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Risk Factors Influencing Anaemic Prevalence Among Adolescent Girls in Pathanamthitta District in Kerala

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A B S T R A C T

Introduction: Anaemia in adolescent girls is a significant public health issue in Kerala, influenced by poor dietary habits, insufficient iron intake, menstrual health issues, socioeconomic disparities, and limited healthcare access. Cultural practices and gender norms further exacerbate anaemia. Addressing this requires comprehensive public health interventions, nutritional education, and policy changes.

Methods: A cross-sectional study was conducted in Konni village, Pathanamthitta district, Kerala, with 200 adolescent girls aged 15–18 years from five schools (one government, one private-aided, and three private). Data were collected using a pre-tested structured questionnaire from January to February 2023, covering socio-economic details, parents' education and occupation, and dietary habits (age, BMI, type of school and family, mother's education, monthly income, father's occupation, and fruit and leafy vegetable consumption). Statistical analysis included percentage calculation, chi-square tests (p = 0.05), odds ratio, 95% confidence interval, and Principal Component Analysis (PCA) using SPSS 19.

Results: Dietary diversity was poor, with only 2% of participants consuming fruits and leafy vegetables daily, and most consuming them monthly or occasionally. PCA identified nine key risk factors for anaemia, including socio-economic variables like mother's educational level and family type. Lower maternal education correlated with higher anaemia rates, likely due to insufficient knowledge about nutrition and healthcare.

Conclusion: The study highlights the significant impact of anaemia, with notable associations with age, father's occupation, and fruit and vegetable consumption. Despite Kerala's relative development, anaemia remains a major public health concern. PCA revealed critical risk factors, emphasising the complex interplay of socio-economic factors, personal hygiene, and dietary habits in anaemia prevalence.

Keywords: Risk Factors, Menstrual Health Issues, Dietary Habits, Nutritional Education, Overall Health, Well-Being, Principal Component Analysis

Introduction

Anaemia is characterised by a reduction in the concentration of haemoglobin (Hb) in the blood, regardless of its underlying cause, red blood cell morphology, or function. The severity of anaemia is classified into mild, moderate, and severe categories based on WHO Hb thresholds. The global emphasis on the well-being of adolescents and youth is evident in various commitments to their holistic development— encompassing personal, spiritual, social, mental, and physical dimensions. The cultural context of adolescence varies across settings, influencing the future health status of countries and regions. Adolescence serves as the 'gateway,' and youth as the 'pathway' to adult life.[1]

The prevalence of anaemia in adolescent girls results from a complex interplay of risk factors. Nutritional deficiencies, including insufficient intake of iron, folic acid, and vitamin B12, coupled with poor dietary choices and limited access to nutritious foods, contribute significantly. Menstrual blood loss, especially when not adequately managed, poses an additional risk. Regions with prevalent parasitic infections, such as hookworm, face increased anaemia risks due to blood-feeding parasites. Socioeconomic status is a crucial factor, with low economic standing limiting access to essential resources.[2] The rapid growth spurt during puberty, when combined with inadequate nutritional intake, can lead to anaemia. Dietary habits, specifically a diet low in iron absorption inhibitors, contribute to the condition. Poor hygiene and sanitation practices elevate the risk of infections, further exacerbating anaemia. Underlying chronic diseases, genetic factors, and a lack of education about nutrition and anaemia also contribute to the vulnerability of adolescent girls to this health issue.[1,3]

Addressing these risk factors through improved nutrition, health education, access to healthcare, and sanitation practices can help reduce the prevalence of anaemia among adolescent girls.[4,5]

Iron deficiency anaemia is the leading cause of nearly 50% of global maternal deaths, attributed to inadequate nutritional consumption and a lack of proper healthcare. In India, anaemia prevalence is alarming, with adolescent girls exhibiting a high prevalence (72.6%). The latest survey, NFHS-5 (2019–21), reported a significant increase in anaemia prevalence among various age groups, with the most dramatic rise observed among children aged 6 months to five years.[6,7] From 2015–2016 to 2019–2021, anaemia prevalence among Indian adolescent females rose from 54% to 59%. Globally, there were 1.76 billion prevalent cases of anaemia in 2019, causing 50.3 million YLDs.[8,9]

Iron, a crucial component of the haemoglobin molecule, plays a vital role in fixing oxygen in the lungs and releasing it in the tissues to generate energy for the body. The primary clinical symptom of anaemia and iron deficiency is pallor, with fatigue as its physical manifestation, leading to reduced work capacity.[10] Despite government programmes aimed at adolescents, private agencies are also actively working for women and children. Inadequate nutritional consumption and lack of proper healthcare are identified as major reasons for the prevalence of anaemia in India.

