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Impact of Nutritional Health Among Adolescents in Rural India

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Abstract

Adolescence is a phase of accelerated development requiring heightened macro- and micronutrient intake. In rural India, adolescents frequently encounter food instability, inadequate dietary diversity, and restricted access to health services. Anemia and undernutrition hinder physical development, cognitive abilities, and attending classes. This study evaluates the dietary status and factors contributing to anemia in rural adolescents. Adolescence (10–19 years) represents a pivotal period for nutritional treatments. This research addresses the nutritional status, dietary diversity, and factors linked to anemia and undernutrition in adolescents residing in rural India. Cross-sectional study including 202 teenagers in rural communities (simulated dataset). socio-demographics, Dietary Diversity Score (DDS; 0–9), anthropometry (BMI-for-age z-score), hemoglobin concentration (g/dL). Analyses: descriptive statistics, chi-square tests, t-tests, Spearman correlation In this simulated rural adolescent cohort, female adolescents exhibited increased probabilities of anemia. Dietary diversity (DDS) exhibited no significant correlation with anemia in the adjusted model. It is advised to concentrate programmatic efforts on adolescent girls, specifically regarding iron supplements, school-based nutrition, and menstrual health counseling.

Keywords: Nutritional Health, Adolescents, Rural India, Dietary Diversity

Introduction

Adolescence is a phase of accelerated development requiring heightened macro- and micronutrient intake. Adolescents in rural India frequently encounter food insecurity, inadequate dietary diversity, and restricted access to healthcare services. Anemia and undernutrition hinder physical development, cognitive abilities, and school attendance. This research evaluates the dietary status and factors influencing anemia in rural adolescents. Nutritional problems in adolescence are frequently exacerbated by gender inequities, with girls being particularly susceptible due to cultural standards, early marriage, and iron loss associated with menstruation. Inadequate dietary habits, characterized by insufficient intake of green leafy vegetables, legumes, and animal-derived meals, lead to micronutrient deficiencies. Insufficient understanding of balanced meals, together with misconceptions about certain foods, exacerbates the issue (Gupta, A., et.al., 2019).

The absence of school-based health interventions in numerous rural regions diminishes prospects for the early identification and management of anemia. Public health initiatives, including Weekly Iron and Folic Acid Supplementation (WIFS), have been instituted; nonetheless, coverage and adherence continue to be irregular. Socioeconomic position, parental education, and

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family food availability are essential factors affecting adolescent nutritional outcomes. Climate-related causes, seasonal food shortages, and insufficient water, sanitation, and hygiene (WASH) practices intensify malnutrition risks. Resolving these challenges necessitates a holistic strategy that incorporates nutrition education, dietary variety, routine health assessments, and community involvement. Enhancing school health services and guaranteeing regular supplement distribution could significantly improve adolescent health outcomes in rural India.

Review of Literature

Ansuya et al. (2021) performed a cross-sectional study in an area of South India to evaluate malnutrition in school-aged adolescents. The results indicated a substantial incidence of undernutrition, especially among females, with dietary diversity and socio-economic factors significantly influencing the situation. The research highlighted the need of community-oriented nutritional interventions and awareness initiatives to tackle both undernutrition and overnutrition. It also underscored deficiencies in school health initiatives in effectively reaching teenagers. This indicates that a comprehensive strategy engaging families, educational institutions, and policymakers is essential for enduring enhancement (Ansuya et al., 2021).

Khan, Ahmed, and Sinha (2020) investigated the effects of weekly iron–folic acid supplementation alongside nutritional advice on the hemoglobin levels of teenage girls in rural India. The results demonstrated notable enhancements in hemoglobin levels and a decrease in the prevalence of anemia throughout the trial duration. The incorporation of counseling was observed to improve adherence and awareness relative to supplements alone. This research advocates for the integration of medical and educational approaches to achieve enhanced outcomes. It also offers substantiation for the expansion of analogous treatments in resource-constrained rural regions (Khan et al., 2020). Joshi and Gumashta (2020) assessed the efficacy of weekly iron-folic acid supplementation combined with health education for teenage schoolgirls. Their comparative analysis revealed a notable reduction in anemia prevalence following the intervention period. The integration of supplements and education proved to be more beneficial than supplementation in isolation. Research indicated that improving dietary knowledge positively affects health-seeking behavior and adherence. The research promotes the incorporation of health education into current school health initiatives (Joshi & Gumashta, 2020).

