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Anaemia and Its Associated Demographic and Nutritional Factors among Children Residing in Child Care Institutions.

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Abstract

Background: Children residing in Child Care Institutions are vulnerable to anaemia because of dietary inadequacy, micronutrient deficiencies, recurrent infections, intestinal parasitic infestation and adverse socioeconomic circumstances preceding institutionalization. Evidence concerning the prevalence and associated factors of anaemia in this population remains limited. Aim: To assess the prevalence of anaemia and its associated demographic and nutritional factors among children residing in Child Care Institutions. ***Materials and Methods***: An institution-based analytical cross-sectional study was conducted among 433 children aged 6-15 years residing in 12 selected CCIs in Dharwad district from June 2018 to May 2019. Institutions were selected purposively, and all eligible and consenting children present during the study visits were included. Data were collected using a pretested semi-structured questionnaire, 24-hour dietary recall, clinical examination and standardized anthropometric measurements. Haemoglobin was estimated using Sahli's acid-haematin method and classified according to applicable age- and sex-specific criteria. Associations were evaluated using the chi-square test, Fisher's exact test and Welch's t test. Unadjusted odds ratios and mean differences were reported with 95% confidence intervals. A p value below 0.05 was considered statistically significant. ***Results***: Anaemia was present in 121 of 433 children, giving a prevalence of 27.9% (95% CI: 23.9%-32.4%). Mild anaemia affected 17.6%, while 10.4% had moderate anaemia; no severe anaemia was recorded. Anaemia prevalence differed significantly across age groups (p=0.042). It was considerably higher among females than males (40.2% versus 16.0%; OR=3.53, 95% CI: 2.25-5.56; p<0.001). Mean haemoglobin was significantly lower among females than males (11.80±1.11 versus 12.55±1.08 g/dL; MD=−0.75, 95% CI: −0.96 to −0.54; p<0.001). Anaemia was significantly associated with parental status (p<0.001); its prevalence increased from 12.8% among children whose parents were both present to 34.0% among paternal orphans, 36.7% among maternal orphans and 48.0% among double orphans. Double orphans had the greatest odds of anaemia (OR=6.26, 95% CI: 3.09-12.69). Children residing with siblings also had greater unadjusted odds of anaemia than those not residing with siblings (OR=2.31, 95% CI: 1.51-3.55; p<0.001). Although calorie inadequacy, protein inadequacy and abnormal BMI-for-age were common, their direct associations with anaemia could not be estimated from the available aggregate data. ***Conclusion***: Anaemia constituted an important health problem among children residing in CCIs, particularly females and double orphans. Routine haemoglobin screening, dietary improvement, deworming, iron-folic acid supplementation and timely treatment or referral are required. Participant-level nutritional analyses and multivariable studies are needed to identify independent determinants.

Keywords: Anemia; Child Care Institutions; Institutionalized children.

INTRODUCTION

Anaemia is a major nutritional and public-health problem among children and adolescents, particularly in populations affected by poverty, dietary inadequacy, infection and limited access to preventive healthcare. It is characterized by a haemoglobin concentration below the age- and sex-specific reference value and can impair physical growth, immunity, cognitive development, attention, academic performance and work capacity. Children residing in Child Care Institutions (CCIs) constitute a vulnerable group because many have experienced parental loss, abandonment, poverty, food insecurity or inadequate healthcare before institutionalization. Although CCIs provide shelter and regular meals, uniform menus, inadequate dietary diversity and insufficient consumption of iron-, protein-, folate- and vitamin B_{12}-rich foods may increase the risk of anaemia. Reddy and Ramya (2017)[1] reported a substantial burden of anaemia and other physical morbidities among children residing in orphanages in Karnataka. Karam et al. (2021)[2] identified palmar pallor in 26.8% of children residing in childcare homes in Puducherry and found that undernutrition and nutritional deficiencies were among their most common health problems. Riaz et al. (2021)[3] reported inadequate consumption of protein, iron and fats among institutionalized children, together with underweight, stunting and thinness, demonstrating the close relationship between dietary inadequacy and nutritional morbidity. DeLacey et al. (2020)[4], in a systematic review, found wide variation in anaemia prevalence among institutionalized children and concluded that undernutrition, micronutrient deficiencies and infections frequently coexisted in this population. Tandoh and Asamoah (2022)[5] also documented hidden hunger and micronutrient deficiencies among school-aged children living in orphanages, emphasizing that micronutrient deficiencies may remain undetected when assessment is restricted to anthropometry. The causes of anaemia among institutionalized children may include inadequate intake of iron and protein, increased requirements during growth and puberty, menstrual blood loss among adolescent girls, worm infestation, recurrent infections and chronic illness. Demographic and institutional factors, including age, gender, parental status, duration of institutionalization and sibling co-residence, may further influence vulnerability. Periodic haemoglobin estimation combined with anthropometric and dietary assessment is therefore necessary for early identification and treatment. However, evidence concerning anaemia and its associated demographic and nutritional factors among children residing in CCIs remains limited. The present study was undertaken to estimate the prevalence and severity of anaemia and identify associated demographic and nutritional factors among children residing in selected CCIs.

