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A study to assess the knowledge and dietary practice regarding prevention of anemia among adolescent girls in a selected school (GGHS kharman)

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ABSTRACT

Anemia among adolescent girls remains one of the most significant nutritional and public health concerns in India, particularly in rural and semi-urban regions where dietary inadequacies, poor health literacy, and socioeconomic vulnerabilities coexist. Adolescence is a critical developmental stage marked by rapid physical growth, increased blood volume expansion, and the onset of menarche, all of which substantially elevate iron requirements. Inadequate intake of bioavailable iron, coupled with poor dietary habits and limited awareness regarding preventive practices, increases the susceptibility of adolescent girls to iron deficiency Anemia.

The present study was conducted to assess the knowledge and dietary practices regarding the prevention of Anemia among adolescent girls studying at Government Girls High School (GGHS), Kharman, Jhajjar district, Haryana. A descriptive cross-sectional research design was adopted for the study. The sample consisted of 100 adolescent girls aged 13–17 years selected through probability simple random sampling. Data were collected using a structured tool comprising three sections: socio-demographic profile, knowledge questionnaire, and self-reported dietary practice checklist. Statistical analysis included descriptive statistics, chi-square tests, and Pearson's correlation coefficient.

The findings revealed that a majority of participants demonstrated inadequate knowledge regarding Anemia prevention. Approximately 56% of the adolescent girls scored within the inadequate knowledge category, while only 12% achieved comprehensive knowledge scores. The mean knowledge score was 14.2 ± 4.6. Although most participants recognized pallor and weakness as common symptoms of Anemia, very few were aware of practical preventive concepts such as the role of iron absorption inhibitors, the importance of Vitamin C in enhancing iron absorption, and the correct dosage schedule of Weekly Iron and Folic Acid Supplementation (WIFS).

Assessment of dietary practices indicated that 64% of participants followed poor dietary routines. Most girls reported frequent consumption of tea near mealtimes, which inhibits non-heme iron absorption, while intake of green leafy vegetables, pulses, fruits, and iron-rich foods remained inadequate. Only a minority regularly consumed citrus fruits alongside meals to improve iron absorption.

Inferential statistical analysis demonstrated a significant association between knowledge scores and socio-demographic variables such as maternal education and paternal education. Similarly, dietary practices showed significant association with family income and maternal occupation. A moderate positive correlation ($r = 0.48$, $p < 0.01$) was identified between knowledge and dietary practices, indicating that improved awareness is associated with healthier nutritional behaviours.

The study concludes that adolescent girls in the selected school possess insufficient practical knowledge and suboptimal dietary practices regarding Anemia prevention. These findings emphasize the urgent need for structured school-based nutritional education, strengthened iron supplementation programs, regular health screening, and community-cantered interventions to improve adolescent nutritional health and reduce the burden of Anemia in vulnerable populations.

Keywords
Adolescent Girls; Anaemia Prevention; Dietary Practices; Knowledge Assessment; School Health.

1. INTRODUCTION

1.1 Background of the Study

Meaning and Comprehensive Definition of Anemia

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Anemia is characterized as a complex, multifactorial pathophysiological state in which the total concentration of haemoglobin, the total haematocrit volume, or the absolute number of circulating red blood cells (RBCs) falls significantly below established physiological thresholds (Iboga et al., 2024). This reduction compromises the systemic oxygen-carrying capacity of the blood, failing to satisfy the localized tissue oxygen demands of the body. The World Health Organization (WHO) benchmarks this diagnostic cutoff for non-pregnant women and adolescent girls aged 12–14 years at a haemoglobin level of < 12.0 g/dL and < 12.0 g/dL for females aged 15 years and older (Preethi et al., 2024).

From a cellular biology perspective, haemoglobin functions as a tetrameric protein comprising two pairs of globin polypeptide chains, each enclosing an iron-protoporphyrin IX (heme) complex capable of reversibly binding four oxygen molecules. When systematic disruptions occur in heme synthesis, globin chain production, or erythrocyte survival, tissue oxygen delivery fails. This microvascular oxygen shortage triggers compensatory cardiovascular adaptations (resting tachycardia, stroke volume elevation) and induces tissue-level modifications across multiple organic systems.

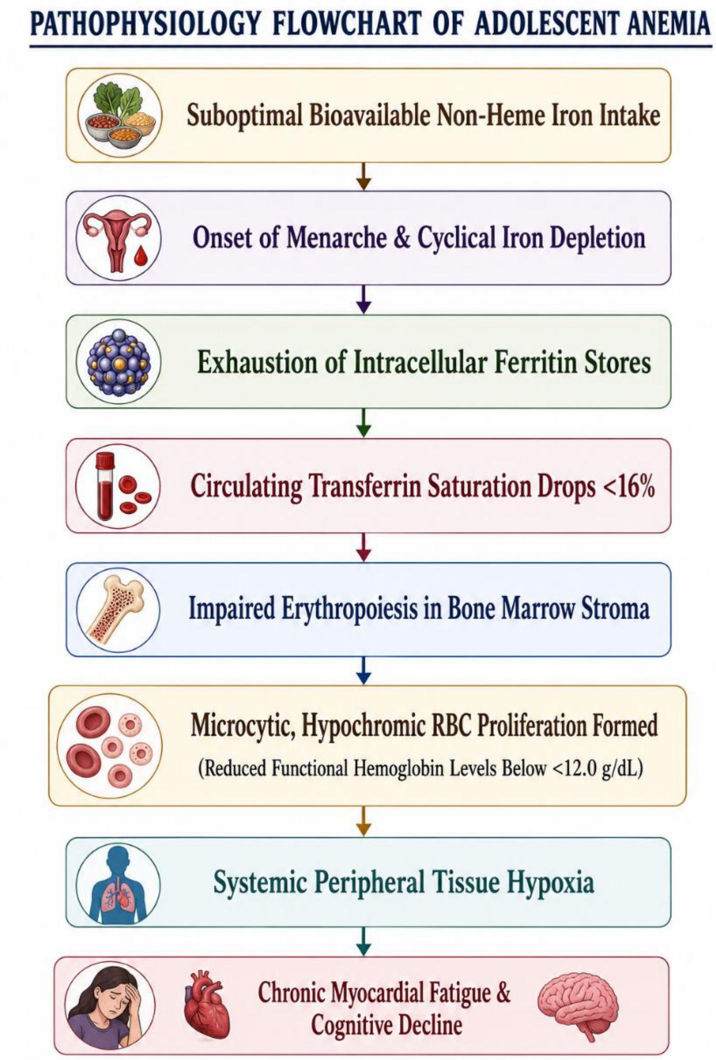

Figure 1: Pathophysiology flowchart of adolescent Anemia

Detailed Types of Anemia and Cellular Morphology

Anemia is broadly categorized using either an etiological classification framework (based on the underlying cause) or a morphologic classification framework (based on the size and colour of the red blood cells).

