Prevalence of Anemia and Dietary Habits Among Preschool Children

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Abstract — Childhood anemia is a crucial issue related to nutrition and public health. At the same time, there is a need to clarify the link between anemia prevalence and dietary habits without confusing it with low hemoglobin levels. The current paper offers a framework of a cross-sectional study in a community to evaluate the prevalence of anemia among children aged 24–59 months. The simulation contains 300 children diagnosed with anemia according to the World Health Organization guidelines in 2024: hemoglobin < 11.0 g/dL. Dietary assessment includes caregiver-administered 24-hour recall and food-frequency questionnaire for seven days. Anemia is diagnosed in 174 children, which constitutes 58.0% (95% confidence interval: 52.3%–63.4%) of the study group. Mild, moderate, and severe anemia constitute 32.0%, 24.0%, and 2.0% of the total number of participants, respectively. The prevalence of anemia in case of low dietary variety is 70.0% and 40.0% in case of high dietary variety, and the unadjusted prevalence ratio is 1.75 (95% confidence interval: 1.38–2.22). Moreover, children with anemia report lower consumption of pulses and foods rich in vitamin C. These simulated associations illustrate the reporting framework that needs further data to draw conclusions.

Keywords — Anemia, preschool children, dietary habits, hemoglobin, dietary variety, child nutrition

Introduction

Anemia is a disease marked by a lower hemoglobin concentration level than the normative one. In preschool children, it can result from nutrient deficiencies, infection, inflammation, inherited blood disorders or their combination. Therefore, anemia detection is just a starting point in the process of evaluation.

According to the new WHO guideline, anemia in children aged 24–59 months is diagnosed in case of hemoglobin < 110 g/L, which equals 11.0 g/dL [1]. Such restriction is aimed at avoiding the mixing of data for children that have different age thresholds for anemia.

During 2019–2021, anemia was reported in 67.1% of children aged 6–59 months according to the NFHS-5 survey in India [2]. The mentioned statistics illustrates the scale of the problem but cannot serve as a comparable benchmark for any local study of anemia in preschool children. Age structure, sampling and blood collection methods can affect the comparability of data.

Dietary assessment is required as children's food depends on their caregivers. However, there is no need to assume that a diet consisting of various food groups always contains enough absorbable iron or other necessary components. Food portion size, food composition, fortification, and combinations of products matter.

The current study framework evaluates anemia in relation to certain dietary behaviors and the clear indicator of food-group variety.

Literature review

Burden and causes of anemia in children

Balarajan et al. [3] described the phenomenon of anemia in low-income and middle-income countries as a complex condition affected by a combination of many different factors including nutritional, infectious, biological and socioeconomic ones. Such approach is required for an assessment that goes beyond the evaluation of food intake.

Household disadvantage may impact dietary habits, care access and the risk of infection at once, creating the associations that cannot be explained through a single mechanism.

The findings of NFHS-5 [2] serve as nationally representative evidence of high anemia burden in Indian children. It is a valuable resource for public health planning, and local research can shed light on the peculiarities of behavioral factors and health services gaps that are difficult to explain

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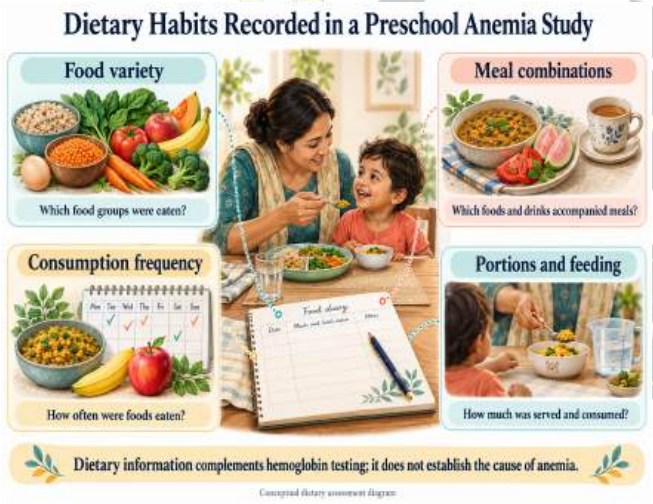
within the summary data. Nevertheless, the results of a small community sample cannot determine the trend nationwide.