AIM
To assess the prevalence of anaemia and its associated demographic and nutritional factors among children residing in Child Care Institutions.

OBJECTIVES
1. To estimate the prevalence and severity pattern of anaemia among children residing in Child Care Institutions.
2. To compare haemoglobin levels and anaemia prevalence according to age, gender and selected institutional characteristics.
3. To determine the association of dietary adequacy and anthropometric nutritional status with anaemia among the study participants.

MATERIALS AND METHODS
Source of Data
Primary data were obtained from children aged 6-15 years residing in selected government and non-government CCIs in Dharwad district. Information was collected directly from participating children and supplemented by institutional caregivers, designated informants and available institutional records.
The collected information included demographic characteristics, parental status, reason for institutionalization, duration of institutional residence, sibling co-residence, dietary intake, anthropometric measurements, history of illness, clinical signs of nutritional deficiency and haemoglobin concentration.

Study Design
An institution-based analytical cross-sectional study was conducted.

Study Location
The study was conducted in selected CCIs situated in Dharwad district, Karnataka. At the time of the study, the district had 32 CCIs, including 23 non-governmental and nine government institutions. Twelve eligible institutions that granted administrative permission were included.

Study Duration
The study was conducted over one year, from June 2018 to May 2019.

Study Population
The study population comprised children aged 6-15 years residing in the selected CCIs during the study period.

Sample Size
A total of **433 eligible children** were included. All eligible and consenting children who were present in the selected institutions during the scheduled data-collection visits were assessed. The final sample available for analysis was 433.

Sampling Technique

The participating CCIs were selected purposively according to administrative permission and eligibility. Within each selected institution, all children satisfying the selection criteria and available during the study visit were approached for participation.

Inclusion Criteria

- Children aged 6-15 years residing in the selected CCIs.
- Children present during the scheduled data-collection visits.
- Children who provided age-appropriate assent or verbal consent.
- Children whose participation was permitted by the institutional authorities or legal caregivers.
- Children who cooperated during the interview, physical examination, anthropometric assessment and haemoglobin estimation.

Exclusion Criteria

- Children younger than six years or older than 15 years.
- Children who declined participation or haemoglobin estimation.
- Children who did not cooperate with the study procedures.
- Children who were severely ill or bedridden at the time of assessment.
- Children with severe physical or intellectual disabilities that prevented the planned assessment.
- Children with known HIV infection or active tuberculosis who were receiving care in specialized institutions outside the sampling framework.
- Children admitted under the Protection of Children from Sexual Offences Act when participation could compromise their privacy or legal protection.
- Children absent during the scheduled institutional visits.
- Children from institutions that did not provide permission.

Study Variables

Primary outcome variable

- Presence or absence of anaemia based on age- and sex-specific haemoglobin cut-offs.

Secondary outcome variables

- Severity of anaemia: mild, moderate or severe.
- Mean haemoglobin concentration in g/dL.

