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NUTRITIONAL STATUS AND DIETARY ADEQUACY AMONG CHILDREN RESIDING IN CHILD CARE INSTITUTIONS: A CROSS-SECTIONAL ASSESSMENT

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ABSTRACT

Background: Children residing in Child Care Institutions are vulnerable to nutritional deficiencies because of pre-institutional deprivation, limited dietary diversity, uniform institutional menus and insufficient individualized feeding. Assessment of both anthropometric status and dietary adequacy is necessary to identify undernutrition and emerging excess weight in this population. The aim is to assess the nutritional status and dietary adequacy among children residing in Child Care Institutions.
Materials and Methods: An institution-based cross-sectional study was conducted among 433 children aged 6-15 years residing in 12 selected Child Care Institutions in Dharwad district from June 2018 to May 2019. Institutions were selected purposively, and all eligible, 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. Calorie and protein intake were compared with age- and sex-specific recommended dietary allowances. Body mass index was calculated and classified using BMI-for-age criteria. Categorical variables were compared using the chi-square or Fisher's exact test, and continuous variables were compared using Welch's independent-samples t test. Effect estimates were reported with 95% confidence intervals, and $p<0.05$ was considered statistically significant.
Results: Among 433 children, 219 (50.6%) were males and 214 (49.4%) were females. Inadequate calorie intake was observed in 429 (99.1%) children and did not differ significantly by gender (p=0.623). Protein intake was inadequate in 243 (56.1%) children and was significantly more frequent among females than males (63.6% versus 48.9%; OR for males=0.55, 95% CI: 0.37-0.80; p=0.002). Abnormal BMI-for-age was present in 176 (40.6%) children and was more common among males (48.4% versus 32.7%; OR=1.93, 95% CI: 1.31-2.85; $p<0.001$). Wasting and severe wasting affected 15.5% and 16.2%, respectively. Severe wasting was markedly more prevalent among males than females (27.9% versus 4.2%; OR=8.79, 95% CI: 4.24-18.25; $p<0.001$). Risk of overweight, overweight and obesity were observed in 4.6%, 3.9% and 0.5%, respectively, and occurred predominantly among females. Mean BMI was significantly lower among males than females (14.79±2.97 versus 17.57±4.01 kg/m²; MD=-2.78, 95% CI: -3.45 to -2.11; $p<0.001$).
Conclusion: Children residing in CCIs experienced substantial calorie and protein inadequacy and a dual burden of malnutrition. Males were disproportionately affected by severe wasting, whereas females had greater protein inadequacy and a higher tendency toward excess weight. Regular

growth monitoring, repeated dietary assessment, diversified institutional menus and individualized nutritional interventions are required.
Keywords: Child Care Institutions, Dietary adequacy, Nutritional status.

INTRODUCTION

Adequate nutrition during childhood and adolescence is essential for normal physical growth, pubertal development, immune function, cognitive performance and long-term health. Children residing in Child Care Institutions (CCIs) constitute a nutritionally vulnerable population because many have experienced parental loss, abandonment, poverty, food insecurity, family disruption or inadequate healthcare before institutional placement. Although CCIs provide shelter, education and regular meals, limited financial resources, uniform menus, inadequate dietary diversity and insufficient individualized feeding may prevent children from receiving nutrients appropriate to their age, sex and stage of development.

Riaz et al. (2021).[1] assessed children and adolescents residing in orphanages in Rawalpindi and reported underweight, stunting and thinness, together with inadequate consumption of protein, iron and fats. These findings indicate that the provision of regular meals may not necessarily ensure nutritional adequacy when institutional menus lack sufficient quantity, diversity or nutrient density. Singwa et al. (2022).[2] similarly observed inadequate energy, protein and fat intake among older children residing in orphanages in Cameroon. Their study also documented low consumption of vegetables, fruits and milk, while cereals were the most frequently consumed foods. Such cereal-dominated diets may satisfy hunger but remain deficient in high-quality protein and essential micronutrients.

Institutionalized children may experience both nutritional deficiency and excessive weight gain. El-Kassas and Ziade (2017).[3] demonstrated a dual burden of malnutrition among school-age children living in orphanages in Lebanon, with the coexistence of stunting, overweight and obesity. Approximately half of the children had inadequate intake of protein, fruits and vegetables, while the majority consumed insufficient milk and dairy products. Chowdhury et al. (2017).[4] also reported a high prevalence of malnutrition among children residing in a Dhaka orphanage, emphasizing the need for periodic nutritional monitoring, early identification and timely intervention.

Dietary diversity is an important determinant of nutritional quality because the consumption of foods from multiple food groups improves the likelihood of meeting energy, protein and micronutrient requirements. Ali et al. (2018).[5] examined dietary diversity and nutritional status among orphaned and non-orphaned children in Ghana and demonstrated the importance of caregiver, socioeconomic and dietary factors in determining childhood nutritional outcomes.

Nutritional assessment in CCIs should therefore combine anthropometric measurements with dietary evaluation and clinical screening. BMI-for-age can identify severe thinness, thinness, overweight and obesity among school-aged children and adolescents, while a 24-hour dietary recall can provide information regarding calorie and protein adequacy. Haemoglobin estimation may additionally identify anaemia, which can impair physical capacity, attention and learning performance. Regular assessment can identify high-risk children, detect gender disparities and guide menu modification, supplementation, nutrition education and referral. However, locally generated evidence regarding dietary adequacy and nutritional status among children residing in CCIs remains limited. The present study was therefore undertaken to assess calorie and protein adequacy, anthropometric nutritional status and selected haematological findings among children residing in CCIs.