Pasricha et al. [4] examined the factors of anemia in young children in rural India. Such study illustrates the significance of investigating both biological and contextual factors. Furthermore, it confirms the inability of a dietary questionnaire alone to prove the cause of the detected low level of hemoglobin.

Iron deficiency and the interpretation of biomarkers

Pasricha et al. [5] provide an overview of the problem of iron deficiency including its biological mechanisms, diagnosis, and management. Iron deficiency and anemia are associated, but they should not be confused with each other as iron deficiency can exist without anemia and vice versa. This fact is essential for the interpretation of prevalence study based on hemoglobin testing.

The WHO recommendations concerning ferritin [6] offer the framework of the assessment of iron status. Inflammation affects ferritin levels, which makes it necessary to consider it during the interpretation. The proposed study cannot classify children with iron-deficiency anemia due to lack of data about ferritin and inflammation-related measurements.



The significance of iron deficiency among infants and young children was historically described in Baker and Greer's clinical report [7]. This report covers children up to the age of three years, and is thus limited in its applicability as a protocol for all preschool children considered in this study.

Food composition and food group intake

According to Hurrell and Egli [8], iron availability is not determined solely by the iron content in the diet. In addition, the balance between absorption enhancers and inhibitors, food sources, and the individual's iron status plays a role. Hence, recorded intake frequency cannot be considered as a direct measure of absorbed iron.

Kennedy, Ballard, and Dop [9] offered a methodology for measuring dietary diversity within households and individuals. Such a framework allows the structured food-group assessment, although the interpretation of the score depends on the population, food groupings used, and purposes of its construction. Locally developed score will require specific definitions of the measures to be used.

WHO/UNICEF's feeding indicator guidance [10] is aimed at infants and young children younger than two years. Thus, the minimum dietary diversity indicator from the document should not be transferred directly to the population aged 24-59 months. In the present framework, the term 'dietary variety' is used with a study-specific definition rather than claiming the use of the minimum dietary diversity indicator proven for preschools.

Dietary evidence from Indian population and intervention implications

Kathuria et al. [11] studied dietary diversity and anemia in children aged 6-59 months in rural North India. Their results showed that low dietary diversity is associated with increased odds of anemia in addition to maternal educational status and socio-economic circumstances. The study demonstrates the necessity of evaluating dietary patterns while considering confounders and age differences in the measurement.

WHO's guideline on daily iron supplementation [12] provides the recommendations for population-level prevention under certain conditions. It shows that anemia prevention implies not only dietary measures, but also organized health interventions. A dietary association measured in cross-sectional study cannot determine treatment decisions for individual children or predict the effects of supplementation.

Gap in research

The practical problem of interest is developing a well-defined preschool assessment tool including age-appropriate anemia classification and food measures understandable to the target population. The suggested approach allows separating dietary variety, food frequency, and severity of anemia while taking into account the impossibility of making conclusions regarding etiology based on hemoglobin level alone.

Objectives

The main objective of the project is the estimation of anemia prevalence and description of its severity among children aged 24-59 months.

Secondary objectives are to explore unadjusted associations between anemia and dietary variety, selected food-consumption frequencies, age, and gender.

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Hypotheses

The null hypothesis is that anemia prevalence does not differ between children with low and high dietary variety.

Secondary null hypotheses are that anemia prevalence is not associated with selected dietary behaviors, age, or gender.

Materials and Methods

Study design and population

Community-based cross-sectional survey is suggested for children aged 24-59 months living in a defined study catchment area. The sampling frame should cover the list of eligible children residing in the study area as a result of household enumeration with the help of preschool and community services records.

