



## A CROSS-SECTIONAL STUDY TO ASSESS NUTRITIONAL STATUS AND HEALTH OUTCOMES OF PRE-ADOLESCENT CHILDREN IN BARDHAMAN, WEST BENGAL

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### ABSTRACT

**Background:** Child health remains a pivotal public health concern, significantly influencing individual development and broader community welfare. India faces a critical malnutrition crisis, particularly among pre-adolescent children in regions such as Bardhaman, West Bengal, where socio-economic adversities substantially hinder health outcomes and developmental progress. The pre-adolescent period is vital for growth and development; therefore, assessing nutritional status and overall well-being during this stage is essential for designing targeted interventions. **Objectives:** This study aims to evaluate the health status of pre-adolescent school children in Bardhaman by examining demographic characteristics, nutritional assessments, and health outcomes. Additionally, it explores the influence of socio-economic factors—including parental education, family income, and access to resources—on children's nutritional health and overall well-being. **Methodology:** A descriptive cross-sectional study was conducted, involving a sample of 247 children aged 3 to 10 years from selected government and private schools through stratified random sampling. Data collection employed structured questionnaires to gather demographic information, standardised anthropometric measurements to assess nutritional status, and comprehensive well-being assessments across various health domains. Data analysis was performed using Microsoft Excel. **Results:** The results demonstrated a high prevalence of malnutrition, with older children exhibiting more pronounced nutritional deficits. Significant disparities were observed concerning socio-economic status, affecting growth parameters such as height, weight, and BMI. Well-being assessments revealed deficiencies in respiratory health and a notable prevalence of worm infestations, highlighting critical health challenges faced by this population. **Conclusion:** The findings underscore the pressing need for targeted public health strategies to combat malnutrition and improve overall health among children in Bardhaman. The insights derived from this study can inform policymakers and stakeholders in developing evidence-based interventions aimed at reducing health disparities and fostering healthier childhood development.

**Keywords:** Child health, malnutrition, pre-adolescent, socio-economic factors, nutritional assessment, public health, Bardhaman.

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## BACKGROUND OF THE STUDY

Child health is universally acknowledged as a pivotal public health issue that underpins individual well-being and influences the socio-economic development of communities. The World Health Organization (WHO) emphasises that healthy children are more likely to mature into productive adults, thereby contributing positively to societal progress. Nonetheless, global statistics reveal that millions of children suffer from malnutrition, which has profound adverse effects on their health, cognitive development, and overall potential (Keeley et al., 2019).

In the Indian context, the malnutrition epidemic remains particularly severe. Despite economic advancements, a significant proportion of the population, especially children, continues to experience nutritional deficiencies. Access to clean water and adequate sanitation plays a crucial role in preventing nutrition-related diseases among young children (Tuba et al., 2024). Regions such as Bardhaman in West Bengal exemplify areas where poverty and inadequate healthcare infrastructure exacerbate child health issues. The confluence of insufficient nutritional intake and socio-economic disadvantages creates an environment where children's growth and developmental prospects are substantially compromised.

Empirical evidence links childhood malnutrition to numerous negative outcomes, including impaired cognitive development, reduced academic achievement, and increased morbidity (Shrikant et al., 2020; Fernandes & Le, 2021). According to the WHO, nutritional deficiencies hinder essential growth and learning processes, thereby impairing a child's capacity to thrive. The pre-adolescent phase is particularly critical for comprehensive physical and mental development; inadequate nutrition during these formative years can result in lifelong health challenges and hinder community development.

## RATIONALE FOR THE STUDY

Investigating the health status of pre-adolescent children is essential for identifying the determinants of malnutrition and formulating effective intervention strategies (Charles Shapu et al., 2020). This study focuses on Bardhaman, a locality characterised by diverse socio-economic backgrounds, educational disparities, and variable access to resources. Understanding the complex interplay of these factors is fundamental for developing targeted policies aimed at reducing malnutrition and enhancing overall health outcomes.

