR further complicate their roles. These educators frequently work with children from underprivileged backgrounds, requiring them to be exceptionally adaptable and resourceful. The stress from these demands can significantly impact their mental health and psychological well-being.¹⁴

Regular teachers, too, encounter substantial stressors. They must balance large class sizes, varied student abilities, and the integration of children with special needs, often without adequate training or support.¹⁵ The administrative burdens and high expectations from parents and society exacerbate these challenges.¹⁶ In India, cultural norms and economic conditions add another layer of complexity. Teachers are expected to be moral guides and role models, increasing their psychological burden.¹⁷

Despite these challenges, the mental health and psychological well-being of teachers remain underexplored in India, particularly in the Delhi NCR region. The stigma associated with mental health issues, as stated by Ahad et al. often prevents educators from seeking help, leading to a decline in their well-being and job performance.¹⁸ Understanding these issues is essential for developing targeted interventions and support systems to improve the quality of education and the well-being of educators.

This comparative study aims to highlight the differences in the levels of mental health and psychological well-being between special educators and mainstream teachers in Delhi NCR. By examining and comparing these levels, we seek to shed light on the unique challenges faced by each group. This research will provide insights into the varying degrees of mental health and psychological well-being among these educators, emphasizing the need for tailored support systems. Ultimately, this study will contribute to a better understanding of the mental health landscape for educators in Delhi NCR, offering a foundation for future interventions and policy developments to support their well-being.

METHODS

This study employed a cross-sectional observational study design based on primary data collection, conducted prospectively among school teachers in the Delhi NCR region in 2025. The study involved the collection of data at a single point in time to compare mental health and psychological well-being between special educators and regular teachers.

This piece of research was conducted in 2025.

Objectives

The following were the objectives of our study:

- To examine the differences in mental health levels of special educators and regular teachers within the school settings of Delhi NCR.
- To examine the differences in the psychological well-being of special educators and regular teachers within the school settings of Delhi NCR.

Hypotheses

Based on the objectives of our study, the following hypotheses were formulated:

- There will be a significant difference in the mental health levels of special educators and regular teachers within the school settings of Delhi NCR.

- There will be a significant difference in the psychological well-being of special educators and regular teachers within the school settings of Delhi NCR.

Study Design

A cross-sectional observational study was conducted in the Delhi-NCR region to compare the mental health and psychological well-being levels of special educators and regular teachers.

Participants

A total of 100 elementary and primary school teachers participated in the present study. Among these participants, 50 were regular teachers instructing typically developing children ($n_1 = 50$), and 50 were special educators working with children with special needs ($n_2 = 50$). Both groups were selected from the same school system. The sampling method employed was purposive random sampling, ensuring a representative and intentional selection of participants for the study.

Instruments

For our study, we used a questionnaire specifically created for this purpose to gather sociodemographic information such as age, gender, marital status, and level of education. In addition, standardized scales were used to assess the psychological characteristics of the participants.

- Mental Health Inventory (MHI) developed by Veit and Ware, the MHI assesses psychological distress and well-being across 38 items.¹⁹ It measures emotional well-being, social functioning, and anxiety levels. The inventory has demonstrated good internal consistency with Cronbach's alpha coefficients ranging from 0.78 to 0.91, indicating reliable psychometric properties. Validity has been supported through correlations with other established measures of mental health.¹⁹
- Friedman Psychological Well-Being Scale, developed by Friedman, this assessment comprises 20 bipolar adjectives.²⁰ It is straightforward to administer, score, and interpret. The assessment yields an overall measure of well-being, known as the Friedman Well-being Composite, and assesses five subscales: Emotional stability, self-esteem/self-confidence, joviality, sociability, and happiness. Norms are available for clinical, college, and community populations. It exhibits significant correlations with over 100 clinical, personality, attitudinal, stress, relational, marital, and interpersonal scales and subscales. Results can be interpreted using the COPERS model and the BETSI-HI lens of well-being, as outlined in the comprehensive professional manual.²⁰

Procedure

Before commencing data collection, consent was obtained from all participants involved in the study. Each participant was then briefed on the study's objectives. Permission was also sought from school authorities. Ethical guidelines pertinent to the study were strictly adhered to, ensuring the confidentiality of participant information. Establishing rapport facilitated participant engagement. Data collection began with individual administration of tests during participants' leisure time, with a mandatory 10-minute rest interval following each test to minimize fatigue. Subsequent scoring for each test adhered to procedures outlined in their respective manuals. Data were meticulously entered item by item into an Excel spreadsheet to facilitate data interpretation. Additionally, demographic information was systematically collected and recorded in Excel using a standardized format.

Table 1: Sociodemographic characteristics of the participants

	General teachers (<i>N</i> = 50)	Special educators (<i>N</i> = 50)
Mean age (SD)	34 (7.53)	31.82 (3.64)
Gender (<i>n</i> , %)		
Males	21 (42%)	14 (28%)
Females	29 (58%)	36 (72%)

Statistical Analysis

Following the collection of data using the MHI and measures of psychological well-being, scoring procedures were executed according to their respective manuals. Data were meticulously entered into an Excel spreadsheet on an item-by-item basis to facilitate comprehensive data interpretation. Both direct and reverse scoring methods were applied as specified in the test manuals. Demographic profiles were obtained and recorded in a standardized Excel format.

Descriptive statistics, including means and standard deviations, were computed for each test and subtest utilized in the study to provide a summary of the data distribution. For inferential statistics, comparisons between scores of the MHI and psychological well-being measures among special educators and regular teachers were conducted using appropriate statistical tests. Student's *t*-test or Mann-Whitney *U* test was selected based on the data distribution and analytical requirements. These analyses were performed to discern any significant differences between the two groups in terms of mental health and psychological well-being outcomes. The results were determined to be statistically significant at $p < 0.05$.

RESULTS

Sociodemographic Characteristics of the Participants

The sociodemographic characteristics of the participants are presented in Table 1, which includes details on their age, gender, and level of education. In the general teachers' group (*N* = 50), the mean age was 34 years [standard deviation (SD) = 7.53], with 29 participants identifying as female (58%). In the special educators' group (*N* = 50), the mean age was 31.82 years (SD = 3.64), with 36 participants identifying as female (72%). The minimum level of education for participants in both groups was a Bachelor of Education (BEd).

Comparison of Mental Health and Psychological Well-being between Regular Teachers and Special Educators

The study provides a comprehensive comparison of mental health and psychological well-being between regular teachers and special educators, revealing significant differences in various aspects, as presented in Table 2.

Mental Health Inventory Scores

The analysis of the MHI scores indicates notable differences between regular teachers and special educators. For anxiety levels, there is no significant difference between regular teachers [mean (*M*) = 24.37, SD = 6.11] and special educators (*M* = 25.10, SD = 4.89), $t(98) = 0.514$, $p = 0.609$. However, special educators report significantly higher

Table 2: Comparison of variables of MHI and Friedman Well-Being between regular teachers and special educators

Variables	Categories	Mean	SD	<i>p</i> -value
Anxiety	General teachers	24.3667	6.10530	0.609
	Special teachers	25.1000	4.88735	
Depression	General teachers	9.6667	3.50697	0.008**
	Special teachers	11.7333	2.16450	
Loss of behavioral control	General teachers	23.5000	6.52713	0.000**
	Special teachers	34.3667	3.01128	
General positive affect	General teachers	39.9000	7.90177	0.886
	Special teachers	40.1667	6.35764	
Emotional ties	General teachers	8.7000	2.18380	0.080
	Special teachers	7.6667	2.30940	
Life satisfaction	General teachers	4.3000	0.95231	0.013**
	Special teachers	3.6667	0.95893	
Psychological distress	General teachers	66.5333	12.70279	0.000**
	Special teachers	79.8333	4.74220	
Psychological well-being	General teachers	56.3333	9.97007	0.439
	Special teachers	54.5667	7.39843	
Total (MHI)	General teachers	122.8667	10.97563	0.000**
	Special teachers	134.4000	7.71295	
Sense of coherence	General teachers	22.3667	4.21396	0.391
	Special teachers	23.3333	4.44377	
Self-esteem	General teachers	19.8333	5.03836	0.016*
	Special teachers	22.7667	4.08262	
Joviality	General teachers	19.6000	5.56219	0.016*
	Special teachers	22.6000	3.57771	
Emotional stability	General teachers	59.3000	13.78693	0.003**
	Special teachers	69.4000	11.49993	
Happiness	General teachers	6.7333	1.74066	0.001**
	Special teachers	8.2000	1.37465	
Total (FWBS)	General teachers	127.8333	26.92273	0.005**
	Special teachers	146.3000	21.27026	

* $p < 0.05$, ** $p < 0.01$

levels of depression (*M* = 11.73, SD = 2.16) compared to regular teachers (*M* = 9.67, SD = 3.51), $t(98) = 2.75$, $p = 0.008$.

Special educators also exhibit significantly higher levels of loss of behavioral control (*M* = 34.37, SD = 3.01) than regular teachers (*M* = 23.50, SD = 6.53), $t(98) = 8.28$, $p < 0.001$. While general positive affect scores are similar between regular teachers (*M* = 39.90, SD = 7.90) and special educators (*M* = 40.17, SD = 6.36), $t(98) = 0.14$, $p = 0.886$, life satisfaction is significantly lower for special educators (*M* = 3.67, SD = 0.96) compared to regular teachers (*M* = 4.30, SD = 0.95), $t(98) = 2.57$, $p = 0.013$.

Additionally, overall psychological distress is significantly higher among special educators (*M* = 79.83, SD = 4.74) compared to regular teachers (*M* = 66.53, SD = 12.70), $t(98) = 5.37$, $p < 0.001$. The total MHI score also reflects this disparity, with special educators (*M* = 134.40, SD = 7.71) scoring higher than regular teachers (*M* = 122.87, SD = 10.98), $t(98) = 4.71$, $p < 0.001$. These findings underscore the considerable mental health challenges faced by special educators compared to their counterparts.



Psychological Well-being Scores

The psychological well-being scores further illustrate differences between regular teachers and special educators. Special educators demonstrate significantly higher overall psychological well-being as measured by the Total Friedman Well-Being Scale ($M = 146.30$, $SD = 21.27$) compared to regular teachers ($M = 127.83$, $SD = 26.92$), $t(98) = 2.95$, $p = 0.005$. This suggests that special educators report better overall psychological well-being.

Significant differences are observed in specific dimensions of psychological well-being. Special educators show higher self-esteem ($M = 22.77$, $SD = 4.08$) than regular teachers ($M = 19.83$, $SD = 5.04$), $t(98) = 2.48$, $p = 0.016$. Joviality is also significantly higher among special educators ($M = 22.60$, $SD = 3.58$) compared to regular teachers ($M = 19.60$, $SD = 5.56$), $t(98) = 2.49$, $p = 0.016$.

Emotional stability scores are higher for special educators ($M = 69.40$, $SD = 11.50$) than for regular teachers ($M = 59.30$, $SD = 13.79$), $t(98) = 3.08$, $p = 0.003$. Special educators also report significantly higher levels of happiness ($M = 8.20$, $SD = 1.37$) compared to regular teachers ($M = 6.73$, $SD = 1.74$), $t(98) = 3.62$, $p = 0.001$.

While the sense of coherence is similar between the groups ($p = 0.391$), these results collectively suggest that special educators, despite facing higher mental health challenges, report higher scores in several key areas of psychological well-being compared to regular teachers. This duality in findings highlights the complexity of psychological experiences among educators working with special needs children.

DISCUSSION

The present study aimed to compare the mental health and psychological well-being of regular teachers and special educators in Delhi NCR, revealing significant differences across various dimensions. The findings provide insights into the unique challenges and strengths experienced by educators working in different educational settings.

The analysis of the MHI scores highlighted several noteworthy differences between regular teachers and special educators. While anxiety levels did not significantly differ between the two groups, special educators exhibited significantly higher levels of depression and psychological distress compared to regular teachers. These findings align with previous research indicating that educators in special education face heightened stressors related to managing diverse student needs and behaviors.²¹

The elevated levels of depression and distress among special educators underscore the need for targeted interventions and support systems to mitigate these mental health challenges.²²

Moreover, special educators reported significantly higher levels of loss of behavioral control and lower life satisfaction than regular teachers. These results suggest that the demands of working with children with special needs may contribute to increased emotional exhaustion and reduced personal fulfillment among special educators.¹¹ The higher total MHI scores among special educators further emphasize the cumulative impact of these stressors on their overall mental health.

In contrast to the mental health findings, special educators demonstrated higher overall psychological well-being as measured by the Friedman Psychological Well-Being Scale. They reported significantly higher scores in self-esteem, joviality, emotional stability, and happiness compared to regular teachers. These findings suggest that despite facing greater mental

health challenges, special educators may derive satisfaction and fulfillment from the meaningful impact of their work with special needs children.²³

The higher levels of psychological well-being among special educators could be attributed to factors such as intrinsic motivation, resilience, and professional commitment, which are critical for coping with the demands of their role.²⁴ Positive perceptions of job satisfaction and environmental satisfaction reflect the rewarding aspects of their work environment, potentially buffering against the negative impacts of stress and burnout.²⁵ Additionally, a longitudinal study by Schneider et al. concluded that emotional intelligence (EI) ability facilitates increased positive affect and reduced negative affect, acting as a resilient stress factor.²⁶ These elements collectively contribute to the enhanced psychological well-being observed among special educators.

Strengths and Weaknesses

This study offers several strengths in understanding the mental health and psychological well-being of educators. Its comparative approach provides clear insights into the differing profiles of regular teachers and special educators, highlighting unique challenges faced by each group. Focusing on the Delhi NCR region adds valuable contextual relevance to the Indian educational context, contributing to the limited research on teacher well-being. Additionally, using established inventories like the MHI and the Friedman Well-Being Scale ensures a comprehensive and reliable assessment.

However, the study has some limitations. The sample size of 100 teachers may limit the generalizability of the findings, suggesting a need for larger, more diverse samples. The reliance on self-reported data could introduce bias, as participants might underreport or overreport their mental health and well-being. Finally, the cross-sectional design captures a single point in time, restricting the ability to infer causality or observe changes over time. Longitudinal studies would be more effective in understanding the dynamics of mental health and well-being among teachers.

Implications and Recommendations

These findings hold significant implications for educational policy and practice in India, particularly in enhancing support structures for educators. Developing targeted interventions to address mental health issues such as depression and distress among special educators is crucial. This may include implementing regular mental health assessments, providing access to counseling services, and fostering a supportive school environment.²⁷ Addressing teachers' mental health is not just about improving their quality of life; it directly impacts the educational outcomes of students. Teachers experiencing high levels of stress and mental health issues may struggle with classroom management, show reduced effectiveness in delivering lessons, and have lower overall job performance.^{28,29}

Mental health issues among teachers can also lead to increased absenteeism and higher turnover rates, which are detrimental to the stability and quality of education.³⁰ High turnover disrupts student learning and incurs high costs for schools due to the need for ongoing recruitment and training.³¹ Therefore, supporting teachers' mental health is essential for maintaining a consistent and high-quality educational environment.

Furthermore, promoting strategies to enhance job satisfaction, self-esteem, and overall well-being among regular teachers could contribute to improving their resilience and job performance.³²

Professional development programs focusing on stress management, coping strategies, and inclusive teaching practices could benefit both groups of educators.³³ Ensuring that teachers have access to professional development opportunities and mental health resources can foster a more resilient and effective teaching workforce, ultimately benefiting student outcomes and overall school performance.

In conclusion, while special educators face significant mental health challenges compared to regular teachers, they also demonstrate higher levels of psychological well-being. Addressing the mental health needs of educators is imperative for fostering a conducive learning environment and promoting sustainable educational practices in diverse educational settings. By investing in the mental health and well-being of teachers, educational systems can ensure better educational outcomes for students and create a more supportive and productive work environment for educators.

CONCLUSION

The study reveals significant differences in mental health and psychological well-being between regular teachers and special educators in the Delhi NCR region. Special educators exhibit higher levels of depression and loss of behavioral control compared to their counterparts, indicating greater mental health challenges. They also report significantly higher psychological distress and lower life satisfaction. Conversely, special educators demonstrate higher overall psychological well-being, including greater self-esteem, job satisfaction, environmental satisfaction, and happiness.

These findings suggest that while special educators face more substantial mental health issues, they also experience higher levels of psychological well-being in several domains. This paradox may reflect the complex nature of their work, which, despite its challenges, may provide a strong sense of purpose and fulfillment. The duality in these results underscores the necessity targeted mental health support for special educators to address their unique stressors while fostering the positive aspects of their psychological well-being. Future interventions and policy developments should focus on providing comprehensive support systems to enhance both mental health and psychological well-being among educators, ultimately improving the quality of education and the overall well-being of teachers in inclusive educational settings.

DECLARATIONS

Data Availability

Data is available with the author. But for the purpose of confidentiality authors can not share it.

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The authors declare that in preparation of the manuscript, the researchers have not taken the help/used artificial intelligence generated content (AIGC) tools such as ChatGPT and others based on large language models (LLMs) used in developing any portion of the manuscript within the Methods section of their manuscript.

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Sociocultural Taboos Experienced by School-going Adolescent Girls during Menstruation in Rural Areas of Shimla, Himachal Pradesh

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ABSTRACT

Adolescence is a transitional phase of human development between childhood and adulthood, marked by biological, social and psychological changes. The menstrual period can be a challenging and difficult time in the lives of adolescent girls. Though it is a unique experience and natural biological process experienced by adolescent girls worldwide, it has been shrouded in stigma, myths, and misconceptions across cultures for centuries. Despite its central role in reproduction and the continuity of life, menstruation is often surrounded by taboos. The present paper has tried to examine the sociocultural taboos and restrictions experienced by school-going adolescent girls in the rural areas of Chhauhara Block in Shimla. Further, an effort was made to examine the beliefs around menstruation, among school-going adolescent girls. The present study has followed a liberal feminist theoretical perspective and has focused on the school-going adolescent girls from 9th to 12th class studying in Government High Schools and Government Senior Secondary Schools of Chhauhara Development Block in Shimla district. The present study has found that menstruation is still a taboo subject in rural areas. These taboos are deeply rooted in cultural beliefs and are often enforced by older female family members in the family.

Keywords: Adolescence, Adolescent girls, Menstrual health, Menstrual hygiene, Menstruation, Taboos.

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INTRODUCTION

Adolescence is a transitional stage of human development that occurs between childhood and adulthood. This transition involves biological, social and psychological changes. It heralds the onset of physiological maturity in girls. It is recognized as the most unique stage of life in terms of health. Though menstruation is a natural process, it is linked with several taboos and practices within society, which sometimes may result in adverse health outcomes. Good menstrual hygiene is crucial for health, education and dignity of adolescent girls.¹

A girl's first menstrual period has a major impact on her life and is seen as a milestone marking the transition to womanhood. Menstruation is the first visible sign of puberty, a stage characterized by physical changes that transform a child's body into that of an adult. Each month, millions of adolescent girls worldwide experience pain, discomfort, shame, and anxiety when their menstrual cycle begins. Although a natural biological process, menstruation typically occurs for the first time between the ages of 11–14.²

Before the scientific understanding of menstruation, its biological processes were a mystery, and most explanations of menstruation were based on observations. This lack of knowledge often led to myths. However, scientific studies indicate that the actual reasons for menstruation are ovulation, a missed opportunity for conception, endometrial vascular bleeding, and the beginning of the subsequent cycle. Thus, there doesn't seem to be any justification for the constant belief that women who menstruate are impure.