Explanatory variables

- Age and age group.
- Gender.
- Educational status.
- Parental or orphan status.
- Age at institutionalization.
- Duration of institutional residence.
- Residence with or without siblings.
- History of illness during the preceding year.
- History of worm infestation.
- Calorie and protein adequacy.
- Height, weight and BMI.
- BMI-for-age category.
- Clinical signs of nutritional deficiency.
- Intake of iron, folic acid or other nutritional supplements.

Data Collection

Data were collected using a predesigned, semi-structured and pretested questionnaire. A face-to-face interview was conducted with each child in a language the child understood. Information provided by younger children was verified, wherever possible, with the responsible caregiver or available institutional records.

The questionnaire covered:

- Demographic and educational characteristics.
- Parental and orphan status.

- Reasons for institutionalization.
- Age at admission and duration of residence.
- Sibling co-residence.
- Previous illness and worm infestation.
- Dietary consumption during the preceding 24 hours.
- Intake of calorie- and protein-rich foods.
- Use of iron, folic acid, vitamins or other supplements.
- Menstrual history among eligible adolescent girls.
- Anthropometric and clinical findings.
- Haemoglobin concentration.

Each participant was assigned a unique identification number. Completed forms were checked daily for completeness and consistency.

Procedure and Methodology

Administrative permission was obtained from the District Child Protection Office and heads of the participating institutions. A suitable date and time were arranged for each visit. The study purpose and procedures were explained to institutional authorities, caregivers and children. Age-appropriate assent or verbal consent was obtained before assessment. A pilot study was conducted among ten children residing in a government CCI. The clarity and feasibility of the questionnaire and assessment procedures were examined, and necessary modifications were made before the main study. Children participating in the pilot study were not included in the final analysis.

Interview and clinical examination

Each child was interviewed individually. A general physical examination and relevant systemic examination were performed. Children were assessed for pallor, icterus, lymphadenopathy, oedema, skin or hair changes, angular stomatitis, glossitis, dental abnormalities, nail changes and other signs suggestive of nutritional deficiency.

Dietary assessment

Dietary intake was assessed using a 24-hour dietary recall. Children were asked to report all foods and beverages consumed during the preceding day. The timing, approximate quantity and serving size of each item were documented. Information was cross-verified with caregivers, kitchen personnel and institutional menus when available.

Food quantities were converted into grams using standard household measures. Estimated calorie and protein intake was compared with the age- and sex-specific recommended dietary allowance. Intake was categorized as adequate or inadequate.

Anthropometric assessment

Height was measured without footwear using a non-stretchable measuring tape fixed vertically against a flat wall. Children stood upright with their heels together and head appropriately positioned. Height was recorded to the nearest centimetre.

Weight was measured using a calibrated digital weighing scale placed on a firm, level surface. Children were weighed in light clothing and without footwear. The scale was checked for zero error before each measurement, and weight was recorded in kilograms.

BMI was calculated as:

BMI-for-age was classified using the adopted age- and sex-specific reference criteria. Children were categorized as having severe wasting, wasting, normal BMI-for-age, risk of overweight, overweight or obesity.

Haemoglobin estimation

Haemoglobin concentration was estimated using Sahli's acid-haematin method under aseptic precautions. The procedure was explained to each child before finger-prick collection. Haemoglobin values were recorded in g/dL and categorized using appropriate age- and sex-specific criteria.

Anaemia was classified as:

- No anaemia.
- Mild anaemia.
- Moderate anaemia.
- Severe anaemia.

Children identified with anaemia or another health problem were reported to the responsible institutional authority for appropriate evaluation, treatment or referral.

Sample Processing

The fingertip was cleaned using an alcohol swab and allowed to dry. A sterile, single-use lancet was used to obtain capillary blood. The required quantity of blood was drawn into the graduated Sahli tube containing the prescribed amount of 0.1 N hydrochloric acid.

The contents were mixed thoroughly and allowed to stand for approximately 10 minutes for the formation of acid haematin. Distilled water was subsequently added drop by drop while mixing until the colour matched the comparator standard. The haemoglobin concentration was read at the lower meniscus and recorded in g/dL.

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he result was entered against the participant's unique identification number. No biological specimen was stored after the test. Used lancets were immediately placed in a puncture-proof sharps container, while blood-contaminated cotton, swabs and other materials were disposed of in accordance with biomedical-waste-management procedures.