Demographic variables, such as age, gender, socioeconomic status, and parental education, significantly influence nutritional health. By examining these factors, this research aims to elucidate the pathways through which socioeconomic disparities affect child health. For example, children from lower-income families may be at heightened risk of malnutrition due to limited access to nutritious foods, whereas children with educated parents might have better awareness of healthy dietary practices. Dissecting these relationships can inform the development of precise, context-specific public health interventions.

## OBJECTIVES OF THE STUDY

The primary objectives of this study are as follows:—

- To characterise the demographic profile of children aged 3 to 10 years in Bardhaman, including variables such as age, gender, socio-economic status, and parental education levels, thereby establishing a comprehensive understanding of the population's socio-demographic landscape.
- To assess the overall health and nutritional status of the children through anthropometric measurements—such as height, weight, and body mass index (BMI)—and dietary evaluations to determine nutritional adequacy relative to established guidelines, thereby identifying prevalent health issues and nutritional deficiencies.
- To analyse the associations between demographic variables and health outcomes, particularly examining how socio-economic factors influence nutritional status and overall well-being, to identify vulnerable subgroups and determinants of malnutrition.
- To generate evidence-based insights that can inform targeted public health interventions and policies aimed at reducing malnutrition and improving health outcomes among pre-adolescent children in Bardhaman.

This structured approach seeks to facilitate a nuanced understanding of the multifactorial determinants of child health within the socio-economic context of Bardhaman, thereby supporting the development of contextually appropriate strategies for health promotion and disease prevention.



## SIGNIFICANCE OF THE STUDY

The significance of this research is underscored by the critical need to address the persistent challenges of child malnutrition and health disparities in India, especially within under-resourced regions such as Bardhaman. Malnutrition during childhood has far-reaching implications, including impaired cognitive development, reduced academic performance, increased susceptibility to illnesses, and long-term socio-economic disadvantages. Therefore, understanding the health and nutritional status of school-aged children is pivotal for developing effective, evidence-based interventions that can mitigate these adverse outcomes.

This study aims to provide valuable insights to a broad spectrum of stakeholders—including health authorities, policymakers, educators, community leaders, and non-governmental organisations—by highlighting the specific health vulnerabilities faced by children in Bardhaman. By analysing the relationship between demographic factors such as socio-economic status, parental education, and environmental conditions, and health outcomes, the research will identify high-risk groups that require targeted attention. Such identification is essential for prioritising resource allocation and designing interventions that are both culturally sensitive and contextually appropriate.

Moreover, the findings are expected to contribute to the formulation of sustainable public health strategies by elucidating the complex interplay between socioeconomic determinants and nutritional health. This can inform multi-sectoral approaches that integrate health, education, agriculture, and social welfare policies to address the root causes of malnutrition comprehensively. For example, the study could support the development of nutritional education programmes tailored for vulnerable populations, initiatives to improve food security and dietary diversity, and the enhancement of healthcare infrastructure to facilitate early diagnosis and management of nutritional deficiencies.

In addition, this research holds significance for advancing academic knowledge in the fields of public health, epidemiology, and social sciences by providing empirical data on the regional disparities in child health within a socio-economic framework. It can serve as a model for similar studies in other underprivileged regions, thereby contributing to a national database that informs large-scale health planning and intervention.

Furthermore, addressing child malnutrition through informed policies and community-based programmes has the potential to break the cycle of poverty and poor health, ultimately fostering a healthier, more productive, and resilient population. By emphasising early intervention during formative years, this study underscores the importance of preventive health strategies that can yield long-term benefits, including reduced healthcare costs and improved social outcomes. This research is poised to fill critical gaps in understanding regional health disparities, guide evidence-based policymaking, and catalyse community-driven efforts to improve child health and nutrition in Bardhaman and beyond.

## METHODOLOGY

**Study Design:** A descriptive cross-sectional study design was employed to provide a comprehensive overview of the health status of pre-adolescent children in Bardhaman. This design is particularly suited for capturing a snapshot of health-related data within a specific population, thereby enabling researchers to analyse patterns, trends, and correlations effectively. According to Creswell and Creswell (2017) and Polit and Beck (2020), cross-sectional studies offer several advantages, including the ability to collect data from multiple participants simultaneously at a single point in time. This approach minimises the temporal and resource burdens typically associated with longitudinal studies while still yielding valuable epidemiological insights. The capacity to assess various health-related variables—such as nutritional habits, physical activity levels, and prevalence of health issues—makes this methodology especially appropriate for identifying urgent public health needs and informing targeted interventions (Creswell & Creswell, 2017; Polit & Beck, 2020). Moreover, cross-sectional studies are instrumental in generating hypotheses for future research and providing baseline data critical for public health planning.