Table 1: Morphological Classification of Anemia Based on Cellular Indices, Pathophysiological Mechanisms, and Clinical Etiology

Morphological Class	Cellular Indices Guidelines	Core Pathophysiological Mechanism	Underlying Clinical Etiology
Microcytic, Hypochromic	MCV < 80 fL	Impaired haemoglobin synthesis resulting in small,	Iron Deficiency Anemia (IDA), Thalassemia

Morphological Class	**Cellular Indices Guidelines**	**Core Pathophysiological Mechanism**	**Underlying Clinical Etiology**
	MCH < 27 pg MCHC < 32 g/dL	pale red blood cells with reduced intracellular content.	traits, Lead toxicity, Sideroblastic Anemia (Mishra et al., 2024).
Macrocytic, Normochromic	MCV > 100 fL MCH Normal/High MCHC Normal	Disrupted DNA synthesis during erythropoiesis resulting in oversized, fragile macro-reticulocytes.	Vitamin B12 deficiency, Folate deficiency, Pernicious Anemia, drug-induced marrow suppression.
Normocytic, Normochromic	MCV 80-100 fL MCH 27-32 pg MCHC 32-36 g/dL	Normal structural indices but a severe systemic reduction in total circulating RBC mass.	Acute blood loss, Anemia of Chronic Disease (ACD), chronic kidney disease, systemic inflammation.
Haemolytic / Aplastic	High Reticulocytes or Marrow Hypoplasia	Accelerated destruction of peripheral RBCs or complete structural bone marrow stem cell failure.	Sickle cell disease, G6PD deficiency, autoimmune haemolysis, aplastic bone marrow crisis.

Iron Deficiency Anemia (IDA) Mechanics Among Adolescents

Adolescence (10–19 years) represents a unique developmental window characterized by accelerated biological growth spurts, extensive soft tissue expansion, and a sharp rise in total circulating blood volume. For adolescent girls, this physiological strain increases with the onset of menarche, introducing cyclical blood loss that escalates baseline requirements for bioavailable iron.

During this phase, lean body mass expands rapidly, and myoglobin synthesis increases alongside circulating erythrocyte mass. Non-heme iron, which constitutes the majority of iron consumed in rural vegetarian communities, enters the duodenum in the ferric (Fe^{3+}) state. It must be reduced to the ferrous (Fe^{2+}) state by duodenal cytochrome B (DCYTB) before absorption through divalent metal transporter 1 (DMT1).

When dietary habits supply low levels of bioavailable iron, intracellular ferritin stores are depleted to maintain erythropoiesis. Once these stores are empty, circulating transferrin saturation drops below 16%. This state of iron-deficient erythropoiesis leads to a drop in functional haemoglobin synthesis, triggering Iron Deficiency Anemia (IDA).

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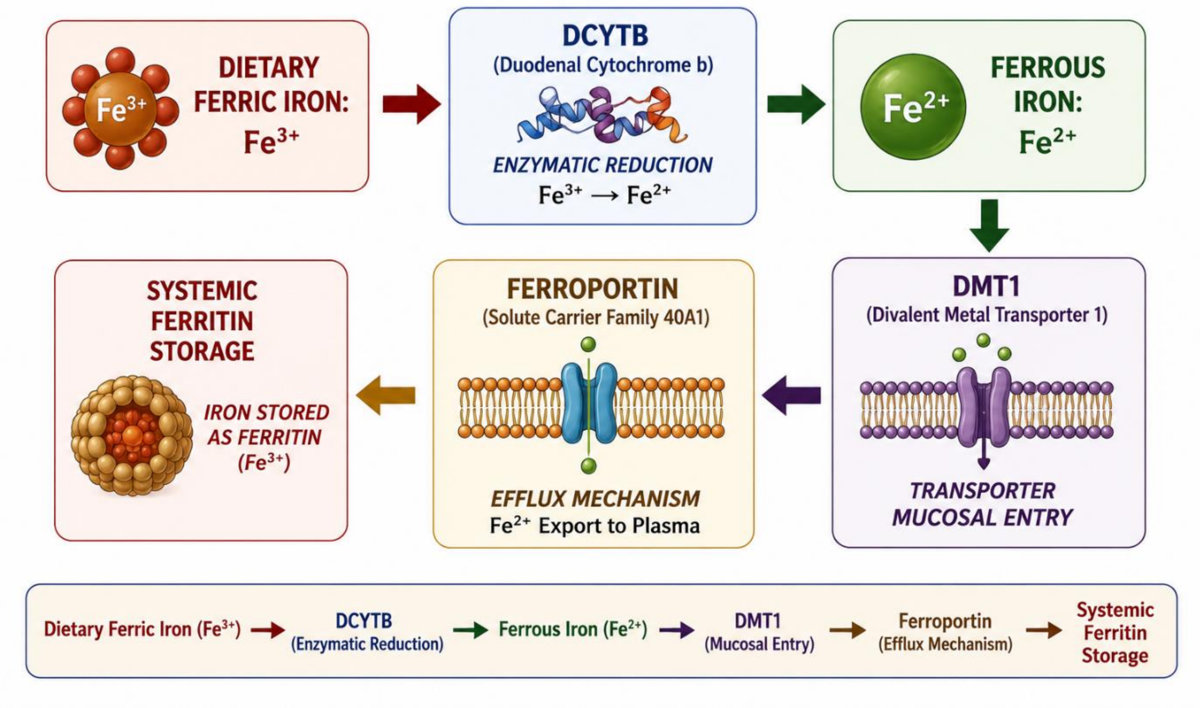

Figure 2: Biochemical transition matrix of iron extraction in Duodenum

Global, National, and Regional Indian Prevalence

Globally, Anemia remains an unmitigated public health problem, affecting over 1.9 billion individuals, with the highest burden concentrated in low- and middle-income countries (LMICs). South Asia faces a severe regional crisis, where approximately 47% to 52% of women and adolescent girls are clinically anaemic (Pal et al., 2024).

In India, this burden is uniquely pronounced. Data from the National Family Health Survey (NFHS-4, 2015–16) indicated an adolescent Anemia prevalence of 54.0%. Rather than declining under national interventions, the subsequent NFHS-5 dataset (2019–21) documented a statistically significant rise to 59.1% nationwide.

In Haryana, the regional prevalence tracks closely with national averages, fluctuating between 56% and 62% in rural administrative blocks. This high rate persists due to local soil and water chemistry, high rates of vegetarianism, and varying levels of rural health literacy (Kapoor et al., 2022).