Selection of participants from the aggregated list will decrease the risk of exclusion of children attending preschool. One child will be randomly selected in each household to control for household-level correlation.

The simulated sample size includes 300 children. No information on location, recruitment period, response rate, or completion of the fieldwork is presented.

Sample-size determination

For an unknown prevalence of anemia equal to 50%, 95% confidence interval, and the margin of error of 6 percentage points:

$$n = \frac{1.96^2 \times 0.50 \times 0.50}{0.06^2} \approx 267.$$

The target of 300 complete assessments exceeds this minimum under simple random sampling. 334 letters of invitation would be required in case of expected non-response rate of 10%. Under cluster sampling, the additional design effect factor will be needed.

Hemoglobin measurement

Field measurements would include venous blood sampled by trained personnel and tested using a calibrated automated hematology analyzer.

For children aged 24–59 months, anemia would be classified using WHO 2024 thresholds [1]:

Classification	Hemoglobin concentration
No anemia	≥11.0 g/dL
Mild anemia	≥10.0 to <11.0 g/dL
Moderate anemia	≥7.0 to <10.0 g/dL
Severe anemia	<7.0 g/dL

The altitude-based adjustments will be made wherever necessary. The classification system described is based on measurements obtained from an environment that does not require any adjustments in relation to altitude. The severity criteria are based on the selected age group.

Dietary assessment

The caregivers would complete a multiple-pass 24-hour recall for foods eaten at home, preschool, and other places. Mixed foods will be disaggregated into their constituent foods with the help of standardized prompts.

Seven-category variety score would include the following:

- Grains, roots and tubers.
- Pulses, nuts, and seeds.
- Dairy and milk.
- Eggs.
- Meat, fish and poultry.
- Vegetables.
- Fruits.

Food from less than five categories will be defined as low variety and more than five categories as high variety. This is a predetermined analysis grouping and not any threshold of nutrient adequacy for the preschool children. Condiments and insignificant side dishes will not be counted as individual food items.

A seven-day questionnaire will ask about pulse and vitamin C containing foods as less than four days and four or more days per week. The seven-day questionnaire will also record tea intake with or within one hour of meals in at least three days a week, and intake of milk above 500 ml/day.

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Other variables

Age would be confirmed from records and divided into 24–35, 36–47, and 48–59 months. Information on sex, education of caregiver, household resources, illness, supplements, and deworming history should be collected.

Contextual variables would provide the background needed for the adjusted analysis. But since joint individual data was not provided, no adjusted effect sizes are presented here.

Statistics

Anemia prevalence is given with a Wilson 95% confidence interval. Chi-square tests are used for comparing categorical data distributions without continuity correction. Prevalence ratio estimates unadjusted for other covariates are given with confidence intervals on the logarithmic scale.

Variety of the diet is the main variable being compared. Other analyses of the diet data are exploratory and their p-values are not corrected for multiplicity. Statistics were computed from simulated contingency table counts. No regression modeling and diagnostics are assumed.

Ethics

Implementation in practice would need ethics committee clearance and consent from caregivers. Collection of blood samples would adhere to guidelines for children. Children with suspicious results would be referred for clinical evaluation. Approval number and informed consent were not obtained for this draft.

Findings

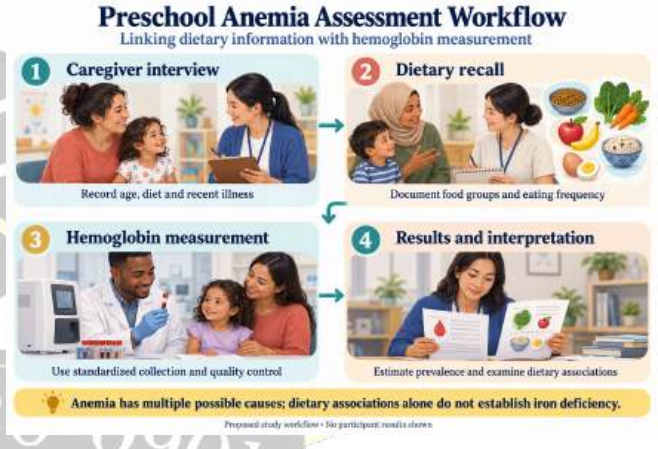
Characteristics of Participants

The generated sample consists of 156 boys and 144 girls. Each group by age is composed of 100 children. Equal distribution of children by age is a deliberate construct and cannot be considered an actual community distribution.