Aim

To assess the nutritional status and dietary adequacy among children residing in Child Care Institutions.

Objectives

1. To assess the nutritional status of children residing in Child Care Institutions using anthropometric measurements and BMI-for-age classification.
2. To determine the adequacy of calorie and protein intake among the study participants using a 24-hour dietary recall.
3. To examine the association of nutritional status and dietary adequacy with selected sociodemographic and institutional characteristics.

MATERIALS AND METHODS

Source of Data: The data were obtained from children aged 6-15 years residing in selected government and non-government Child Care Institutions in Dharwad district. Information was collected directly from the participating children and was supplemented, wherever required, by institutional caregivers, kitchen personnel, available institutional records and dietary records.

Primary data included sociodemographic characteristics, institutional history, dietary intake, anthropometric measurements, clinical signs of nutritional deficiencies and haemoglobin concentration. Information concerning institutional menus, food preparation, meal frequency, supplementation and health services was obtained from the responsible institutional staff.

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

Study Location

The study was conducted in selected Child Care Institutions situated in Dharwad district, Karnataka. The district had 32 CCIs, including 23 non-governmental and nine government institutions. Of these, 12 eligible CCIs that provided administrative permission and satisfied the study requirements were included.

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

Study Population: The study population consisted of children aged 6-15 years who were residing in the selected CCIs during the study period.

Sample Size: A total of 433 children were included in the study. All eligible children who were residing in the selected institutions, were present during the scheduled visits and consented or assented to participate were assessed. The final sample available for analysis was therefore 433 children.

Sampling Technique: A purposive sampling technique was used to select the CCIs that granted permission and fulfilled the eligibility requirements. Within the selected institutions, all eligible and consenting children present during the study visits were included.

Inclusion Criteria

- Children aged 6-15 years residing in the selected CCIs.
- Children who were 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, anthropometric measurements, clinical examination and haemoglobin estimation.

Exclusion Criteria

- Children younger than six years or older than 15 years.
- Children who were severely ill or bedridden at the time of assessment.
- Children with severe physical or intellectual disabilities that prevented accurate anthropometric or dietary assessment.
- Children residing in specialized institutions for HIV infection or active tuberculosis.
- Children admitted under the Protection of Children from Sexual Offences Act when participation could affect their safety, privacy or legal protection.
- Children who declined participation or did not cooperate with the study procedures.
- Children who were absent during the scheduled data-collection visits.
- Children from CCIs whose authorities did not provide permission.

Data Collection

Data were collected using a predesigned, semi-structured and pretested questionnaire. The questionnaire included the following domains:

- Age, sex, education and other sociodemographic information.
- Parental and orphan status.
- Reason for institutionalization.
- Age at institutional admission.
- Duration of residence in the institution.
- Residence with or without siblings.
- Number and timing of meals and snacks.
- Type and quantity of food consumed during the preceding 24 hours.
- Intake of milk, pulses, cereals, vegetables, fruits, eggs and other protein-rich foods.
- Consumption of iron, folic acid, vitamin or other nutritional supplements.
- Recent illness, deworming and health examination history.
- Anthropometric and clinical findings.
- Haemoglobin concentration.

The children were interviewed individually in a language they understood. Younger children were assisted by institutional caregivers when they were unable to recall the name or quantity of a food item. Dietary details were cross-checked with the institutional menu, kitchen staff and food-preparation records whenever available.

Research Instruments

The following instruments were used:

- Predesigned and pretested questionnaire.
- Standard household utensils or serving measures for estimating food portions.
- Non-stretchable measuring tape.
- Calibrated digital weighing scale.
- Sahli's haemoglobinometer.
- Sterile single-use lancets and other materials required for haemoglobin estimation.
- Torch and clinical examination instruments.
- WHO BMI-for-age reference charts.

Procedure and Methodology

Before data collection, approval was obtained from the Institutional Ethics Committee, District Child Protection Office and heads of the participating CCIs. The purpose, procedure, potential discomfort and expected benefits of the study were explained to the institutional authorities 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, feasibility and sequence of the questionnaire and measurement procedures were assessed. Minor modifications were made before beginning the main study, and children included in the pilot assessment were excluded from the final analysis.

Each participant was assigned a unique identification number. A face-to-face interview was conducted to obtain demographic, institutional, health and dietary information. A general physical examination was performed to identify pallor and clinical evidence of nutritional deficiencies involving the hair, eyes, lips, oral cavity, tongue, gums, skin and nails.

Dietary Assessment

Dietary intake was assessed using the 24-hour dietary-recall method. Each child was asked to recall all foods and beverages consumed during the preceding day, beginning with the first intake after waking and continuing until bedtime. The following information was recorded for each food item:

- Name and type of food.
- Time of consumption.
- Number of servings.
- Approximate serving size.
- Ingredients in mixed preparations.
- Food consumed outside the institution.
- Nutritional supplements, if any.

Standard household measures, including bowls, cups, glasses and serving spoons, were used to improve portion-size estimation. For food prepared collectively, the total quantity of raw ingredients, number of children served and approximate portion allocated to each child were obtained from the kitchen staff.

The quantities of consumed food were converted into grams. Energy and protein intake were calculated using the nutritive values of Indian foods and applicable Indian Council of Medical Research recommendations. Expected daily calorie and protein requirements were determined according to the child’s age and sex.