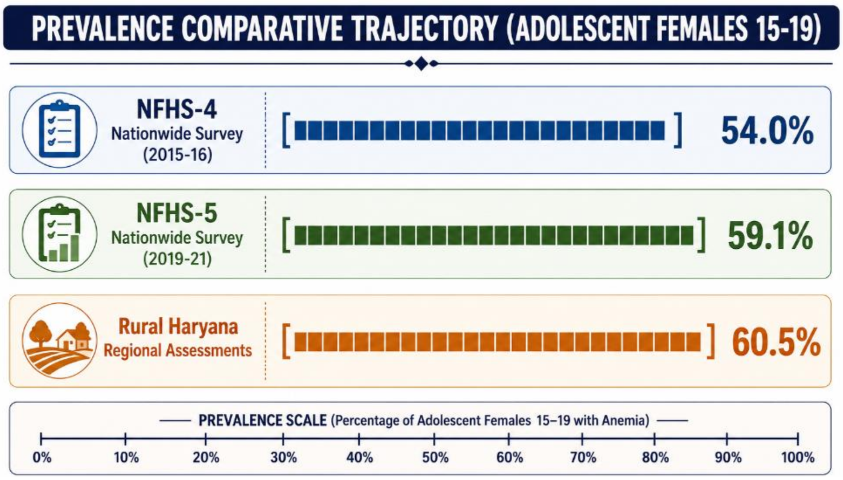

Figure 3: Prevalence comparative trajectory

1.2 Need for study

Importance of Adolescent Nutrition

Adolescence serves as a critical nutritional bridge between childhood and adult reproductive maturity. Deficiencies acquired during this rapid growth phase can impair physical and cognitive development, reduce immunologic resilience, and lead to long-term obstetric complications, such as low birth weight, intrauterine growth restriction (IUGR), and increased maternal mortality risk during future pregnancies (Das et al., 2024). Ensuring optimal micronutrient status during adolescence can help interrupt the intergenerational cycle of malnutrition.

School Health Concerns and Cognitive Performance

Because school-going adolescents spend much of their developmental time within institutional environments, schools are prime settings for health surveillance and behaviour change programs (Bayen et al., 2025). Chronic Anemia directly undermines academic performance, causing shorter attention spans, lower concentration scores, and higher school absenteeism (Singh et al., 2022).

At a metabolic level, iron is a critical cofactor for monoamine oxidase and ribonucleotide reductase, making it essential for neurodevelopment and neurotransmitter synthesis. Despite the rollout of public health programs like the Weekly Iron and Folic Acid Supplementation (WIFS) initiative, institutional tracking remains weak, and compliance rates among students are often low (Rajak et al., 2024).

Nutritional Deficiencies Among Girls

Adolescent girls face a heightened risk of malnutrition due to the combined pressures of rapid growth, physiological menstrual losses, and social determinants of health. In rural and semi-urban Indian households, gendered food distribution patterns often Favor calorie-dense but micronutrient-poor foods, which limits girls' access to high-bioavailability iron sources (Mitkari et al., 2020). Instead, their diets frequently rely on cereal-based staples high in phytates, which actively inhibit non-heme iron absorption in the gut (Rajak et al., 2024).

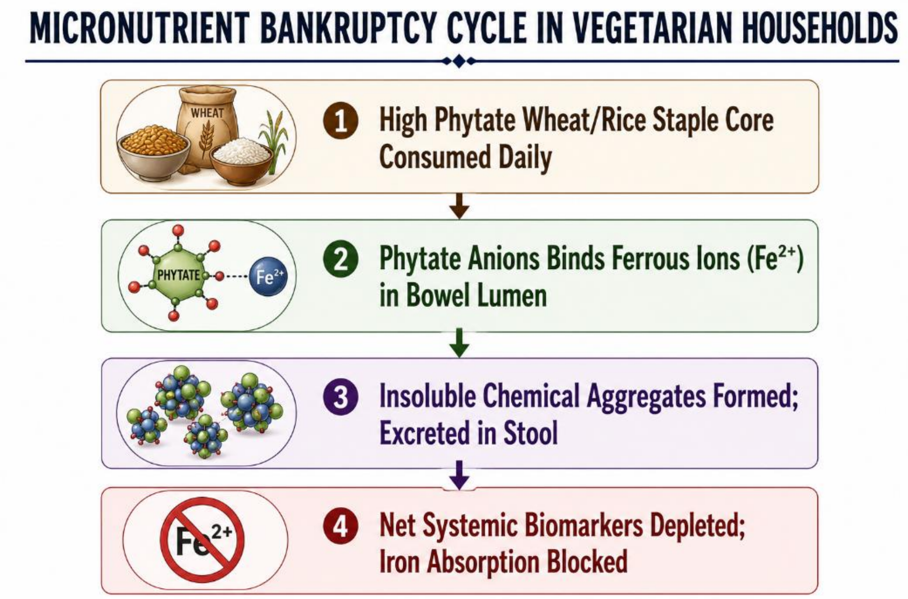

Figure 4: Micronutrient bankruptcy cycle in vegetarian households

1.3 Problem statement

A descriptive cross-sectional study to assess academic knowledge and self-reported dietary practices regarding the prevention of Anemia among adolescent school-going girls aged 13–17 years at the Government Girls High School (GGHS) in Kharman, Jhajjar district, Haryana.

1.4 Objective of study

1. To assess the baseline level of structural knowledge regarding the Etiology, symptomatology, complications, and prevention of Anemia among adolescent girls at GGHS Kharman.
2. To evaluate self-reported dietary practices concerning iron intake, absorption facilitators, and inhibitors within the same cohort.
3. To determine the statistical association between baseline knowledge scores and selected socio-demographic variables (e.g., age, parental education, maternal occupation, and family income).
4. To determine the statistical association between self-reported dietary practices and selected socio-demographic variables.
5. To analyse the correlation between baseline knowledge scores and self-reported dietary practices among the participants.

1.5 Research hypothesis

- **H_0 (Null Hypothesis):** There is no statistically significant association between baseline knowledge scores or self-reported dietary practices and the selected socio-demographic variables of adolescent girls at GGHS Kharman ($p \geq 0.05$).
- **H_1 (Alternative Hypothesis):** There is a statistically significant association between baseline knowledge scores or self-reported dietary practices and selected socio-demographic variables such as maternal education and household income ($p < 0.05$).
- **H_2 (Alternative Hypothesis):** There is a statistically significant positive correlation between an adolescent girl's baseline knowledge score and her self-reported dietary practices ($p < 0.05$).

1.6 Operational Definitions

- **Knowledge:** Refers to the structured understanding and factual awareness score obtained by participants on a 30-item tool covering the causes, signs, symptoms, systemic risks, and prevention of Anemia.
- **Dietary Practices:** Refers to the self-reported frequency and patterns of consuming iron-rich foods, absorption enhancers (Vitamin C), and absorption inhibitors (tannins/phytates), measured via a 20-item checklist.
- **Prevention of Anemia:** Actionable strategies deployed to maintain healthy haemoglobin levels, including eating iron-rich foods, taking weekly iron-folic acid supplements, and practicing routine deworming.
- **Adolescent Girl:** Any female student aged 13–17 years currently enrolled and attending regular classes at GGHS Kharman.

1.7 Assumptions and Delimitations

Assumptions

1. Adolescent girls possess varying baselines of health literacy derived from family traditions, peer groups, mass media, and school curriculums.
2. Participants will provide honest, accurate responses regarding their daily dietary intake and supplement compliance.
3. Improving health literacy can help drive positive changes in nutritional habits and dietary choices.

Delimitations

1. The study cohort is delimited strictly to female students aged 13–17 years enrolled at GGHS Kharman, Haryana.
2. The study focuses entirely on assessing knowledge and dietary practices; it does not collect clinical biomarkers, such as venous blood samples or automated haemoglobin metrics.