(Mistry, et.al., 2021) examined compliance with weekly iron–folic acid supplementation among teenage girls in India and the factors affecting it. The study found that adherence was influenced by socio-demographic variables, awareness levels, and school-based program delivery. Insufficient awareness, assumptions regarding adverse consequences, and inconsistent supply chains constituted significant obstacles. Enhancing school-based distribution and guaranteeing consistent follow-up were advised. The study provides strategic insights for policymakers to enhance adolescent health programs (Mistry et al., 2021). Rai and Fawzi (2021) examined the variability of malnutrition among teenage girls in India utilizing nationally representative survey data. The study revealed considerable variations in nutritional status across regions, socio-economic classes, and caste groups. Stunting, thinness, and anemia prevalence varied significantly, indicating the need for targeted interventions. The authors advocated for initiatives that tackle

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structural inequities impacting nutritional outcomes. Their work underscores the importance of disaggregated data for designing effective nutrition programs (Rai & Fawzi, 2021).

Objectives of the research

- To assess the nutritional status (underweight, BMI z-scores, anemia) of adolescents (10–19 years) in selected rural communities.
- To examine associations between dietary practices (DDS), socio-economic status (SES), and nutritional status.
- To evaluate the impact of nutritional status on health outcomes (anemia prevalence used as a proxy for micronutrient deficiency).

Hypothesis of the research

- H01: There is a significant association between household socio-economic status (SES) and the nutritional status of adolescents.
- H02: Poor dietary diversity is significantly associated with higher prevalence of micronutrient deficiency (anemia) among adolescents, controlling for age and sex.

Methods Adopted & Research Design

Table 1: Variables & measurements

Variables	Measurements
Demographics	age, sex, SES (Low/Middle/High), parental education
Dietary Diversity Score (DDS)	continuous 0–9 (simulated distribution; mean ≈ 4.2).
Anthropometry	BMI-for-age z-score (BMI_z); underweight defined as BMI z < -2
Hemoglobin (g/dL)	point-of-care simulated values; anemia defined as Hb < 12 g/dL for males and Hb < 11.5 g/dL for females (applied in classification)
Outcome variable for regression	Anemia (Yes/No → binary)

Cross-sectional community study utilizing simulated data representing 202 adolescents aged 10 to 19 years from rural areas. Descriptive statistics, including means, standard deviations (SDs), counts, and percentages, were calculated for all variables to encapsulate the characteristics of the adolescent sample.

Bivariate studies were performed to investigate the correlations among major variables:

- The Chi-square test was utilized to evaluate the correlation between socio-economic level (SES) and underweight status (BMI-for-age z-score < -2).
- An independent samples t-test was employed to evaluate the mean Dietary Diversity Scores (DDS) between adolescents with anemia and those without. • Spearman's rank correlation coefficient was computed to assess the monotonic association between DDS and hemoglobin levels.
- Binary logistic regression was conducted for multivariable analysis to identify the determinants of anemia, using anemia status (Yes/No) as the dependent variable and age, sex, DDS, and SES as independent factors. Regression outcomes were displayed as

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coefficients, standard errors, z-statistics, p-values, and odds ratios (ORs) accompanied with 95% confidence intervals.

Results & Analysis

Table 2 — Sociodemographic Characteristics (n=202)

Variable	Category	n	%	Mean ± SD
Age (years)	–	–	–	13.8 ± 1.9
Sex	Male	99	49.0	–
	Female	103	51.0	–
Socioeconomic Status	Low	68	33.7	–
	Middle	69	34.2	–
	High	65	32.2	–
Dietary Diversity Score (DDS)	–	–	–	4.20 ± 1.40
Hemoglobin (g/dL)	–	–	–	11.7 ± 1.3

Table 3 — Nutritional Status Prevalence

Indicator	Category	n	%
BMI z-score	Underweight	12	5.9
	Normal weight	182	90.1
	Overweight/Obese	8	4.0
Anemia	Yes (<12 g/dL)	97	48.0
	No (≥12 g/dL)	105	52.0

Table 4 — Chi-square Test: SES vs Underweight

Test	χ^2	df	p-value	
SES × Underweight	0.039	2	0.981	No statistically significant association between socioeconomic status and underweight prevalence.

Table 5 — T-test: DDS by Anemia Status

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Group	n	Mean DDS	SD	Mean dietary diversity score is slightly higher among anemic adolescents, but the difference is not statistically significant.
Anemia = Yes	97	4.44	1.36	
Anemia = No	105	4.20	1.43	
t-test	–	t = 1.152	p = 0.251	

Table 6 — Spearman Correlation: DDS vs Hemoglobin

ρ	p-value	No significant monotonic relationship between dietary diversity score and hemoglobin levels.
-0.058	0.410	

Table 7 — Logistic Regression: Predictors of Anemia

Variable	Coefficient	Std. Error	z	p-value	95% CI (Lower)	95% CI (Upper)
Intercept	-1.367	0.948	-1.442	0.149	-3.225	0.491
Age	-0.001	0.052	-0.015	0.988	-0.102	0.101
Sex (Female)	1.214	0.300	4.048	0.000***	0.626	1.801
DDS	0.127	0.103	1.233	0.218	-0.075	0.328
SES (Middle)	0.258	0.327	0.790	0.430	-0.382	0.898
Female adolescents have significantly higher odds of anemia compared to males ($p < 0.001$), controlling for age, dietary diversity, and SES. Other predictors were not statistically significant.						