The present study focuses on identifying the risk factors behind anaemic prevalence in the Pathanamthitta district of Kerala state.

Methodology

The current cross-sectional study was conducted in Konni village within the Pathanamthitta district of Kerala, focusing on 200 adolescent girls aged between 15 and 18 years. The sample group was drawn from five schools in the area, encompassing one government school, one private-aided school, and three private schools. Data collection involved utilising a pre-tested structured questionnaire during the time period from January 2023 to February 2023. Approval for the study was obtained from the school authorities as part of the Health Week Programme organised by Konni Village and informed consent was obtained from the participants.

The primary variable of interest was the analysis of haemoglobin levels, with 3 ml of venous blood collected and measured using Drabkin's cyanmethemoglobin. The classification of haemoglobin levels followed the guidelines provided by the World Health Organization (WHO). Anthropometric measurements constituted the second outcome, where height and weight were assessed using standard instruments such as a stadiometer and a digital weighing scale with precision to 0.1 cm and 0.1, respectively. Body Mass Index (BMI) was then calculated based on the WHO classification, which defines adolescents as individuals aged 10–19 years, further categorised into early (10–14 years) and late (15–19 years) adolescence.[11,12]

Anaemia severity was classified into mild, moderate, and severe based on haemoglobin concentration, with WHO-recommended cutoff values for non-pregnant women: non-anaemic (≥ 12 g/dL), mild (11.0–11.9 g/dL), moderate (8.0–10.9 g/dL), and severe (< 8 g/dL).[13,14] Public health significance of anaemia prevalence was determined according to WHO criteria: not a public health problem (≤ 4.9%), mild (5.0–19.9%), moderate (20.0–39.9%), or severe (≥ 40.0%).[13,14]

The comprehensive questionnaire covered socio-economic information, parents' education and occupation, as well as dietary habits and patterns, considering nine attributes: age, BMI, type of school, type of family, mother's education, monthly income, father's occupation, consumption of fruits, and leafy vegetables.

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Subsequently, the collected data underwent statistical analysis, employing methods such as percentage calculation, chi-square tests (p value < 0.05 was considered statistically significant), Odd's ratio, 95% confidence interval, and principal component analysis using SPSS 19.

Results

A total of 200 adolescent girls across from five schools in plus one and plus two standards were covered during this study.

Table 1 shows the baseline survey results. Among the adolescent age group, the majority were 16 years old, comprising 124 individuals (62%), followed by 50 individuals (25%) who were 17 years old, 18 individuals (9%) who were 15 years old, and 8 individuals (4%) who were 18 years old, with none in the 18–19 age range. Regarding BMI, 120 (60%) were underweight, 60 (30%) had a normal BMI, 16 (8%) were overweight, and 4 (2%) were obese. Out of 200 girls, only 4 (2%) were found to have normal haemoglobin values; 74 (37%) were found to have mild anaemia, while 122 (61%) had moderate anaemia, with no cases of severe anaemia identified. The majority of the sample respondents had an income level of less than INR 10,000, with 144 individuals (57%) falling into this category. This was followed by 46 individuals (23%) with an income of INR 10,000–20,000, 20 individuals (10%) with an income of INR 20,000–30,000, and 20 individuals (10%) with an income above INR 30,000. Most respondents' fathers were farmers or daily wage labourers (140, 70%), with 28 (14%) owning businesses, 10 (5%) being in government jobs, and 22 (11%) in private jobs. Regarding mothers' education, 144 (72%) had education between the 10th and 12th grades, 20 (10%) had less than 10th-grade education, and 34 (17%) were graduates, with 2 (1%) having postgraduate degrees.

Dietary diversity, assessed using the food frequency method, revealed that only 4 respondents (2%) consumed fruits daily, 44 (22%) consumed them weekly, and the majority, 152 (76%), consumed them monthly or occasionally. Similarly, leafy vegetable consumption was poor, with only 2% eating them daily, 42% weekly, and 56% monthly or occasionally.