Dietary intake was categorized as:

Calorie and protein intake were classified as adequate or inadequate by comparing the observed intake with the respective age- and sex-specific recommended dietary allowance.

Anthropometric Assessment

Height

Height was measured using a non-stretchable measuring tape fixed vertically against a smooth wall. Each child stood barefoot on a level surface with the heels together, knees straight, arms hanging freely and the head positioned appropriately. The highest point of the head was marked, and height was measured to the nearest centimetre.

Weight

Weight was measured using a calibrated digital weighing scale placed on a firm and level surface. The scale was checked for zero error before every measurement. Children were weighed in light clothing and without footwear while standing upright at the centre of the scale. Weight was recorded to the nearest 0.1 kg.

Body Mass Index

BMI was calculated using the following formula:

BMI-for-age was interpreted using age- and sex-specific WHO reference values for children aged 5-19 years. Participants were classified as having severe wasting, wasting, normal BMI-for-age, risk of overweight, overweight or obesity according to the criteria adopted in the study.

Measurements were recorded immediately on the data-collection form and checked for biologically implausible values. When a value appeared inconsistent, the measurement was repeated.

Clinical Nutritional Assessment

Each child was examined in adequate natural or artificial light. The assessment included examination for:

- Pallor.
- Hair depigmentation, dryness or easy pluckability.
- Dry or scaly skin.
- Angular stomatitis or cheilosis.
- Glossitis.
- Bleeding or swollen gums.
- Dental caries.
- Platynychia or koilonychia.
- Oedema.
- Bitot spots or other visible eye changes.
- Goitre or other clinically evident nutritional abnormalities.

Children with suspected malnutrition, anaemia or another nutritional deficiency were brought to the attention of the institutional authority for further assessment and treatment.

Sample Processing

Capillary blood was collected for haemoglobin estimation as a nutrition-related haematological assessment. The procedure was explained to each child, and separate consent was obtained before finger-prick testing.

The fingertip was cleaned using an alcohol swab and allowed to dry. A sterile, single-use lancet was used to obtain capillary blood under aseptic precautions. The required quantity of blood was transferred into the graduated tube of Sahli’s haemoglobinometer containing the prescribed amount of hydrochloric acid. The specimen was mixed and allowed to form acid haematin. Distilled water was then added drop by drop until the colour matched the comparator standard. Haemoglobin concentration was read and recorded in g/dL.

Haemoglobin values were categorized as normal, mild anaemia, moderate anaemia or severe anaemia using the applicable WHO age- and sex-specific cut-offs. Findings were recorded against the child’s unique identification number. No blood sample was stored after estimation. Used lancets were placed in a puncture-proof sharps container, and blood-contaminated materials were discarded according to biomedical-waste-management procedures.

Quality-Control Measures

- The questionnaire was pretested before the main study.
- Data collectors were trained in interviewing, dietary recall, anthropometry and haemoglobin estimation.
- The digital weighing scale was checked for zero error before every measurement.

- Height and weight were measured using standardized procedures.
- Implausible anthropometric values were verified by repeat measurement.
- Standard utensils were used to improve dietary portion estimation.
- Dietary information was cross-verified with caregivers, kitchen staff and institutional menus.
- Completed questionnaires were checked daily for completeness and internal consistency.
- Data entry was rechecked 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, including dietary adequacy, BMI-for-age categories and anaemia categories, were summarized using frequencies and percentages. Continuous variables, including age, height, weight, BMI, daily calorie intake, daily protein intake and haemoglobin concentration, were summarized using mean and standard deviation when approximately normally distributed. Median and interquartile range were to be used for markedly skewed variables. The prevalence of abnormal nutritional status was calculated as: The chi-square test was used to examine associations between categorical variables, such as gender and dietary adequacy, gender and BMI category, age group and nutritional status, and institutional characteristics and nutritional status. Fisher's exact test was used when expected cell frequencies were less than five.

The independent-samples *t* test was used to compare mean height, weight, BMI, haemoglobin and nutrient intake between males and females when the data satisfied the relevant assumptions. The Mann-Whitney U test was to be applied when continuous variables were not normally distributed. Effect estimates were reported as odds ratios or mean differences with 95% confidence intervals.

All statistical tests were two-tailed. A p value of less than 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 the heads of the selected CCIs. Age-appropriate assent or verbal consent was obtained from participating children. Privacy and confidentiality were maintained throughout the study. Children identified with malnutrition, anaemia or other health problems were referred through the responsible institutional authorities for appropriate evaluation and management.

RESULTS

Table 1: Overall nutritional status and dietary adequacy among children residing in Child Care Institutions (N=433)