Table 8: Multivariable logistic regression — Predictors of anemia

(Table shown in the interactive output (Key coefficients))

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Predictor	Coef.	Std.Err	z	p-value	95% CI	OR (approx)	
Intercept	-1.367	0.948	-1.442	0.149	-3.225, 0.491	0.255	Model: Anemia_bin ~ Age + Sex_Female + DDS + SES_Middle + SES_High
Age	-0.001	0.052	-0.015	0.988	-0.102, 0.101	~1.00	
Sex_Female	1.214	0.300	4.048	<0.001	0.626, 1.801	OR ≈ 3.37	
DDS	0.127	0.103	1.233	0.218	-0.075, 0.328	1.14	
SES_Middle	0.258	0.327	0.790	0.430	-0.382, 0.898	1.29	
SES_High	0.246	0.478	0.514	0.607	-0.691, 1.183	1.28	
Female adolescents had significantly higher odds of anemia (adjusted OR ≈ 3.37, $p < 0.001$). Age, DDS, and SES were not statistically significant predictors in this simulated sample.							

Discussion & Findings

In this simulated rural teenage cohort, the principal finding indicated a robust correlation between female sex and anemia; adolescent females exhibited significantly greater odds of anemia compared to boys after controlling for dietary diversity score, age, and socioeconomic status. This corresponds with field research indicating a greater prevalence of anemia among adolescent girls attributable to menstruation, nutritional deficiencies, and gender-specific feeding patterns. The DDS in this simulation could not significantly predict anemia, likely due to the constraints of a single 24-hour-derived diversity score, measurement inaccuracies, or the features of the simulated sample. Socioeconomic status was not correlated with underweight or anemia in our simulated analysis.

Public health implications

- Emphasize the importance of iron and folic acid supplementation and nutrition education for adolescent girls.
- Enhance school health initiatives (monthly iron supplements, deworming, nutritional counseling).
- Enhance dietary diversity via improvements in school kitchens, midday meal programs, and community behavior modification initiatives.

Limitations of the research

This study possesses specific limitations that require acknowledgment. The dataset employed was simulated for demonstration reasons instead of being gathered from real-world environments; hence, the prevalence rates and statistical correlations observed may not accurately

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represent those in genuine rural teenage communities. The study's cross-sectional design examines associations at a singular moment and cannot determine temporal or causal linkages. The Dietary Diversity Score utilized herein functions solely as a proxy for nutrient adequacy and may not comprehensively reflect dietary quality, whereas hemoglobin levels were derived from simulation rather than direct measurement. Moreover, other pertinent predictors of anemia, such as recent infections, malaria, helminth infestations, menstrual blood loss, and a history of vitamin supplementation, were excluded from the analysis, which may result in residual confounding.

Conclusion

This research, utilizing a simulated sample of 202 rural teenagers, identifies female adolescents as a high-risk demographic for anemia, mirroring trends frequently observed in community-based surveys. Programmatic treatments targeting teenage girls, such as iron and folic acid supplementation, menstrual health management, and dietary diversity promotion, are necessary to meet the physiological growth needs and nutritional deficiencies common in rural areas. Enhancing school-based nutrition initiatives, incorporating anemia screening into standard adolescent health assessments, and increasing caregiver understanding of nutrient-dense meals can bolster preventative strategies.

Although simulated data provide valuable insights into statistical correlations, empirical investigations utilizing actual dietary intake measures, biomarkers of iron status, and inflammatory markers would provide a more precise assessment of prevalence and determinants. Longitudinal follow-up strategies may elucidate the impact of seasonal fluctuations, dietary patterns, and health interventions on anemia risk across time. Incorporating qualitative research can illuminate cultural eating behaviors, gender norms, and obstacles to dietary enhancement, which are frequently overlooked in quantitative surveys. Partnerships among educational institutions, community health practitioners, and local self-help organizations could enhance the reach and sustainability of these programs.

Translating these findings into effective public health interventions necessitates a synthesis of evidence-based dietary initiatives, focused health education, and supportive policy frameworks that emphasize adolescent health within comprehensive rural development agendas.

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