Millions of adolescent girls worldwide are deprived of the ability to manage their menstrual cycles with dignity and proper hygiene. Factors such as gender inequality, discriminatory social norms, cultural taboos, poverty, and inadequate access to basic services often leave their menstrual health and hygiene needs unaddressed.³

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In many parts of the world, menstruation is not openly discussed, even within families. Many parents themselves hesitate to discuss this topic openly with their daughters, resulting in a lack of accurate information on menstrual hygiene. A lack of awareness, combined with social restrictions, often causes them to feel ashamed or hesitant to discuss their menstrual experiences, even with family, friends, or trusted individuals.⁴

Though menstruation is a natural process, it is linked with several taboos and practices within society. In India, even mention of the topic has been taboo in the past and even to this date. Cultural norms and religious taboos on menstruation are often compounded by traditional associations with evil spirits, shame and embarrassment surrounding sexual reproduction. In some parts of India, dietary restrictions are also followed, sour foods like curd, tamarind, and pickles are usually avoided by menstruating girls. It is believed that such foods will disturb or stop the menstrual flow. Menstruation taboos present in many societies have an impact on girls' and women's emotional states, mentalities, lifestyles, and most importantly, health.⁵

The attitude of societies towards menarche varies from joy and pride to fear and shame. In a few Hindu communities of South India, there is a tradition called "*Ritushuddhi*" or "*Ritushodhakam*" also known as "*Ritu Kala Samskara*," regarding the celebration of an adolescent girl's first menstruation. During this ceremony, the girl is adorned with special clothing (half saree), jewelry, and flowers. Female family members and friends gather to offer blessings and advice on womanhood, including guidance on hygiene, health, and familial responsibilities.⁶

Joshi et al. in their study in the Pindar Valley of Uttarakhand found that menstruating women and girls in remote villages of the Himalayas still practice segregation due to the belief that menstrual blood is impure. They are confined to the cowshed (*goth*) and are not allowed to interact with others. Over 90% of women and girls live separately in the cattle sheds (*goth*) along with the cows and buffaloes when they get their periods.⁷

Kaur and Vats, in their study of Nahan in Himachal Pradesh, observed that girls are restricted from visiting temples and performing prayers during menstruation. These girls are not allowed to enter the kitchen for cooking and serving. Some other restrictions observed were on watching television, doing physical exercise, using mirrors, restricted food habits, as well as being restricted from meeting with the males in the family.⁸

The present paper has made an effort to examine the sociocultural taboos and restrictions faced by school-going adolescent girls in the rural areas of Shimla. Further, an effort was made to look into various beliefs around menstruation, followed by school-going adolescent girls.

MATERIALS AND METHODS

The present study has followed descriptive-cum-exploratory research design and was conducted for one and half years i.e., from 2023 to mid 2024. The present study has followed the liberal feminist theoretical perspective. Liberal feminism sets out to challenge the man's nascent desire for a society that insists that each individual is a creature shaped by nature and not by social conditioning. Liberal feminists argue that patriarchal structures intrude on women's personal and political choices. They support laws and regulations that promote gender equality and ban practices that are discriminatory towards women.⁹

Menstrual health is a feminist issue in several ways, as body literacy helps women make informed decisions about their bodies. Menstruation is a part of taboos surrounding women's bodies that often prove women's inferiority. Psychoanalyst Sigmund Freud claimed that menstrual taboos were an attempt to control women. Menstrual taboos lead to silence, which makes people who menstruate even more powerless.¹⁰

Adolescent girls' overall development goal is to create a unique identity. However, these young girls experience many difficulties related to gender beliefs and expectations. They are taught notions and roles of femininity from a young age. Therefore, these girls are under great pressure to conform to these beliefs and cultural expectations that affect their health directly or indirectly.¹¹

The study was carried out in the schools of Chhauhara Development Block in Shimla District, which comprises of three Education Blocks, namely Chhauhara Education Block, Ransar (Jangla) Education Block, and Dodra Kewar Education Block. The purposive sampling method was used to select the area of study. From each of the Education Blocks of Chhauhara Development Block, four government schools, comprising one Government High

Table 1: Experiencing menstrual taboos at the home

Response	Number of respondents	Percentage
Yes	186	48.9
No	194	51.1
Total	380	100.0

School and three Government Senior Secondary Schools, were selected through purposive sampling based on the maximum number of adolescent girls enrolled in these schools.

The universe of the present study includes all the school-going adolescent girls from 9th to 12th class studying in various Government High Schools and Government Senior Secondary Schools of Chhauhara Development Block in Shimla district. The sample for the present study has been drawn from the adolescent girls studying in four government schools of each of the three Education Blocks of Chhauhara Development Block. There were total of 764 adolescent girls enrolled in all 12 selected schools of Chhauhara Development Block. Considering the large number of adolescent girls enrolled in these selected schools, 50% of adolescent girls have been selected from each of the government schools for the purpose of the present study through convenience sampling. Thus, the final sample included 380 adolescent girls. The structured interview with the help of an interview schedule was carried out with these 380 adolescent girls to realize the objectives of the study. SPSS software was used to analyze the data.

RESULTS AND DISCUSSION

The sociocultural taboos have been analyzed with the help of various questions, such as the types of taboos adolescent girls face, reasons for keeping in separate rooms, cultural beliefs regarding disposal of used pads, etc.

Menstrual Taboos Faced in the Home

Menstrual taboos often involve social exclusion; restrictions on day-to-day activities, negative perceptions and misinformation about menstruation, impacting the well-being of those experiencing it. The present study aimed to explore the existence of menstrual taboos within the households of school-going adolescent girls. When asked about the presence of such taboos at home, over half of the respondents, specifically 51.1% reported that no menstrual taboos were practiced in their households. However, the remaining girls indicated that they do experience menstruation-related restrictions at home. This finding highlights that many rural adolescent girls still face menstrual taboos within their families. This reflects the persistence of deep-rooted cultural beliefs, myths, limited awareness, and a conservative mindset prevailing in certain communities regarding menstruation. The following table shows the answers of adolescent girls to the question of menstrual taboos in their homes (Table 1).

When further inquired about types of menstrual taboos faced by adolescent girls who replied in affirmative, it was found that majority of the adolescent girls are not allowed to go into the *pooja* room and offer prayers (90.9%) followed by no entry into kitchen without bath (71.5%), prohibition from going on the roof of the house (62.4%) and not making food (32.8%) as the major taboos. Earlier studies have also observed restrictions, particularly related to offering prayers, no entry into the kitchen and prohibitions on going to religious places during menstruation.^{12,13} Thus, we can say that even today, adolescent girls in rural areas face many taboos

Table 2: Types of taboos faced by adolescent girls

Taboos	Number of respondents	Percentage
Restrictions on entering the kitchen without bath	133	71.5
Restrictions on going to the <i>Pooja</i> room and offering prayer	169	90.9
Don't touch a sick person	25	13.4
Live in a separate room	13	7.0
Restriction in making food and touch the drinking water	61	32.8
Prohibition of going on the roof of a house	116	62.4
Restriction on eating food items like curd, pickle, lassi	49	26.3
Restriction on touching any seeds before sowing	29	15.6
Don't water the plant	5	2.7

The number of responses shown in the table is more than 186 as this was a multiple-choice question and one respondent gave more than one response

Table 3: Touch the infant during menstruation

Response	Number of respondents	Percentage
Yes	293	77.1
No	87	22.9
Total	380	100.0

related to menstruation. All these taboos imposed on them in their homes have reinforced a negative attitude towards this natural phenomenon in adolescent girls (Table 2).

Restrictions on Touching the Infant during Menstruation

Infants are newborns, typically aged 0–12 months. Cultural norms often prioritize the well-being of infants, promoting protective environments. In the present study, an attempt has been made to find whether adolescent girls are allowed to touch the infant before taking a bath during menstruation. It was observed that the majority of adolescent girls (77.1%) replied affirmatively to this question. However, some girls (22.9%) were restricted from touching the infant before bathing. Similarly, a research report on menstrual health and hygiene among schoolgirls in Tanzania found that there is a socially constructed belief that during menstruation, touching neonates could bring them skin rashes.¹⁴ The following table summarizes the responses of these adolescent girls to the question regarding touching the infants before taking a bath.

Taboos regarding touching infants or objects were largely constructed around myths and beliefs depicting menstruation as a "curse." In older times, when hygiene products and facilities were limited, this restriction may have had practical reasons to prevent infections or illnesses (Table 3). When the adolescent girls were inquired about the reason for not being allowed to touch an infant before taking bath during menstruation, it was found that most of the adolescent girls, i.e., 16.3%, say their mothers told them not to touch infants during their periods because a newborn baby needs a clean environment to stay healthy (Table 4).

Table 4: Reason behind not being allowed to touch the infant

Response	Number of respondents	Percentage
Mother refuses to touch the infants	62	16.3
We are considered impure these days	25	6.6
Non-applicable	293	77.1
Total	380	100.0

Table 5: Allowed to touch the male members

Response	Number of respondents	Percentage
Yes	276	72.6
No	104	27.4
Total	380	100.0

Table 6: Reason behind not being allowed to touch the male members

Response	Number of respondents	Percentage
Father selected as a <i>Kardar</i> (temple worker)	64	16.8
Priest of a local deity	33	8.7
Female members deny	7	1.8
Non-applicable	276	72.6

Touch the Male Members

In many traditional cultures, including some Indian communities, there are restrictions on touching male members during menstruation. These practices are rooted in religious customs and notions of preserving spiritual purity. In the present study, an attempt has also been made to find out whether adolescent girls are allowed to touch male members during menstruation. The study revealed that, as shown in Table 5, the overwhelming majority of school-going adolescent girls, i.e., 72.6% replied that they can touch male members of the family, while substantial number of these girls (27.4%) said they are restricted from touching male members during menstruation. Thus, we can say that even today in rural regions, some girls are not permitted to touch the males of their family during menstruation. The following table shows the opinion of adolescent girls regarding this question.

When further inquired about the reason for not being allowed to touch the male members during menstruation, it has been found, as illustrated in Table 6, that most of the adolescent girls, i.e., 16.8% said that their fathers are selected as a *Kardar* (temple worker) of the local deity. Therefore, they have to go to the temple premises for most of the time. Due to the belief system that menstruation is an impure process, these adolescent girls keep themselves away from male members, while some (8.7%) adolescent girls said that their fathers are priests of a local deity, so they have to stay away from them during periods. A few of them said that women in their homes forbid them from touching men during menstruation.

Stay Away from Flowing Water

In many rural communities, there is a prevalent belief that women should not go near flowing water during their periods. In these areas, when people didn't have tap connections at their homes, they used to bring water from traditional sources like *bawdie* and springs. These places were kept very clean, and people considered them to be pure. The present study found that the majority of school-going adolescent girls (62.1%) don't stay away



Table 7: Stay away from flowing water

Response	Number of respondents	Percentage
Yes	144	37.9
No	236	62.1
Total	380	100.0

Table 8: Reason behind stay away from flowing water

Reason	Number of respondents	Percentage
Fear of water deities	74	19.5
Fear of <i>Nag Devta</i>	42	11.1
Contaminate the water	12	3.2
Fear of health problem	11	2.9
Water can dry up	5	1.3
Non-applicable	236	62.1

from flowing water during menstruation. However, a significant portion (37.9%) reported that they do stay away from flowing water during their periods (Table 7). In certain communities in Gujarat, this practice is even more prevalent, with 91% of girls reporting that they avoid flowing water during menstruation. These girls are typically not permitted to access or use water sources during this time.¹⁵

Further, an attempt was made to gain deeper insight into the reason for keeping away from water during menstruation. It has been observed, as shown in Table 8, that most of the adolescent girls, i.e., 19.5%, say that in the village, it is said that deities reside near water bodies and so if they go and play there during periods, deities will punish them followed by 11.1% of them who say that due to fear of "*Nag Devta*" they do not go there during menstruation. There are some adolescent girls who say that during their periods they were asked to keep away from water bodies due to fear of contaminating the water. A few of these adolescent girls think that going to these places could cause health problems, and some girls say that water could dry up. This reflects the presence of a deeply rooted belief system about water bodies in rural areas.

Living in a Separate Room during Menstruation at Home

In many parts of India, the custom of keeping women and girls separate in their homes is common during menstruation. Historically, this custom may have been a way to allow women and girls to take rest during menstruation. However, in many cases, it has perpetuated stigma and isolation. In the present study, an attempt has been made to find whether the school-going adolescent girls are kept in a separate room during menstruation. It has been found, as illustrated in Table 9, that the overwhelming majority of the adolescent girls (81.6%) replied negatively to this question. However, there are some school-going adolescents (18.4%) who stated that they receive instructions to remain in a different room while they are menstruating. Chaudhary, in her study of *Chhaupadi* practice in Nepal relating to menstrual impurity of women and girls, found that menstruating women and girls were placed in a special residence, i.e., *chaau goth*, a separate place with a small, cramped room that lacks of light and air circulation to keep other people in the house holy.¹⁶ From this, we learn that even today in our society, some people follow the practice of keeping women and adolescent girls away from the family during menstruation, as their touch is considered impure during this time.

Table 9: Keeping girls in a separate room during menstruation

Response	Number of respondents	Percentage
Yes	70	18.4
No	310	81.6
Total	380	100.0

Table 10: Reasons for keeping girls in separate rooms during menstruation

Response	Number of respondents	Percentage
Fear of deity	36	9.5
Fear of contaminating the household items	32	8.4
Take full rest	2	0.5
Non-applicable	310	81.6
Total	380	100.0

Table 11: Taboos/restrictions on disposal of used menstrual pads

Response	Number of respondents	Percentage
Yes	133	35.0
No	247	65.0
Total	380	100.0

An effort was also made to explore the reasons behind the practice of isolating girls at home during menstruation. Most adolescent girls stated that in their homes, a small temple dedicated to local deities is established, so they are asked to stay in a separate room until their periods end. Some have mentioned that they are considered impure during menstruation, and there is a fear of contaminating household items, so they are kept in a separate room. Two of them have stated that the reason for staying in a separate room is the need for complete rest during this period, so they are asked to rest comfortably in a separate room (Table 10).

Restrictions regarding Disposal of Menstrual Pads

Disposal of menstrual pads in a proper manner is essential because these commercial pads contain plastic and super absorbent polymers that take 500 years or more to decompose these pads fully. Improper disposal can contribute to environmental pollution and also lead to the spread of infections and diseases. When school-going adolescent girls were asked about cultural beliefs related to the disposal of menstrual pads, the findings revealed that the majority of them (65.0%) said that there are no cultural beliefs regarding the disposal of menstrual pads. However, a substantial number of adolescent girls (35.0%) reported that there are many cultural beliefs and taboos regarding the disposal of menstrual pads in open spaces (Table 11).

Further, when inquired about the kind of taboos regarding the disposal of menstrual pads is found in their society, it has been observed, as illustrated in Table 12, that a large portion of the school-going adolescent girls, i.e., 57.1% feels that disposing of used pads in open places is considered a matter of shame in our society for those who throw them away. Additionally, 45.9% mentioned that it is forbidden to throw used pads in open places due to the fear that animals might eat them. Some adolescent girls were advised to dispose of used pads in a place where no one can see them again. A few think that throwing used pads in open places

Table 12: Kind of cultural beliefs or taboos regarding disposal of used menstrual pads

<i>Response</i>	<i>Number of respondents</i>	<i>Percentage</i>
Throwing it in the open places is considered a matter of shame	76	57.1
Animals can eat	61	45.9
Throw it in a place where no one can see it again	29	21.8
The environment gets polluted from dirty pads	15	11.3
Non-applicable	247	65.0
Total	380	100.0

The number of responses shown in the table is more than 133 as this was a multiple-choice question and one respondent gave more than one response

Table 13: Belief about not becoming mother if cow consume used pads

<i>Response</i>	<i>Number of respondents</i>	<i>Percentage</i>
Yes	153	40.3
No	227	59.7
Total	380	100.0

pollutes the environment. We can say that these cultural beliefs in one way or another, play a vital role in keeping the environment clean, but they also highlight the need for proper disposal methods among adolescent girls.

Belief about Cow Consuming Used Pads on Becoming a Mother

Scientifically, there is no connection between a cow consuming used pads and a girl's future ability to conceive. Such ideas likely emerged from mixed ritual purity concepts, taboos surrounding menstruation and the sacred status of cows in certain cultures, particularly in India. Adolescent girls were asked whether there is a negative effect of cow consuming their used pads on their ability to become mothers in the future. It has been found, as shown in [Table 13](#), that the majority of the adolescent girls, i.e., 59.7%, replied that they can become mothers, while a substantial number of school-enrolled adolescent girls (40.3%) said that they cannot become mothers if a cow consumes their used pads. This is because in our Hindu religion, the cow is considered a sacred animal and menstruation is considered impure. Therefore, these adolescent girls fear that if a cow consumes a used pad, they will incur sin and may be punished by not being able to become mothers in the future.

When adolescent girls were asked about the reasons behind not becoming mothers if cows consume their used pads, it was found that most of the school going adolescent girls (18.9%) mentioned if this kind of act happens, then it is considered a bad omen in our society for the girl who threw her used pad in the open, followed by 18.7% of adolescent girls who says that God punishes them ([Table 14](#)).

Talk Openly about Menstruation

Open discussions about menstruation among school-going adolescent girls are important for breaking stigma, providing accurate knowledge, empowering these adolescent girls to

Table 14: Reasons for not becoming mothers if cow consume used pad

<i>Response</i>	<i>Number of respondents</i>	<i>Percentage</i>
Get punishment	71	18.7
It's like a bad omen	72	18.9
Don't know the reason	10	2.6
Non-applicable	227	59.7

Table 15: Talk openly about menstruation

<i>Response</i>	<i>Number of respondents</i>	<i>Percentage</i>
Yes	62	16.3
No	318	83.7
Total	380	100.0

Table 16: Person with whom they don't talk openly about menstruation

<i>Response</i>	<i>Number of respondents</i>	<i>Percentage</i>
With father	80	21.1
With brother	20	5.3
All male members in the family	218	57.4
Non-applicable	62	16.3
Total	380	100.0

understand and manage their menstrual cycle confidently, and reducing feelings of shame or embarrassment. When inquired about whether the adolescent girls talk openly about menstruation with male members, it was found that a large majority of the girls, i.e., 83.7%, do not talk openly about this topic. However, there are some adolescent girls (16.3%) who used to talk openly about menstruation ([Table 15](#)). This study highlights a significant gap in open communication about menstruation in rural areas. Menstruation is still a taboo subject in rural areas, leading to a lack of open dialogue and potential misinformation among adolescent girls. There is a need to organize awareness programs and open discussions to break the silence around menstruation and normalize conversations about it among people in rural areas.

When further inquired about the person with whom these school going adolescent girls do not talk openly on this topic, it was found, as illustrated in [Table 16](#), that most of the adolescent girls, i.e., 57.4% do not talk openly about menstruation with all male members of their family. While 21.1% of adolescent girls have said that they do not talk openly on this topic with their fathers. Thus, we can say that even today, in the 21st century, where most of the males are educated, they hesitate to talk openly about menstruation. They never try to discuss this topic in their family. That is why all female members shy away from discussing it with them on this topic. This shows the need to lift the black veil that has been placed over the important process of a girl's life in society through awareness programs.

CONCLUSION

Thus, it was found that there are substantial numbers of adolescent girls who are facing many taboos related to menstruation in their homes. These include being prohibited from entering the *puja* room, the kitchen, going on the roof or preparing food. These practices reinforce the idea that menstruation is impure or dirty, leading to negative feelings and a sense of shame among girls. Some are even restricted from touching infants or male members



of their family, further isolating them during their periods. These taboos are deeply rooted in traditional beliefs and are often enforced by older female family members, highlighting the need for intergenerational education to challenge these outdated norms.

It has been observed that many adolescent girls avoid going near flowing water during their periods. This avoidance stems from a fear of water deities, indicating the influence of beliefs about flowing water. Some girls are even kept in a separate room because people fear they will contaminate the household items. Some girls also sprinkle cow urine on themselves because they believe it will purify them. None of the respondents' homes had celebrated any special ceremonies to mark girls' first period. Most girls don't talk openly about their periods, especially with male members of their family. Even fathers, who are usually educated, do not feel comfortable talking about it.

DECLARATIONS

Data Availability Statement

The data used in this study are available from the corresponding author upon reasonable request.

Ethical Approval Statement

The research study was duly approved by the Research Degree Committee and it has followed all the ethical standards. Further, the informed consent of respondents was taken and they were informed about the purpose of study and their confidentiality was fully maintained.

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The study did not receive any funding.

Conflict of Interest

There is no conflict of interest involved.

AI Disclosure

The study did not use AI assisted technology.