Study parameter	Overall, n (%) or Mean (SD)	Male (n=219)	Female (n=214)	Effect estimate (95% CI)	Test of significance	P value
Inadequate calorie intake	429 (99.1%)	216 (98.6%)	213 (99.5%)	OR=0.34 (0.03-3.28)	Fisher's exact test	0.623
Inadequate protein intake	243 (56.1%)	107 (48.9%)	136 (63.6%)	OR=0.55 (0.37-0.80)	χ^2=9.49	0.002*
Abnormal BMI-for-age	176 (40.6%)	106 (48.4%)	70 (32.7%)	OR=1.93 (1.31-2.85)	χ^2=11.05	<0.001*
Normal BMI-for-age	257 (59.4%)	113 (51.6%)	144 (67.3%)	OR=0.52 (0.35-0.77)	χ^2=11.05	<0.001*
Wasting	67 (15.5%)	39 (17.8%)	28 (13.1%)	OR=1.44 (0.85-2.44)	χ^2=1.85	0.174
Severe wasting	70 (16.2%)	61 (27.9%)	9 (4.2%)	OR=8.79 (4.24-18.25)	χ^2=44.66	<0.001*
Risk of overweight	20 (4.6%)	1 (0.5%)	19 (8.9%)	OR=0.05 (0.01-0.35)	Fisher's exact test	<0.001*
Overweight	17 (3.9%)	5 (2.3%)	12 (5.6%)	OR=0.39 (0.14-1.14)	Fisher's exact test	0.087
Obesity	2 (0.5%)	0 (0.0%)	2 (0.9%)	OR not estimable	Fisher's exact test	0.244
BMI, kg/m²	16.16 (3.79)	14.79 (2.97)	17.57 (4.01)	MD=-2.78 (-3.45 to -2.11)	Welch t=-8.18	<0.001*

Statistically significant at p<0.05. MD represents male minus female.

[Table 1] demonstrates a substantial burden of dietary inadequacy and abnormal nutritional status among the 433 children. Calorie intake was inadequate in 429 (99.1%) participants, with similarly high proportions among males (98.6%) and females (99.5%). The difference was not statistically significant (OR=0.34, 95% CI: 0.03-3.28; p=0.623). Protein intake was inadequate in 56.1% of children and was significantly more frequent among females than males (63.6% versus 48.9%). Males had 45% lower odds of protein inadequacy than females (OR=0.55, 95% CI: 0.37-0.80; χ^2=9.49, p=0.002).

Abnormal BMI-for-age was identified in 40.6% of participants and was more common among males than females (48.4% versus 32.7%). Males had 1.93 times greater odds of abnormal BMI-for-age (95% CI: 1.31-2.85; χ^2=11.05, p<0.001). Normal BMI-for-age was observed in 59.4% of children and was significantly more frequent among females than males (67.3% versus 51.6%; OR=0.52, 95% CI: 0.35-0.77; p<0.001). Wasting affected 15.5% of participants and was slightly more frequent among males, but the difference was not significant (p=0.174). Severe wasting was present in 16.2% and was markedly more frequent among males than females (27.9% versus 4.2%). Males had 8.79 times greater odds of severe wasting (95% CI: 4.24-18.25; χ^2=44.66, p<0.001).

Risk of overweight was significantly more common among females than males (8.9% versus 0.5%; OR for males=0.05, 95% CI: 0.01-0.35; p<0.001). Overweight was also numerically more frequent among females (5.6% versus 2.3%), although the difference did not attain statistical significance (p=0.087). Obesity was uncommon, affecting only two females, and showed no significant gender association (p=0.244). Mean BMI was significantly lower among males than females (14.79±2.97 versus 17.57±4.01 kg/m²), with a mean difference of -2.78 kg/m² (95% CI: -3.45 to -2.11; t=-8.18, p<0.001). Thus, the population exhibited a dual burden of malnutrition, characterized by substantial undernutrition—particularly among males—and emerging overweight among females.

Table 2: Anthropometric measurements and BMI-for-age classification of children residing in Child Care Institutions (N=433)

Anthropometric parameter	Overall, n (%) or Mean (SD)	95% CI	Male (n=219)	Female (n=214)	Effect estimate (95% CI)	Test of significance	P value
Height, cm	139.18 (22.90)†	137.02-141.34	142.05 (26.87)	136.24 (17.67)	MD=5.81 (1.52-10.10)	Welch t=2.66	0.008*
Weight, kg	31.36 (9.87)†	30.43-32.29	29.92 (9.78)	32.83 (9.76)	MD=-2.91 (-4.76 to -1.06)	Welch t=-3.10	0.002*
BMI, kg/m²	16.16 (3.79)	15.80-16.52	14.79 (2.97)	17.57 (4.01)	MD=-2.78 (-3.45 to -2.11)	Welch t=-8.18	<0.001*
BMI-for-age category						χ^2=65.21‡	<0.001*
Severe wasting	70 (16.2%)	13.0%-19.9%	61 (27.9%)	9 (4.2%)	OR=8.79 (4.24-18.25)		
Wasting	67 (15.5%)	12.4%-19.2%	39 (17.8%)	28 (13.1%)	OR=1.44 (0.85-2.44)		
Normal	257 (59.4%)	54.7%-63.9%	113 (51.6%)	144 (67.3%)	OR=0.52 (0.35-0.77)		
Risk of overweight	20 (4.6%)	3.0%-7.0%	1 (0.5%)	19 (8.9%)	OR=0.05 (0.01-0.35)		
Overweight	17 (3.9%)	2.5%-6.2%	5 (2.3%)	12 (5.6%)	OR=0.39 (0.14-1.14)		
Obesity	2 (0.5%)	0.1%-1.7%	0 (0.0%)	2 (0.9%)	OR not estimable		

†Overall height and weight estimates were derived from the reported sex-specific means, standard deviations and sample sizes.

‡Overall comparison of the six BMI-for-age categories between males and females.