Table 2 shows the descriptives of anthropometric and haematological parameters with a 95% confidence interval, indicating that haemoglobin levels are notably low. Table 3 highlights the significance of anaemia according to various risk factors, showing that father's occupation and frequency of consumption of fruits and leafy vegetables were highly statistically significant factors (p value < 0.01). The association between age and anaemia was also found to be significant (p value < 0.05). Tables 4–6 present the prominent risk factors for anaemia identified using Principal Component Analysis.

Table 1.Baseline Data

S. No.	Attributes	Characteristics/ Variables	Number	Percentage (%)
1	Age (years)	15	18	9
		16	124	62
		17	50	25
		18	8	4
2	Type of school	Government	50	25
		Private	150	75
3	Type of family	Nuclear	136	68
		Joint	150	75
4	Mother's education	< 10th	20	10
		10th and 12th	144	72
		Graduate	34	17
		Postgraduate	2	1
5	Father's occupation	Farmer/ labourer	140	70
		Government/ private	32	16
		Business	28	14

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6	Monthly income (INR)	< 10000	114	57
		10000–20000	46	23
		20000–30000	20	10
		> 30000	20	10
7	Haemoglobin test	Normal	4	2
		Mild	74	37
		Moderate	122	61
		Severe	0	0
8	BMI	Underweight	120	60
		Normal	60	30
		Overweight	16	8
		Obesity	4	2
9	Dietary fruit	Daily	4	2
		Weekly	44	22
		Monthly	32	16
		Occasionally	120	60
10	Leafy vegetable	Daily	4	2
		Weekly	84	42
		Monthly	78	39
		Occasionally	34	17

Table 2.Descriptives of Anthropometric and Haematological Parameters in the Study Subjects

Parameters	N	Mean value	Std. Deviation	95% Confidence Interval of the Mean	
				Lower limit	Upper limit
Haemoglobin	200	10.5030	0.97439	10.3671	10.6389
Height	200	155.7910	13.89412	153.8536	157.7284
Weight	200	47.7164	15.45255	45.5617	49.8711
BMI	200	18.9019	4.11806	18.3277	19.4761
Age	200	16.2400	0.66680	15.1470	16.3330

Table 3.Significance of Anaemia According to Various Risk Factors

Attributes	Mild		Moderate		Total		Chi-square	Odd-ratio	95% CI	p Value
	n	%	n	%	n	%				
Age (years)										
15–16	48	24.5	94	48.0	142	37.0	1.840	0.5499	(0.29, 1.04)	0.0458*
17–18	26	13.0	28	14.0	54	27.5				
BMI										
Up to 20	54	27.5	98	50.0	152	77.5	1.192	0.6612	(0.34, 1.31)	0.2332
More than 20	20	10.0	24	12.0	44	22.0				
Type of school										
Government	20	10.0.	30	15.0	50	25.0	0.379	1.1358	(0.59, 2.19)	0.7045
Private	54	27.5	92	47.0	146	74.5				

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Type of family										
Nuclear	48	24.5	84	43.0	132	67.5	0.577	0.8352	(0.45, 1.54)	0.5641
Joint	26	13.0	38	19.0	64	32.0				
Mother's education										
Up to 10th	62	31.5	100	51.0.	162	82.5	0.325	1.1367	(0.53, 2.46)	0.7448
More than 10th	12	6.0	22	11.0	34	17.0				
Monthly income (INR)										
Up to 10000	42	21.0	70	36.0	112	57.0	0.085	0.975	(0.54, 1.75)	0.9322
More than 10000	32	16.0	52	26.5	84	42.5				
Father's occupation										
Government/ private	42	21.0	96	49.0	138	70.0	3.208	0.3555	(0.19, 0.67)	0.0013**
Labourer/ farmer	32	16.5	26	13.0	58	29.5				
Fruits										
Regular	36	18.0	24	12.0.	60	30.0	4.156	3.8684	(2.04, 7.32)	0.0001**
Irregular	38	19.5	98	50.0	136	69.5				
Leafy vegetable										
Regular	56	29.0	41	21.0	97	49.0	4.235	3.6423	(2.01, 6.63)	0.0008**
Irregular	27	14.0	72	36.5	99	50.5				