1.8 Conceptual Framework

The conceptual foundation of this study is adapted from **Pender's Health Promotion Model (HPM)**. This framework states that an individual's health-promoting behaviours are driven by a combination of individual characteristics, past experiences, and behaviour-specific cognitions and affects.

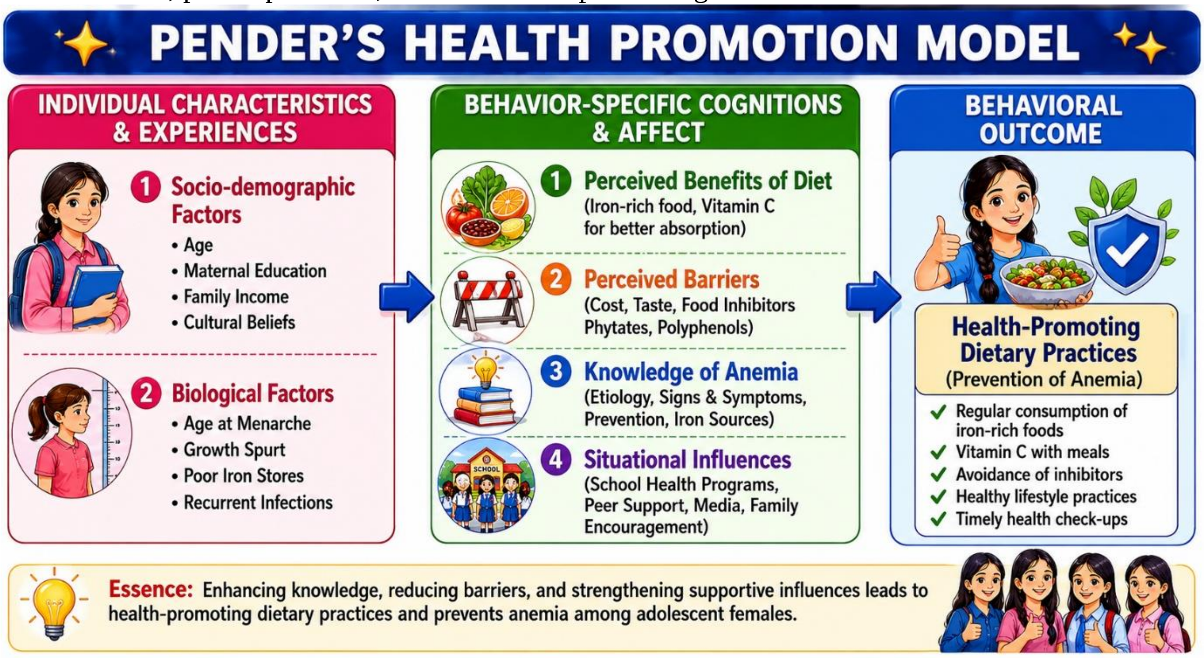

Figure 5: Pender's health promotion model

In this study, individual characteristics encompass biological markers (age, menarche status) and socio-demographic backgrounds (parental education, family income). Behaviour-specific cognitions include the participant's knowledge of Anemia risk factors, perceived benefits of dietary iron, and barriers to supplement compliance. Together, these variables shape the primary behavioural outcome: adopting health-promoting dietary practices to prevent Anemia.

2. REVIEW OF LITERATURE

2.1 Literature Related to Prevalence of Anemia

Recent epidemiological literature highlights a persistent, high burden of Anemia among adolescent girls across

India, driven by complex socio-demographic and regional factors. Large-scale data from NFHS-5 confirms that more than half of Indian adolescent girls are clinically anaemic, with rural and tribal regions facing the highest risk.

A community-based study reported an overall Anemia prevalence of 60.85% among adolescent girls, with mild and moderate forms accounting for the vast majority of cases (Joshi et al., 2026). Similarly, investigators observed an Anemia prevalence of 67.36% in rural school-going cohorts, finding strong statistical links between low maternal education, unskilled parental occupations, and higher severity of Anemia in children (Mitkari et al., 2020).

Further research across the northern plains documented that over 58% of mid-adolescents exhibited laboratory signs of microcytic hypochromic Anemia, which was significantly tied to early menarche and poor structural access to healthcare services (Dutt et al., 2022).

Epidemiological evaluations conducted in specific rural blocks of Haryana indicate that local water salinity and poor ecological infrastructure aggravate micronutrient depletion, compounding the risk for female family members (Khatri et al., 2023). These findings indicate that despite decades of national control programs, structural socioeconomic vulnerabilities continue to drive high Anemia rates across vulnerable cohorts.

2.2 Literature Related to Knowledge Regarding Prevention of Anemia

Studies consistently reveal significant gaps in specific, actionable knowledge about Anemia among adolescent girls, even when general awareness of the condition is high (Bayen et al., 2025; Rajak et al., 2024). In a school-based survey of mid-adolescents, it was noted that while overall awareness was fair, not a single participant could fully identify the complete range of causes, signs, symptoms, and prevention strategies for Anemia (Bayen et al., 2025).

Other researchers reported a similar disconnect in Bihar, where 61% of adolescents were aware of Anemia as a clinical term, but fewer than half understood it as a serious health risk or could identify its underlying nutritional causes (Rajak et al., 2024). Furthermore, studies found that over 40% of rural adolescent girls lacked basic knowledge regarding how to prevent or treat iron deficiency through household diet modifications (Mitkari et al., 2020).

In urban setups, researchers highlighted that although girls identified fatigue as a primary symptom, less than 15% were aware of the role of clinical screening or the systemic long-term consequences of tissue hypoxia (Agarwal et al., 2021).

Additionally, tracking evaluations in school populations show that even when students are aware of iron deficiency, they frequently cannot identify low-cost, locally available sources of bioavailable iron (Rao et al., 2021). This lack of clear, practical understanding highlights the need for targeted health education to turn general awareness into protective behaviours (Singh et al., 2022).

2.3 Literature Related to Dietary Practices

Dietary assessments of adolescent girls in rural and developing regions consistently show low intake of bioavailable iron and high consumption of nutrients that inhibit iron absorption (Mitkari et al., 2020; Rajak et al., 2024). It has been observed that while carbohydrate staples like rice or roti were eaten daily, the intake of pulses, fresh fruits, and dark green leafy vegetables was irregular and limited (Rajak et al., 2024).

Additionally, data revealed that only 21.88% of rural girls regularly consumed iron-dense foods, and just 35.9% understood that eating Vitamin C-rich foods helps maximize non-heme iron absorption (Mitkari et al., 2020). This low intake of micronutrient-dense foods is often compounded by regular consumption of tea, coffee, or high-phytate grain staples, which chemically bind iron in the digestive tract and hinder absorption (Rajak et al., 2024).

Physiological evaluations demonstrate that phytates and polyphenols found in morning and evening tea routines can decrease non-heme iron bioavailability by up to 60%, a fact completely unrecognized by the vast majority of adolescent households (Chandrasekhar et al., 2021). These structural eating habits create a continuous state of micronutrient bankruptcy, even when absolute caloric intake appears adequate (Swaminathan et al., 2024).