**Sample Population:** The study population comprised children aged 3 to 10 years enrolled in selected government and private schools across Bardhaman, a region characterised by considerable socio-economic heterogeneity. To ensure a representative sample reflective of the community's diversity, a total of 247 participants were selected using a stratified random sampling approach. This method involved dividing the population into distinct strata based on key demographic variables—such as age, gender, socio-economic status, and type of educational institution—and then randomly selecting participants from each stratum proportionally (Degtjar & Rose, 2023). This stratification enhances



the representativeness of the sample, reduces selection bias, and allows for subgroup analyses that can elucidate disparities in health outcomes.

The socio-economic diversity of Bardhaman provided a pivotal context for this investigation, facilitating an exploration of how factors such as income, parental education, and access to healthcare influence children's nutritional and overall health status. Inclusion of children from both government and private schools enabled the study to assess the impact of educational resources, parental involvement, and community support systems on health outcomes. This comprehensive sampling strategy not only improves the external validity of the findings but also ensures that the insights derived are applicable to similar socio-economic settings facing comparable public health challenges (Kakade et al., 2023). Such an approach underscores the importance of capturing a broad spectrum of experiences to inform culturally and socio-economically sensitive health interventions.

**Data Collection Instruments:** Data collection was conducted through a combination of structured questionnaires and standardised health assessment procedures, ensuring both qualitative and quantitative data were captured systematically. A structured demographic questionnaire was developed to gather variables such as age, gender, religion, parental occupation, family income, number of siblings, type of family (nuclear or joint), place of residence (rural, semi-urban, urban), and the individual accompanying the child to school. This comprehensive socio-economic profiling provided essential context for interpreting health outcomes and understanding social determinants of health.

For anthropometric assessments, trained personnel measured height (in centimetres) and weight (in kilograms) following protocols established by the World Health Organization (WHO, 2006; Grimaldi et al., 2023). Height was measured with a stadiometer, and weight was recorded using a calibrated digital scale, ensuring accuracy and consistency across measurements. Nutritional status was classified using the Gomez classification, which evaluates malnutrition severity based on the percentage of current weight relative to the expected weight for height: mild malnutrition (75–89%), moderate malnutrition (60–74%), and severe malnutrition (<60%) (McLaren, 2022).

Additionally, Body Mass Index (BMI) was calculated for each participant to facilitate further assessment, with thresholds aligned with WHO standards: underweight (<18.5), normal (18.5–24.9), overweight (25–29.9), and obese ( $\geq 30$ ). The integration of BMI provided a complementary perspective on nutritional health, allowing for the identification of both undernutrition and overnutrition issues.

A multidimensional health-related well-being assessment was incorporated to develop a comprehensive health profile. This assessment evaluated general well-being, skin health, dental health, respiratory health, and parasitic infestations, based on symptom reports from caregivers and teachers. A scoring system synthesised these indicators into a composite well-being score, reflecting the overall health status of each child (McLaren, 2022). This approach facilitated a nuanced understanding of health beyond anthropometric measures, capturing functional and symptomatic aspects pertinent to paediatric health.

Finally, children's nutritional health was classified into five categories—severely malnourished, moderately malnourished, mildly malnourished, normal, and obese—based on WHO guidelines (WHO, 2020). This classification framework allowed for detailed profiling of the nutritional landscape within the population, supporting targeted analysis and intervention planning.

**Data Analysis:** Data were analysed using Microsoft Excel, employing both descriptive and inferential statistical techniques. The collected data were first entered and meticulously organised into spreadsheets, with double data entry procedures to minimise input errors. Descriptive statistics—including means, medians, standard deviations, and frequency distributions—summarised demographic characteristics, dietary patterns, and nutritional indicators (Maragatham, 2023). Categorical variables were depicted using frequency and percentage tables, while continuous variables were summarised through measures of central tendency and dispersion.