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AUTHOR'S CONTRIBUTION

The study was conceptualized and designed by Dr Ashwani Kumar and Aradhna Pitan. Aradhna conducted fieldwork and collected data. Data analysis and interpretation were carried out jointly by

both authors. The first draft of the manuscript was prepared by Aradhna and Dr Ashwani Kumar has critically reviewed and revised the manuscript.

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Maternal Health in a Tribal District of Nandurbar, Maharashtra: Program Coverage, Risk Factors, and Social Determinants

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ABSTRACT

Background: Maternal health in India's tribal communities is a public health concern, with high rates of anemia, malnutrition, and limited access to care. Nandurbar district in Maharashtra, India, shows these problems, with social and economic challenges influencing pregnancy outcomes.

Objective: To assess program coverage, high-risk indicators, and social determinants of maternal health among pregnant women in a tribal block of Nandurbar.

Materials and methods: A descriptive, cross-sectional study was conducted in a tribal area of Nandurbar district, Maharashtra, India. The study included 132 pregnant women. Data were collected through household surveys using a structured questionnaire. Information from accredited social health activist (ASHA) and auxiliary nurse midwife (ANM) records was also used to support the survey data. The key variables included age, parity, education, and occupation. High-risk factors such as anemia, body mass index (BMI), and height were recorded. Information on tobacco use, migration, child marriage, Janani Suraksha Yojana (JSY) enrollment, and awareness of scheme entitlements was also collected. Descriptive statistics were used for analysis. Frequencies and percentages were calculated. The findings were presented in tables.

Results: Most respondents (87.1%) were in the 20–35 age-group, but 5.3% were <20 years and 7.6% were >35 years, both of which are high-risk categories. Anemia was highly prevalent (84.8%), along with low BMI (74.2%) and short stature (36.3%). Tobacco use was reported by 33.3% of women. Additionally, 45.4% expected to migrate during pregnancy. Although 51.5% were registered under JSY, awareness of scheme entitlements was comparatively higher (69.7%).

Conclusion: High biological risks, along with migration, tobacco use, and incomplete program coverage among women, were observed. This highlights the need for more effective nutritional interventions, strong outreach, and culturally responsive maternal health programs in tribal regions.

Keywords: Anemia, High-risk pregnancy, Janani Suraksha Yojana, Maternal health, Tribal women.

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INTRODUCTION

Health is considered the foundation of well-being and human development. In India, the right to health is enshrined in the Constitution as part of the right to life and personal liberty. The evolution of public health in India, from the recommendations of the Bhole Committee (1946) to the Alma-Ata Declaration (1978), has emphasized primary healthcare, equity, and universal access.¹

Maternal health is a significant public health concern, and inequalities are clearly seen among tribal and rural women. Studies show that tribal women often have less access to antenatal check-ups and institutional deliveries, and postnatal care remains substantially lower among tribal women compared to national averages.² For example, nationally, the proportion of women completing at least four antenatal care (ANC) visits increased from 51% in NFHS-4 (2015–16) to 59% in National Family Health Survey-5 (NFHS-5) (2019–21), while institutional births rose from 79 to 89% in the same period.³ Yet, such improvements are not equally shared across tribal regions, contributing to higher maternal and infant mortality rates.

Anemia is one of the leading risk factors for maternal and neonatal complications. According to NFHS-5, the prevalence of anemia among pregnant women in India is 53%, but among Scheduled Tribes, it rises to 60%.³ In addition, socio-cultural factors such as child marriage, migration, tobacco consumption, and low awareness of maternal health services further increase risks. In

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districts like Nandurbar, Maharashtra, India, these challenges are particularly acute. National Family Health Survey-5 (2019 to 20) shows that only 51% of mothers received ANC in the first trimester, 59% completed four or more ANC visits, and 24% of women aged from 20 to 24 years were married before 18 years. Anemia among pregnant women was as high as 68%, and 27% of women reported using tobacco.^{4,5} These findings underline the urgent need to assess multiple determinants of maternal health, not only medical but also social and programmatic.

Previous research also highlights the unique health challenges faced by tribal women. Kumar M et al. reported that the “quadruple burden of disease,” which includes mental health disorders, addictions, malnutrition, and communicable and non-communicable diseases, disproportionately affects tribal

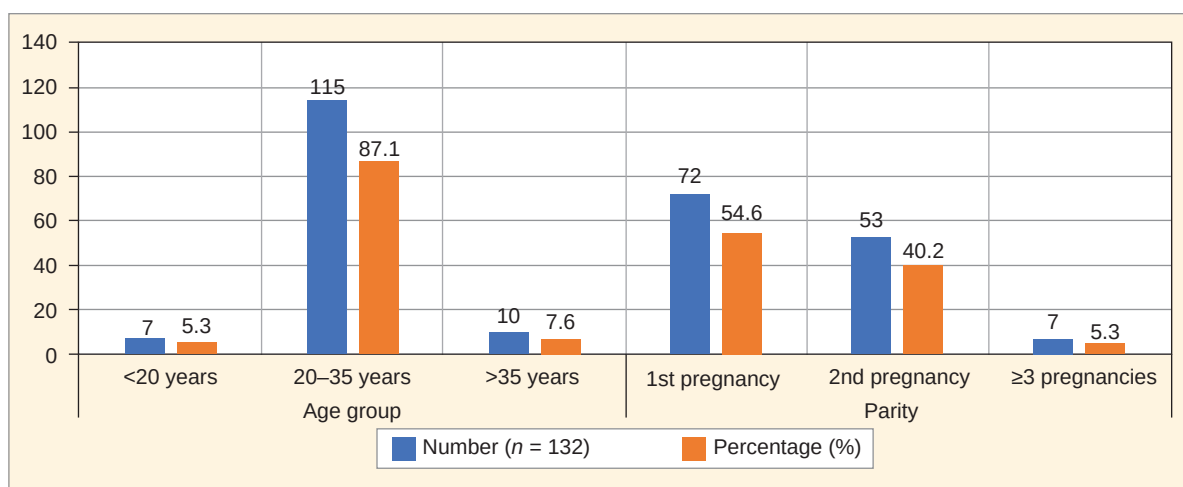


Fig. 1: Basic profile of pregnant women

populations. Poor health-seeking behavior and limited access to services worsen these problems (Fig. 1). The Expert Committee suggested a parallel health system that prioritized primary care, governance, and skilled labor, with culturally sensitive interventions involving tribal youth and traditional healers.⁶ Other studies (Bakshi et al., 2024) show that maternal health outcomes have improved through schemes like Janani Suraksha Yojana (JSY), Pradhan Mantri Matru Vandana Yojana (PMMVY), and LaQshya program. These programs provide institutional delivery support, nutritional benefits, and quality care, although disparities persist.⁷ Further, Akkiraju V identified that maternal and child health (MCH) indicators differed between tribal and non-tribal areas. Maternal mortality, infant mortality, malnutrition, and low literacy rates are still higher among tribal populations. Despite comparable institutional delivery rates in some states, tribal regions lag in female literacy, use of iron-folic acid tablets, and access to maternal health services, underscoring the need for targeted interventions.⁸

Based on these gaps, this study would try to raise certain research questions: Firstly, what is the proportion of pregnant women enrolled under the JSY, and how many are not enrolled? Secondly, what proportion of pregnant women are classified as high-risk based on age, hemoglobin level, weight, height, and obstetric history, and lastly, what is the prevalence of socio-cultural factors (tobacco consumption, migration, child marriage) and the level of awareness about ANC and maternal health services among pregnant women?

To address these questions, the study has framed the following research objectives: To assess the proportion of pregnant women enrolled under the Social Security program, JSY, and identify those who are not enrolled. It also estimates the prevalence of high-risk pregnancies based on age, hemoglobin level, weight, height, and obstetric history. And lastly, it evaluates the prevalence of socio-cultural factors, including tobacco consumption, migration, and child marriage, and assesses the level of awareness about ANC and maternal health services among pregnant women.

MATERIALS AND METHODS

This study follows a descriptive, cross-sectional quantitative study conducted among pregnant women in a tribal region. The study was conducted from August 2025 to mid-September 2025. The aim was to assess program coverage, high-risk indicators, and social determinants of maternal health. The study was carried out in

Akkalkuwa tehsil (Sub-district), Nandurbar district, Maharashtra, a predominantly tribal region with limited healthcare infrastructure and socio-economic challenges, and maternal health indicators remain below the state and national averages as per NFHS-5. The population included pregnant women residing in Akkalkuwa, using records from local accredited social health activist (ASHAs) and household visits. Women were included if they were pregnant and provided informed consent to participate. A total of 132 out of 150 pregnant women were surveyed. Participants were selected using purposive sampling, considering availability and willingness to participate.

Data were collected through door-to-door household surveys using a structured questionnaire and information from ASHAs and auxiliary nurse midwife (ANM) workers from August to mid-September. The questionnaire was first created in English and then translated into Marathi for fieldwork, using simple wording and visual aids to help participants understand better.

Ethical Considerations and Patient Consent Statement

Participants were informed about the purpose of the study prior to data collection. Verbal informed consent was obtained before interviews. Confidentiality and anonymity were maintained, and participation was voluntary. The responses were manually recorded and later digitized for analysis using charts, tables, and descriptive statistics.

RESULTS

The data collected from 132 pregnant women from Akkalkuwa tehsil, district Nandurbar, Maharashtra, were analyzed using descriptive statistics. Results are presented in terms of frequencies and percentages to address the study objectives. The analysis covers socio-demographic characteristics, enrollment under the JSY, high-risk pregnancy indicators, tobacco consumption, migration status, child marriage, and awareness of maternal health services. Each finding is supplemented with an interpretation to highlight its implications for maternal health in the tribal context.

Basic Profile of Pregnant Women (n = 132)

The majority of respondents (87.1%) were in the 20–35 years age-group, which represents the typical reproductive age. Only 5.3% were below 20 years, while 7.6% were above 35 years, both

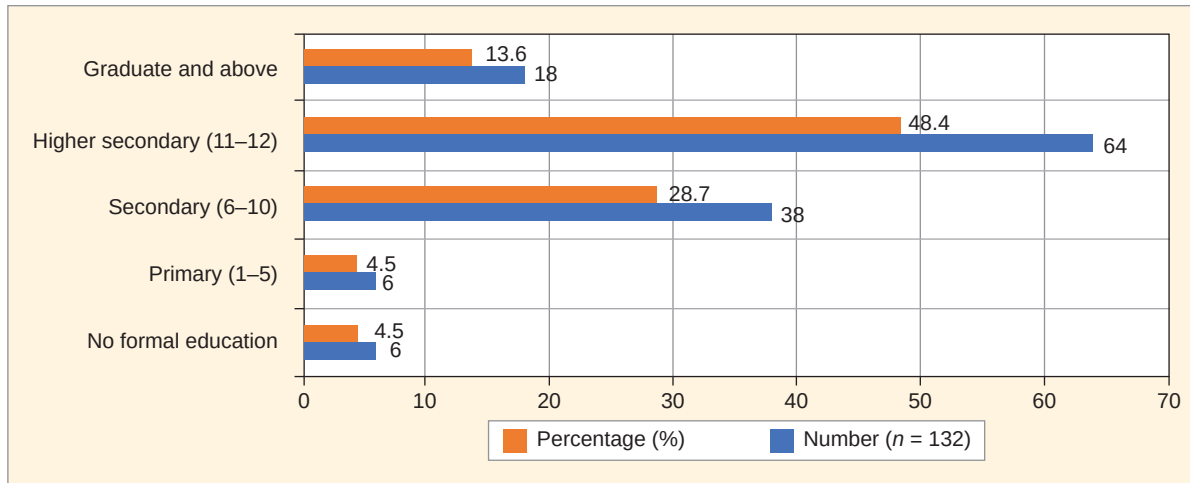


Fig. 2: Educational status of respondents

categories considered high-risk for pregnancy. Regarding parity, over half of the women (54.6%) were experiencing their first pregnancy, while 40.2% were in their second, and only 5.3% had three or more pregnancies (Fig. 2).

The data indicate that although most women fall within the safe reproductive age, the presence of adolescent and late-age pregnancies highlights persisting risks. High first-pregnancy cases suggest the importance of focused ANC and counseling.

Educational Status of Respondents

Educational attainment among respondents shows that a majority had completed higher secondary education (48.5%), followed by secondary education (28.8%). Only 13.6% were graduates or above, while a small proportion had no formal education (4.5%) or only primary schooling (4.5%). This reflects relatively better educational access compared to typical rural-tribal patterns, where lower literacy is more common.

The strong presence of higher secondary education suggests improved awareness potential for maternal health programs. However, the small share of higher education and the existence of uneducated women indicate gaps, highlighting the need for simplified health communication strategies in the region.

Occupational Status of Respondents

Occupational distribution reveals that the largest share of respondents were daily wage workers (25%), followed closely by housewives (19.7%) and those in "other" occupations (19.7%). Agricultural laborers accounted for 18.9%, while 16.7% were migrant workers. This pattern highlights the economic dependence of many families on informal, low-paying, and unstable sources of livelihood, typical of tribal regions.

Economic vulnerability is seen in high dependence on daily wages and migrant workers, which may limit women's chances of receiving quality ANC. The importance of livelihood-sensitive maternal health interventions is highlighted by the ways in which occupation can affect healthcare-seeking behavior, accessibility, and nutrition.

JSY Enrollment Status

Out of the 132 pregnant women surveyed, 68 (51.5%) were registered under the JSY, while 64 (48.4%) were not enrolled.

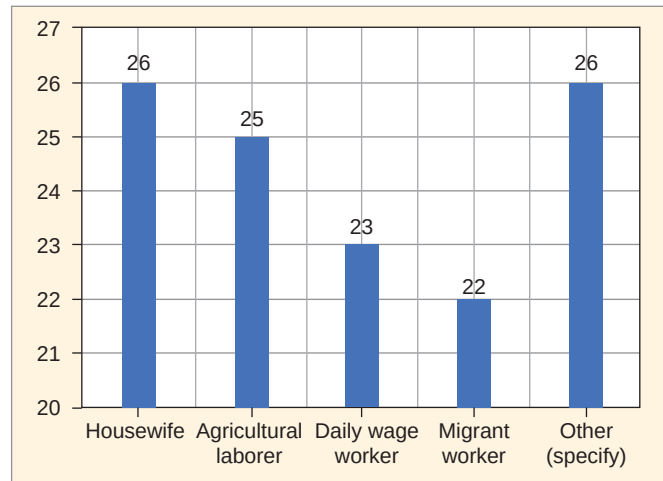


Fig. 3: Occupational status of respondents

This suggests that, although being eligible, nearly half of the respondents did not take advantage of this important maternal health problem. The enrollment rate is slightly above 50%, reflecting moderate program reach in the tribal region (Fig. 3).

The significant proportion of unregistered women highlights gaps in program coverage and awareness. Strengthening outreach, community mobilization, and health education could improve JSY enrollment, ensuring more women benefit from financial incentives and institutional delivery support, ultimately improving maternal and neonatal health outcomes.

High-risk Indicators among Pregnant Women

Among 132 pregnant women, 17 (12.9%) fell in the high-risk age category (<20 or >35 years). Anemia was highly prevalent, affecting 112 women (84.8%). Low weight or body mass index (BMI) was observed in 98 women (74.2%), while 48 women (36.3%) were of short stature (<145 cm). High parity (≥ 3 pregnancies) was the least common risk factor, seen in seven women (5.3%). Overall, a substantial proportion of respondents exhibited one or more high-risk indicators, indicating that biological vulnerability is widespread in the tribal population.

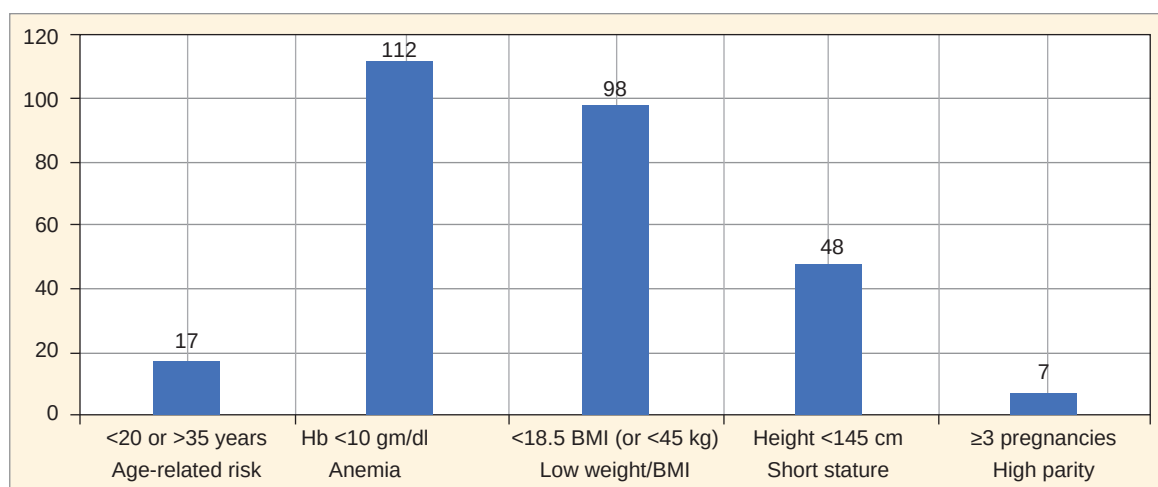


Fig. 4: High-risk indicators among pregnant women

The high prevalence of anemia, low BMI, and short stature underscores the urgent need for targeted nutritional and antenatal interventions. Early identification and monitoring of these high-risk pregnancies are essential to prevent maternal and neonatal complications (Fig. 4).

Tobacco Consumption

Out of 132 pregnant women surveyed, 44 (33.3%) said they had used tobacco in some form, while 88 (66.6%) did not. This indicates that almost one-third of pregnant women are in the study area. They are exposed to tobacco, either as a habit or due to socio-cultural acceptance in tribal communities. The prevalence is much higher than the national average, indicating that pregnant women's tobacco use is a serious health issue in the region.

Tobacco consumption among pregnant women increases the risk of low birth weight, stillbirth, and maternal complications. Addressing this issue through awareness campaigns, counseling, and community-based interventions is critical for improving maternal and neonatal outcomes.

Migration Status during Pregnancy

Out of 132 pregnant women surveyed, 15.1% (20) had already migrated, while 45.4% (60) reported that they would migrate in the upcoming months. Only 39.3% (52) reported staying in their native place. In Nandurbar district, seasonal migration is common among rural and tribal families. From August to mid-September, many migrate for agricultural and daily wage work, while a major wave occurs from October to March for sugarcane cutting to neighboring states such as Gujarat and Madhya Pradesh. This pattern reflects limited local employment and reliance on seasonal labor.

High levels of migration during pregnancy disrupt the continuity of maternal healthcare. Women who move face greater chances of missing antenatal check-ups, losing access to nutrition schemes, and experiencing barriers in reaching institutional delivery services. This increases their vulnerability to maternal and neonatal health risks.

Child Marriage among Pregnant Women

Out of 132 pregnant women surveyed, 5.3% had been married before the legal age of 18 years. This aligns with broader NFHS-5 data, which shows that child marriage is still prevalent in tribal

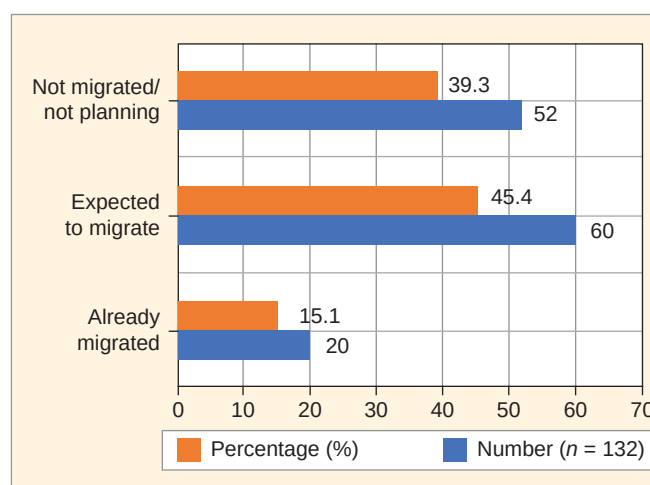


Fig. 5: Migration status during pregnancy

regions of Maharashtra, though declining compared to earlier years. Most women (94.7%) reported marriage at or after 18 years, suggesting a gradual shift toward delayed marriage.