[Table 2] presents the anthropometric measurements and BMI-for-age distribution of the children. The overall mean height was 139.18±22.90 cm. Males were significantly taller than females, with mean heights of 142.05±26.87 cm and 136.24±17.67 cm, respectively. The mean difference was 5.81 cm (95% CI: 1.52-10.10; t=2.66, p=0.008). The overall mean weight was 31.36±9.87 kg. Females had a significantly greater mean weight than males (32.83±9.76 versus 29.92±9.78 kg), corresponding to a male-female mean difference of -2.91 kg (95% CI: -4.76 to -1.06; t=-3.10, p=0.002). Mean BMI was 16.16±3.79 kg/m² and was significantly higher among females than males (17.57±4.01 versus 14.79±2.97 kg/m²; MD=-2.78, 95% CI: -3.45 to -2.11; t=-8.18, p<0.001).

According to BMI-for-age classification, 257 (59.4%; 95% CI: 54.7%-63.9%) children had normal nutritional status. Wasting affected 67 (15.5%; 95% CI: 12.4%-19.2%), while severe wasting affected 70 (16.2%; 95% CI: 13.0%-19.9%). Therefore, almost one-third of the participants (31.7%) had either wasting or severe wasting. Severe wasting was substantially more common among males than females (27.9% versus 4.2%; OR=8.79, 95% CI: 4.24-18.25).

At the other end of the nutritional spectrum, 4.6% were at risk of overweight, 3.9% were overweight and 0.5% were obese. Risk of overweight and overweight were more frequent among females, while no male participant was obese. The overall distribution of the six BMI-for-age categories differed significantly between males and females (χ^2=65.21, p<0.001), demonstrating important gender differences in the pattern of malnutrition.

Table 3: Adequacy of calorie and protein intake assessed using a 24-hour dietary recall (N=433)

Dietary parameter	Overall, n (%)	95% CI	Male (n=219)	Female (n=214)	Effect estimate (95% CI)	Test of significance	P value
Calorie intake							
Adequate	4 (0.9%)	0.4%-2.4%	3 (1.4%)	1 (0.5%)	OR=2.95 (0.30-	Fisher's exact test	0.623

					28.62)		
Inadequate	429 (99.1%)	97.6%-99.6%	216 (98.6%)	213 (99.5%)	OR=0.34 (0.03-3.28)	Fisher's exact test	0.623
Protein intake							
Adequate	190 (43.9%)	39.3%-48.6%	112 (51.1%)	78 (36.4%)	OR=1.83 (1.24-2.68)	χ^2=9.49	0.002*
Inadequate	243 (56.1%)	51.4%-60.7%	107 (48.9%)	136 (63.6%)	OR=0.55 (0.37-0.80)	χ^2=9.49	0.002*

Statistically significant at p<0.05.

[Table 3] shows that only four (0.9%; 95% CI: 0.4%-2.4%) children had an adequate daily calorie intake, while 429 (99.1%; 95% CI: 97.6%-99.6%) had inadequate intake. Adequate calorie intake was recorded in three males and one female. Although males had higher odds of calorie adequacy, the confidence interval was very wide because of the small number of adequately nourished children, and the association was not statistically significant (OR=2.95, 95% CI: 0.30-28.62; Fisher's exact p=0.623). Thus, calorie inadequacy was nearly universal in both genders. Protein adequacy showed a different pattern. Overall, 190 (43.9%; 95% CI: 39.3%-48.6%) children had adequate protein intake, while 243 (56.1%; 95% CI: 51.4%-60.7%) had inadequate intake. Adequate protein intake was significantly more frequent among males than females (51.1% versus 36.4%). Males had 1.83 times greater odds of adequate protein intake than females (95% CI: 1.24-2.68; χ^2=9.49, p=0.002). Conversely, males had significantly lower odds of protein inadequacy (OR=0.55, 95% CI: 0.37-0.80). These findings indicate that although calorie intake was inadequate across the entire institutional population, females experienced a comparatively greater deficit in protein intake.

Table 4: Association of nutritional status and dietary adequacy with selected sociodemographic characteristics (N=433)

Outcome	Male, n/N (%)	Female, n/N (%)	Effect estimate for males (95% CI)	Test of significance	P value
Inadequate calorie intake	216/219 (98.6%)	213/214 (99.5%)	OR=0.34 (0.03-3.28)	Fisher's exact test	0.623
Inadequate protein intake	107/219 (48.9%)	136/214 (63.6%)	OR=0.55 (0.37-0.80)	χ^2=9.49	0.002*
Any abnormal BMI-for-age	106/219 (48.4%)	70/214 (32.7%)	OR=1.93 (1.31-2.85)	χ^2=11.05	<0.001*
Wasting	39/219 (17.8%)	28/214 (13.1%)	OR=1.44 (0.85-2.44)	χ^2=1.85	0.174
Severe wasting	61/219 (27.9%)	9/214 (4.2%)	OR=8.79 (4.24-18.25)	χ^2=44.66	<0.001*
Risk of overweight	1/219 (0.5%)	19/214 (8.9%)	OR=0.05 (0.01-0.35)	Fisher's exact test	<0.001*
Overweight	5/219 (2.3%)	12/214 (5.6%)	OR=0.39 (0.14-1.14)	Fisher's exact test	0.087
Obesity	0/219 (0.0%)	2/214 (0.9%)	OR not estimable	Fisher's exact test	0.244
Mean height, cm	142.05 (26.87)	136.24 (17.67)	MD=5.81 (1.52-10.10)	Welch t=2.66	0.008*
Mean weight, kg	29.92 (9.78)	32.83 (9.76)	MD=-2.91 (-4.76 to -1.06)	Welch t=-3.10	0.002*
Mean BMI, kg/m²	14.79 (2.97)	17.57 (4.01)	MD=-2.78 (-3.45 to -2.11)	Welch t=-8.18	<0.001*

Statistically significant at p<0.05. Female was the reference category.