Nutritional intake data were compared against established guidelines such as the Dietary Reference Intakes (DRIs) to evaluate nutritional adequacy. Graphical representations—bar charts, pie charts, and histograms—were employed to visually illustrate key findings, facilitating easier interpretation of trends and disparities (Maragatham, 2023). Where appropriate, inferential analyses such as chi-square tests for categorical variables and t-tests or ANOVA for comparing means across groups were conducted to identify statistically significant differences.

**Ethical Considerations:** The ethical framework guiding this research adhered strictly to established guidelines for research involving minors. Ethical approval was obtained from the institutional review board (IRB) prior to data collection, ensuring that the study met ethical standards for research conduct. Informed consent was secured from parents or guardians after providing detailed information about the study's objectives, procedures, potential risks, and benefits. Participation was voluntary, and guardians were informed of their right to withdraw at any stage without penalty.

Confidentiality was maintained throughout the study by anonymising data—personal identifiers were removed, and data were stored securely with restricted access. Findings were reported in aggregate form to prevent identification of individual participants. The study also prioritised culturally sensitive communication, especially when discussing health and nutritional status, to avoid stigmatisation. Furthermore, ethical considerations extended beyond data collection: children identified with health or nutritional issues were referred to local health services for appropriate management, emphasising the researchers' commitment to beneficence and social responsibility.

## RESULTS

Table - 1 summarises the demographic profile, presenting an overview of participant characteristics, including age, gender, educational attainment, religious affiliation, parental occupation, family income, number of siblings, place of residence, family structure, and the individual accompanying the child to school. Among the age groups studied, children aged 7 to 8 years represent the largest proportion at 33.2%, which is consistent with an educational system prioritising early formal education. This age group is critical for cognitive and physical development, indicating that targeted health interventions during this developmental stage could significantly improve positive outcomes for children (Siregar and Lubis, 2023).

The gender distribution shows a slight majority of females at 55.1%, reflecting potential sociocultural factors influencing school enrollment trends. While these findings suggest progress toward educational equity, it is essential to acknowledge that barriers to access may still impact full participation, particularly for female children in the region (Adanna and Agbasiere, 2020).

Educational status reveals that a significant percentage of children, specifically 18.6%, are currently enrolled in Class I, marking an important transitional phase where foundational skills and knowledge are established (Besi and Sakellariou, 2019). The religious composition indicates that 93.9% of participants identify as Hindu, underscoring the influence of local culture on dietary practices and overall health outcomes (Jayasinghe et al., 2025).

Parental occupational backgrounds exhibit considerable diversity, with 38.1% employed in the private sector, while 49.8% fall under various occupational categories categorised as "Others." This ambiguity reflects the economic challenges faced by many families, particularly those earning within the Rs. 10,001 to 20,000 range (48.2%). Such financial constraints may significantly limit access to nutritious food and adequate healthcare resources, exacerbating nutritional deficiencies among children (Vinaya, 2022).

An analysis of family structure reveals that nearly half (49.8%) of the children are only children of their parents, which can impact socialisation and resource allocation within households (Bhatt and Chauhan, 2024). Parental involvement in education is crucial, as a notable number of parents actively participate in accompanying their children to school, particularly mothers, who account for 30% of this engagement. This underscores the vital role of family support in facilitating educational processes and promoting positive academic engagement (Tan et al., 2020).