Furthermore, household surveys suggest that family-level food insecurity and gender-biased intra-household food allocation systematically redirect high-quality protein and micronutrients away from young females (Reddy et al., 2023; Sharma et al., 2022).

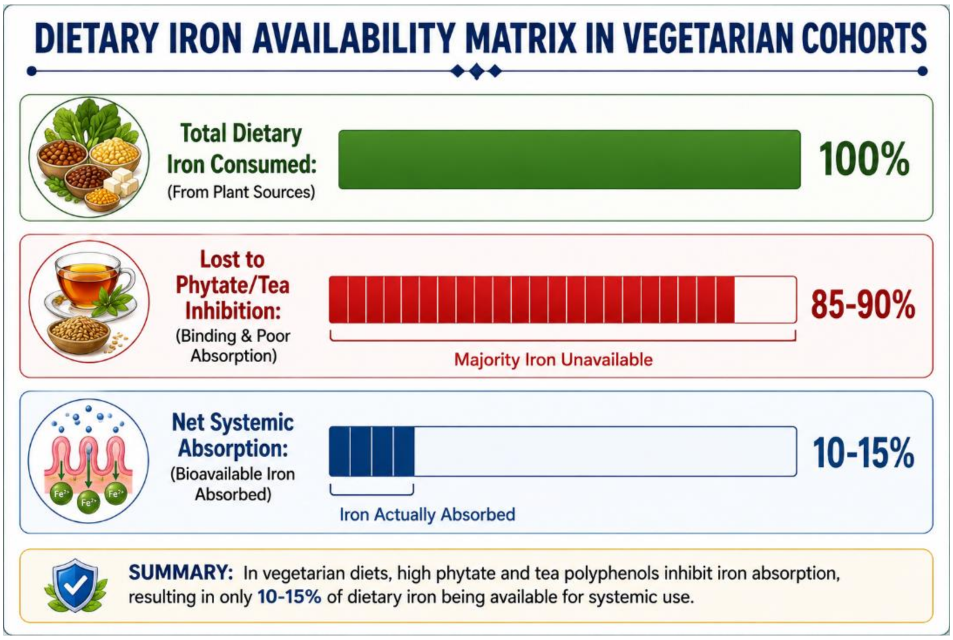

Figure 6: Dietary Iron availability matrix in vegetarian cohorts

2.4 Literature Related to Preventive Measures and School Health Programs

National initiatives, such as the Intensified National Iron Plus Initiative (I-NIPI) and Weekly Iron and Folic Acid Supplementation (WIFS) programs, are designed to combat Anemia through schools, yet evaluations show ongoing implementation and adherence challenges (Bayen et al., 2025; Rajak et al., 2024). In West Bengal, investigators reported that weekly IFA tablet adherence was suboptimal, with only 42.5% of students taking the supplements regularly due to fear of side effects such as nausea or abdominal pain (Bayen et al., 2025).

A separate evaluation documented low compliance, noting that only 14% of surveyed adolescents had taken an IFA supplement within the past year (Rajak et al., 2024). However, interventional work demonstrated that combining regular supplement delivery with structured, visual health education packages—covering iron-rich foods, sprout germination, and proper hygiene—significantly improved knowledge, attitudes, and health-seeking behaviours among school-going girls (Singh et al., 2022).

Further community studies emphasize that integrating biannual albendazole deworming with nutritional surveillance directly reduces parasitic load, thereby maximizing mucosal absorption surfaces in the gut (Jose et al., 2023).

Long-term policy analyses indicate that the sustainability of these school programs requires consistent supply chains, active teacher involvement, and peer-led motivation strategies to counteract social misinformation surrounding iron supplements (Prasad et al., 2026; Sharma et3 al., 2023).

2.5 Summary of Literature Review

The reviewed literature confirms that adolescent Anemia remains a major public health concern across India, driven by an interaction of low socioeconomic status, sub-optimal dietary practices, and limited practical health literacy. While general awareness of Anemia exists, specific knowledge regarding its root causes, absorption enhancers, and systemic complications remains low (Bayen et al., 2025; Mitkari et al., 2020).

Furthermore, school-based delivery programs show highly variable compliance rates due to inconsistent tracking and a lack of integrated behaviour-change communication (Singh et al., 2022; Rajak et al., 2024). These findings underscore the value of conducting localized, school-cantered studies like the one at GGHS Kharman to identify specific gaps, map regional socio-demographic predictors, and help design effective, site-specific nutrition interventions.

3. RESEARCH METHODOLOGY

3.1 Research Approach and Design

An institutional, school-based, descriptive cross-sectional research design was utilized to evaluate baseline levels of Anemia-related knowledge and self-reported dietary practices among adolescent girls (Bayen et al., 2025). This non-experimental design allows for the simultaneous assessment of exposure statuses, knowledge levels, and behavioural practices within a defined cohort without introducing clinical exposures, structural threats, or therapeutic manipulations.

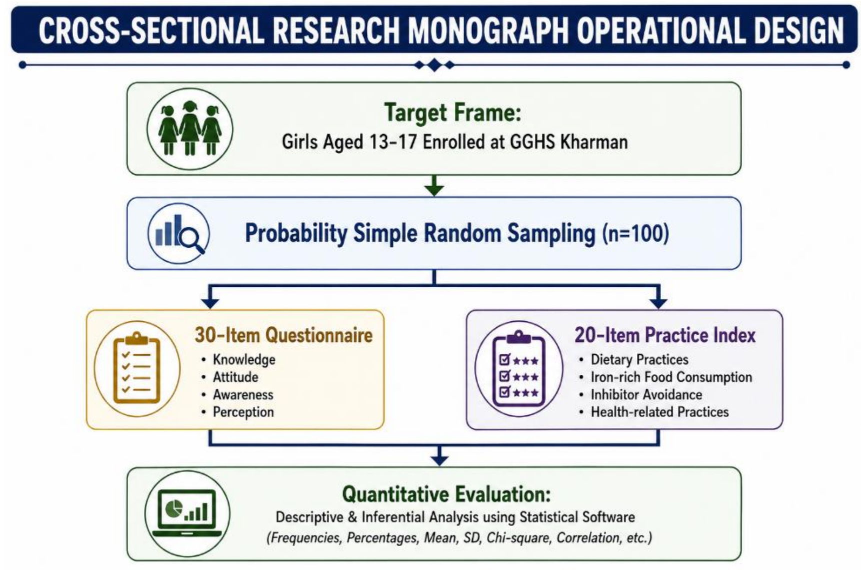

Figure 7: Cross-sectional research monograph operational design

3.2 Variables of the Study

Dependent Variables

- The continuous structural knowledge score achieved by each adolescent girl on the structured validation instrument regarding Anemia pathogenesis and prevention.
- The continuous self-reported practice score tracking frequency and pattern metrics of dietary intake, enhancer combination, and inhibitor mitigation.