Child marriage remains a social determinant of poor maternal health, as it often leads to early pregnancies, nutritional deficiencies, and limited healthcare access. Even though the percentage is low, it signals the persistence of harmful practices that need community-level awareness and interventions (Fig. 5).

Awareness of Maternal Health Services

Most women (89.4%) were aware of the importance of ANC, while awareness of institutional delivery was universal (100%). At 69.7%, awareness of JSY was low, and around 30% of women were still not aware of the program's benefits. This gap highlights that while general maternal health messages have reached almost all women, specific program-related knowledge is not uniformly available.

High awareness of ANC and institutional delivery suggests successful health promotion by frontline workers and community-level efforts. The lack of knowledge about JSY entitlements, however, suggests that chances to increase program participation and funding were lost. The gap can be minimized, and awareness can be converted into better service use by stepping up targeted

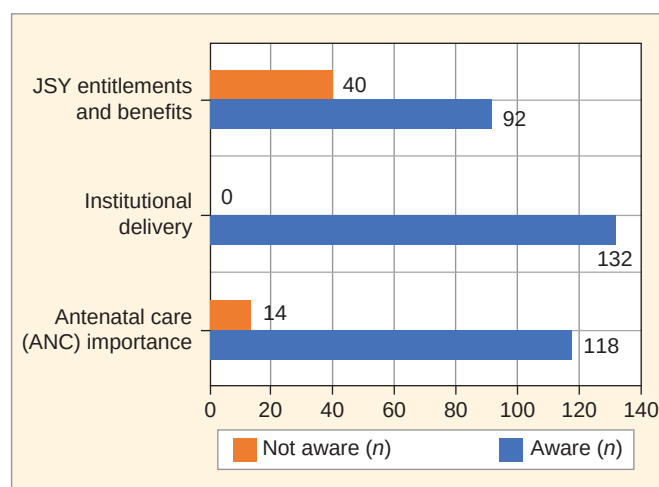


Fig. 6: Awareness of maternal health services

communication and making sure all registered women are informed about JSY benefits (Fig. 6).

DISCUSSION

This study shows that in Akkalkuwa tehsil, Nandurbar district, most pregnant women (87.1%) were in the safe reproductive age-group of 20–35 years, but a small proportion were below 20 (5.3%) or above 35 years (7.6%), which are both considered high-risk. More than half of the respondents were in their first pregnancy, while 40% were in their second, and only a few had three or more. This indicates that early pregnancies and late-age pregnancies still exist, which increases risks for both mothers and babies.

Education levels were relatively better than expected in a tribal area. Almost half of the women had studied up to higher secondary, while smaller groups had only primary schooling or no education at all. Occupation patterns showed that most women came from families dependent on informal work such as daily wage labor, agriculture, and migration. These forms of work are insecure and low-paying, which directly affects women's nutrition and regular access to ANC.

High-risk health indicators were very common. Anemia was the most widespread, affecting 84.8% of respondents, followed by low BMI and underweight status (74.2%) and short stature (36.3%). Only a few women had high parity, but the overall picture shows that the majority of women carried at least one risk factor. Such biological vulnerabilities are linked with complications during pregnancy and delivery.

The percentage of women who reported using tobacco was 33.3%, which is much higher than the national average. This reflects the cultural acceptance of tobacco use in tribal areas and raises serious concerns about pregnancy outcomes such as low birth weight and stillbirth. Child marriage frequently results in early pregnancies and health risks; the percentage of women who reported it was 5.3%, which is lower but still significant. Another significant problem was migration during pregnancy. For seasonal work, about 15% had already moved, and another 45% were anticipated to do so in the upcoming months. This creates disruptions in healthcare, as women who move often miss regular check-ups and lose access to schemes and institutional delivery services.

In terms of health programs, 51.5% of women were registered under JSY. However, awareness of the scheme was higher, with nearly 70% knowing about its benefits. This gap between awareness and actual registration suggests that barriers such as documents, access, or follow-up by health workers prevent full enrollment.

Overall, the study shows that a combination of medical problems like anemia and undernutrition, and social factors like migration, child marriage, tobacco use, and weak program coverage shapes maternal health in tribal areas. Although there is an improvement in awareness of services, actual utilization is still uneven. To reduce this gap, healthcare systems must be strengthened, in addition to addressing tribal women's everyday social and economic challenges.

CONCLUSION

This village-level study highlights the maternal health challenges faced by pregnant women in the tribal areas of Nandurbar. While most women (87.1%) were in the safe reproductive age-group, cases of adolescent (5.3%) and late-age pregnancies (7.6%) still persist, posing risks to maternal health. High prevalence of anemia, low BMI, and short stature among respondents further underline widespread nutritional and biological vulnerabilities.

Awareness about ANC (89.4%) and institutional delivery (100%) was encouraging, but gaps remain in knowledge and utilization of specific schemes like JSY entitlements. Although half of the women were registered under JSY, many were either unaware of the benefits or had not received them, reflecting barriers in access and communication. Tobacco consumption by one-third of respondents and high seasonal migration during pregnancy were additional concerns, as they directly disrupt healthcare access and increase risks for mothers and newborns.

The results indicate that improved nutrition support and regular ANC monitoring are needed in tribal areas. Focused interventions that address migration-related issues, maternal schemes, and dangerous practices such as tobacco smoking can improve outcomes. By bridging gaps in program reach and ensuring culturally sensitive community-level engagement, MCH in tribal populations can be significantly improved.

DECLARATIONS

Data Availability Statement

The data used in this study are available from the corresponding author upon reasonable request. Due to privacy and confidentiality considerations of the participants, the data are not publicly available.

AI Disclosure

AI-assisted tools (such as ChatGPT) were used to support language editing and structuring of the manuscript. All content was carefully reviewed, edited, and verified by the author, who takes full responsibility for the accuracy and integrity of the final manuscript.

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Biosocial Factors and Neonatal Mortality among Particularly Vulnerable Tribe of India

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ABSTRACT

Background: India has seen a significant downward trend in its neonatal mortality rate (NNMR), declining from 26 per 1,000 live births in 2014 to 19 per 1,000 live births in 2022. However, the trend is higher in tribal communities, 41 per live birth.

Methods: Using the purposive sampling technique, the current study aims to explain the interconnectedness of bio-social factors and neonatal mortality in the tribal community of India. Sixty-one ever-married tribal mothers were interviewed, and a total of 72 neonatal deaths were found that they have experienced to date.

Results: The study found that lower birth weight, prematurity, infection, including asphyxia and hypothermia, along with limited access to quality health care, socioeconomic factors, geographical isolation, and traditional practices are associated with neonatal mortality.

Conclusion: The findings highlight the role of bio-social factors in neonatal mortality in tribal communities of India.

Keywords: Child mortality, Cultural taboos, Demography, Geographical isolation, India, Maternal and child health, Maternal health, Neonatal mortality, Odisha, Socioeconomic factor, Tribal population.

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INTRODUCTION

Neonatal mortality remains a critical indicator of health system performance. The World Health Organization (WHO) estimated that globally, 2.3 million children died in the 1st month of life, and in the year 2023, approximately 6,300 neonatal deaths occur every day.¹ Although the WHO report affirms that the neonatal deaths have decreased by 44%, however, still nearly half (47%) of all deaths in children under 5 years of age occurred in the newborn period (the 1st 28 days of life), which is among the most vulnerable periods of life and requires intensified quality intrapartum and newborn care.¹ The 2023 UNICEF data indicates that Sub-Saharan Africa has the highest neonatal mortality rate (NNMR) in the world at 26 deaths per 1,000 live births, followed by central and southern Asia, with an NNMR of 22 deaths per 1,000 live births. The UNICEF report also indicates that South Asia has made significant progress in reducing childhood deaths; despite this progress, 38% of neonatal deaths in the world still occur in South Asia.²

Each year, over 65,000 mothers and 1 million newborns die in the region, with an additional 1 million babies stillborn.³ In South Asia, in India and Bangladesh, neonatal preterm birth, neonatal sepsis, and other neonatal infections contributed to mortality.⁴ Meanwhile, in India, the national average trend has improved, but stark disparities have persisted across different rural areas. The National Family Health Survey - 5 (NFHS - 5) data indicate that the trend has shown that in tribal and rural areas, the total neonatal rate is 27.5%, which has been a matter of concern.⁵ As per the Sample Registration System (SRS) statistical report 2020, the national NNMR in India is 20 per 1,000 live births at the national level, whereas in rural level, the rate of neonatal mortality is 23 per 1,000 live births, which is significantly higher than the national level.⁶ According to UNICEF, the major causes of neonatal deaths include prematurity and low birth weight (LBW) (48%), birth asphyxia and birth trauma (13%), and neonatal pneumonia (12%).²

In India, the northern region, mainly the states of Uttar Pradesh, Madhya Pradesh, Bihar, and Rajasthan, contributes approximately

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Conflict of interest: None

55% of the total neonatal deaths in the country and about 15% of global neonatal deaths annually.⁷ The neonatal mortality varies significantly across gender, socioeconomic status, and geographical variation in rural and urban areas. Various factors contribute to the burden of neonatal mortality, such as healthcare access, maternal education, infrastructure, and socioeconomic status. For example, the study on maternal and obstetric factors like age of mother, preeclampsia, hypertension in pregnancy, eclampsia, antepartum hemorrhage, polyhydramnios, premature rupture of membranes, and multiple gestation is one of the important factors of having neonatal death in Udupi District, Karnataka, India.⁸ Not only in the southern part but also in the northern part of India, states like Uttar Pradesh indicate that the key determinants for child mortality, including neonatal, are breastfeeding status, number of births in the preceding 5 years, child's gender, birth intervals, antenatal care (ANC), birth order, type of water source, and maternal body mass index.⁹

Although few studies have been conducted on neonatal mortality among the tribal population of India, some reflect that both infant and child mortality are higher throughout the country and in the tribal pocket of India also. The study in Nagpur district of Maharashtra state shows that overall neonatal mortality is

higher among the tribal population compared to the nontribal population because of LBW, followed by sepsis and respiratory illness.¹⁰ Similarly, in tribal communities of Madhya Pradesh, it was found that socioeconomic factors such as low literacy of mothers, involvement in agriculture as labor, early childbearing age, LBW, and low institutional delivery were the causes of neonatal mortality.¹¹ The geographical barriers, inadequate water, sanitation, indoor air pollution, crowding, and poor housing conditions are some of the causes for neonatal mortality, mostly seen in vulnerable tribal groups.^{12,13}

Previous studies have shown enough evidence of socioeconomic and demographic factors associated with neonatal mortality in India. Despite these efforts, challenges such as biological factors and social and cultural practices continue to hinder progress in reducing neonatal mortality, mainly among the tribal population. Thus, the present study aims to elucidate the factors of neonatal mortality, encompassing socioeconomic status, educational attainment, age at marriage, maternal age at childbirth, ecological conditions, and social and cultural practices, to analyze the interrelated biosocial factors within a relatively less disadvantaged group, specifically the particularly vulnerable tribal group (PVTG) of India.

Theoretical Model Linking Cultural and Biological Indicators to Neonatal Mortality

Neonatal mortality refers to the death of a newborn within the 1st 28 days of life. It is a critical public health indicator reflecting the overall health status of a population, as well as access to maternal and child health care. Despite several policies and programs, it has been seen that the NNMR has not reduced. The reason behind neonatal mortality is the complex interrelation of both the cultural and biological factors that are intricately related to each other. According to UNICEF, the proposed targets for child mortality aim to end, by 2030, aiming to reduce neonatal mortality at least as low as 12 deaths per 1,000 live births.² The main causes of neonatal mortality in India are preterm birth complications, LBW (35%), lack of ANC, poor maternal nutrition, lack of oxygen at birth, known as asphyxia (20% of neonatal death), and neonatal infections such as pneumonia and sepsis, which are common in home births. Lack of hygienic practices, lack of skilled birth attendants, and emergency care are the causes which are prone toward the neonatal mortality.¹⁴

There is considerable evidence of socioeconomic as well as cultural factors linked to neonatal mortality like mother's and father's lower educational level, poor wealth status, being 1st born neonate, early maternal age, having no ANC visit, and no media access, which tend to increase the neonatal mortality.^{15,16} In many studies, it has been shown that socioeconomic status correlates with higher neonatal deaths due to limited healthcare access, poor living conditions, and malnutrition, with inequalities in early neonatal mortality.¹⁷ Besides socioeconomic factors, traditional beliefs and practices in newborn care persist as a major key factor to neonatal mortality, especially applying oil immediately after birth, applying cow dung, and turmeric to the cord, which are some of the harmful practices and are the cause of neonatal death. However, unscientific and superstitious practices followed by family members are the cause of neonatal mortality.¹⁸

In contrast to this, the biological model postulates that children born to mothers at a younger age are advanced stage of risk, independent of their socioeconomic, demographic, biological, and health characteristics. Likewise, the "age effect" model or inherent physiological factors associated with maternal age are

primarily responsible for the elevated mortality risk. Impacting maternal age and birth spacing on mortality of children, a study tells that spacing the child between 2 and 3 years is more likely to occur compared to spacing the child 3 years and above.^{19,20} In accordance with the mother's age and the birth order, the neonatal death is affected more adversely. In a study, it has been shown that India's high prevalence of maternal undernutrition and its correlation with age, and that both first- and last-born children are at significantly greater risk of dying compared with those in the middle.^{21,22} In contrast to this, another study reveals that mothers' height, birth order, sex of the child, child weight at birth, caste and religion, wealth quintiles, and place of delivery are the major factors for neonate death.²³

On the other hand, environmental factors are an important cause of maternal deaths, mainly obstetric and neonatal complications. In a study, it is shown that LBW and short gestation caused over 80% of newborn deaths, profoundly affecting environmental factors, including pollution, population, climate change, and associated risks.^{4,24,25} The geographical location and climate conditions in which a pregnant woman resides can impact neonatal health. Extreme temperatures, whether hot or cold, can pose risks to maternal and fetal health, emphasizing the need for appropriate clothing and shelter. Geographical factors also include access to healthcare services; limited access to prenatal healthcare facilities is the major cause of neonatal death.

Poverty is closely linked to poor environmental health conditions. This encompasses a lack of access to clean water, inadequate sanitation facilities, and reliance on polluting cooking fuels, leading to household air pollution. These factors increase the risk of infections (e.g., pneumonia, sepsis) and respiratory distress in newborns, contributing significantly to mortality. Rural settings often exhibit poorer sanitation, limited access to clean water, and lower hygiene practices, contributing to higher infection risks for newborns.²⁶ Furthermore, rural areas typically have lower household incomes and maternal education levels, which are interconnected with higher mortality risks, creating a complex web of disadvantage.²⁶

Keeping in view from the above discussion, three major factors have emerged for study. First, the studies examining the socioeconomic and cultural factors like the parents' education and the beliefs and practices, which are directly related to each other, need to be examined further. Second, the influence of maternal age and the birth spacing needs to be elaborated in a precise way in response to socioeconomic factors related to advanced ages and the risk factor relating to neonatal death. Third, socioecological factors, considering the geographical isolation associated with the low level of literacy, poor knowledge regarding health, low level of economic status in relation to hot or cold climatic conditions, play a more dominant role in neonatal mortality (Appendix Fig. 1).²⁷

METHODOLOGY

Research Design

The study design is explicitly mixed method design both qualitative and quantitative method has been adopted for the study. The present study adopts the mixed method to critically analyze the bio-cultural indicators causing the neonatal mortality in one of the vulnerable tribal communities in India. The study was conducted from August to December 2024, with the help of a pretested semistructured questionnaire. Initially, interviews were done by some of the few respondents to meet the required area.

After fulfilling this, a full-phase interview was conducted with respondents through the recall method.

Study Area and Population

The study was conducted on one of Odisha's PVTGs of Odisha. Chuktia Bhunjia, who inhabit the western part of Odisha, in the Komna block of the Nuapada district. The majority of the Chuktia Bhunjia tribe's members are settled cultivators. The Bhunjia is a numerically small and little-known tribe of Odisha that belongs to the proto-Australoid racial group. The name "Bhunjia" signifies one who lives on the soil.²⁸

Sample Size and Sampling Method

The present study includes a sample of 61 ever-married women of reproductive age-groups (15–49) from one block with five different villages. The study employed a purposive sampling technique to select households with at least one neonatal mortality case in her reproductive time. A semistructured schedule was used to collect data with the help of a village community worker, Accredited Social Health Activist (ASHA). A door-to-door survey was conducted for each respondent, and for qualitative data, a focused group discussion with audio clips was recorded to know the cultural attributes of neonatal mortality among the Chuktia Bhunjia tribe. For data analysis, SPSS software was used for quantitative data, and for qualitative data, thematic data analysis was used to explore biosocial factors influencing neonatal mortality related to socioeconomic conditions, cultural beliefs, access to health care, and healthcare-seeking behavior (Appendix Fig. 1).

Ethical Considerations

The study was conducted in adherence to the Indian Council of Medical Research (ICMR) National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017) and the WHO. International Ethical Guidelines for Health-related Research Involving Humans (2016), considering the objective and purpose of the study.^{29,30} Prior to the study, all the participants were informed about the research and provided verbal consent. The confidentiality of all the participants' information was maintained strictly.

Limitation of the Study

The present study on PVTGs has limitations. Due to geographical isolation and cultural diversity, it was a daunting task to collect data. Recalling the memory regarding neonatal events was difficult for the mother. Due to low literacy, filling out the consent form and building trust in them were major constraints of the research.

RESULTS

Neonate mortality is one of the ever-growing concern subjects in the low-middle income countries, especially in South Asia, India. There are several emerging factors that are related directly or indirectly to neonatal mortality. In general, more hands will produce more money for better survival was one of the taglines for the Bhunjia communities. Keeping in mind that most of the tribal communities' people tend to marry and produce more offspring. In the present study, the data show that age at marriage and the number of children a lady can produce are major factors for the vulnerability of neonatal death. In order to understand the neonatal mortality in a vulnerable tribal group, some measures were taken as indicators in the context of biological factors. Appendix Table 1 depicts that

the study based on the current age of the mother and the number of neonatal mortalities varies according to the age-groups. The age-group ranges from 19 to 25 years. Women in this age-group have a smaller proportion (5.5%) of neonatal mortality, whereas the above 30 years of age-group has the majority (79.16%) of experienced neonatal mortality during their reproductive lifetime. In the present study, as expected, the older age (presently old age) groups were found to have a greater number of neonatal deaths as compared to younger age-groups. Similarly, the mother's age at birth and birth order in the studied population are related very significantly. It has been seen that mothers' age at birth ranges from 16 to 21 years has (19.4%) neonatal mortality, whereas mothers' age at birth above 28 years signifies a higher percentage (43.05%) of neonatal mortality that has occurred in the study area. Regarding birth order, the study found that higher birth orders had a significantly greater proportion (33.33%) compared to first-born children. It has been observed that birth order is directly related to the mother's age at birth as well as the mother's present age. The mother's present age and age at birth have played a significant role in determining the neonatal death of the birth order. Here in the studied population, the women who have above 30 years in both mother's present age and mother's age at birth, nearer to 30 years or 30 years above, show a significantly high birth order (3–4), showing 50% of neonatal mortality. This is due to the socioeconomic vulnerability in terms of the quantity of economic resources and the quality of parental resources, which are not invested because of an economically poor status. Due to low literacy level, the risk of behavioral conditions of mothers toward hospitalization directly affects the birth order of neonates. In addition, geographical isolation, along with several morbidities such as hypothermia and asphyxia, is the major factor of neonatal mortality. The physiological condition also plays a role, those who give birth early, like 16-year age-group, and around this age, the number of children later born to the mother are more likely vulnerable, because older mothers who have already given birth to a number of children are physiologically less able to produce stronger children.³¹ The results of Chi-square between two categorical variables, mother's age-group and neonatal mortality, have a statistically significant association ($p = 0.23 < 0.05$), which implies that neonatal mortality varies by age-groups.