Quality-Control Measures

- The questionnaire was pretested before the main study.
- The investigator was trained in standardized interviewing, anthropometry and haemoglobin estimation.
- The weighing scale was checked for zero error before every measurement.
- Anthropometric measurements were repeated when values appeared inconsistent.
- Sterile, single-use lancets were used for every child.
- The Sahli haemoglobinometer was cleaned and checked regularly.
- Dietary information was cross-verified with institutional menus and caregivers.
- Data-collection forms were reviewed daily for completeness.
- Data entry was checked against the original forms before analysis.

Statistical Methods

Data were coded and entered into Microsoft Excel 2010 and analysed using IBM SPSS Statistics version 21.0.

Categorical variables were summarized using frequencies and percentages. Continuous variables were summarized using mean and standard deviation when approximately normally distributed and median with interquartile range when skewed.

The prevalence of anaemia was calculated as:

The prevalence estimate was reported with a 95% confidence interval. The chi-square test was used to examine associations between anaemia and categorical variables such as age group, gender, parental status, sibling residence, dietary adequacy and BMI category. Fisher's exact test was used when expected cell frequencies were below five.

The independent-samples *t* test was used to compare mean haemoglobin values between two independent groups when the assumptions of normality and variance were satisfied. Welch's *t* test was used when variance equality was not satisfied. The Mann-Whitney U test was used for non-normally distributed continuous variables.

Crude odds ratios with 95% confidence intervals were calculated to quantify associations between selected factors and anaemia. Because the available results were based on bivariate analyses, these estimates were interpreted as unadjusted associations rather than independent predictors.

All tests were two-tailed. A p value below 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of Karnataka Institute of Medical Sciences, Hubballi. Administrative permission was obtained from the District Child Protection Office and heads of the participating CCIs. Age-appropriate assent or verbal consent was obtained from each child. Privacy and confidentiality were maintained, and the collected information was used only for research purposes. Children found to have anaemia, malnutrition or another health problem were referred through the institutional authorities for appropriate management.

RESULTS

Table 1: Overall prevalence of anaemia and its associated demographic and nutritional factors among children residing in CCIs (N=433)

Study parameter	Anaemia present, n/N (%)	Anaemia absent, n/N (%)	Effect estimate (95% CI)	Test of significance	P value
Overall anaemia	121/433 (27.9%)	312/433 (72.1%)	Prevalence=27.9% (23.9%-32.4%)	One-sample proportion estimate	
Age group				χ^2=6.33	0.042*

6-9 years	32/99 (32.3%)	67/99 (67.7%)	Reference		
10-12 years	47/142 (33.1%)	95/142 (66.9%)	OR=1.04 (0.60-1.79)		
13-15 years	42/192 (21.9%)	150/192 (78.1%)	OR=0.59 (0.34-1.01)		
Gender				χ^2=31.49	<0.001*
Male	35/219 (16.0%)	184/219 (84.0%)	Reference		
Female	86/214 (40.2%)	128/214 (59.8%)	OR=3.53 (2.25-5.56)		
Parental status				χ^2=39.44†	<0.001*
Both parents present	23/179 (12.8%)	156/179 (87.2%)	Reference		
Paternal orphan	18/53 (34.0%)	35/53 (66.0%)	OR=3.49 (1.70-7.15)		
Maternal orphan	55/150 (36.7%)	95/150 (63.3%)	OR=3.93 (2.27-6.80)		
Double orphan	24/50 (48.0%)	26/50 (52.0%)	OR=6.26 (3.09-12.69)		
Sibling co-residence				χ^2=15.05	<0.001*
Residing with sibling	64/166 (38.6%)	102/166 (61.4%)	OR=2.31 (1.51-3.55)		
Not residing with sibling	57/267 (21.3%)	210/267 (78.7%)	Reference		
Nutritional factors overall prevalence					
Inadequate calorie intake	429/433 (99.1%)		99.1% (97.6%-99.6%)		
Inadequate protein intake	243/433 (56.1%)		56.1% (51.4%-60.7%)		
Abnormal BMI-for-age	176/433 (40.6%)		40.6% (36.1%-45.3%)		
Wasting or severe wasting	137/433 (31.6%)		31.6% (27.4%-36.2%)		

*Statistically significant at p<0.05.
†The overall test included the single child recorded under guardian status.
‡The aggregate source did not report anaemia separately according to calorie intake, protein intake or BMI category.