Table A. Simulated anemia distribution by age and sex

Characteristic	Total	With anemia	Without anemia	Anemia prevalence
Age 24–35 months	100	67	33	67.0%
Age 36–47 months	100	59	41	59.0%
Age 48–59 months	100	48	52	48.0%
Boys	156	93	63	59.6%
Girls	144	81	63	56.3%
Overall	300	174	126	58.0%

Age and sex are separate classifications of the same 300 children.



Anemia prevalence differed across age categories, $\chi^2(2) = 7.47$, $p = 0.024$. The sex comparison was not statistically significant, $p = 0.555$.

Prevalence and severity

Anemia occurred in 174 children, giving a simulated prevalence of 58.0% (95% CI: 52.3%–63.4%).

Table B. Simulated anemia severity

Hemoglobin classification	Children	Percentage of total sample
No anemia	126	42.0%
Mild anemia	96	32.0%
Moderate anemia	72	24.0%

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Severe anemia	6	2.0%
Total	300	100.0%

In children diagnosed with anemia, 55.2% had mild, 41.4% had moderate, and 3.4% had severe anemia. These percentages are based on the number of the children having anemia as the denominator.

Dietary diversity

Dietary diversity was lower in 180 children, out of which 126 were anemic. Dietary diversity was higher in 120 children, out of which 48 were anemic.

Table C. Simulated association between dietary variety and anemia

Variety category	Total	With anemia	Without anemia	Prevalence
Lower: <5 groups	180	126	54	70.0%
Higher: ≥5 groups	120	48	72	40.0%
Total	300	174	126	58.0%

The unadjusted prevalence ratio was 1.75 (95% CI: 1.38–2.22), \(p<0.001\). The absolute prevalence difference was 30 percentage points.

Selected dietary behaviours

Table D. Simulated dietary comparisons

Dietary comparison	Anemia in exposed group	Anemia in reference group	Unadjusted prevalence ratio (95% CI)	p-value
Pulses <4 vs. ≥4 days/week	100/150 (66.7%)	74/150 (49.3%)	1.35 (1.11–1.65)	0.002
Vitamin C-rich foods <4 vs. ≥4 days/week	112/170 (65.9%)	62/130 (47.7%)	1.38 (1.12–1.70)	0.002
Tea near meals: yes vs. no	44/60 (73.3%)	130/240 (54.2%)	1.35 (1.12–1.64)	0.007
Liquid milk >500 vs. ≤500 mL/day	59/90 (65.6%)	115/210 (54.8%)	1.20 (0.99–1.45)	0.083

Each row represents a unique classification of the same sample. Behaviours overlap and cannot be summed.

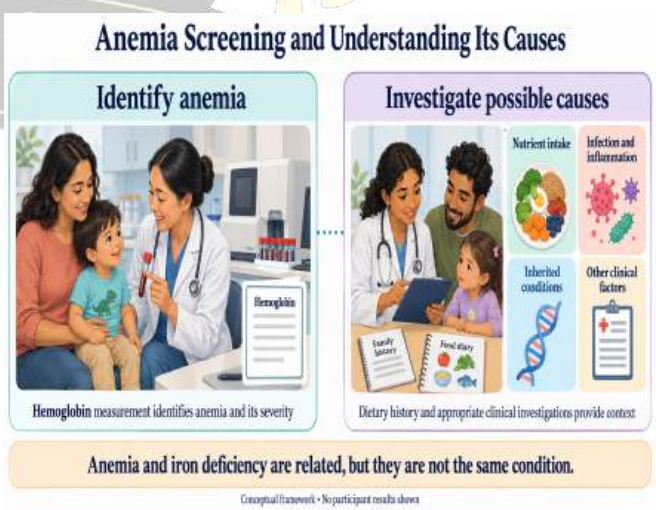
Low frequency of pulse and vitamin C-rich food and tea near meals showed exploratory associations with anemia. There was no significant association for milk consumption.