Sociodemographic and Cultural Practices of the Study Village

The cultural customs and socioeconomic status are intricately linked to health outcomes, especially for PVTGs who are already at risk. Various factors, including income, education, occupation, access to resources, and cultural beliefs, have a profound impact on nutrition and health-seeking behavior and the use of healthcare services in the light of mother and newborn health. Acceptance or rejection of biological therapy is frequently impacted by gender roles, traditional therapeutic methods, and cultural norms surrounding childbirth. To create a thorough and context-sensitive plan to enhance general health and lower infant mortality, it is essential to comprehend these traits. In the present context, of 61 tribal participants, only 18 mothers had formal education, while a significant majority (70.49%) were nonliterate. Similarly, in terms of paternal education, 25 male partners were literate, whereas (57.62%) were have not received their any formal education. This low level of parental education reflects a direct bearing on health-seeking behavior, especially the choice of place for childbirth. A significant number of participants opted for home delivery, while only two cases received institutional delivery at a primary healthcare center (PHC). Pertinent to the study, the



figure shows that (83.09%) of neonate deaths have occurred among those who have not received formal education, whereas 16.90% have occurred among those who have received formal education, contextualizing the reason the respondents stated that the cultural attributes, the place of baby delivery, and the culture. This shows that educational poverty is directly linked to insufficient use of maternal healthcare (MHC) services.

The socioeconomic condition of the studied tribal group worsens the situation. According to data, firewood is the primary cooking fuel for the vast majority of participants. This suggests that biomass fuels are one of the significant contributing factors of indoor pollution, as well as an associated condition for neonatal mortality outcomes, such as low respiratory and various congenital health-related issues. In the present context (93.05%), those who are using basic wood fuel for cooking purposes are more vulnerable to neonatal death as compared to non-wood fuel. This is the reason behind the situation where the cooking activities are being done, the child's living room is not far distance, the newly born children are being taken care of in the same place, and the mother, who is not aware of the wood smoke, are many times coming with the same vulnerable situation that short breathing problems cause the neonate death. In terms of hygiene and sanitation, none of the 61 participants reported access to toilet facilities. Lack of proper sanitation increases exposure to infectious disease, which affects maternal and neonatal health. The absence of basic hygiene infrastructure reflects the health outcomes faced by these tribal communities and contributes particularly to the elevated rates of neonatal mortality.

Cultural Attributes of Neonate Death

In the present context, the study emphasizes the influence of cultural beliefs and practices on neonatal outcomes in one of the most vulnerable tribal groups. Because of their geographical isolation and limited access to healthcare infrastructure, these tribals rely primarily on traditional practices and cultural norms, including taboos around delivery and newborn care. Deep-rooted cultural norms frequently delay the utilization of formal healthcare services during delivery and the neonatal. A sizable portion of the studied population attributed newborn deaths to culturally accepted causes, but many respondents were unable to explain the reason for neonatal deaths. Still, the present study tried to find out some of the confounding factors rooted in their beliefs and practices regarding delivery and neonatal birth. In the study area, the table showed that most of the participants chose the home delivery practices due to only for the shyness toward the modern delivery practices and gender bias. One of the old ladies explained that "delivery of a child is not being played by any male member of society, it is being done by only the elderly lady of the particular community, and there is no involvement of any male member." So, we preferred home delivery. Similarly, another person of the community stated about the purification ritual of the mother after delivery, "she stated the birth purification of the mother and the child." It is customary that after delivering a child, the bath of the mother is necessary for purification. And if the delivery happened nighttime, the mother will take her birth in the morning as well with the child. Until the mother has not taken her birth, she is unable to feed milk to her child, and there is no custom of colostrum milk in the studied community, because of indigestion issues in children. The umbilical cord cutting is also one of the reasons behind the vulnerability of neonatal mortality. It has been seen that, as a part of customary rituals, the cord cutting is done by the elderly lady

of that community, with the help of a new thread and a blade. But, after cutting the stump, the cord remains uncovered, and there is no way to take care of the cord during bathing practice, which is done by the community remain vulnerable to be infected. As they have a ritual which is known as "sathi" on the 7th day of childbirth, where the cord is buried under the soil for the betterment of life. For this specific time, the cord remains uncovered for drying, which remains vulnerable to neonate health in terms of infection, such as redness and pus being seen in the studied area.

Neonatal Mortality

In order to find out the neonate death in more deftly, it was found that the number of neonate deaths is more in the 3rd week of the month. Neonate mortality (death of newborn within 28 days) is followed by the 2nd week (25.35%) and so on (Appendix Table 2). The reason behind the death is infection. Due to the high prevalence rate of LBW babies and the geographical location, people are more adapted to cold climatic conditions, for which infections like pneumonia are more in number, followed by several morbidity reasons like hypothermia, asphyxia, and preterm birth. The morbidities, as well as the socioeconomic factors, play a key role in determining the neonate mortality in the study area (Appendix Table 3).

Appendix Table 4 explains the reason for neonate death in the study area. It was analyzed that the number of ANC received and not received in the studied regions. Of 61 ever-married women, only 11 women received the 1st ANC, followed by only one woman who received the 2nd ANC as well as the 3rd ANC. In response to this, the table below shows that the number of women who have not received ANC service is 48. The nonsurvivability condition of the child also shows statistically high (54) in number as compared to the 1st ANC received neonate death occurred in 12 in number. For those who have taken more than 2 ANC, the number of neonate deaths is comparatively very low. Even with these improvements, there are still significant regional disparities because in rural area mothers who had at least four ANC visits been 54.2% and who had an ANC check-up in the 1st trimester is 67.9% (MoHFW, 2021).⁵

Distribution of Cause over Neonatal Mortality in the Studied Population

Appendix Table 5 despite several ANC check-ups and cultural and traditional practices, the present study depicts the distribution pattern of morbidities associated with neonatal mortality in the studied population. Of 72 recorded neonate deaths, 31.9% were attributed to infections. The following unidentified cause accounted for (25%) of all deaths, indicating allowing god's wrath to be their fate. Hypothermia and asphyxia were jointly responsible for 16.6% of neonate deaths, followed by preterm birth, which accounted to 9.72% of the mortality cases. Existing literature suggests that most marginalized settings include sepsis, pneumonia, diarrhea, prematurity, neonatal tetanus, and birth asphyxia, which are the leading causes of neonatal death.³²

DISCUSSION

The findings of the above study reveal that neonatal mortality among the vulnerable tribal population is not solely a biomedical issue but a complex interlinking interaction of biological vulnerabilities and is deeply embedded in a socio-cultural practice. Reflecting the socio-cultural importance of newborn health care in PVTGs of India analyzed umbilical cord care practices, and it anoints,

bathing practices, skincare, and oral care are the major issues that caused for neonatal mortality.³³ Moreover, highlighting the health status of PVTGs in Odisha stated about community intervention around knowledge and practices in health and treatment-seeking behavior, and addressing traditional beliefs hold the key to the betterment of living communities.³⁴

The present study highlights several factors significantly attributed to neonatal mortality among the studied population. One of the most profound factors associated with, based on the mother's current age and the mother's age at birth, related to birth order, has shown a significant relationship with adherence to neonatal mortality. According to the analysis, the data revealed that a significant proportion (79.16%) of neonatal mortality has occurred among mothers who are above 30 years, and the significant value shows ($p = 0.001$). This suggests that, in the study area, with an increase in mothers' age, the risk of neonatal outcomes is also at an adverse stage. This is due to the unknown age-related complications like hypertension, unawareness of health symptoms, and belief in their cultural attributes, as well as the ecological conditions due to high altitude and the lowering of temperature, which leads to pneumonia, causing neonatal mortality. Whereas a study on maternal age and the risk of adverse pregnancy outcomes stated that pregnancy-related hypertensive disorder, neonatal resuscitation, and neonatal intensive care unit and periventricular leukomalacia are carefully taken into account in order to improve maternal as well as neonatal health care.³⁵

Similarly, a mother's age at birth is a critical indicator. The present study shows that neonatal mortality is highest among 3rd to 4th order (33.33), followed by 5th to 6th order (27.7). This statistical data suggests that in the present study, the number of mothers who were 28 years or above during childbirth was more risk of neonatal death, although the age above 20 years is a standard age to deliver a child, the birth interval was very short among the studied mothers. There is a notion that a male child is an economic asset to society, irrespective of the number of births and spacing of children; they want to produce more. This reflects the economic burden, poor health care, maternal nutritional depletion, and limited access to healthcare services. The cultural attributes quoted, *"the child we produce is like fruit of a mango tree we do not know either the fruit we will get in ripen form or it will fall half way, this depends on the god,"* while the study reveals that maternal age at birth and neonatal mortality in low-middle income country has neonates born to younger (<25 years) and mothers (>30 years) which are at increased risk of neonate.³⁶

Socioeconomic status of the population is one of the intriguing factors relating to neonatal mortality. Here, the present study indicates that parental education plays a significant role in neonatal mortality. Out of 61 women, the majority proportion of women (70.49%) are nonliterate, whereas more than 50% (57.62%) father is nonliterate. Likewise, place of birth, fuel for food preparation, and sanitation facilities significantly impact newborn morbidities, and the condition of the infant is more vulnerable. Although, socioeconomic condition and cultural roots are rooted very deeply in the studied area, cultural attributes specify the risk, unlike bath of the newborn with rice husk ash in the morning before nursing, a quick hot water bath for the mother after giving birth, and the colostrum (first milk) is frequently discarded owing to social stigma, despite it is immunological benefits are some of the customaries in the communities. On the other hand, in a study reporting on colostrum milk, Mukherjee stated that due to the thickness as well

as its yellow color, the texture and structure of milk are very dirty and harmful.³⁷ Similarly, understanding socio-cultural beliefs in perinatal and neonatal health in rural areas, emphasizing older beliefs and utilizing modern approaches, is essential to promoting better antenatal and postpartum care in rural India.³⁸

For neonatal mortality, health and sanitation are closely related and vice versa. Sanitation is one of the foremost factors related to neonatal morbidities. A study in neonatal mortality in rural India states that out of 204 live births, 72.05% of newborns developed complications within 6 weeks of the delivery. This is due to poor environmental conditions, and lack of personal hygiene and ignorance are the main attributed causes for neonatal mortality in rural India.³⁹ Likewise, LBW, miscarriages, and abortions were at a higher rate in tribal women compared to non-tribal women. The main cause of neonatal mortality was sepsis and respiratory illness, which were associated with preterm, maternal morbidities, as well as delay in initiation of breastfeeding.¹⁰ In the present context, the majority of causes (31.9%) are infections, followed by "do not know" response, and very few mothers can explain the behavior of the disease in terms of environmental factors influencing neonatal mortality, with some cultural factors.

In response to the above, the age-effect model and the socioeconomic disparities, the study indicates that ANC (antenatal coverage) and the birth order also have a profound significance in neonatal mortality. According to Singh et al., their study tried to explain the ANC intervention in terms of folic acid consumption and TT injection, interlinking these two components of ANC. They analyzed that those who do not have two TT injections and less than 90 iron-folic acid (IFA) tablets are more prone to neonatal mortality.⁴⁰ Use of antenatal and delivery care services and their association with infant mortality in rural India has stated that consumption of IFA tablets and lack of maternal blood group checks during pregnancy were associated with an increased rate of infant mortality.⁴¹ Antenatal care check-up is one of the major factors to know the position of the infants. In the present context, the number of ANC received (18.03) in terms of number is very low compared to those who are not received (78.68); accordingly, the outcome of neonate varies from 12 to 54 in number, respectively. This is because of unawareness, low literacy, and inaccessible to healthcare facilities. While in the Juang tribe, the utilization of MHC shows that only 11% had full ANC. The MHC service utilization is low and unevenly distributed because of social norms that discourage early disclosure of pregnancy, continuing preference for home delivery.⁴²

Environmental indicators are one of the underlying reasons for neonatal mortalities. It was found that due to geographical isolation, sanitation facilities, and cooking fuel use were reasons for neonatal mortality. Due to low economic conditions, the space used for cooking was very near, which directly leads to some shorts of irritation in newborn babies and babies in a fatal condition. As the study area is geographically isolated, far from the health facilities, and the topography of that area is wet in most of the months, due to low temperature in the high altitude area, both the mother and the newborn baby are highly vulnerable to the ecological health condition, and the effect of that condition leads to pneumonia disease. Pneumonia is one of the major causes of neonatal mortality.

So, one of the important frameworks for understanding neonatal mortality outcomes, particularly in low- and middle-income countries, is a three delays model, which was critically analyzed to interpret the neonatal mortality and morbidity, specifically in low- and middle-income countries. This model contributed three types



of delays in seeking care, reaching care, and receiving care. Delay in seeking care happens at the community level, gender roles, and cultural beliefs and norms. Delay in reaching a health facility is due to lack of transportation, geographic barriers, and distance to the facility. Delay in receiving care occurs due to a lack of trained staff, inadequate medical supplies, or equipment.

CONCLUSION

According to the intricate relationship between cultural and biological indicators, early marriage and pregnancy are common among tribal women, often resulting in multiple birth outcomes (usually six to seven births). The desire for a male offspring and lack of female literacy (70.49%) are the profound causes found by the studied villages. This is significantly linked to the socioeconomic condition, as well as cultural factors, contributing to poor maternal and newborn health outcomes, including high risk of neonatal disorders such as birth hypoxia (low level of oxygen) and infections. Emphasizing knowledge, attitude, practices (KAP) described how knowledge learned through social context and how it influences behavioral attitude and is practiced in the day-to-day life of common people in a cultural social context.

The present study emphasizes the complex relationship between the cultural and biological factors in the context of vulnerable tribal communities in India. The vulnerable tribal communities are known for their unique cultures and lifestyles, relying more on nature and the natural conditions of the tribe. Most of the tribal communities are residing far away from the rural settlement, mostly in remote and geographical isolation place. In the present study, the data suggested that the age-effect model of the socioecological model explains how the different levels of organization influence the neonatal mortality from the individual sphere to the community sphere and beyond the policymaker. At every level, the socioeconomic condition acts as a barrier for the neonate. At the individual level, low levels of literacy and poor health status increase the neonatal risk. At the interpersonal level, it highlights the role of family influence, traditional birth practices, and decision-making behaviors, and beyond policymaking, the age-old cultural practices act as obstacles for neonatal morbidities.

Meanwhile, some of the interesting aspects linked to neonatal death include maternal education, home deliveries, inadequate sanitation, and deeply embedded cultural entities that influence biological indicators such as age at marriage, age at childbirth, and spacing between childbirths. Despite numerous national and international initiatives to lower newborn mortality, India's vulnerable tribal groups continue to bear a disproportionately high cost. Neonatal mortality remains a significant concern in the health sector despite numerous plans and initiatives. Despite several national and global goals aimed at reducing neonatal mortality, the burden remains unevenly high among vulnerable tribal populations in India. Similarly, the KAP model describes above that the present communities within their knowledge system, how they develop the attitude and see their health behavior differently as cultural entities and practice in their sphere as a cultural attribute, which affects the neonate's health very closely in terms of pneumonia and several skin infections. In spite of several plans and policies, the burden of neonatal mortality still exists as a major engrossing factor in the health sector. To lower the neonatal mortality, community workers should work at the grassroots level; more importantly, they should raise awareness at the base level about the importance of using ANC and post-natal check-up (PNC) at the grassroot level.

DECLARATIONS

Data Availability Statement

The data that support the findings of the study are available on request from the corresponding authors. The data are not publicly available due to containing information that could compromise the privacy of the participants. It is available in the Department of anthropology and it can be provided upon a written request.

Ethical Approval

The author declares that the paper is an original work, and it has not been published before or submitted for publication to another scientific journal. The research has been approved ethically with the free and informed consent of the participants.

Artificial Intelligence (AI) Disclosure

The corresponding author acknowledge that no AI-assisted technologies were used.

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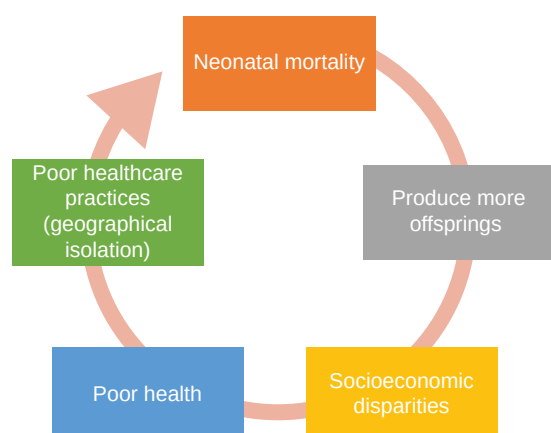
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APPENDIX



Appendix Fig. 1: Conceptual framework for neonatal mortality

Appendix Table 1: Indicators related to neonatal mortality

Indicators	Neonatal mortality		Significant
	N	%	
Age cohort based on present age			
19-25	4	5.5	p = 0.0001
26-30	11	15.27	
Above 30	57	9.16	
Mother's age at birth			
16-21	14	19.4	p = 0.023
22-27	27	37.5	
28 and above	31	43.05	
Birth order			
1	7	9.72	
2	21	29.16	
3-4	24	33.33	
5-6	20	27.7	

(Source: Fieldwork, 2024)

Appendix Table 2: Socioeconomic status of the studied population

Indicators	N	Neonatal mortality	(%)
Mother's education			
Literate	18	12	16.90
Nonliterate	43	59	83.09
Total	61	71	100
Father's education			
Literate	25	–	42.37
Nonliterate	34	–	57.62
Total	59	–	100
Place of delivery			
Home delivery	56	68	85.91
PHC delivery	2	2	
CHC delivery	3	1	1.40
Total	61	71	100

(Contd...)

Appendix Table 2: (Contd...)

Indicators	N	Neonatal mortality	(%)
Fuel for cooking purpose			
Wood/fuel	54	67	93.05
Ujjwala and wood	7	5	6.94
Total	61	72	100
Sanitation facility			
Using	0	–	0
Not using	61	72	100
Total	61		100

CHC, community health center; (Source: Fieldwork, 2024)

Appendix Table 3: Indicating the number of weeks

Indicator	Number of deaths of newborns	(%)
Number of weeks		
1st week	15	21.12
2nd week	18	25.35
3rd week	21	29.57
4th week	17	23.94
Total	71	100

(Source: Fieldwork, 2024)

Appendix Table 4: No. of ANC received and not received over neonatal death in studied population

ANC received	N	Neonatal mortality			Total
		Yes	No	Total	
1st ANC	11	12	65	77	$p\text{-value} < 0.001$
2nd ANC	1	3	37	40	
3rd ANC	1	3	22	25	
ANC not received	48	54	75	129	

(Source: Fieldwork, 2024)

Appendix Table 5: Distribution of cause over neonatal mortality in studied population

Cause of neonatal mortality	N	(%)
Hypothermia	12	16.6
Infection	23	31.9
Preterm birth	7	9.72
Asphyxia	12	16.6
Do not know	18	25
Total	71	100

(Source: Fieldwork, 2024)

The Role of Human Papillomavirus Infection in Male Infertility: A Literature Review

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ABSTRACT

Objective: Human papillomavirus (HPV) infection is commonly a sexually transmitted infection (STI) that links to many cancers, especially cervical cancer (CC). Several studies have reported a positive link between HPV infection and female infertility; however, its impact on male fertility and sperm quality, particularly in couples facing infertility issues, has gained increasing attention in recent years.

Materials and methods: This review examines current literature on how HPV infection, either directly or indirectly, affects male fertility outcomes and various sperm parameters. It also discusses the underlying mechanisms, clinical implications, and potential directions for future research.

Results and discussion: It has been found that HPV infection not only affects female fertility but may also significantly impact male fertility outcomes. It can generate reactive oxygen species (ROS), inflammatory responses, and cytokine release, indicating that the virus may cause both direct and indirect damage to sperm function.

Conclusion: These adverse effects emphasize the importance of considering HPV status when evaluating and treating male infertility. While current evidence highlights the deleterious effects of HPV on the quality of sperm, more future studies are needed to better understand its mode of action in causing adverse effects on male fertility outcomes and also to develop effective interventions.

Keywords: Human papillomavirus, Male infertility, Male reproductive tract, Oxidative stress, Sperm parameters.