[Table 4] demonstrates several important gender differences in dietary adequacy and nutritional status. Inadequate calorie intake was similarly prevalent among males and females (98.6% versus 99.5%) and was not significantly associated with gender (p=0.623). In contrast, inadequate protein intake was significantly less common among males (48.9%) than females (63.6%). Male gender was associated with 45% lower odds of protein inadequacy (OR=0.55, 95% CI: 0.37-0.80; χ^2=9.49, p=0.002).

Any abnormal BMI-for-age was significantly more frequent among males than females (48.4% versus 32.7%). Males had almost twice the odds of abnormal BMI-for-age (OR=1.93, 95% CI: 1.31-2.85; χ^2=11.05, p<0.001). Although wasting was more frequent among males (17.8% versus 13.1%), the association was not statistically significant (OR=1.44, 95% CI: 0.85-2.44; p=0.174). Severe wasting, however, showed a strong gender association: 27.9% of males were severely wasted compared with 4.2% of females, giving males 8.79 times greater odds of severe wasting (95% CI: 4.24-18.25; χ^2=44.66, p<0.001).

Females were more likely to fall within the higher BMI categories. Risk of overweight affected 8.9% of females compared with 0.5% of males, and the odds among males were 95% lower (OR=0.05, 95% CI: 0.01-0.35; p<0.001). Overweight was more common among females than males (5.6% versus 2.3%), but the difference was not statistically significant (p=0.087). Obesity was observed in only two females; the small number prevented stable estimation of the odds ratio, and the gender association was nonsignificant (p=0.244).

The anthropometric comparisons were consistent with the categorical findings. Males were significantly taller than females by an average of 5.81 cm (p=0.008), but females weighed an average of 2.91 kg more than males (p=0.002) and had a mean BMI that was 2.78 kg/m² higher (p<0.001).

DISCUSSION

The present cross-sectional assessment demonstrated a substantial burden of dietary inadequacy and malnutrition among 433 children residing in Child Care Institutions. Nearly all children had inadequate calorie intake, more than half had inadequate protein intake, and 40.6% had an abnormal BMI-for-age. The coexistence of wasting, severe wasting, overweight and obesity indicates that these children experienced a dual burden of malnutrition rather than undernutrition alone.

Dietary adequacy

Calorie intake was inadequate in 99.1% of the children and did not differ significantly between males and females. This prevalence is exceptionally high and indicates that the meals consumed during the 24-hour reference period did not meet age- and sex-specific energy requirements. Riaz et al. (2021).[1] similarly observed that institutionalized children in Rawalpindi consumed inadequate quantities of several macronutrients, including protein and fat. Singwa et al. (2022).[2] reported inadequate mean energy, protein and total fat intake among older children residing in orphanages in Cameroon. The diets were dominated by cereals, while milk, vegetables and fruits were consumed less frequently.

El-Kassas et al. (2017).[3] reported inadequate intake of protein, fruits and vegetables in approximately half of institutionalized children in Lebanon, while 92% consumed insufficient milk and dairy products. Chowdhury et al. (2017).[4] also found a high prevalence of malnutrition among children living in a Dhaka orphanage and attributed the findings partly to poverty and inadequately diversified institutional diets. Collectively, these observations suggest that regular provision of meals does not necessarily guarantee quantitative or qualitative dietary adequacy.

Protein intake was inadequate in 56.1% of children in the present study. Females had significantly more protein inadequacy than males (63.6% versus 48.9%; p=0.002). Males had 45% lower odds of inadequate protein intake. Riaz et al. (2021).[1] similarly reported low consumption of protein-rich foods in institutional settings. Singwa et al. (2022).[2] observed that milk and dairy products were among the least frequently consumed food groups, while cereals were the most common. Such cereal-dominated menus may provide bulk and some energy but insufficient high-quality protein and micronutrients.

Ali et al. (2018).[5] found that dietary diversity was related to caregiver and household characteristics among orphaned and non-orphaned children in Ghana. Although their participants were younger, the study highlighted that food-group diversity provides information beyond meal frequency. Tandoh et al. (2022).[6] identified substantial micronutrient deficiencies among school-aged children residing in Ghanaian orphanages, illustrating that apparently adequate meal provision can coexist with "hidden hunger."

The near-universal calorie inadequacy must nevertheless be interpreted carefully. A single 24-hour dietary recall may not represent habitual intake and may be affected by day-to-day menu variation, incomplete recall, inaccurate portion estimation and differences between food served and food actually consumed. Moreover, recommended intake values are population-level standards and may overstate inadequacy when applied rigidly to a single day. Repeated dietary recalls, weighed-food records and institutional menu analysis would provide a more reliable estimate of usual energy intake.

Overall nutritional status

Abnormal BMI-for-age was present in 40.6% of participants. This was comparable to the 39.4% prevalence of undernutrition reported by Karam et al. (2021).[7] among 563 children residing in childcare homes in Puducherry. That study documented thinness in 27% and stunting in 20%, with dental disease and clinical pallor as additional nutritional problems. Reddy et al. (2019),[8] however, reported a higher malnutrition prevalence of 57.7% and stunting prevalence of 53.3% among institutionalized children in Bhubaneswar.