Table 1 presents the overall prevalence of anaemia among 433 children residing in child care institutions (CCIs), along with demographic and nutritional correlates. Anaemia was present in 27.9% of children (95% CI: 23.9%-32.4%). Prevalence varied significantly by age group (χ^2=6.33, p=0.042), being highest among 10-12 year olds (33.1%) and lowest among 13-15 year olds (21.9%), though only the 13-15 year comparison approached a protective association relative to the 6-9 year reference group. Gender showed a strong association (χ^2=31.49, p<0.001), with females having more than three times the odds of anaemia compared to males (OR=3.53, 95% CI: 2.25-5.56). Parental status was also strongly associated with anaemia (χ^2=39.44, p<0.001), with risk rising progressively from children with both parents present (12.8%) to paternal orphans (34.0%), maternal orphans (36.7%), and double orphans (48.0%, OR=6.26 relative to the reference group). Children residing with a sibling had significantly higher anaemia prevalence than those without a co-resident sibling (38.6% vs 21.3%, OR=2.31, p<0.001). On the nutritional side, inadequate calorie intake (99.1%) and inadequate protein intake (56.1%) were highly prevalent, as were abnormal BMI-for-age (40.6%) and wasting or severe wasting (31.6%), though the source data did not permit estimating their direct association with anaemia status.

Table 2: Prevalence and severity pattern of anaemia among children residing in CCIs (N=433)

Haemoglobin status	Overall, n (%)	95% CI	Male (n=219)	Female (n=214)	Effect estimate (95% CI)	Test of significance	P value
Any anaemia	121 (27.9%)	23.9%-32.4%	35 (16.0%)	86 (40.2%)	OR=0.28 (0.18-0.45)	χ^2=31.49	<0.001*
Mild anaemia	76 (17.6%)	14.3%-21.4%	23 (10.5%)	53 (24.8%)	OR=0.30 (0.18-0.52)†		
Moderate anaemia	45 (10.4%)	7.9%-13.6%	12 (5.5%)	33 (15.4%)	OR=0.25 (0.13-0.51)†		

Severe anaemia	0 (0.0%)	0.0%-0.9%‡	0 (0.0%)	0 (0.0%)	Not estimable		
No anaemia	312 (72.1%)	67.6%-76.1%	184 (84.0%)	128 (59.8%)	Reference		
Overall severity distribution by gender						χ^2=31.64§	<0.001*
Haemoglobin, g/dL	12.18 (1.16)¶	12.07-12.29#	12.55 (1.08)	11.80 (1.11)	MD=0.75 (0.54-0.96)	Welch t=7.10	<0.001*

†Odds ratio for males versus females, with normal haemoglobin as the comparator.
‡Rule-of-three upper 95% confidence limit.
§Comparison of normal, mild and moderate categories between males and females.
¶Overall mean and SD were derived from the reported sex-specific summary statistics.
#95% CI for the overall mean.

Table 2 details the severity distribution of anaemia and its relationship with gender and haemoglobin levels. Of the 27.9% overall prevalence, 17.6% of children had mild anaemia and 10.4% had moderate anaemia, with no cases of severe anaemia recorded. Both mild anaemia (24.8% vs 10.5%) and moderate anaemia (15.4% vs 5.5%) were markedly more common in females than males, and the overall severity distribution differed significantly by gender (χ^2=31.64, p<0.001). Mean haemoglobin was significantly lower in females (11.80 g/dL) than males (12.55 g/dL), a mean difference of 0.75 g/dL (95% CI: 0.54-0.96, Welch t=7.10, p<0.001).