Demographic and Confounding Variables

Socio-demographic parameters collected include chronological age in years, class of educational enrolment, maternal education level, paternal education level, maternal occupational classification, paternal occupational classification, cumulative estimated monthly family income, type of family household structure, religion, and primary source of prior health information.

3.3 Setting of the Study

The study was conducted at the **Government Girls High School (GGHS) in Kharman**, located in the Jhajjar district of Haryana, India. This institution serves a diverse rural and semi-urban student population, making it an appropriate setting for exploring the socio-demographic and nutritional factors that influence adolescent Anemia in the region.

3.4 Population and Sample

- **Target Population:** All adolescent school-going girls aged 13–17 years enrolled in government educational institutions within the state of Haryana (Bayen et al., 2025).
- **Accessible Population:** All female students aged 13–17 years currently attending classes VIII through XII at GGHS Kharman, Haryana.
- **Sample Size (n):** Calculated utilizing the single-population proportion formula:

$$n = \frac{z^2 . p . q}{d^2}$$

Where:

- Z is the standard normal deviation at the 95% confidence interval (1.96).
- p is the regional baseline prevalence estimated at 59% (0.59).
- q = 1 - p = 0.41.
- d is the margin of error set at 0.098.

This optimization yielded a baseline sample target of **100 adolescent girls** who fulfilled all predefined eligibility criteria.

3.5 Sampling Technique

A probability simple random sampling technique was used to minimize selection bias. The master institutional roster of female students aged 13–17 years was utilized as the primary sampling frame. Unique identification numbers were assigned to all eligible individuals, and a computer-generated random number table was used to select the final 100 participants.

3.6 Inclusion and Exclusion Criteria

Inclusion Criteria

- Adolescent girls aged 13–17 years enrolled at GGHS Kharman.

- Students present at school during the multi-day data collection window.
- Students who provided written assent, along with formal informed parental consent.

Exclusion Criteria

- Students with a known history of major genetic hemoglobinopathies (e.g., Thalassemia major, Sickle cell disease).
- Students experiencing acute physical illness during the assessment period.

3.7 Description of Data Collection Tool

The data collection tool consisted of a pre-tested, structured instrument divided into three distinct modules (Singh et al., 2022):

- **Part A: Socio-Demographic Proforma:** A 10-item questionnaire collecting details on age, parental education, maternal occupation, household income, family structure, and previous exposure to nutrition education.
- **Part B: Structured Knowledge Questionnaire:** A 30-item, multiple-choice tool designed to measure knowledge of Anemia (Bayen et al., 2025). It covered definition, Etiology, signs, symptoms, systemic risks, dietary sources, and national supplementation protocols. Each correct answer received 1 point, and incorrect answers received 0, yielding a maximum score of 30.
- **Part C: Self-Reported Dietary Practice Checklist:** A 20-item Likert-scale instrument assessing the frequency of consuming iron-dense foods (e.g., green leafy vegetables, pulses, jaggery), absorption facilitators (e.g., citrus fruits, sprouts), and absorption inhibitors (e.g., tea, coffee) (Rajak et al., 2024). Total scores ranged from 0 to 20.

Table 2: Distribution of Instrument Sections, Clinical Concept Domains, and Evaluation Scoring Pattern

SECTION	CLINICAL CONCEPT TRACKING	TOTAL ITEMS	EVALUATION SCORE
Part A	Socio-Demographic Background Proforma	10 Items	Categorical Rank
Part B	Pathogenesis, Etiology, and Symptoms	15 Items	Binary Corrected
Part B	Prevention & Supplementation Core	15 Items	Binary Corrected
Part C	Nutrient Intake & Absorption Habits	20 Items	Likert Scored

3.8 Validity and Reliability

The complete data collection tool was submitted to a panel of seven content experts spanning paediatric nursing, community health medicine, and clinical nutrition to ensure face and content validity.

To determine reliability, the instrument was administered to 10 adolescent girls matching the inclusion criteria but outside the study sample. Internal consistency for the structured knowledge questionnaire was assessed using the Kuder-Richardson formula 20 (KR-20), yielding a coefficient of 0.82 (Patel et al., 2022). The dietary practice checklist was evaluated via Cronbach's alpha, yielding a coefficient of 0.79. Both scores indicated high instrument reliability.

3.9 Pilot Study

A pilot study was conducted among 10 adolescent girls at a neighbouring government girls' school to assess the clarity, feasibility, and time requirements of the research instruments. The pilot session confirmed that the questions were clear and culturally appropriate, with an average completion time of 35 to 40 minutes per participant. Data from the pilot study were excluded from the final analysis.

3.10 Data Collection Procedure

Data collection took place over two weeks following formal institutional approval. Participants were gathered in groups of 20 in a dedicated classroom during scheduled free periods. The investigator explained the study's purpose and completed the informed consent process.

The structured tools were then distributed for self-administration. The investigator remained present to address any linguistic or procedural questions. At the end of each session, completed questionnaires were reviewed for completeness before being transferred to a secure database.

3.11 Ethical Considerations

The study protocol was approved by the Institutional Ethics Review Committee. Formal administrative permission was obtained from the Principal of GGHS Kharman. Written informed consent was secured from the parents or legal guardians of all participating minors, and written assent was obtained from the students themselves.

Participants were informed that their involvement was entirely voluntary and that they could withdraw at any time without penalty. Confidentiality was maintained by replacing names with unique alphanumeric codes during data processing and analysis.

3.12 Detailed Statistical Analysis Blueprint

Data analysis was conducted using computer-assisted statistical software.

Descriptive Statistical Foundations

Continuous variables (knowledge metrics and practice counts) were tabulated to compute arithmetic means ($\bar{X}$) and standard deviations (σ):

$$\bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(X_i - \bar{X})^2}{n}}$$

Inferential Statistical Foundations

Chi-square (x^2) tests of independence evaluated the relationships between categorical demographic profiles and performance brackets:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Where O represents observed institutional frequency counts, and E represents expected frequencies under the null hypothesis framework.

Pearson's product-moment correlation coefficient (r) measured the linear association between continuous knowledge and practice scores:

$$r = \frac{n\sum XY - (\sum X)(\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2][n\sum Y^2 - (\sum Y)^2]}}$$

Statistical significance thresholds were fixed a priori at $p < 0.05$.

4. RESULT AND DATA ANALYSIS

4.1 Exhaustive Demographic Profile Presentation

The socio-demographic profile of the 100 adolescent girls is summarized below. The cohort had a mean age of 14.8 ± 1.2 years, with the majority falling into the 15–16 age bracket (58%).