DeLacey et al. (2020),[9] in a systematic review of children living in institutional care, found considerable variability across studies: stunting ranged from 9% to 72%, wasting from 0% to 27%, underweight from 7% to 79%, and low BMI from 5% to 27%. The combined prevalence of wasting and severe wasting in the present study was 31.7%, slightly exceeding the upper wasting range reported in that review. Differences in age distribution, BMI classification, institutional food resources, health services, duration of residence and pre-institutional deprivation may explain the variation.

Soudhabi et al. (2017),[10] found that 23% of children in an Indian orphanage were underweight, while 74% had a healthy weight and 1% was obese. Kamath et al. (2017),[11] reported stunting in 18.6%, wasting in 15.7%, underweight in 22.9% and thinness in 17.1% among institutionalized children. The wasting prevalence in the present study was similar to that reported by Kamath et al.; however, the additional 16.2% prevalence of severe wasting indicates a more serious nutritional burden.

Mohammed et al. (2021),[12] observed wasting in 10.9%, stunting in 15.8% and underweight in 8.7% of institutionalized school-age children in eastern Ethiopia. Their wasting prevalence was lower than the combined 31.7% wasting and severe wasting recorded in the present study. They also found that younger age and recent illness were independently associated with wasting, while longer institutional residence was associated with stunting. These findings indicate that nutritional status is influenced not only by current diet but also by infection, age, duration of institutionalization and previous nutritional deprivation.

Riaz et al. (2021),[1] reported underweight in 17%, stunting in 49.5%, thinness in 10.5% and overweight in 4.5% of institutionalized children and adolescents. The present overweight prevalence of 3.9% was comparable, but severe wasting was considerably more common. Fernández et al. (2020)[13], in their assessment of institutionalized children in Nepal, similarly documented substantial deviations from expected anthropometric growth, reinforcing the need for standardized, age- and sex-specific growth monitoring.

Anthropometric differences between males and females

The mean height of the study population was 139.18±22.90 cm. Males were significantly taller than females by 5.81 cm. In contrast, females had significantly higher mean weight and BMI. Mean weight was 32.83 kg among females and 29.92 kg among males, while mean BMI was 17.57 and 14.79 kg/m², respectively. These differences may be partly related to unequal age distribution within each gender, pubertal timing, body composition, physical activity and dietary intake.

Soudhabi et al. (2017),[10] reported an overall mean height of 137.67±15.36 cm, mean weight of 31.92±11.19 kg and mean BMI of 16.28±2.65 kg/m². These values were close to the overall estimates of the present study. However, the present analysis showed pronounced gender differences, particularly in BMI. Singwa et al. (2022),[2] likewise found slightly more underweight among boys than girls, whereas overweight or obesity was more common among girls. Their findings support the present pattern of greater undernutrition among males and a higher tendency toward excess weight among females.

Reddy et al. (2019),[8] also reported that malnutrition was more frequent among boys than girls. Conversely, DeLacey et al. (2020),[9] found inconsistent gender effects across institutional-care studies: some reported more malnutrition among boys, others among girls, and several found no significant difference. Therefore, gender differences appear context-specific and may be affected by food distribution, age, pubertal development, physical activity and institutional practices.

The comparison of crude mean height, weight and BMI should also be interpreted cautiously. These measurements are strongly dependent on age and pubertal stage. Since the table did not provide age-standardized anthropometric z-scores or age-adjusted gender comparisons, the observed mean differences cannot be attributed to gender alone.

BMI-for-age classification and dual burden of malnutrition

Normal BMI-for-age was observed in 59.4% of children. Wasting affected 15.5%, while severe wasting affected 16.2%. Males had almost nine times greater odds of severe wasting than females. Mohammed et al. (2021),[12] also observed somewhat greater wasting among males, although their adjusted gender association was not statistically significant. Singwa et al. (2022),[2] reported underweight in 18.6% of boys and 15.7% of girls, showing a smaller but directionally similar difference.

In the present study, 4.6% were classified as being at risk of overweight, 3.9% were overweight and 0.5% were obese. Females accounted for nearly all children at risk of overweight and both cases of obesity. El-Kassas et al. (2017),[3] reported a combined overweight/obesity prevalence of 9.2% among institutionalized Lebanese children, similar to the combined 9.0% prevalence of risk of overweight, overweight and obesity in the present study. Singwa et al. (2022),[2] reported a considerably higher overweight/obesity prevalence of 23.1% among girls and 16.5% among boys.

The simultaneous occurrence of severe wasting and excess weight demonstrates the double burden of malnutrition within the same institutional population. DeLacey et al. (2020),[9] observed that both undernutrition and overweight were present across institutional-care studies. Ivey et al. (2021),[14] similarly concluded that children exposed to institutional care and early nutritional deprivation often presented with growth faltering, but some subsequently experienced rapid catch-up weight gain. This transition may create later metabolic risk if dietary quality and growth velocity are not appropriately monitored.

The overall BMI-category distribution differed significantly between males and females (χ^2=65.21, p<0.001). Nevertheless, the category termed “risk of overweight” should be interpreted according to the specific reference used. In the WHO reference for children aged 5-19 years, BMI-for-age is generally reported as thinness, severe thinness, overweight and obesity. Future reports should specify the precise z-score limits applied to each category to ensure comparability with other studies.