Table 3: Comparison of haemoglobin level and anaemia prevalence according to demographic and institutional characteristics (N=433)

Characteristic	**n**	**Anaemia, n (%)**	**95% CI for prevalence**	**Unadjusted OR (95% CI)**	**Test of significance**	**P value**
Age group					χ^2=6.33	0.042*
6-9 years	99	32 (32.3%)	23.9%-42.0%	Reference		
10-12 years	142	47 (33.1%)	25.9%-41.2%	1.04 (0.60-1.79)		
13-15 years	192	42 (21.9%)	16.6%-28.2%	0.59 (0.34-1.01)		
Gender					χ^2=31.49	<0.001*
Male	219	35 (16.0%)	11.7%-21.4%	Reference		
Female	214	86 (40.2%)	33.8%-46.9%	3.53 (2.25-5.56)		
Mean haemoglobin by gender						
Male	219	12.55 (1.08) g/dL	12.40-12.69†	Reference	Welch t=7.10	<0.001*
Female	214	11.80 (1.11) g/dL	11.65-11.95†	MD=−0.75 (−0.96 to −0.54)‡		
Parental status					χ^2=39.44§	<0.001*
Both parents present	179	23 (12.8%)	8.7%-18.5%	Reference		
Paternal orphan	53	18 (34.0%)	22.7%-47.4%	3.49 (1.70-7.15)		
Maternal orphan	150	55 (36.7%)	29.4%-44.6%	3.93 (2.27-6.80)		
Double orphan	50	24 (48.0%)	34.8%-61.5%	6.26 (3.09-12.69)		
Sibling co-residence					χ^2=15.05	<0.001*
Residing with sibling	166	64 (38.6%)	31.5%-46.1%	2.31 (1.51-3.55)		
Not residing with sibling	267	57 (21.3%)	16.9%-26.7%	Reference		

Table 3 consolidates comparisons of haemoglobin levels and anaemia prevalence across demographic and institutional characteristics. It largely reiterates the age, gender, parental status, and sibling co-residence patterns from Table 1, while adding mean haemoglobin values by gender: males averaged 12.55 g/dL (95% CI: 12.40-12.69) compared to 11.80 g/dL (95% CI: 11.65-11.95) in females, a statistically significant difference (Welch t=7.10, p<0.001). Across all characteristics age, gender, parental status, and sibling co-residence anaemia prevalence and odds ratios were consistent with those reported in Table 1, reinforcing female gender, orphan status (particularly double orphan status), and sibling co-residence as the strongest correlates of anaemia risk in this population.

DISCUSSION

The prevalence of anaemia in this cohort of children residing in child care institutions (CCIs) 27.9% sits toward the lower end of the very wide range (3-90%) reported for institutionalised children globally by DeLacey et al. (2020)[1], whose systematic review of 25 studies found substantial heterogeneity in anaemia burden driven by region, age range and institutional food security. This relatively favourable figure is more comparable to community-based estimates from Ethiopia, such as Tegegne et al. (2022)[2], who found 47.9% anaemia among children 6-23 months in the Bale zone, and Kuziga et al. (2017)[3], who reported 58.8% prevalence among Ugandan preschoolers both substantially higher, likely reflecting the younger, more nutritionally vulnerable age bands sampled in those studies compared with the present cohort's older age range (6-15 years).

The age pattern observed here lower anaemia prevalence among adolescents (13-15 years) than younger children parallels national Indian survey data. Rahman et al. (2020)[4] similarly found that anaemia among 5-9-year-old Indian children was more common at younger ages within that band, and Scott et al. (2022)[5], analysing nationally representative adolescent data, likewise documented declining anaemia burden with advancing age through adolescence, consistent with the protective trend (OR=0.59) seen for the oldest age group in this study.

The pronounced female excess in anaemia (40.2% vs 16.0%, OR=3.53) is a more striking gender gap than typically reported in general Indian child populations. Patel et al. (2021)[6], using NFHS data on children aged 6-59 months, explicitly concluded that "gender does not play any role" in anaemia risk in that younger age group. However, once adolescence is reached, the gap widens substantially: Scott et al. (2022)[5] found anaemia in 40% of Indian adolescent girls versus 18% of boys, and Chauhan et al. (2022)[7], studying adolescents in Bihar and Uttar Pradesh, reported a similar disparity (20% vs 8.7%). Dhurde et al. (2024)[8], focusing specifically on adolescent girls in Maharashtra, further linked female anaemia to iron and vitamin B12 deficiency and non-nuclear family residence a pattern that resonates with the elevated risk seen among sibling-co-resident and orphaned children in the present study. The convergence of a strong gender effect emerging specifically in the older/pubertal age bands across these studies suggests menstrual iron loss compounds the institutional nutritional deficit captured here.