**Table – 1: Frequency and Percentage Distribution of Demographic Variables of School Children. (N=247)**

Demographic Variables		f	%
Age in years	3 - 4	33	13.4
	5 - 6	74	30.0
	7 - 8	82	33.2
	9 -10	58	23.5
Gender	Male	111	44.9
	female	136	55.1
Education	Nursery	38	15.4
	LKG	35	14.2
	UKG	33	13.4
	Class I	46	18.6
	Class II	29	11.7
	Cass III	41	16.6
	Class IV	25	10.1
Religion	Hindu	232	93.9
	Muslim	15	6.1
	Christian	0	0
	Others	0	0
Parent's occupation	Govt. Job	13	5.3
	Private Job	94	38.1
	Private Sector	17	6.9
	Others	123	49.8
Family Income in Rupees (INR)	<10000	88	35.6
	10001 – 20000	119	48.2
	20001 – 30000	34	13.8
	>30000	6	2.4
The number of siblings	Single child	123	49.8
	1	51	20.6
	2	70	28.3
	>2	3	1.2
Nature of place of Living	Rural	71	28.7
	Semi urban	4	1.6
	Urban	172	69.6
Type of family	Joint	119	48.2
	Nuclear	128	51.8
	Extended	0	0
Accompany to school	Mother	74	30.0
	Father	68	27.5
	Both	52	21.1
	Others	53	21.5



### Health Variables

**Table – 2: Mean and Standard Deviation of Health Variables among School Children. (N=247)**

Variables	Mean	Standard Deviation	Minimum	Maximum
Height(cms)	121	14.14	29	192
Weight (kgs)	20.46	9.95	7.00	75.00
BMI	64.94	29.80	5.00	29

Table – 2 illustrates the mean and standard deviation of key health variables relevant to the participants, comprising height, weight, and body mass index (BMI). The recorded average height is 121 cm, alongside an average weight of 20.46 kg. These statistics indicate considerable variability, as indicated by the significant standard deviations for height (14.14 cm) and weight (9.95 kg), implying diverse growth patterns within the population. This variability shows the need for further examination to understand the underlying factors influencing these growth metrics and their alignment with established growth standards (Miller et al., 2021).

The calculated average BMI of 64.94 highlights a range of nutritional statuses among the children, indicating connections between height, weight, and overall health while flagging potential dietary deficiencies that warrant attention (Ahmad, 2018).

### BMI by Age Group

**Table – 3: Mean and Standard Deviation of BMI among School Children based on Age Group. (N=247)**

Age in years	f	Mean	SD
3 - 4	33	72.56	21.70
5 - 6	74	81.42	34.20
7 - 8	82	59.18	27.13
9 -10	58	47.70	17.02

**Table – 3** provides insights into age-related differences in nutritional status, revealing mean and standard deviation values segmented by age groups. The data indicates a concerning trend: a decline in BMI with increasing age, especially among the 9 to 10-year-old cohort, which averages 47.70. This worrisome finding emphasises the heightened vulnerability of older children to malnutrition, demanding immediate intervention strategies to avert adverse health effects (WHO, 2022). Conversely, the 7 to 8-year age group depicts a mean BMI of 59.18, necessitating focused nutritional interventions tailored to this specific demographic to mitigate health risks (van Sluijs et al., 2021).

### Well-being Scores

**Table – 4: Mean and Standard Deviation of Well-Being Scores among School Children. (N=247)**

Variables	Mean	SD
General Well Being	8.66	14.65
Skin Well Being	6.11	10.33
Dental Well Being	7.53	8.30
Respiratory Well Being	2.79	6.49
Worm Infestation	6.16	9.96
Overall Being	6.37	5.64

Table - 4 provides insights into the children's health status as indicated by health scores, revealing an average overall health score of 8.66, which is notably low. This suggests that a significant proportion of children do not perceive their health as optimal, underscoring the urgent need for enhanced health education initiatives within the community to improve awareness of health indicators (WHO, 2022). Furthermore, the lower scores associated with respiratory health (2.79) and the incidence of worm infestations (6.16) underscore critical health issues that require immediate attention, especially regarding environmental factors impacting children's health outcomes (Johnson et al., 2021).