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INTRODUCTION

Globally, around 10–20% of couples in the reproductive age-group are facing fertility-related issues. Among these, the male factor accounts for approximately 50% of these cases, and this percentage is rising swiftly each year.¹ A number of risk factors, including varicocele, testicular failure, endocrine dysfunction, genital tract infection, testicular disorders, testicular cancer, genetic factors, and various environmental and nutritional factors, have been recognized as contributing either to reversible or irreversible influences on male fertility. Yet, in half of the reported cases, the cause of male infertility remains unknown, and it is termed idiopathic infertility.² Also, the presence of various pathogens and their pathogenesis in semen and the genital tract, playing a significant role in altering male fertility outcomes, has been widely reviewed.^{3,4} These infections can result in either temporary or permanent infertility, manifested as hormonal impairment, testicular malfunction, or abnormal spermatogenesis, and play a substantial role in overall incidences of male infertility cases.⁴

Among several contemporary and emerging viruses, human papillomavirus (HPV) infection stands out as a common sexually transmitted infection (STI) that carries considerable consequences for both men and women across all geographical, racial, and socioeconomic subgroups globally.^{5,6} The prevalence rate of HPV infection among men is reported to be nearly equivalent to that of women, with a greater prevalence observed in the younger age-group compared to the older one.^{7–11} However, the existing data regarding the epidemiology of HPV and its impacts on the male reproductive physiology is comparatively scarce when juxtaposed with that of women globally. Although the virus has been identified in almost every part of the male reproductive system, including the testis, epididymis, ductus deferens, and semen ejaculate, it is still generally regarded as transient and

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asymptomatic, and over time could result in the development of genital warts and has also been associated with cancers of the penis, anus, and oropharynx.^{4,12–15} Given these manifestations in the male genital tract, attention has been shifted toward understanding its potential role in altering male fertility outcomes, particularly in idiopathic male infertility.^{9,16,17} It may also be speculated to transmit the infection during intercourse to the placenta through the cervix, causing miscarriages and infertility in couples.^{17,18} Recently, it has been reported that the prevalence of HPV is found in 20% of semen samples of men visiting fertility clinics, in contrast to 11% in the general population. This further signifies its role in causing fertility-related pathologies in men.^{9,19} Moreover, in infertile males seeking artificial reproductive techniques (ARTs), the risk of carrying the infection is reportedly much higher compared to fertile controls.^{20–22}

The asymptomatic manifestation of viral infections in the human reproductive system is one of the foremost causes of poor fertility outcomes. Among the viral infections identified in the male genital tract, HPV stands out as one of the prevalent causes of

sexually transmitted diseases affecting the anogenital tract and is one of the leading causes of viral infection-related cancers globally. Also, emerging research data indicate a positive association of HPV and anomalies in male/female reproductive health and raise concerns about its potential role in poor fertility outcomes. Despite the growing body of evidence, the impact of HPV infection on male fertility remains least explored. Hence, this article serves as a synthesis to review the available information on this topic and to offer a thorough overview of the significant impact HPV could play in altering the male reproductive parameters, leading to poor fertility outcomes.

MATERIALS AND METHODS

A literature search was performed on topics such as semen infection, the presence of HPV in the male genital tract and ejaculated semen, viral load, the mechanism of action, and the significance of ARTs to combat their adverse effects. To perform this review, original research articles, case reports, and review articles were taken into account. Databases such as PubMed, Medline, Scopus, Web of Science, Google Scholar, and other accessible online sources were explored using the keywords such as semen and viral infection, sperm viral infection, prevalence of viral infection in infertile couples, HPV and sperm parameter alteration, and ART. The search strategy used was to combine the keywords using Boolean operators (AND, OR) for a comprehensive search. The titles, contents, and abstracts were meticulously examined to identify pertinent articles that qualify for this review. Additionally, the cross-references cited in the literature were also investigated to explore further significant studies. As an inclusion criterion, all relevant peer-reviewed English articles, mostly comprising human studies, were included for review.

REVIEW OF LITERATURE

Male Infertility

Infertility is classified as a condition affecting both the male and female reproductive system, characterized by the inability to attain a clinical pregnancy after 12 months or longer of consistent unprotected sexual intercourse.²³ It is a physiological condition that impacts approximately 70 million people globally. The general prevalence of primary infertility varies between 3.9 and 16.8%, with male factor accounting for nearly 50%.²⁴ Male infertility is represented as sperm abnormalities or male sexual disorders or both. Several risk factors have been identified as contributors to male infertility, including sexual dysfunction, varicocele, congenital dysplasia, endocrine disorders, immune factors, and STIs. In India, nearly 50% of infertility cases are associated with reproductive anomalies or disorders in the male; of these, more than 25% have been reported as cases of unexplained infertility.²⁵

The male reproductive tract (MRT) is comprised of a network of organs and ducts, which are responsible for the production, storage, and transportation of male gametes and endocrine functions. Alterations in male organ integrity and function can adversely impact both general and reproductive health. Infections in MRT can result in either temporary or permanent infertility, hormonal dysfunction, testicular malfunction, or altered spermatogenesis, leading to a considerable increase in infertility rates in 15–20% of all cases.³ Such infections may access the reproductive organs through sexual contact or via the systemic route.³ While some of these infections do not directly impair the male genital tract organs,

they can rather impact sperm functional parameters and quality of semen, ultimately leading to poor fertility outcomes.²⁵

Viral Infections Associated with Male Infertility

More than 30 viruses have been reported in human semen to date.³ Among these are genital viruses (e.g., herpes simplex virus, HPV, etc.), as well as systemic viruses [e.g., human immunodeficiency virus (HIV), hepatitis B virus, Zika (ZIKV), Ebola virus (EBOV), etc.], which not only affect the testis but also other male reproductive organs and may serve as reservoirs for various viral infections.^{26,27} These infections in the MRT frequently go unnoticed, and shedding of semen may be either prolonged or short-lived, complicating its detection.^{26,27} The subsequent induction of oxidative stress, local and systemic inflammation, and the generation of antisperm antibodies (ASAs) could cause testicular damage, compromising the functioning of both germinal and endocrine cells.²⁸

Human papillomavirus is one of several viruses that infect the male genital tract. It is a member of the papillomavirus family. It comprises a group of small nonenveloped double-stranded circular DNA genomes of 8,000 bp. The 55 kDa primary capsid protein is the focus of research on HPV therapy due to its high-affinity domains with the host and its role in eliciting the immune response.^{29,30} Presently, above 200 various HPV genotypes have been recognized and are categorized into two types: Low-risk and high-risk.³¹ Low-risk HPV India (LR-HPV) are typically asymptomatic or lead to self-limited infections such as skin warts, among others. In contrast, high-risk human papillomaviruses (HR-HPV) are associated with cancer due to their significant correlation with various neoplasms located at different anogenital sites, including the cervix, vulva, vagina, penis, and anus.³¹ Among the HR-HPVs, 16 and 18 variants are significantly linked to the advancement of infections and their oncogenic potential, contributing to increased morbidity and mortality rates in African and Asian countries.³² The undifferentiated basal epithelial cells of the skin and/or mucous membrane, which have high mitotic capacity, are the target of HR-HPVs. Once in contact with the outer apical surface of the skin and/or mucous membranes, the viruses can reach the target cells through microlesions in the upper layer of cells. Depending on the specific molecular interactions between the viral antigens and host receptors, they can infect the host cell, leading to malignancy.³³

Prevalence of HPV Infection

The HPV infection is frequently detected in the anogenital region of both males and females and typically presents with or without symptoms, regardless of the appearance of clinical lesions.³⁴ The total prevalence of infection by any variant of HPV is 40.0%, with males exhibiting a rate of 41.8% and females a rate of 38.4%. Conversely, the prevalence of infections caused by HPV types associated with disease is 24.2% in males and 19.9% in females, estimating the total numbers to be 23.4 and 19.2 million, respectively. Each year, HPV causes over 6,00,000 new cancer cases globally, representing 8.6% of all cancers in females and 0.8% in males.^{35,36} The majority of cervical cancer (CC) cases are reported in Asia and Africa, with 1.02–3.12 million women affected annually, respectively.³⁷ In India, CC ranks as the second most common cancer among women aged between 15 and 44 years, with approximately 1,23,907 new cases and 77,348 deaths each year.³⁸ These figures represent almost one-third of global fatalities linked to CC.³⁹ The occurrence of HPV in males is nearly the same as in females; however, most cases act as reservoirs within the MRT and facilitate the transmission of the infection during sexual intercourse to both men and women. Often, there are few

clinical symptoms, which may explain why HPV receives less priority compared to other concerns.³⁷ Nevertheless, irrespective of age, the prevalence of HPV in men varies from 1.3 to 72.9%, with a peak of 65.4% observed in individuals aged between 18 and 40 years, showing higher rates among the younger men compared to older counterparts, thereby increasing the risk of negative consequences for the male genital tract.⁶

HPV Infection and Male Infertility

The etiology of HPV infection in women is well-established; however, in men, it is rarely a concern and typically regarded as transient and lacking significant clinical consequences. It is mostly benign, and in rare cases, it has an association with anal, penis, and oropharynx cancers.^{12–15,40,41} As a fertility-altering agent in male HPV, it may be involved through the non-infectious cancer-producing pathway to alter the reproductive health and fertility outcome.^{42–45} The virus has been detected in almost every part of the male reproductive system, including the testis, epididymis, ductus deferens, and ejaculated semen.^{46–49} With a 16% presence, the infection is more common in semen samples of infertile males as compared to the 10% in the general population, which may negatively impact the quality of the sperm through its direct action on spermatozoa's functional ability or via disturbing the process of spermatogenesis at the testicular level and steroidogenesis at the hypothalamus pituitary testicular (HPT) axis.^{17,48}

Effects of HPV Infection on Semen and Sperm Parameters

The presence of HPV in the seminal fluid of men experiencing idiopathic infertility raises concerns regarding a potential association between seminal HPV and an increased risk of infertility in these individuals.^{40,48,50} First highlighted by Lai et al. in 1997, the infection has been reported to be associated with a reduction in progressive sperm motility, variations in the rate of immotile sperm, alteration in sperm morphology, decreased sperm concentration, elevated DNA fragmentation, and diminished capacity for fertilization.^{17,19,47,50–53} In semen, too, the detection of HR-HPV genotypes causes alterations in sperm morphology and sperm DNA fragmentation.^{54–56} Moreover, in HPV-positive patients, the infection has also been found to be a potential risk factor for the generation of seminal ASAs, in addition to poorer sperm quality compared to HPV-negative ones.^{57,58} Also, the infection was found to be associated with altered functioning of prostate and seminal vesicle glands, which are responsible for maintaining the appropriate semen composition and normal pH value on ejaculation through their secretions.^{59,60} Any adversity in the functioning of these glands will negatively affect the sperm concentration and its functional parameters, resulting in an adverse effect on fertility outcomes.^{40,61,62}

The possible mechanisms through which the HPV exerts its direct and indirect effects on the male genital tract, leading to poor sperm quality and fertility outcomes, have been proposed by its action on sperm production, maturation, and transportation. Understanding of this mechanism is crucial for developing effective strategies for managing HPV-related infertility issues.

Potential Mechanism of Action of HPV Infection Causing Sperm Abnormalities

The precise mechanism by which the HPV affects male fertility remains unclear; current literature suggests that the adverse effects of the virus are due to its direct viral impact or indirect effects such

as production of reactive oxygen species (ROS), inflammatory responses, and the formation of ASAs, which are elaborated upon.

HPV-induced Oxidative Stress

The existing evidence suggests a direct interaction of HPV with both the head and mid-piece of spermatozoa.⁶³ This interaction of viral particles with sperm membranes can disrupt normal cellular processes and increase ROS production.⁴⁶ The resulting oxidative state could be implicated in the persistence of the infection and may contribute to viral integration and promotion of carcinogenesis.⁶⁴ These highly reactive molecules are produced as a result of HR-HPV presence, which interferes with the antioxidant defense mechanisms, resulting in low levels of antioxidant enzymes like superoxide dismutase and glutathione. The compromised antioxidant environment causes damage to sperm membrane proteins through lipid peroxidation and impaired sperm motility due to disrupted mitochondrial function and adenosine triphosphate (ATP) synthesis.^{46,65,66} The infection has also been shown to correlate with increased levels of DNA fragmentation in HPV-positive men as compared to normal men, leading to low fertilization rates, poor embryo quality, and a greater risk of miscarriage.^{65,67,68} Yuan et al. found it as a trigger to stimulate apoptotic pathways in HPV-positive sperm cells and suggest that the virus can initiate cell death processes and compromise sperm viability.⁶⁹ As an indirect effect, increased levels of ROS may result in cellular damage in the testes, affecting sperm cells, consequently leading to impaired spermatogenesis.^{65,70}

HPV-induced Inflammatory Responses

Inflammation represents a tissue response elicited by HPV infection aimed at facilitating viral elimination. The rapid and transient inflammatory response triggered by HPV infection may lead to the release of proinflammatory cytokines.⁷¹ These cytokines can consequently stimulate the generation of ROS through the activation of immune cells, including macrophages and neutrophils. This activation further exacerbates the oxidative stress and leads to direct damage to the spermatozoa. Indirectly, this process may interfere with the regular mechanism of sperm production and maturation by causing damage to testicular tissue.⁷² Such a condition was further corroborated in asymptomatic infertile males with high levels of HPV infection or coinfection with *Chlamydia trachomatis*, who exhibited an alkaline pH more than the normal range, induced by a proinflammatory state and elevated oxidative stress levels.⁷³ At the HPT axis too, HPV may trigger the release of proinflammatory cytokines, potentially disrupting the normal regulation of hormonal balance. This disruption may lead to alteration in the secretion of gonadotropin-releasing hormone (GnRH) from the hypothalamus, which consequently results in altered release of luteinizing hormone (LH) and follicle-stimulating hormone (FSH) from the pituitary gland.⁷⁴

HPV-induced ASAs

The production of ASAs is considered a significant factor contributing to male infertility.⁷⁵ Antisperm antibodies adversely affect semen parameters, such as sperm concentration, motility, and liquefaction. The resulting high rates of ASAs on the sperm surface in HPV-positive male patients in comparison with the non-HPV group indicate a possible role of HPV in triggering antigenic stimulation that leads to the formation of ASAs in semen.^{57,76} Studies exploring the relation between HPV infection and ASA and infertility in men are very limited; therefore, further research is required to



clarify the relationship between these two factors, HPV and ASAs, to draw any definitive conclusions.

Impact of HPV Infection on Assisted Reproductive Technology (ART)

The evidence indicating both the direct and indirect association between HPV infection and increased levels of sperm DNA damage is available, suggesting a compromised genetic integrity of sperm, which impacts its ability to fertilize and affects embryonic development.^{77,78} This is particularly concerning for couples undergoing ART. Men with HPV-infected semen often experience low fertilization rates, poor embryo quality, and diminished pregnancy rates during ART procedures.⁶⁵ Furthermore, the chronic inflammatory response within the MRT can influence the seminal environment, possibly creating a hostile milieu for sperm viability and functionality, which in turn, decreases the success rates of ART.⁷² As a result, couples using ART should take extra caution while managing male HPV infection. Techniques like intracytoplasmic sperm injection (ICSI) and semen washing to remove HPV can be used to circumvent potential fertilization challenges caused by poor sperm quality, thereby enhancing the outcomes.⁷⁹ However, it was observed that washing did not remove the high-risk HPV located at the sperm head in semen samples from couples receiving *in vitro* fertilization (IVF) therapy. This suggests that HPV either binds strongly to the sperm surface or internalizes into the spermatozoon, which requires more research.^{46,80,81}

Given that its presence was noted in the cumulus cells during fertilization and may manifest in subsequent developmental stages, the aforementioned results indicate that the HPV virus can attach to the sperm membrane and potentially transfer its viral DNA to oocytes. These couples are at risk of miscarriages and infertility due to the infection's increased trophoblastic apoptosis and decreased endometrial implantation.^{17,18,21,43} The pathophysiology of premature rupture of membranes and spontaneous preterm birth may be related to vertical HPV transmission during pregnancy. Also, a reduced conception rate was found to be associated with HPV infection in patients receiving intrauterine insemination (IUI) for idiopathic infertility.²¹ In their mouse model-based study, Mastora et al. imply that HPV-positive sperms have a detrimental effect on the development of the embryo, implantation, and the outcome of fertilization. These findings further suggest that HPV interferes with sperm and oocyte fusion.⁸² Therefore, it has been recommended to investigate viral clearance strategies or particular techniques for seminal fraction preparation in ARTs, and the significance of HPV screening as part of infertility treatment has been underlined.⁷⁴ However, the evidence regarding any detrimental impact of HPV infection on IVF outcomes is still inconclusive, and more studies are needed for further understanding.

CONCLUSION

Although HPV infection is not an independent cause of male infertility, it still remains a significant risk factor that can lead to serious deleterious impacts on sperm production, sperm quality, and semen parameters, ultimately resulting in poor fertility outcomes alongside associated STIs. These implications underscore the necessity of incorporating HPV screening in semen analyses of men experiencing fertility challenges. Current evidence regarding the detrimental effects of HPV on sperm parameters and the MRT is quite limited; therefore, further prospective studies are needed to clarify the direct and indirect association of HPV infection with

male infertility, as well as the underlying mechanisms involved. This knowledge is crucial for developing effective strategies and techniques for the early diagnosis, prevention, and fertility treatment of HPV infection in infertile couples.

AI Disclosure

It is hereby confirmed that no AI tool or version was used in the drafting of the article.

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AUTHOR'S CONTRIBUTIONS

Rekha Meena as corresponding author, was involved in conceptualisation, framing, literature search, editing, and development of the final draft.

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Internet Addiction among University Students in Myanmar: A Narrative Review of Prevalence and Health Correlates

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ABSTRACT

Background: Internet addiction (IA) is an emerging behavioral health concern associated with psychiatric morbidity and functional impairment. Myanmar has undergone a rapid digital transformation over the past decade, yet the implications for university student health remain insufficiently synthesized.

Methods: A narrative review was conducted to identify all empirical studies using the Internet Addiction Test (IAT) among university students in Myanmar. Five studies published between 2017 and 2023, including four pre-pandemic and one pandemic-period study, were included, comprising 4,480 students across multiple regions and university types.

Results: Four pre-pandemic cross-sectional studies ($n = 3,530$) reported consistent IA prevalence estimates ranging from 27.5 to 30.4%, yielding a sample-size-weighted descriptive estimate of 28.0%. A nationwide study of medical students conducted during the COVID-19 pandemic ($n = 950$) reported a substantially higher prevalence of 72.2% (95% CI: 69.3–75.0%). Internet addiction was consistently associated with anxiety ($OR = 3.7$) and depression ($OR = 8.7$), moderately correlated with stress ($r = 0.360$), and negatively associated with academic performance ($\beta = -0.327$). Behavioral correlates reported across studies included irregular meals, late sleep, midnight waking, reduced physical activity, and social withdrawal. Identified risk factors included first-year status, non-dormitory residence, male sex, technical discipline, higher personal expenditure on internet data, and peer influence.

Conclusion: Prior to the COVID-19 pandemic, approximately one in four university students in Myanmar met criteria for IA, with prevalence appearing comparatively high relative to some international estimates, although methodological differences limit direct comparison. Internet addiction was consistently associated with psychiatric distress, disrupted health behaviors, and poorer academic performance. Coordinated prevention and early-intervention strategies within university and public health systems are warranted.

Keywords: Behavioral addiction, COVID-19, Digital well-being, Internet addiction, Mental health, Myanmar, University students.