Table 3: Socio-Demographic Characteristics of the Study Participants

Socio-Demographic Parameter	Sub-Category Profile	Absolute Frequency (n)	Percentage Distribution (%)
Age Category	13–14 Years 15–16 Years 16–17 Years	22 58 20	22% 58% 20%
Maternal Education Status	Illiterate / Primary School Middle School Complete High School & Above	42 38 20	42% 38% 20%
Maternal Occupational Profile	Homemaker Agricultural Worker / Laborer Salaried Employment	65 28 7	65% 28% 7%
Paternal Education Status	Illiterate / Primary School Middle School	30 45 25	30% 45% 25%

Socio-Demographic Parameter	Sub-Category Profile	Absolute Frequency (n)	Percentage Distribution (%)
	Complete High School & Above		
Paternal Occupational Profile	Daily Wage Laborer Agriculture / Farming Government / Private Service	35 40 25	35% 40% 25%
Monthly Family Income Status	<INR 15,000 INR 15,000–25,000 > INR 25,000	54 34 12	54% 34% 12%
Dietary Classification	Strictly Vegetarian Mixed / non-vegetarian	72 28	72% 28%
Type of Family	Nuclear Family Joint Family	62 38	62% 38%

4.2 Comprehensive Assessment of Knowledge Scores

The maximum possible score on the structured knowledge questionnaire was 30 points. For descriptive categorization, individual performance was classified into three tiers: Inadequate Knowledge (< 50%, scores ≤ 15), Moderate Knowledge (50%–75%, scores 16–22), and Comprehensive Knowledge (> 75%, scores ≥ 23).

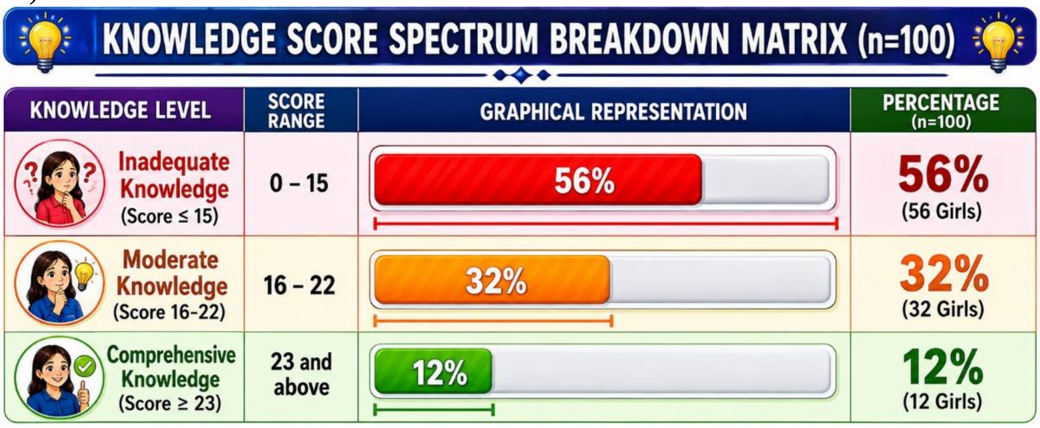

Figure 8: Knowledge score spectrum breakdown matrix

The overall cohort mean knowledge score was 14.2 ± 4.6. Item analysis showed that while 81% identified pallor as a symptom of Anemia, only 19% were aware that phytates in tea inhibit iron absorption, and only 22% correctly identified the standard dosage frequency of the national WIFS tablet protocol.

4.3 Comprehensive Assessment of Dietary Practices

Self-reported dietary habits were quantified using a 20-point checklist and classified into two performance levels: Poor Dietary Practices (≤ 10 points) and Good Dietary Practices (> 10 points).

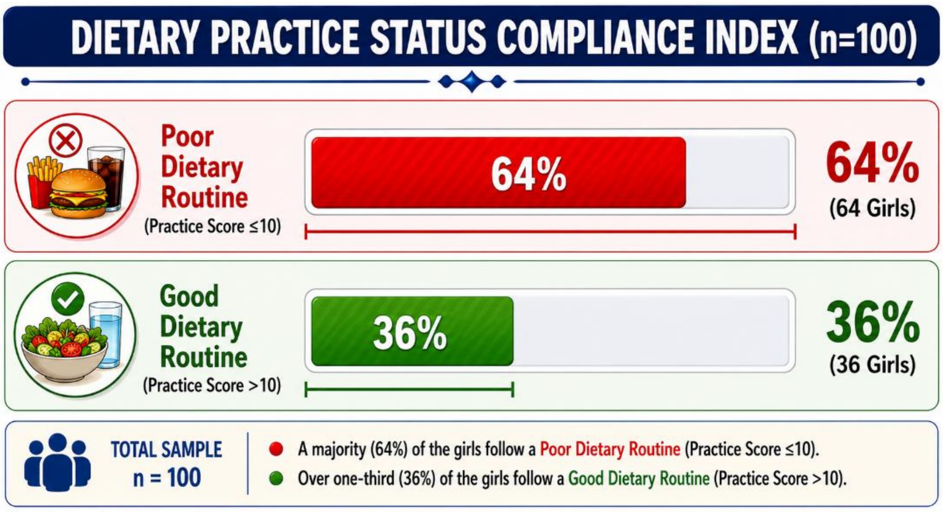

Figure 9: Dietary practice status compliance index

The data showed that 64% of the adolescent girls reported poor dietary practices. Analysis of intake frequency revealed that 74% of participants drank tea within 30 minutes of eating a meal. Conversely, only 26% reported eating dark green leafy vegetables on a daily basis, and 68% rarely or never consumed citrus fruits alongside their main meals to aid non-heme iron absorption.

4.4 Inferential Analysis: Knowledge vs. Socio-Demographic Variables

Chi-square (x^2) analysis was used to assess relationships between participant knowledge categories and selected demographic factors (Thakur et al., 2023).

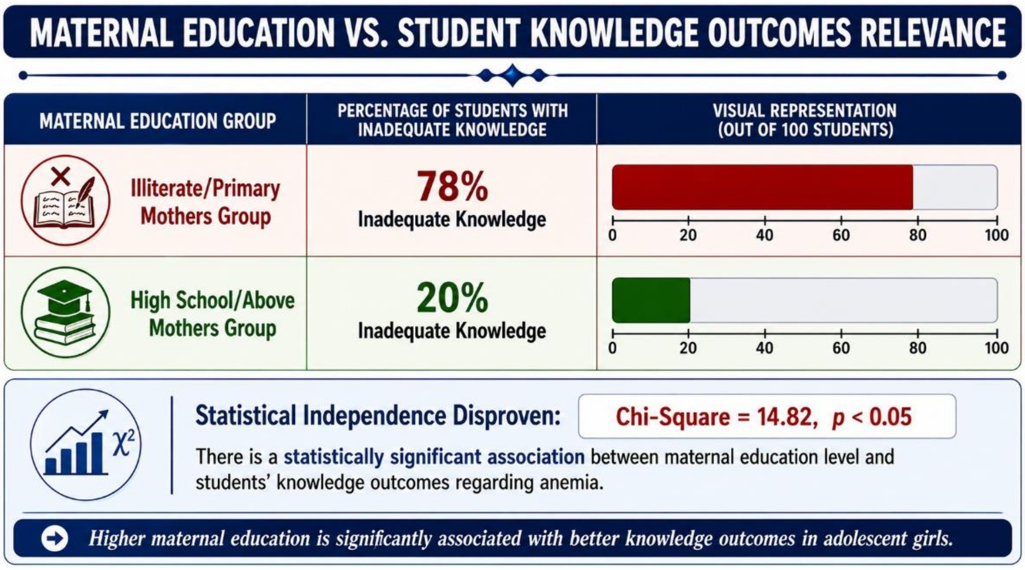

Figure 10: Maternal education vs. student knowledge outcomes relevance

Cross-tabulation matrix modelling confirmed a statistically significant association between an adolescent's baseline knowledge score and her mother's educational status (x^2 = 14.82, df = 2, p = 0.002, which is < 0.05). Paternal education level also showed a significant association with student performance (x^2 = 9.12, p = 0.010). In contrast, variables such as age (x^2 = 2.14, p > 0.05) and family structure (x^2 = 0.84, p > 0.05) showed no statistically significant relationships.