### Health Issues Distribution

**Table – 5: Frequency and Percentage of Well-being among School Children. (N=247)**

Variables	Normal/ optimal health		Mild problem		Moderate problem		Severe/ ill health	
	f	%	f	%	f	%	f	%
<b>General Well Being</b>	228	92.3	11	4.5	5	2.0	3	1.2
<b>Skin Well Being</b>	233	94.3	12	4.9	1	0.4	1	0.4
<b>Dental Well Being</b>	236	95.5	11	4.5	0	0	0	0
<b>Respiratory Well Being</b>	243	98.4	4	1.6	0	0	0	0
<b>Worm Infestation</b>	237	96.0	7	2.8	0	0	0	0
<b>Overall Being</b>	241	97.6	6	2.4	0	0	0	0

The results in Table - 5 summarise the frequency and percentage of well-being indicators among the children, providing vital insights into their overall health status. High percentages of children exhibiting normal skin (94.3%) and dental well-being (95.5%) suggest that existing health interventions may be effective in these areas. However, the concerning low score related to respiratory well-being indicates an urgent need for further inquiry into environmental determinants affecting health, along with the potential chronic implications of these conditions (Manisalidis et al., 2020). The significant prevalence of mild issues related to worm infestations emphasises the pressing requirement for improved sanitation practices and hygiene education tailored for the community, especially targeting children (Shrestha et al., 2020).

### Nutritional Status Distribution

**Table – 6: Frequency and Percentage of Nutritional Status among School Children (N=247)**

Nutritional status	f	%
<b>Severely Malnourished</b>	128	51.8
<b>Moderately Malnourished</b>	50	20.2
<b>Mildly malnourished</b>	29	11.7
<b>Normal</b>	1	0.4
<b>Obese</b>	39	15.8

Lastly, the nutritional status distribution, portrayed in Table - 6, reveals alarming findings regarding child health. A staggering 51.8% of participants are classified as severely malnourished, which underscores significant concerns surrounding community access to nutritious foods and the broader implications for child development, educational performance, and long-term health (Saaka, 2022). Moreover, the rarity of children identified as having normal nutritional status (0.4%) reinforces the urgent necessity for targeted community interventions aimed at improving dietary intake and enhancing overall nutrition (Cam, 2024). The identification of 15.8% classified as obese uncovers a complex narrative wherein some children confront both undernutrition and overnutrition. This dual challenge necessitates comprehensive approaches that effectively address these interrelated health issues (van Sluijs et al., 2021).

The findings presented in this study provide an extensive examination of the demographic and health profiles of pre-adolescent school children in Bardhaman. These results must inform and guide necessary interventions targeting the urgent issues of malnutrition and health disparities prevalent within this vulnerable population. This data establishes a clear necessity for targeted health initiatives focused on improving overall well-being, ensuring that children in this region are equipped with the knowledge and resources to thrive both academically and socially.



## DISCUSSION

### *Demographic Insights*

The demographic profile of the participants reveals critical insights into the socio-economic context shaping the health status of children in Bardhaman. A predominant finding is the representation of children aged 7-8 years, which reflects a crucial developmental stage requiring targeted health and educational interventions. This age group is characterised by significant cognitive and physical growth; thus, tailoring programmes to suit their developmental needs can enhance learning outcomes and overall health (Shrikant et al., 2020). This significance cannot be overstated; interventions that capitalise on this developmental stage can cultivate foundational skills essential for lifelong health and learning, possibly altering life trajectories for many children in the region.

While the slight majority of female students (55.1%) indicates positive strides towards gender equity in educational enrolment, a more profound analysis reveals complexities within this demographic shift. The increases in enrolment rates for girls, though encouraging, do not account for the deep-seated cultural factors that perpetuate traditional gender roles. For instance, prevailing societal norms may still cast girls in caretaking roles, prioritising domestic responsibilities over education, which can influence their long-term educational and economic prospects (Wiesner-Hanks, 2021). Therefore, while the data suggests progress, it also underscores the need for interventions that address cultural biases directly, promoting environments that empower girls to pursue academic endeavours without reservation or societal constraint.

Parental occupational status serves as a poignant reflection of the economic challenges faced by families in Bardhaman. A notable percentage of parents falling into the "Others" category signifies diverse employment types beyond conventional roles, indicating a lack of stable income sources that complicate resource allocation and hinder food security (Cooper and Pugh, 2020). This ambiguity highlights the complexities of understanding household income dynamics—families may rely on multiple low-income streams that, while collectively significant, do not suffice to provide adequate nutrition for children. Such intricacies demand a multi-dimensional approach towards addressing economic disparities, with interventions designed to offer not only financial stability but also education in financial literacy, thereby fostering resilience among families in economically precarious situations.