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INTRODUCTION

Internet addiction (IA)—characterized by excessive or poorly controlled preoccupation with internet use, withdrawal symptoms when internet access is unavailable, tolerance manifested by increasing time online, and clinically significant impairment in social, occupational, or academic functioning—is increasingly recognized as a behavioral health concern with substantial psychiatric and physical health consequences.^{1,2} First conceptualized by Young in 1996, and operationalized through the Internet Addiction Test (IAT) in 1998, the condition has gained increasing clinical and research attention as internet penetration has expanded globally.³ The 11th revision of the International Classification of Diseases (ICD-11) has formally included gaming disorder, acknowledging that behavioral addictions can produce neurobiological changes analogous to substance use disorders.⁴ Affected individuals experience elevated rates of anxiety, depression, sleep disruption, sedentary behavior, and social isolation.^{5–7} Among university students, IA has been associated with lower academic achievement, impaired professional development, and reduced quality of life.⁸ Global prevalence estimates vary widely, ranging from 0.8 to 26.7% depending on diagnostic criteria and population, with Asian countries generally reporting higher rates than Western nations.^{9,10}

Myanmar represents a notable case of rapid digital transformation and its potential behavioral health consequences. Following decades of restricted internet access, widespread digitalization accelerated after 2014 with the entry of transnational

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telecommunications companies.¹¹ Internet penetration increased from 33.4% in 2018 to 52.1% by 2021, with high usage among young adults.^{12,13} For the 16–24 year age-group—Myanmar's university student population—penetration rates approach saturation, with over 53% of Facebook users falling within this age range.¹⁴ This rapid transition, compressed into less than a decade, occurred in the absence of established social norms, intergenerational guidance, or public health infrastructure to support healthy technology use, raising concerns about potential impacts on student well-being.

The health burden of IA extends beyond individual psychopathology and spans multiple domains of adolescent health.^{15,16} Sleep disruption is consistently reported across Myanmar studies,

Table 1: Characteristics of included studies on IA among university students in Myanmar

Author (year)	Sample size (n)	Population and region	Prevalence (%)	Key findings
Win KS et al., 2017	400	Arts and Science students, Kyaukse University	27.5	Anxiety (36.5%) associated with IA (OR = 3.7); depression (17.5%) strongly associated (OR = 8.7); higher phone expenditure ($\geq 30,000$ MMK) and smoking linked to IA
San H and Johnson DA, 2020	113	Education students, Kachin Region	30.4	Mean IAT score 61.0; anxiety predicted IA ($\beta = 0.429$); IA negatively predicted GPA ($\beta = -0.327$)
Thant KN and Khaing NN, 2020a	405	Technology/Computer students, Sagaing and Yangon Regions	30.4	81.5% nighttime use; males had a higher risk; mean online time 3.92 hours/day; the number of social networking platforms correlated with IA
Thant KN and Khaing NN, 2020b	2,612	Multidisciplinary students, nationwide sample	27.6	Stress correlated with IA ($r = 0.360$); dormitory residence protective; first-year students at higher risk; higher prevalence among males
Soe PP et al., 2023	950	Medical students, nationwide sample	72.2	Irregular meals (AOR = 4.4); late sleep (AOR = 2.0); midnight awakening (AOR = 2.6); peer pressure (AOR = 1.9); higher pocket money associated with IA

AOR, adjusted odds ratio; GPA, grade point average; IA, internet addiction; IAT, internet addiction test; MMK, Myanmar kyat; OR, odds ratio; r , correlation coefficient; β , standardized regression coefficient

with most students describing predominantly nocturnal internet use.^{17,18} Chronic sleep deprivation in young adults is associated with impaired immune function, metabolic dysregulation, mood disorders, and increased risk of unintentional injury.¹⁹ Associations with irregular meals, reduced physical activity, and social withdrawal suggest clustering of health-risk behaviors that may compound adverse outcomes. These findings indicate that IA may coexist with broader behavioral health challenges rather than representing an isolated problem (Table 1).

University counseling services remain limited, and awareness of behavioral addictions as health conditions is still developing in Myanmar.²⁰ No treatment protocols for IA have been developed or validated for the Myanmar context, and no preventive interventions have been implemented or evaluated. The empirical research base, though growing, has never been systematically synthesized to inform health policy and clinical practice. The IAT developed by Young represents the most widely used measure internationally, and several Myanmar studies have employed this instrument with standard cut-off scores, enabling meaningful comparison across populations and time periods.³

This narrative review, therefore, aims to synthesize all available empirical research using the IAT to examine IA as a health problem among Myanmar university students. Specifically, it seeks to: (1) characterize the prevalence of IA across different populations and time periods; (2) synthesize evidence on psychiatric comorbidities including anxiety, depression, and stress; (3) document health-risk behaviors associated with IA, including sleep disruption, irregular eating, physical inactivity, social withdrawal, and tobacco use; (4) identify demographic, financial, environmental, and social risk factors; and (5) derive evidence-informed recommendations for health system strengthening, clinical practice, and public health policy in Myanmar.

METHODS

Review Design

This study was conducted as a narrative review aimed at synthesizing available empirical evidence on IA among university students in Myanmar. Because of the limited number of eligible studies and heterogeneity in populations and study contexts, a formal meta-analysis was not performed.

Search Strategy

Electronic searches were conducted in PubMed and Google Scholar, together with Myanmar institutional repositories (Yangon University of Education, Sagaing University of Education, Defence Services Medical Academy, and Myanmar Academy of Arts and Science Journal). Searches included combinations of the following keywords: "Myanmar" OR "Burma" AND "internet addiction" OR "Internet Addiction Test" AND "university students." The search covered studies published from database inception to December 2025. Reference lists of retrieved articles were also manually screened.

Inclusion Criteria

Studies were included if they: (1) involved undergraduate or postgraduate university students in Myanmar; (2) used the IAT to measure IA; (3) reported primary empirical data; and (4) were published in English. Studies using substantially different diagnostic thresholds were excluded to improve comparability.

Data Extraction and Synthesis

Data were extracted on study characteristics, prevalence estimates, psychiatric correlates, behavioral factors, and identified risk factors. Because this review was narrative in nature, findings were synthesized descriptively. A simple sample-size-weighted estimate of prevalence was calculated to provide a descriptive overview of trends across studies; this estimate should not be interpreted as a pooled meta-analytic prevalence. Study selection and data extraction were performed manually by the author.

RESULTS

Characteristics of Included Studies

Five studies met the inclusion criteria, comprising 4,480 university students (range: 113–2,612). They were conducted across all major geographic regions of Myanmar, including Yangon, Mandalay, Sagaing, Kachin, and nationwide samples. University types represented included arts and science, education, technical and computer, and medical institutions. All studies employed cross-sectional designs and used the IAT (Table 1).

Prevalence of IA

Four studies conducted prior to the COVID-19 pandemic reported relatively consistent IA prevalence estimates ranging from 27.5 to 30.4%.^{17,18,21–23} A sample-size-weighted descriptive average across these pre-pandemic studies ($N = 3,530$) yielded an estimated prevalence of approximately 28.0%, suggesting a stable baseline level across different regions and university types.

One nationwide study conducted among medical students during the COVID-19 pandemic reported a substantially higher prevalence (72.2%; 95% CI: 69.3–75.0%).¹³ Because this study represented a specific population during an exceptional period of prolonged online learning and social restrictions, it is interpreted as context-specific and is presented separately from the pre-pandemic estimates.

When all five studies (total $N = 4,480$) are considered together, the overall weighted descriptive estimate is 37.4%; however, this figure is heavily influenced by the pandemic-period medical student study and should therefore be interpreted with caution.

Psychiatric Comorbidity

Anxiety

Two studies examined the association between IA and anxiety. In the Kyaukse study, 36.5% of students met criteria for clinical anxiety on the Myanmar-validated Self-rating Anxiety Scale, which has 98% sensitivity for clinician-diagnosed anxiety disorders.²¹ Internet-addicted students were 3.7 times more likely to meet anxiety criteria than non-addicted peers (59.1 vs 27.9%, $p < 0.001$). In the Kachin study, anxiety was the strongest predictor of IA in path analysis, with a standardized β weight of 0.429 ($p < 0.001$).²³ The sample demonstrated mean anxiety scores on the DASS-21 comparable to those of clinical populations with social phobia.

Depression

The Kyaukse study provided the most robust evidence for depression comorbidity using the Myanmar-validated Self-rating Depression Scale.²² Overall depression prevalence was 17.5%. Among internet-addicted students, 42.7% met criteria for clinical depression compared to 7.9% of non-addicted students, yielding an odds ratio of 8.7 ($\chi^2 = 66.881$, $p < 0.001$). The Kachin study found no significant association between IA and DASS-21 depression scores.²³

Stress

The nationwide study of 2,612 students found a moderate positive correlation between stress, measured by the Student Stress Inventory, and IA, with a correlation coefficient of 0.360 ($p < 0.001$).¹⁸ First-year students and those not living in dormitories demonstrated significantly higher addiction scores.

Health-risk Behaviors

Sleep Disturbances

Sleep disruption was the most consistently documented health-risk behavior across studies. Among technology university students, 81.5% reported night as their predominant time for internet use.¹⁷ Among the nationwide sample of 2,612 students, 84.9% reported predominantly nocturnal internet use.¹⁸ The large medical student study provided adjusted odds ratios for specific sleep disturbances associated with IA: Late sleep (AOR = 2.0, 95% CI: 1.3–3.0, $p = 0.001$), waking at midnight (AOR = 2.6, 95% CI: 1.6–4.3, $p < 0.001$), and hypersomnia (AOR = 1.5, 95% CI: 1.0–2.3, $p = 0.051$).¹³

Eating Behaviors

The medical student study identified irregular meals as the strongest behavioral correlate of IA, with an adjusted odds ratio of 4.4 (95% CI: 2.0–9.5, $p < 0.001$).¹³ Addicted students were more than four times as likely as non-addicted peers to skip or delay meals.

Physical Activity

Reduced physical activity was reported by 63.4% of medical students in relation to their internet use and was significantly associated with IA in univariate analysis (OR = 2.5, $p < 0.001$).¹³

Social Participation

Missing social gatherings was significantly associated with IA in both univariate (OR = 2.4, $p < 0.001$) and multivariate analysis (AOR = 2.1, 95% CI: 1.4–3.1, $p < 0.001$).¹³

Tobacco Use

The Kyaukse depression study provided the only examination of substance use in relation to IA.²² Among 400 students, only 18 (4.5%) acknowledged smoking, a rate substantially lower than national male smoking prevalence, suggesting under-reporting due to social desirability bias. Smoking was significantly associated with depression, with 38.9% of smokers meeting depression criteria vs 16.5% of non-smokers ($p = 0.015$).

Risk Factors for IA

Demographic Factors

The nationwide study found that first-year students had significantly higher IA scores than third-year students (40.88 vs 37.76%, $p < 0.001$).¹⁸ Students not living in university dormitories had significantly higher addiction scores than dormitory residents (40.35 vs 38.57%, $p = 0.01$), a Myanmar-specific protective effect. Technology university students demonstrated significantly higher addiction scores than those in other disciplines, with males scoring higher than females (43.58 vs 38.40%, $p = 0.003$).¹⁷ The nationwide study also found males had higher addiction scores than females (42.29 vs 37.54%, $p < 0.001$).¹⁸

Financial Factors

The medical student study identified that spending more than 10% of monthly pocket money on internet data significantly predicted addiction, with an adjusted odds ratio of 1.5 (95% CI: 1.1–2.1, $p = 0.014$).¹³ In the Kyaukse studies, spending 30,000 Myanmar kyats (MMKs) or more monthly on phone bills was associated with significantly higher rates of both anxiety (66.7 vs 35.6%, $p = 0.028$) and depression (58.3% vs 16.2%, $p < 0.001$).^{21,22}

Social Factors

Peer pressure remained significant in multivariate analysis in the medical student study, with an adjusted odds ratio of 1.9 (95% CI: 1.1–3.3, $p = 0.013$).¹³ Notably, 14.4% of medical students explicitly endorsed peer influence as a reason for their internet use.

Academic Performance

The Kachin study examined the relationship between IA and academic performance using actual grade point average (GPA) data.²³ Each unit increase in IAT score significantly predicted a decrease in GPA, with a standardized β weight of -0.327 ($p = 0.002$). This negative association persisted after controlling for gender, study time, and internet attitudes.



DISCUSSION

This review of five studies using the IAT demonstrates that IA affected approximately one in four Myanmar university students. The pre-pandemic prevalence observed in Myanmar appears comparatively high relative to some previously reported international estimates; however, differences in study design, populations, and diagnostic thresholds limit direct cross-country comparison.⁹ This finding is remarkably consistent across studies conducted between 2015 and 2020, spanning diverse regions including Kachin, Mandalay, Sagaing, Yangon, and nationwide samples, as well as different university types including arts and science, education, technological, and medical institutions. The consistency suggests a stable underlying vulnerability in this population rather than transient fluctuations related to access or infrastructure. The marked elevation to 72.2% among medical students in 2020 may reflect the extraordinary circumstances of the COVID-19 pandemic. University closures, transition to online learning, and prolonged social isolation likely amplified pre-existing vulnerabilities.¹³ Across all five studies, the overall weighted descriptive estimate was 37.4%, although this figure was strongly influenced by the pandemic-period medical student study. Given the predominance of cross-sectional designs among included studies, interpretations should emphasize associations rather than causation.

The psychiatric comorbidity documented in these studies is substantial and clinically significant. This finding, derived from a Myanmar-validated, clinician-referenced depression scale with established sensitivity and specificity, provides robust evidence that IA in this context is not merely excessive screen time but a condition with profound mental health implications. The association with anxiety (OR = 3.7) and stress ($r = 0.360$) further establishes IA as a condition with substantial psychiatric morbidity.^{21,22} These findings have clear clinical implications: Students presenting with mental health complaints should be routinely screened for problematic internet use, and students identified as internet addicted should be assessed for comorbid psychiatric disorders.

The clustering of health-risk behaviors—including irregular meals (AOR = 4.4), sleep disruption (AOR = 2.0–2.6), social withdrawal (AOR = 2.1), and reduced physical activity—suggests that IA may be embedded within a broader pattern of adolescent health-risk behaviors.¹³ This co-occurrence has implications for intervention, indicating that addressing any single behavior in isolation may be insufficient. Instead, comprehensive programs targeting multiple interconnected behaviors and their shared behavioral and environmental determinants are likely to be more effective.

Several findings are distinctive to the Myanmar context and have important policy implications. The protective effect of dormitory residence—contrasting with Western literature where independent living often increases risk—suggests that Myanmar's communal hostel system provides social buffering, peer monitoring, and structured routines that reduce reliance on online social fulfillment. Universities should consider strengthening dormitory systems and extending their protective effects to day-scholar students through structured extracurricular programs and peer mentoring initiatives. The identification of objective, non-self-report risk markers—spending more than 10% of monthly pocket money on internet data or 30,000 MMKs or more monthly on phone bills—provides practical screening tools for families,

university health services, and primary care providers to identify at-risk individuals for early intervention.

The peer pressure finding (AOR = 1.9), with 14.4% of medical students explicitly endorsing peer influence, suggests that IA may be influenced by peer-related social processes.¹³ Group-based interventions that leverage positive peer influence and establish new social norms around healthy technology use may be more effective than individual counseling alone. The heightened vulnerability of first-year students identifies a critical window for preventive intervention during the transition to university life. Orientation programs should include evidence-informed modules on healthy technology use, sleep hygiene, time management, and alternative stress-coping strategies. Technical university students, with their high rates of gaming-related activity and male predominance, may require specialized interventions addressing gaming disorder specifically.

The negative association between IA and academic performance ($\beta = -0.327$) provides additional institutional motivation for action.²³ Each unit increase in IAT score predicted a decrease in GPA, suggesting a potentially important relationship that warrants longitudinal investigation. This finding should motivate universities to invest in prevention and early intervention as part of their core educational mission. Taken together, these findings position IA as an emerging behavioral health issue requiring culturally and contextually appropriate responses in rapidly digitalizing low- and middle-income settings.

Implications for Policy and Practice

The findings of this review have several implications for higher education and public health systems in Myanmar. Universities may consider integrating routine screening for problematic internet use within student health or counseling services, particularly targeting first-year students and those with identified behavioral risk factors. Preventive strategies such as orientation-based digital well-being education, peer-led awareness programs, and structured extracurricular engagement could help promote balanced internet use. At the policy level, collaboration between the education, health, and telecommunications sectors may support the development of national guidelines for healthy digital behaviors among young adults. Given the observed association between IA and mental health symptoms, strengthening university-based mental health services and referral pathways should be prioritized as part of broader adolescent and young adult health strategies.

Limitations

Several limitations should be acknowledged. All included studies were cross-sectional, which precludes causal inference and limits interpretation of temporal relationships. Findings relied entirely on self-reported measures and may therefore be affected by social desirability and recall bias. Only two studies used nationally representative or multi-institutional samples, reducing generalizability across Myanmar's diverse student populations. In addition, no study directly assessed physical health outcomes or health service utilization associated with IA. The evidence base also ends in 2021; subsequent political and economic disruptions may have altered patterns of internet use while simultaneously constraining research capacity. Finally, because a formal quality appraisal tool was not applied, methodological differences across studies could not be systematically quantified. Publication bias and unpublished gray literature were not formally assessed. Therefore,

findings should be interpreted as indicative rather than exhaustive. The small number of eligible studies may also limit the stability of descriptive prevalence estimates. Future syntheses may benefit from formal quality appraisal and inclusion of emerging post-2021 evidence.

Future Research

Longitudinal cohort studies tracking IA, mental health, and physical health outcomes from university entry through graduation are urgently needed. Validation of the IAT in the Myanmar language is essential. Qualitative research should explore lived experience and barriers to help-seeking. Implementation research should develop culturally-appropriate interventions. Studies examining gaming disorder using ICD-11 criteria are needed. Research must extend to non-university youth, rural students, and conflict-affected regions.

CONCLUSION

Prior to the COVID-19 pandemic, IA affected approximately one in four university students in Myanmar, with prevalence appearing comparatively high relative to some international estimates, although methodological differences limit direct comparison. Internet addiction was consistently associated with anxiety, depression, stress, and disruptions in sleep, eating behaviors, physical activity, and social participation. Rapid digitalization in Myanmar may have outpaced the development of digital literacy, social norms, and health system capacity needed to mitigate related harms, while higher prevalence during the COVID-19 period may reflect increased online learning demands and social restrictions. Addressing this issue requires coordinated action across health, education, and telecommunications sectors, including strengthened mental health services, university-based prevention and screening initiatives, and broader public health efforts to promote healthy digital engagement among young adults.

Artificial Intelligence (AI) Disclosure

No generative AI tools or large language models were used in any part of this work, including study conceptualization, literature search, data extraction, synthesis, interpretation, or manuscript writing. The author takes full responsibility for all content presented in this paper.

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Integration of Private Diagnostic Laboratories into the Public Health Surveillance System in India: A Way Forward

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ABSTRACT

Aim and background: India's disease surveillance mainly depends on data from public laboratories, overlooking valuable real-time information from private diagnostic laboratories (PDLs), which perform nearly 70% of the patient testing. Drawing on lessons from the COVID-19 pandemic, this study proposes a framework to integrate PDLs into the integrated health information platform (IHIP) and Integrated Public Health Laboratory (IPHL) network, aiming to strengthen early outbreak detection and engage public health preparedness.

Materials and methods: This qualitative, descriptive study systematically reviewed national guidelines, policy documents, and international models. From numerous sources examined, 42 key articles and reports were selected to develop the proposed framework. References included the Ministry of Health and Family Welfare (MoHFW), the Clinical Establishments Act, global systems, etc.

Results: The proposed framework recommends mandatory reporting by PDLs, digital integration via laboratory information management systems (LIMS) and secure application programming interfaces (APIs), and formal memoranda of understanding (MoUs). It also recommends phased inclusion of labs without National Accreditation Board for Testing and Calibration Laboratories (NABL) accreditation, district-level training, supervision, and linking data to Ayushman Bharat Health Account (ABHA) IDs for accuracy.

Conclusion: Integrating PDLs can bridge data gaps, improve timeliness, and support a resilient, digital surveillance system aligned with India's NITI Aayog Vision 2035.

Keywords: Digital health interoperability, Integrated disease surveillance, Public health laboratory networks, Public health preparedness, Public health surveillance, Public-private partnerships.

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INTRODUCTION

India's public health surveillance system forms the backbone of disease prevention and control for early outbreak detection and timely public health response. The World Health Organization defines surveillance as an ongoing, organized process of collecting, analyzing, and interpreting health-related data to guide public health action.¹ An effective system depends on accuracy, timeliness, and completeness of data, especially during health emergencies when rapid action can save lives.