*p < 0.05, significant
**p < 0.01, non-significant

Table 4.Kaiser-Meyer-Olkin and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.641
Bartlett's Test of Sphericity	Approx. chi-square	528.201
	df	210
	Sig.	0.000011

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy value of 0.741 in PCA indicates good suitability for factor analysis. Values approaching 1 suggest that variables are apt for common factor extraction, implying a favourable correlation structure for principal component interpretation. Communalities, with values exceeding 0.5 for all 21 variables, indicate robust model fit. This suggests that PCA effectively captures over 50% of the variability in each variable, reinforcing the reliability and adequacy of the chosen factors in explaining shared variance among variables. High communalities affirm the effectiveness of common factors in elucidating observed patterns within the dataset.

Table 5.Total Variance Explained

Component	Initial Eigen Values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.446	11.649	11.649	2.446	11.649	11.649
2	1.970	9.382	21.031	1.970	9.382	21.031
3	1.538	7.322	28.354	1.538	7.322	28.354
4	1.401	6.672	35.026	1.401	6.672	35.026
5	1.324	6.306	41.332	1.324	6.306	41.332
6	1.267	6.033	47.364	1.267	6.033	47.364
7	1.254	5.973	53.338	1.254	5.973	53.338
8	1.111	5.291	58.628	1.111	5.291	58.628
9	1.013	4.822	63.451	1.013	4.822	63.451
10	0.937	4.464	67.915	-	-	-
11	0.871	4.149	72.064	-	-	-
12	0.846	4.026	76.090	-	-	-
13	0.787	3.749	79.839	-	-	-
14	0.769	3.661	83.500	-	-	-
15	0.671	3.193	86.693	-	-	-
16	0.602	2.868	89.561	-	-	-
17	0.518	2.466	92.027	-	-	-
18	0.499	2.374	94.401	-	-	-
19	0.450	2.141	96.542	-	-	-
20	0.392	1.869	98.411	-	-	-
21	0.334	1.589	100.000	-	-	-

Extraction Method: Principal Component Analysis

Table 6.Component Score Coefficient Matrix

Variable	Component								
	1	2	3	4	5	6	7	8	9
Duration of menstrual intervals	0.046	-0.045	0.440	-0.149	-0.020	-0.143	0.001	0.025	0.133
Duration of bleeding period	0.013	0.026	0.027	0.085	0.187	-0.089	0.463	-0.090	-0.314
Type of family	0.029	-0.006	-0.113	-0.103	-0.121	0.073	0.683	0.042	0.207
Father's education	0.061	-0.285	-0.023	-0.052	0.270	0.192	-0.158	0.000	-0.102
Mother's education	0.473	0.004	0.082	-0.028	-0.098	0.079	0.119	0.074	0.184
Father's occupation	0.295	-0.075	-0.087	0.154	0.075	-0.056	-0.031	0.001	-0.195

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Mother's occupation	0.253	0.235	0.097	-0.094	-0.028	-0.035	0.018	0.005	-0.012
Monthly income	0.372	-0.010	-0.053	0.010	-0.124	0.019	-0.004	-0.022	-0.033
Bath regularly	-0.028	-0.001	-0.034	-0.033	0.094	-0.001	0.011	-0.027	0.669
Type of diet	-0.066	0.104	-0.067	0.045	0.217	0.659	-0.098	-0.010	-0.010
Rice	-0.069	0.032	-0.024	0.081	0.203	-0.601	-0.090	-0.015	-0.038
Wheat	-0.019	0.142	0.076	-0.197	0.020	-0.050	0.201	0.520	-0.233
Pulses	-0.030	0.104	-0.035	-0.051	0.150	-0.083	0.117	0.661	-0.060
Leaf	-0.048	-0.032	0.656	0.057	0.064	0.059	-0.117	0.000	-0.170
Roots	0.031	0.037	-0.137	0.210	0.380	-0.164	-0.034	0.374	0.203
Fruit	0.181	0.096	0.079	0.355	-0.100	-0.067	-0.033	-0.134	0.071
Nuts	-0.035	-0.106	0.335	0.337	-0.003	0.214	0.197	0.109	-0.018
Meat	-0.024	-0.040	-0.112	0.660	0.019	-0.044	-0.056	0.013	-0.085
Fish	0.038	0.547	-0.031	-0.115	-0.131	0.011	-0.079	0.050	0.039
Egg	-0.048	0.404	-0.101	0.104	0.193	0.084	0.051	-0.075	-0.072
Milk	0.058	0.005	-0.094	0.121	0.658	0.025	-0.046	0.101	-0.082