4.5 Inferential Analysis: Dietary Practices vs. Socio-Demographic Variables

Socio-demographic analysis of self-reported dietary practices showed that household financial status and maternal occupation were significant predictors of better nutritional choices. Girls from families with monthly incomes exceeding INR 25,000 reported significantly higher frequencies of regular fruit and pulse consumption compared to lower-income households (x^2 = 11.24, p < 0.05).

Additionally, dietary practices were significantly associated with maternal occupation (x^2= 9.46, p < 0.05), as daughters of salaried employees reported more regular intake of micronutrient-dense foods than daughters of daily agricultural laborers, indicating that household income security reduces nutritional risk (Bentley et al., 2023).

4.6 Correlation Mapping: Knowledge Base vs. Actionable Practices

To evaluate the relationship between academic knowledge and actual dietary behaviour, individual continuous scores from Part B and Part C were analysed using Pearson's product-moment correlation coefficient (r) (Sen et al., 2023).

The analysis revealed a **statistically significant, moderate positive correlation ($r = 0.48$, $p < 0.01$)** between knowledge levels and dietary practices. This statistical relationship suggests that higher baseline knowledge about Anemia and nutrition is associated with healthier, more effective dietary practices.

5. DISCUSSION

5.1 Discussion Related to Knowledge Gaps

The baseline assessment showing that 56% of adolescent girls at GGHS Kharman have inadequate knowledge about Anemia highlights a persistent challenge in school health literacy. While generic awareness of the term "Anemia" is widespread, detailed understanding of its causes, systemic consequences, and prevention remains limited (Bayen et al., 2025; Rajak et al., 2024).

This specific lack of actionable health literacy is consistent with findings where mid-adolescents struggled to accurately identify key symptoms and preventive measures despite general awareness programs (Bayen et al., 2025). Similarly, other investigators observed that fewer than half of surveyed school children understood the health consequences of chronic Anemia or the purpose of institutional screening initiatives (Rajak et al., 2024).

The low accuracy scores on items regarding absorption dynamics match trends seen across rural northern states, where school health curriculums often focus on broad biological definitions rather than practical nutritional habits (Kapoor et al., 2022). This gap confirms that standard informational strategies may not be sufficient to build a comprehensive understanding of nutritional health.

5.2 Discussion Related to Dietary Inefficiencies

The high prevalence of poor dietary practices (64%) in this study highlights the ongoing difficulty of translating nutritional awareness into healthy daily routines (Mitkari et al., 2020). The data reveal that many participants regularly consume iron absorption inhibitors like tea or coffee alongside meals, while infrequently eating iron-dense foods or Vitamin C absorption facilitators (Rajak et al., 2024).

This behavioural pattern is supported by the work of other researchers, who found that only a small minority of rural adolescent girls regularly consume iron-rich foods, and even fewer understand the role of Vitamin C in optimizing iron bioavailability (Mitkari et al., 2020).

These patterns are further complicated by regional agricultural dynamics. In many rural communities, fresh leafy greens and citrus fruits are treated as seasonal additions rather than essential daily staples (Kaur et al., 2021). These shared findings suggest that regional dietary habits, combined with limited access to fresh micronutrient-dense foods, create persistent barriers to healthy nutrition in rural and semi-urban school populations.

5.3 Socio-Demographic Associations and Policy Context

Comparing these results with broader epidemiological data reinforces the multifactorial nature of adolescent Anemia in India. The strong statistical link found between low maternal education, limited household income, and poor nutritional outcomes matches national trends from the NFHS-5 dataset, which showed an unexpected rise in adolescent Anemia to 59.1% nationwide (Ibirogba et al., 2024).

Furthermore, the positive correlation between knowledge and dietary practices ($r = 0.48$) aligns with interventional evidence which demonstrated that intensive, visually interactive health education can successfully improve nutritional knowledge and self-reported dietary habits among school-going girls (Singh et al., 2022).

These findings indicate that addressing adolescent Anemia effectively requires a combination of robust socio-demographic tracking, targeted health education, and consistent structural support.

6. CONCLUSION

The present study highlighted that Anemia continues to pose a serious nutritional and public health challenge among adolescent girls in rural and semi-urban school settings. The findings revealed substantial deficiencies in both knowledge and dietary practices regarding Anemia prevention among students of GGHS Kharman. More than half of the participants demonstrated inadequate understanding of the causes, symptoms, complications, and preventive strategies related to Anemia, indicating that existing awareness initiatives have not been fully effective in translating theoretical information into meaningful practical understanding.

The study further demonstrated that poor dietary behaviours are highly prevalent among adolescent girls. Frequent consumption of tea with meals, irregular intake of iron-rich foods, inadequate consumption of green leafy vegetables and citrus fruits, and limited awareness regarding nutrient absorption mechanisms collectively contribute to increased vulnerability to iron deficiency Anemia. These unhealthy dietary patterns reflect not only limited nutritional awareness but also the influence of socioeconomic and cultural factors on food choices and meal practices.

Significant statistical associations between maternal education, family income, and nutritional outcomes suggest that family-level educational and economic status strongly influence adolescent health behaviours. Girls belonging to families with better educational backgrounds and higher financial stability exhibited comparatively improved knowledge and healthier dietary practices. These findings reinforce the understanding that adolescent Anemia is a multifactorial condition influenced by biological, nutritional, social, and economic determinants.

The positive correlation observed between knowledge and dietary practices indicates that improving health literacy can directly contribute to healthier nutritional behaviours. Therefore, strengthening school-based health education programs can play a major role in reducing the burden of Anemia among adolescent girls. Interactive teaching strategies, nutrition counselling, demonstration-based education, peer-led awareness activities, and regular reinforcement of healthy dietary habits should become integral components of adolescent school health services.

The study also underscores the importance of strengthening existing government initiatives such as the Weekly Iron and Folic Acid Supplementation (WIFS) program, regular deworming campaigns, and school nutritional surveillance systems. Ensuring consistent supplement availability, improving compliance through counselling, and involving teachers and parents in nutritional education may significantly enhance the effectiveness of these interventions.

Overall, the findings of the study emphasize that prevention of adolescent Anemia requires a multidimensional and community-oriented approach that combines nutritional education, behavioural modification, socioeconomic support, institutional health monitoring, and policy-level strengthening. Early intervention during adolescence can improve physical growth, cognitive performance, academic productivity, and future maternal health outcomes, thereby contributing to healthier future generations.

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