Over the past two decades, India has invested in strengthening its surveillance architecture. The Integrated Disease Surveillance Programme (IDSP), launched in 2004 by the Ministry of Health and Family Welfare (MoHFW), was designed to collect weekly data from public laboratories, community health workers, and government hospitals for early outbreak detection.² In 2018, the Integrated Health Information Platform (IHIP) was introduced to modernize reporting through real-time, case-based digital data entry.³ In 2021, the Integrated Public Health Laboratory (IPHL) network was rolled out under the PM-Ayushman Bharat Health Infrastructure Mission to provide multi-disease diagnostic services under one roof, aiming for coverage at the district and sub-district levels.⁴

Despite these advancements, most data still comes from public facilities, even though private diagnostic laboratories (PDLs) conduct nearly 70% of all diagnostic testing in India, with 98% of National Accreditation Board for Testing and Calibration Laboratories (NABL)-accredited laboratories in the private sector.⁵ This underutilization leads to substantial blind spots in surveillance. Studies have found that data from PDLs seldom flows into IDSP or IHIP, causing delays in detecting outbreaks.^{6,7} The COVID-19 pandemic demonstrated that

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integration is possible—over 2,300 private laboratories were linked to national platforms such as ICMR and IDSP for real-time RT-PCR reporting.⁸ However, this collaboration was largely temporary, with no permanent mechanism for routine involvement once the emergency subsided.⁹

Fragmentation between vertical health programs—such as the National TB Elimination Programme (NTEP), National AIDS Control Programme (NACP), and National Vector Borne Disease Control Programme (NVBDCP)—combined with poor data interoperability, further hampers comprehensive surveillance.⁶ Persistent barriers, including the absence of legal mandates, lack of formal Memorandum of Understanding (MoUs), limited digital readiness, regulatory concerns, and data privacy issues, discourage sustained PDL participation.^{5,7}

Recognizing this gap, the present study proposes a strategic framework to formally integrate PDLs into the IPHL–IHIP surveillance ecosystem. It draws on India's pandemic experience, leverages global best practices such as the U.S. Centers for Disease Control and Prevention's National Notifiable Diseases Surveillance System (NNDSS), which prioritizes collaboration and capacity-building over punitive measures,¹⁰ and aligns with NITI Aayog's Vision 2035 for a future-ready, digitally enabled, and inclusive public health system.¹¹

Presently, there is no permanent mechanism to ensure the routine participation of private laboratories, despite their dominance in diagnostic services. This gap undermines the timeliness and completeness of India's surveillance efforts. This current study aims to design a policy-relevant framework to integrate PDLs into the IPHL–IHIP surveillance ecosystem, drawing on lessons from COVID-19, international best practices, and national health policy priorities.

MATERIALS AND METHODS

This qualitative, descriptive study aimed to propose a strategic framework for integrating PDLs into the IPHL network and IHIP. The approach relied on secondary data sources, focusing on a systematic literature review and thematic analysis of national and international documents.

A structured search was conducted in reputable databases and portals, including PubMed, the MoHFW website, the World Health Organization (WHO) library, and national program repositories.^{12–14} Grey literature, policy reports, and official guidelines were also reviewed. Global surveillance models such as the United States Centers for Disease Control and Prevention's NNDSS and interoperability standards, including Health Level Seven (HL7) and fast healthcare interoperability resources (FHIR), were examined for best practices.^{15–17}

Of the numerous sources screened, 42 research articles, policy documents, and technical guidelines were selected based on their relevance to laboratory integration, surveillance systems, and digital health infrastructure in India and globally.

Inclusion Criteria

Coverage from the initial implementation of the IDSP to recent reforms, including IHIP and IPHL. Official guidelines and program reports from Indian national and state-level agencies. Research articles and openly published data from recognized academic databases (PMC, PubMed, Google Scholar, ResearchGate). Documents directly addressing public health laboratory systems, disease surveillance, private laboratory integration, digital reporting mechanisms, or public–private partnership models. No time limit was applied, but priority was given to documents from 2,000 onwards.

Exclusion Criteria

Blog posts, news articles, or opinion pieces without credible evidence. Documents lacking relevance to disease surveillance, laboratory integration, or public health diagnostics. Sources not originating from credible institutional or peer-reviewed channels.

RESULTS

The analysis of literature, policies, and best practices led to an eight-step strategic framework for integrating PDLs into the IPHL–IHIP ecosystem so that they contribute to disease surveillance

Pillars of the framework

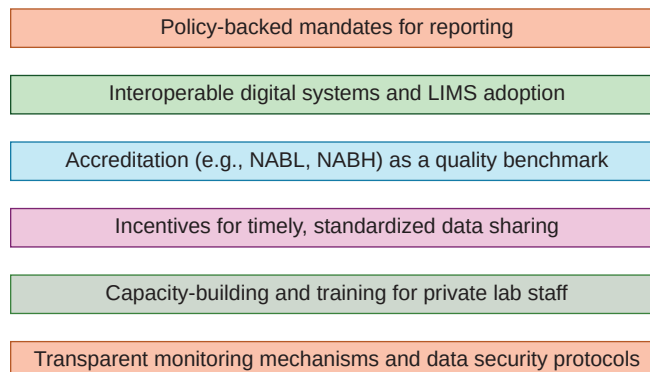


Fig. 1: Conceptual model of private diagnostic laboratory integration into the IPHL–IHIP network

regularly, rather than only during health emergencies (Fig. 1). The steps focus on building legal clarity, expanding registration, ensuring quality, formalizing collaboration, securing digital connectivity, strengthening workforce skills, and maintaining ongoing supervision.

Step 1—Legal and Regulatory Reporting

The framework begins with a legal foundation that makes real-time reporting by PDLs a routine requirement. The Clinical Establishments (Registration and Regulation) Act, 2010 (CEA) can be leveraged to include mandatory disease reporting within its provisions. The list of notifiable diseases should include communicable conditions such as tuberculosis, HIV, dengue, and hepatitis; high-burden non-communicable diseases like diabetes and chronic kidney disease; and emerging or re-emerging infections such as Nipah, Zika, and novel influenza strains. Integrating these rules into an existing Act avoids unnecessary legal complexity while creating clear obligations for reporting.¹⁷

Step 2—Mandatory Facility Registration and Patient Identification

All laboratories—public or private—should be officially registered in the Health Facility Registry (HFR) under the Ayushman Bharat Digital Mission (ABDM) and assigned a unique facility ID. This ensures traceability, standardization, and seamless digital linkage to IHIP and IPHL.

For patient identification, the framework proposes that all test results be linked to an Aadhaar-linked Ayushman Bharat Health Account (ABHA) ID wherever possible. This creates a secure, unique identifier that reduces duplication when patients visit multiple facilities. For individuals without an ABHA ID, labs should collect essential demographic details (name, age, gender, phone number) and, with consent, generate an ABHA ID during the visit. This dual approach—facility registration and Aadhaar-linked patient IDs—supports accuracy, interoperability, and secure health data exchange.^{18,19}

Step 3—Accreditation with Conditional Participation

National Accreditation Board for Testing and Calibration Laboratories accreditation, aligned with ISO 15189 standards, should be the preferred benchmark for all participating labs. However, to avoid excluding small or rural facilities, the framework

Table 1: Eight-step framework for integrating PDLs into India's Public Health Surveillance System

Steps	Focus area	Key suggestions
1. Proposing a legal and regulatory foundation through amendments	Use existing laws	Expand the Clinical Establishments Act, 2010, to mandate disease reporting (TB, HIV, dengue, diabetes, etc.). This avoids new laws while making reporting a routine duty
2. Facility registration and patient identification	Ensure traceability	Register all labs in the HFR under ABDM. Link test results to ABHA IDs for secure, unique patient tracking; where absent, generate IDs with consent
3. Accreditation with conditional participation	Balance quality and inclusivity	Prefer NABL accreditation (ISO 15189). Allow small/rural labs with minimum standards to join conditionally, giving 12–18 months to achieve full accreditation
4. Formal engagement through MoUs	Define roles clearly	Standardized MoUs should cover reporting timelines (24 hrs routine, 4 hrs urgent), formats (HL7/FHIR), responsibilities, and data privacy. Include supportive measures like PM-JAY empanelment, tools, and recognition
5. Quality assurance and data reliability	Strengthen trust in data	Use LIMS-based quality checks and EQAS for external validation. Poor performers should receive retraining, not just penalties. Enforce bio-safety and biomedical waste rules
6. Digital connectivity and secure reporting	Enable real-time data	Link LIMS to IHIP via secure APIs (HL7/FHIR, TLS/SSL). For labs without digital systems, supply government-supported LIMS or secure portals
7. Training and capacity building	Build a skilled workforce	District IPHLs to conduct biannual training. Include AMR and emerging diseases. Assign training managers to ensure compliance
8. Monitoring and continuous improvement	Sustain performance	District teams to conduct site visits; states to oversee EQAS and escalate issues. Reward high-performing labs, assist weaker ones. IHIP dashboards to track timeliness, completeness, and trends

allows conditional inclusion for those meeting minimum staffing, infrastructure, bio-safety, and digital reporting requirements. Such labs must achieve full NABL accreditation within 12–18 months to remain in the network. This staged approach balances inclusivity with quality assurance.²⁰

Step 4—Formal Engagement through MoUs

Standardized MoUs between laboratories and public health authorities should outline: Data to be reported, timelines (within 12–24 hours for routine conditions, within 4 hours for urgent ones), reporting formats (HL7/FHIR), roles and responsibilities for both parties, and privacy safeguards in line with the Digital Personal Data Protection Act, 2023.

Memorandum of understanding can also include benefits for cooperation, such as access to PM-JAY empanelment, free digital reporting tools, accreditation support, public recognition, and eligibility for research or pilot initiatives. This transforms reporting from a compliance task into a collaborative partnership.^{21–23}

Step 5—Quality Assurance and Data Reliability

Each laboratory's laboratory information management system (LIMS) should integrate internal quality controls, such as calibration logs and error flags. External oversight can be provided through the Indian Council of Medical Research's (ICMR) External Quality Assessment Scheme (EQAS), where labs test reference panels and receive performance feedback.

Poor performance should trigger targeted retraining rather than immediate penalties. All labs must comply with WHO-recommended bio-safety practices and India's Biomedical Waste Management Rules to protect staff and preserve sample integrity.^{24,25}

Step 6—Digital Connectivity and Secure Reporting

Private diagnostic laboratories should connect their LIMS directly to IHIP via secure application programming interfaces (APIs) built on HL7 and FHIR standards. Transfers must be encrypted (TLS/SSL) and logged for audit. If connectivity is interrupted, the LIMS should store data locally and forward it once service is restored.

For facilities without digital systems, government-supported, ready-to-use LIMS software or secure reporting portals should be provided. Within IHIP, automated analytics can trigger early alerts when disease patterns deviate from normal baselines.²⁶

Step 7—Training and Capacity Building

District IPHLs should hold structured training at least twice yearly, covering: *Pre-analytical*: correct specimen collection, cold chain, ABHA/Aadhaar linking, *analytical*: equipment calibration, quality checks, coding with ICD-11 and LOINC and *post-analytical*: LIMS entry, IHIP upload, dashboard error reviews.

Specialized training on antimicrobial resistance (AMR) and emerging diseases should be included. Each lab should appoint a Training Manager to track participation and submit training reports to the district and state surveillance units.²⁴

Step 8—Monitoring and Continuous Improvement

A district-level monitoring team—comprising the District Surveillance Officer, IPHL in-charge, data entry operator, and a Lab Supervision Officer—should conduct regular site visits to assess data quality, bio-safety compliance, and operational practices. State Surveillance Units would review aggregated data, coordinate EQAS participation, and escalate unresolved quality issues to the national level.

High-performing labs could receive public recognition, while underperforming ones would get targeted technical assistance before sanctions are considered. Integrated health information platform dashboards would allow continuous tracking of reporting rates, timeliness, and data completeness.^{25,26}

Expected Benefits

If implemented as proposed, the framework could: Increase completeness of laboratory reporting to >90%, reduce reporting time to <24 hours for routine cases and <4 hours for priority conditions, extend surveillance reach into previously unreported private sector activity, and strengthen early outbreak detection through real-time analytics in IHIP (Tables 1 and 2).



Table 2: Strengths, weaknesses, opportunities, and threats (SWOT) analysis of the proposed framework for private diagnostic laboratory integration

<i>Strengths</i>	<i>Weaknesses</i>
Real-time disease surveillance enabling faster outbreak alerts Reduces data gaps by including private labs that handle a large volume of tests Has a detailed training plan for lab staff, DEOs, and IDSP personnel to maintain quality Uses existing digital health infrastructure like ABHA ID, IHIP, IPHL—cost-effective and time-saving Strong focus on data quality, bio safety, and legal compliance Regular monitoring and supervision ensure accountability Encourages labs to sign MoUs, creating formal responsibility Flexibility in training (routine and emergency sessions) Strengthen public awareness by using simple templates to educate people about diseases Making surveillance more complete and reliable	Digital infrastructure in small private labs may be weak or missing Lack of dedicated government support for manpower, monetary, and logistics Labs may not be familiar with platforms like IHIP or ABHA Initial training and setup may require time and resources The risk of duplicate data entries remains if patients visit multiple labs Resistance from private labs due to fear of legal burdens or lack of benefits Data privacy concerns if linking ABHA ID or phone number without proper consent High dependency on the cooperation of private players
<i>Opportunities</i>	<i>Threats</i>
Can create an integrated national-level lab surveillance system by uniting public and private labs Improved data sharing from private labs can strengthen decision-making Helps in early outbreak response, especially in diseases like Monkeypox, COVID, etc. Bridges the urban-rural diagnostic gap through the expansion of surveillance reach Builds the capacity of the private sector to adhere to national reporting standards Enhances public trust in lab data and government health responses Creates a base for future AI-based analytics and predictive models using real-time lab data Helps in quick response and better preparedness during health emergencies Can open doors for policy reforms on lab licensing, accreditation, and surveillance integration	Non-participation of private labs due to a lack of interest or trust Overload on the IHIP portal due to a sudden surge in data from private labs Risk of misuse or leak of patient data without strong privacy controls Monitoring a large number of private labs may burden existing IDSP/DSU staff Lack of clear benefits or reimbursement can cause a drop in interest Policy or legal delays in enforcing participation from private labs Risk of fake data entries or under-reporting if monitoring is weak Lack of inter-department coordination (health, IT, local govt.) may slow implementation Delays or gaps in sharing information with private stakeholders, and the absence of direct contact with them in review meetings

DISCUSSION

This study highlights why bringing PDLs into India's national surveillance network is not merely an option but a critical necessity. While private laboratories conduct close to 70% of diagnostic testing, their routine data often remains outside public systems such as IHIP and IPHL, creating blind spots that delay outbreak detection and reduce the effectiveness of data-driven public health planning.^{5,6}

The proposed framework offers a balanced, stepwise solution to bridge this gap. Rather than enforcing sudden systemic change, it encourages gradual integration through legally mandated disease reporting, clear digital data flow pathways, and formal MoUs that define mutual responsibilities.¹⁷ Importantly, it accounts for disparities in capacity among laboratories, recommending conditional participation for those without accreditation, paired with a time-bound plan for quality improvement.^{24,25} This inclusivity allows engagement from smaller and rural laboratories while preserving quality through NABL accreditation and regular external checks.²⁰

Digitally, the approach emphasizes modern solutions, leveraging LIMS with secure API connections based on HL7 and FHIR standards for real-time rather than retrospective reporting.^{27,28} This ensures seamless integration with IHIP dashboards, enabling public health teams to track disease trends as they occur. The linking of results to Aadhaar-enabled ABHA IDs minimizes duplicate records and improves patient traceability.^{18,19}

A major strength of the framework is its human resource focus. Training sessions led by district-level IPHL teams would address

every stage of laboratory workflow, from safe sample collection and handling to digital coding and secure data transmission.²³ These sessions would also keep staff updated on emerging threats such as AMR, Nipah, and Zika, enhancing their role from passive data collectors to proactive surveillance contributors.^{5,25} A layered monitoring mechanism—combining internal quality checks, district-level audits, and state oversight—strengthens accountability without relying solely on punitive measures.²⁴

Finally, lessons drawn from global examples like the US CDC's NNDSS demonstrate that sustainable surveillance partnerships thrive when enforcement is balanced with technical and operational support.^{10,11} By offering mentoring, retraining, and targeted assistance rather than excluding underperforming laboratories, the framework fosters continuous data contribution and improvement. In doing so, it redefines private laboratories from peripheral actors to core partners in India's public health surveillance ecosystem.

This research paper is primarily based on secondary data sources such as policy documents, reports, and published literature which provide valuable insights, but they may not fully reflect the complexities and operational challenges faced at the ground level. The lack of direct interaction with the key stakeholders including private laboratory personnel, public health officials, and policymakers, limits a deeper understanding of real-world barriers and motivations. The significant differences in infrastructure, governance, and digital readiness in different states of the country may also significantly influence the implementation of the proposed framework. Additionally, the public health and digital ecosystem

in India is continuously evolving; so, some findings may change as systems like IHIP and IPHL are further developed.

Lastly, the framework proposed in this paper remains conceptual and has not been tested in real-world settings, which limits the ability to assess its practical feasibility and effectiveness.

Addressing these Limitations in Future Research

Future research should focus on testing the proposed framework in real-world settings through field-based studies. Collecting primary data using interviews, surveys, and stakeholder consultations can provide better insight into practical challenges.

Studies comparing different states may help identify region-specific issues and best practices, making the framework more flexible. Longitudinal research can also help understand how changes in digital health systems affect surveillance over time.

In addition, pilot testing of the proposed framework in selected districts would help evaluate its effectiveness in terms of data quality, reporting timeliness, and participation. Further research on cost-effectiveness and data security would also support its long-term sustainability.

CONCLUSION

This study reaffirms that integrating PDLs into India's public health surveillance framework is not simply a technical upgrade but a strategic imperative for national health security. At present, the absence of routine, structured data sharing from these laboratories—despite their substantial share in diagnostic testing—creates gaps that delay outbreak detection and weaken the country's ability to respond effectively.

The proposed framework addresses this by combining legal clarity, digital integration, structured partnerships, and phased inclusion of laboratories based on quality readiness. Its design recognizes the diversity in laboratory capacity across India and avoids a one-size-fits-all approach. By mandating facility registration through the Health Facility Registry, linking patient records via Aadhaar-enabled ABHA IDs, and using internationally recognized interoperability standards such as HL7 and FHIR, it creates a foundation for secure, real-time data flow into the IHIP and IPHL network.

Equally important is the human element: Regular district-level training, targeted mentoring, and layered supervision transform private laboratories from passive data providers into active partners in disease surveillance. The emphasis on collaboration—rather than purely on enforcement—mirrors successful international models like the US CDC's National Notifiable Diseases Surveillance System, where sustained participation is achieved through support, trust-building, and shared accountability.

If implemented, this framework has the potential to push laboratory reporting completeness above 90%, significantly reduce reporting delays, and extend surveillance coverage into areas currently invisible to the system. More importantly, it would move India closer to the NITI Aayog Vision 2035 goal of a future-ready, digitally integrated, and inclusive public health ecosystem—capable of detecting, responding to, and preventing health threats in real time.

Policy Implications

This study suggests that integrating PDLs into India's public health surveillance system can substantially strengthen early outbreak

detection and improve data completeness. By embedding Compulsory Legal Reporting, digital infrastructure, accreditation, and collaborative agreements, policymakers and health authorities can create a scalable and inclusive model. The framework aligns with ongoing national programs such as ABDM, IDSP, and IPHL, and offers a pathway to bridge gaps between private and public health sectors.

AI Disclosure

This is to be declared that this article is original and no AI tool has been used, though Gemini has been used for grammatical improvization only.

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AUTHOR'S CONTRIBUTIONS

Rekha Meena as corresponding author was involved in conceptualization of the study, framing, editing and drafting the final manuscript.

Anushka Sahni as co-author was involved in literature search, writing, editing and drafting the final manuscript.

Bhupinder Chaudhary as co-author was involved in framing, editing and drafting the final manuscript.

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