The orphan-status gradient found in this study (from 12.8% anaemia among children with both parents present to 48.0% among double orphans) strongly echoes the broader orphan-nutrition literature, even though most of that literature reports anthropometric rather than haematological outcomes. Mohammed et al. (2021)[9], studying institutionalised school-age orphans in Ethiopia, found consistently elevated undernutrition risk among orphans, while Ali et al. (2018)[10], comparing orphan and non-orphan Ghanaian children, documented significantly poorer nutritional indices among institutionalised orphans. Berr et al. (2021)[11] similarly demonstrated that orphaned and vulnerable children in Addis Ababa fared worse nutritionally than children with parental care, and Etafa et al. (2025)[12], in a more recent Ethiopian cohort, confirmed elevated undernutrition among orphans linked to caregiving arrangement and illness history. Kamath et al. (2017)[13], in a pilot study directly comparing institutionalised orphans and non-orphans, found both higher malnutrition rates and a direct correlation with cognitive delay in the orphan group reinforcing that the parental-loss gradient observed here for anaemia likely reflects a broader pattern of cumulative disadvantage rather than a haematology-specific phenomenon.

The sibling co-residence finding (higher anaemia among children residing with siblings) is less commonly isolated as a variable in the literature, but is consistent with resource-dilution mechanisms described in household nutrition research. El Bilbeisi (2025)[14], studying anaemia determinants among young children in the Gaza Strip, linked larger household/family size to elevated anaemia risk via food insecurity pathways a mechanism plausibly transferable to the institutional setting, where a fixed food ration may be diluted across co-resident siblings rather than allocated per capita.

Regarding nutritional co-factors, the extremely high prevalence of inadequate calorie intake (99.1%) in this cohort is markedly more severe than most reported institutional diets. DeLacey et al. (2020)[1] noted that roughly half of reviewed institutional studies found adequate dietary intake, suggesting considerable variability in CCI food provisioning globally, and the near-universal caloric inadequacy here indicates this particular institutional context is nutritionally under-resourced relative to many other settings.

Finally, the internationally adopted children literature offers a partial external comparator: Buonsenso et al. (2025)[15], studying a large Italian cohort of internationally adopted children (many with prior institutional exposure), found anaemia to be a persistent finding at intake, aligning with the broader observation that pre-adoption or ongoing institutional residence carries elevated haematological risk. Set against the WHO's global benchmark classification of anaemia prevalence (WHO, 2021)[16], the 27.9% prevalence found here falls in the "moderate public health significance" band (20-39.9%), lower than many low-income community and institutional settings but still indicating a substantial, actionable burden within this CCI population.

CONCLUSION

Anaemia affected more than one-fourth of children residing in Child Care Institutions, with an overall prevalence of 27.9%. Mild anaemia was the predominant form, followed by moderate anaemia, while no child had severe anaemia. Female children experienced a disproportionately high burden: their anaemia prevalence was 40.2% compared with 16.0% among males, and their mean haemoglobin concentration was significantly lower. Anaemia was also significantly associated with age, parental status and sibling co-residence. Double orphans had the highest prevalence and more than six times the unadjusted odds of anaemia compared with children whose parents were both present.

The population simultaneously demonstrated widespread calorie inadequacy, protein inadequacy and abnormal BMI-for-age. However, their direct associations with anaemia could not be established from the available aggregate data. Regular haemoglobin screening, dietary assessment, deworming, iron-folic acid supplementation and appropriate clinical referral should be incorporated into routine CCI health services. Female children and those with complete parental loss require particular attention. Further studies using biochemical investigations and adjusted multivariable analyses are needed to identify the independent nutritional and institutional determinants of anaemia.

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