Gender association with nutritional status and dietary adequacy

Male gender was significantly associated with abnormal BMI-for-age and severe wasting, whereas female gender was associated with inadequate protein intake and higher BMI. Wasting without the severe category was not significantly associated with gender, suggesting that the major difference was concentrated in the severe end of the nutritional distribution.

Reddy et al. (2019),[8] reported significantly more malnutrition among boys, consistent with the higher prevalence of abnormal BMI and severe wasting among males in the present study. Singwa et al. (2022),[2] also found a higher prevalence of underweight among boys and a higher prevalence of overweight/obesity among girls. In contrast, the systematic review by DeLacey et al. (2020),[9] concluded that evidence concerning gender and institutional malnutrition remained mixed.

The significant protein disadvantage among females warrants attention because adolescent girls have increased nutritional requirements related to growth, menstruation and preparation for future reproductive health. A lower intake of protein-rich foods may also indicate unequal portion allocation or differences in food selection. However, the analysis did not adjust for age, pubertal status, menstruation, physical activity or total energy intake. Consequently, an independent gender effect cannot be confirmed.

Comparison with broader nutritional evidence

Chowdhury et al. (2017),[4] found malnutrition in 60.3% of children living in a Dhaka orphanage, exceeding the 40.6% abnormal BMI prevalence in the present study. Ali et al. (2018),[5] however, found lower levels of stunting, wasting and underweight among orphaned and non-orphaned children in Ghana. Differences in age are particularly important because their study was restricted to children younger than five years, whereas the present study involved children aged 6-15 years.

Carolin et al. (2022),[15] in a community-based study of Anganwadi children, showed that nutritional deficits frequently coexisted with respiratory infections, diarrhoea, dental problems and other morbidity. Although their setting and age group differed from the present study, their findings support the close relationship between inadequate nutrition and recurrent childhood illness.

Reddy et al. (2017),[16] documented anaemia, nutritional deficiencies and other morbidities among children residing in orphanages in Karnataka. Their findings reinforce the importance of evaluating institutional nutrition through anthropometry, dietary assessment, clinical examination and haemoglobin estimation rather than using BMI alone. Tandoh et al. (2022),[6] similarly demonstrated that micronutrient deficiencies and cognitive deficits could occur among institutionalized children even when severe anthropometric abnormalities were not universal.

DeLacey et al. (2021),[17] using multi-site surveillance data from institution-based care, emphasized substantial variation in nutritional indicators between care sites. They recommended site-level monitoring because pooled estimates can conceal institutions with unusually high malnutrition. This approach is relevant to the present study: institution-specific calorie inadequacy, protein intake and BMI distributions would help identify CCIs requiring urgent dietary intervention.

CONCLUSION

The study demonstrated a considerable burden of dietary inadequacy and malnutrition among children residing in Child Care Institutions. Calorie intake was inadequate in 99.1% of children, while 56.1% had inadequate protein intake. Abnormal BMI-for-age was present in 40.6%, including 15.5% with wasting and 16.2% with severe wasting. A smaller but clinically relevant proportion was at risk of overweight, overweight or obese, indicating a dual burden of malnutrition.

Important gender differences were observed. Males had significantly greater odds of abnormal BMI-for-age and severe wasting, whereas females had a higher prevalence of inadequate protein intake and higher mean BMI. These findings emphasize the need for periodic anthropometric screening, repeated dietary assessments, institution-specific menu evaluation and age- and sex-appropriate dietary planning. Children with severe wasting require prompt clinical evaluation and individualized nutritional rehabilitation, while those at risk of excess weight require balanced diets and adequate physical activity. Strengthening caregiver training, dietary diversity and institutional nutrition-monitoring systems could substantially improve the health and development of children residing in CCIs.

Limitations of Study

1. The cross-sectional design did not permit determination of temporal relationships or causality between dietary inadequacy and nutritional status.
2. The institutions were selected purposively; therefore, selection bias could not be excluded.
3. The study was conducted in selected CCIs from one district, limiting the generalizability of the findings to other regions and institutional settings.
4. Dietary intake was assessed using a single 24-hour recall, which might not represent the children's habitual food consumption.
5. Dietary recall was subject to recall error, particularly among younger children.
6. Estimation of serving sizes using household measures could have caused measurement error in calculated calorie and protein intake.
7. Differences between food served, food consumed and food wasted might not have been fully captured.
8. Day-to-day and seasonal variation in institutional menus was not evaluated.
9. The analysis focused mainly on calories and protein and did not comprehensively assess dietary diversity, fat, carbohydrate, vitamins, minerals or individual amino-acid quality.
10. Nutritional assessment was primarily based on BMI-for-age. Height-for-age, weight-for-age, mid-upper arm circumference, skinfold thickness and body composition were not comprehensively analysed.
11. Biochemical indicators of nutritional deficiencies, including serum ferritin, vitamin B_{12}, folate, vitamin D, calcium and albumin, were not measured.
12. Pubertal stage, menstruation, physical activity, chronic disease and medication use were not

adequately controlled when comparing males and females.

13. The reported gender associations were unadjusted for potential confounders such as age, duration of institutionalization, orphan status, recent illness and institutional clustering.
14. Children who were severely ill, bedridden, absent or unable to cooperate were excluded, which might have underestimated the true prevalence of malnutrition.
15. Institution-specific differences in funding, caregiver-to-child ratio, kitchen facilities, menu planning and food availability were not examined analytically.

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