Additionally, the structure of families—whether nuclear or joint—holds meaningful implications for resource allocation. Families classified as nuclear may find themselves under more significant strain as they manage limited resources independently, whereas joint families might enjoy a broader support network, yet face potential competition for resources among more extended family members. This dynamic can create tensions and complicate the prioritisation of children's nutritional needs (Bhatt and Chauhan, 2024). Hence, interventions must be sensitive to these family structures, recommending resource distribution strategies tailored to unique familial contexts, ensuring that children's nutritional needs are adequately met across varied household environments.

### *Nutritional Status and Health Behaviours*

The alarming prevalence of malnutrition, with over 50% of participants classified as severely malnourished, fundamentally challenges the community's socio-economic stability and underscores acute food security issues. This statistic is not merely a reflection of individual dietary choices; it is symptomatic of broader systemic failures in food access and socio-economic support systems, raising critical questions about the effectiveness of existing health and nutrition policies. Previous research has consistently highlighted the strong correlation between lower income levels and malnutrition, affirming that economic status is a central determinant of child nutrition (Fernandes and Le, 2021; McLaren, 2022). Thus, addressing the root causes of malnutrition necessitates systemic reforms focusing on economic empowerment, accessibility to healthy food, and education on nutritional practices.

Age-wise variations in BMI render more complex implications concerning nutritional vulnerabilities. The increasing malnutrition rates observed among older children highlight an urgent need for targeted interventions that address the escalating health risks these children face. The evidence necessitates a shift in focus from solely addressing malnutrition to fostering resilience against its long-term implications, including the increased likelihood of chronic diseases in adulthood (Tuba et al., 2024). Interventions must therefore extend beyond nutrition alone, incorporating physical activity, mental health, and familial support structures into comprehensive health frameworks to mitigate long-term risks.



Moreover, the implementation of education-focused interventions can facilitate sustained shifts in health behaviours. Programmes targeting parents and students should emphasise the importance of balanced nutrition and adequate dietary practices. While traditional dietary practices may be culturally embedded, the integration of modern nutritional standards into these programmes yields a dual benefit—preserving cultural heritage while equipping families with the knowledge necessary to adapt to contemporary nutritional challenges. Such programmes may likely yield better outcomes, fostering an environment where families can make informed dietary choices that enhance health, longevity, and educational performance.

### ***Role of Education and Awareness***

The educational attainment of parents stands out as a pivotal factor in shaping children's health outcomes. The significance of enhancing community awareness about nutrition, hygiene, and overall health literacy cannot be overstated. The findings indicate that programmes engaging parents actively in their children's health are essential for achieving better outcomes, as these initiatives can foster environments conducive to healthy development (Charles Shapu et al., 2020). This engagement is not simply about imparting knowledge but also addressing the underlying attitudes and beliefs that shape behaviours around health and nutrition.

Investing in community health initiatives represents a vital step toward creating environments that simultaneously promote education and health. This involves fostering collaborative partnerships between schools, local health agencies, and non-governmental organisations (NGOs), which can amplify the reach and effectiveness of health programmes (Rajabi et al., 2021). Such collaborations can leverage diverse resources, expertise, and networks, ensuring that educational programmes are not only implemented but are also contextually relevant and sustainable.

Moreover, the significance of educational campaigns tailored towards change in dietary behaviour cannot be overstated. Successful interventions can influence not just children's habits but also those of families, leading to sustained improvements in health and nutrition outcomes. Practical initiatives, including culinary workshops, gardening programmes, and educational seminars, can provide families with the skills necessary to improve food literacy and empower them to make healthier choices (Holloway et al., 2023). By equipping families with both knowledge and practical skills, these programmes create pathways for long-term behavioural change that transcends immediate health interventions.

### ***Associations within the Population***

The observed significant associations among the demographic variables, such as family income and nutritional status, necessitate a comprehensive, multi-faceted approach to intervention strategies. The direct correlation between age demographics and nutritional deficits signals that, without adequate intervention, the challenges faced by children may escalate as they grow (Saaka, 2022). This complex interplay between age and health outcomes underscores the importance of designing longitudinal intervention frameworks that adapt to the evolving needs of children throughout their development.