Discussion

The fabricated results indicate a considerable burden of anemia together with different diets. They are methodologically consistent in that the total number of anemia cases is 174 in all demographic, severity, and dietary tables, while the associations are derived straightforwardly from the denominators.

The observed reduction in anemia with age might be related to development of food consumption habits, early nutrition, or any other age-related factors. This result cannot prove that age protects from anemia. Real analysis should consider age along with household factors, illnesses, and supplementation.

Dietary diversity appears to be the strongest association shown in the tables. However, the greater number of food groups consumed may be indicative of richer households, better access to services or feeding assistance. Unadjusted prevalence ratio cannot single out the diet effect. Kathuria et al. [11] took into consideration dietary diversity in relation to the broader social context.



Comparisons of pulse and vitamin C-rich food consumption are meaningful from the biological perspective as far as dietary assessment is concerned. Still, frequency does not account for portion size, processing, combinations of foods and nutrients. Hurrell and Egli's study [8] further supports the

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need for differentiation between food consumption and iron availability.

The tea association requires further comments. Its direction fits into concerns about dietary inhibitors, but this questionnaire cannot assess the actual level of iron absorption and show that tea consumption caused anemia.

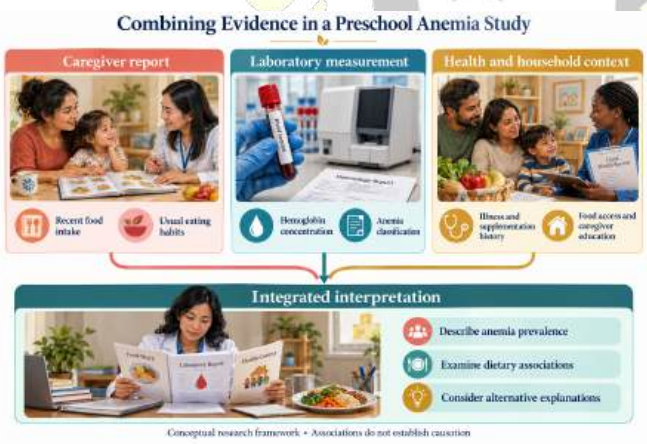
The nonsignificant milk test is another example of how a plausible hypothesis does not necessarily equal a valid conclusion. There is no evidence for any association, and the exposure threshold is study-defined. Such findings would not provide a reason for generalized restrictions on milk intake.

Most important, the outcome measured in the study is anemia, not documented iron-deficiency anemia. It is impossible to know the proportion that is due to iron deficiency without iron status testing. Dietary observation and nutritional counseling, prevention and investigation have different goals.

Limitations

No prevalence rate estimate based on empirical data can be made in this simulated analysis. Real research will face other challenges, such as potential recall error and seasonal effects on diet.

A single 24-hour recall inadequately estimates recent intake and does not prove the usual intake of nutrients by individuals. The threshold for variety requires validation.



Lack of individual-level data makes it impossible to conduct adjusted analyses and verify the full joint distribution of exposures. Additional multiple comparisons will increase the likelihood of spurious results.

Conclusion

An anemia screening of preschoolers would require proper hemoglobin classification according to age criteria and specific information about nutrition, disease, and family conditions. The provided tables show that prevalence, severity, and nutrition associations were reported consistently. No real-life findings have been obtained through simulation. Conclusions need to be based on real data and differentiate between anemia and iron deficiency.

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