Extraction Method: Principal Component Analysis

The Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy value of 0.741 in PCA indicates good suitability for factor analysis. Values approaching 1 suggest that variables are apt for common factor extraction, implying a favourable correlation structure for principal component interpretation. Communalities, with values exceeding 0.5 for all 21 variables, indicate robust model fit. This suggests that PCA effectively captures over 50% of the variability in each variable, reinforcing the reliability and adequacy of the chosen factors in explaining shared variance among variables. High communalities affirm the effectiveness of common factors in elucidating observed patterns within the dataset.

Discussion

Statistical Inference-PCA Analysis

The results obtained from the PCA analysis reveal the extraction of nine components, collectively explaining 63.451% of the total variance, with the eigenvalues for the ninth component surpassing 1. The scree plot obtained from the Principal Component Analysis (PCA) displays the eigenvalues against each principal component, revealing a clear break or "elbow" after the ninth component (Figure 1). This signifies that the first nine components capture a substantial portion of the variance, with a cumulative explained variance of 63.451%, justifying the retention of these components in the analysis.

The examination of the component score coefficient matrix in the Principal Component Analysis (PCA) has facilitated the identification of key risk factors contributing to anaemia. This analysis distilled the complexity of the data into a smaller number of components that capture the most variance within the dataset, thereby highlighting the most significant risk factors.

Nine pivotal risk factors were discerned through this process, encompassing a blend of socio-economic variables, dietary habits, nutritional intake, and personal hygiene practices. Socio-economic variables such as the mother's education level and the type of family emerged as significant predictors. For instance, lower educational attainment of mothers was associated with higher incidences of anaemia among their children, likely due to a lack of knowledge about nutritional requirements and healthcare practices.

In terms of dietary habits, the consumption of various food groups showed a substantial impact. The intake of pulses, leafy vegetables, meat, fish, and milk were all critical factors. Higher consumption of these nutrient-rich foods was inversely related to anaemia prevalence, underscoring the importance of a balanced and diverse diet in preventing anaemia. The component score coefficient matrix revealed high factor loadings for these dietary variables, indicating their strong influence on anaemia outcomes.

Personal hygiene also played a notable role. Variables related to hygiene practices, such as handwashing and

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overall cleanliness, were included in the analysis. Poor personal hygiene can lead to infections and illnesses that exacerbate nutritional deficiencies, thus contributing to anaemia.

The PCA analysis clarified the multifaceted nature of anaemia by consolidating these diverse factors into principal components with high factor loadings, indicating their importance. Each component's highest factor loadings were instrumental in pinpointing the influential risk factors, providing a comprehensive understanding of the interplay between socio-economic status, diet, personal hygiene, and anaemia.

This approach not only highlights the direct nutritional causes of anaemia but also brings attention to indirect factors like socio-economic status and personal hygiene, illustrating the complexity of addressing anaemia in populations. The PCA analysis thus serves as a powerful tool in identifying and prioritising interventions to combat anaemia effectively. This underscores the significance of socio-economic and personal hygiene variables in conjunction with dietary considerations, emphasising the need for a comprehensive approach to address the complexity of anaemia and its determinants.

Conclusion

The observed prevalence of anaemia in the current study surpasses rates reported in previous investigations on the same topic, likely attributed to the predominantly rural and underprivileged nature of the taluk under examination. This study underscores the critical impact of anaemia, revealing significant associations with age, father's occupation, and consumption of fruits, and leafy vegetables among the nine variables considered. Notably, the findings underscore that anaemia remains a substantial public health concern even in relatively developed states like Kerala. Despite ongoing large-scale efforts by the state government and voluntary agencies to mitigate the consequences of anaemia, the study urges prompt corrective actions by authorities and policymakers, highlighting the need for further extensive research. The utilisation of factor analysis through Principal Component Analysis (PCA) identified influential risk factors, emphasising the intricate nature of anaemia and underscoring the pivotal role of socioeconomic factors and personal hygiene variables alongside dietary considerations.

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