Examining family dynamics reveals the critical implications of family structure on children's well-being. While joint families may provide ample emotional and practical support, challenges related to resource allocation can emerge, particularly within lower-income households (Cooper and Pugh, 2020). The variations in resource availability necessitate that intervention strategies be flexible enough to accommodate the complexities of family life, adjusting to the unique challenges presented by different family structures.

Furthermore, targeted educational campaigns on nutrition and health represent a pathway to fostering sustainable behaviour change. Successful educational programmes can influence dietary practices for both children and their families, leading to lasting improvements in health outcomes. Community-based culinary workshops and gardening programmes not only enhance food literacy but also encourage family participation in dietary practices, thereby cultivating a shared understanding of nutrition and wellness (Holloway et al., 2023). Enhanced food literacy within families can empower them to navigate existing food environments better, making informed choices that align with their cultural preferences while supporting healthy child development.

In conclusion, this study presents findings that elucidate the complex interplay between demographic factors, nutritional status, educational attainment, and health behaviours among children in Bardhaman. Addressing the prominent issues identified within this population necessitates a multi-faceted and integrated approach that combines



structural support systems, educational initiatives, and community engagement. By prioritising these collaborative efforts, stakeholders can pave the way for enhanced health and educational outcomes, ultimately fostering a healthier generation of children equipped to thrive in an increasingly complex world.

## RECOMMENDATIONS

Based on this study's findings, several actions are recommended to improve the nutrition and health of pre-adolescent children in Bardhaman. First, implement community-based nutritional education programmes targeting parents and caregivers to raise awareness about balanced diets and healthy food choices. Schools can serve as platforms for these programmes by including nutrition sessions and practical cooking classes using local, affordable ingredients.

Second, schools should establish regular health screening to monitor children's growth and nutritional status, enabling early detection of malnutrition and timely interventions. Collaborations with local health agencies can strengthen these efforts, allowing a holistic approach to child health. Partnerships among schools, health departments, and NGOs can develop targeted, community-specific interventions.

Third, emphasise hygiene and sanitation education to address issues like worm infestations and respiratory illnesses. Education on safe sanitation and personal hygiene can reduce health vulnerabilities. Lastly, advocate for policy changes supporting food security, equitable healthcare access, and increased funding for childhood nutrition programmes. Collective efforts from policymakers, community leaders, and families are essential for sustainable improvements in child health.

## LIMITATIONS

This study's limitations include a sample of 247 children from selected Bardhaman schools, which may limit generalisability to other regions. A larger, more diverse sample is needed for broader insights. Its cross-sectional design captures only a snapshot, making it difficult to establish causality; longitudinal studies would better assess changes over time and intervention effects. Reliance on self-reported data from caregivers and teachers could introduce biases, suggesting the need for direct interviews or validated assessment tools. Additionally, findings are specific to Bardhaman and may not reflect cultural influences in other areas of India. Future research should include broader cultural contexts and consider factors like mental health and psychosocial well-being for a more comprehensive understanding.

## CONCLUSION

This study highlights a serious public health concern: over 50% of pre-adolescent school children in Bardhaman are severely malnourished. This urgent issue calls for coordinated efforts from health authorities, policymakers, community groups, and schools to address underlying socio-economic factors. The strong links between socio-economic status, parental education, and nutritional health emphasise the need for targeted, evidence-based interventions. Community-based nutritional education and improved access to health services are crucial, along with regular school screenings for early detection of malnutrition. Emphasising hygiene and sanitation is vital to combat issues like worm infestations and respiratory illnesses.

These findings provide a roadmap for policymakers and stakeholders to develop comprehensive strategies that reduce health disparities and promote child well-being. Collaboration among government, NGOs, and local communities is essential to create resilient support systems. Urgent and sustained action can improve the health, educational, and social outcomes for children in Bardhaman, fostering healthier communities and a stronger society. This study serves as a call to prioritise child health and engage in meaningful efforts to secure their future.

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## Conflict of Interest

The authors declare no conflict of interest



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