

Original Research Article

Relationship between macronutrient intake and growth pattern among orphan and non-orphan boys of Kolkata: a socio-physiological study

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ABSTRACT

Background: Anthropometric data of orphan children are unavailable, especially in Indian context. It is also unaddressed that whether any difference in nutritional, physiological and socio-economic parameters exists between orphan and non-orphan children in our society.

Methods: This cross-sectional study was conducted among 85 orphan boys from four different orphanages and 160 non-orphan boys from three different schools in Kolkata and surroundings. The body composition analysis and nutritional status was assessed by anthropometric measurements such as body height, body weight, BMI, skinfold measurements and dietary survey which was done by using 24-hour dietary recall method. Statistical analysis was done by using SPSS software.

Results: Orphan boys had significantly lower body weight, body height, and BMI compared to non-orphan boys. Higher prevalence of stunting (82.35%) and wasting (85.88%) among orphan boys were found. Lower body fat percentage and lean body mass in orphan boys were also found. Result showed significantly lower carbohydrate and fat consumption in orphan boys. Protein consumption was adequate in non-orphan boys but higher in orphan boys.

Conclusions: Orphan boys in Kolkata are at risk of malnutrition, with lower anthropometric measurements and inadequate dietary intake. Comprehensive nutrition programmes are necessary to ensure the nutritional growth of children in orphanages.

Keywords: Anthropometry, Body composition, Body mass index, Nutritional status, Non-orphan, Orphan

INTRODUCTION

An estimated 17.8 million orphan children had lost both parents and 153 million children are either single parent or both parents orphan in the world.¹ Orphanages provide an alternative for care and adoption for some of these children. Among the 153 million orphan children in the world, Asia is the home for nearly 60 million orphan children and a substantial part of the world's orphan population lives in underdeveloped or developing countries.² Asia, Africa, Latin America, and the Middle

East are the regions where the largest orphan populations reside. Only India has 31 million orphans and according to data shared by the Ministry of Woman and Child Development, there has been a spike in the number of orphans and abandoned children by 25% in the post-Covid era.^{3,4}

Orphan children are more vulnerable to undernutrition, due to unavailability of parenteral care and household food both of which are linked to a child's nutritional wellbeing.⁵ Nutritional assessment is the process of

gathering and analyzing data in an organized manner to determine the nature and origin of health problems connected to diet. Nutritional evaluation is crucial for children since undernutrition during childhood is the primary cause of growth retardation. Growth and development during infancy and childhood are significantly influenced by nutrition. Evidence suggests that childhood malnutrition, characterized by stunted development, is associated with long-term deficits in academic and cognitive performance in the absence of social and psychological variables. Moreover, children who are falling behind their parents are at an increased risk of malnutrition.⁶ Undernourishment in children under five years old is one of the main public health problems that emerging nation's face.⁷ Inadequate consumption of both macro and micronutrients results in undernutrition, which encompasses stunting, wasting, and underweight. Dietary deficits pertaining to a child's early needs are primarily caused by undernutrition.⁸ Undernutrition in children especially stunting has been linked with lower human capital, and impaired cognitive development, and also lower performance in school.^{9,2}

Physical health and development are among the many components of life affected by orphanhood. Children in institution settings suffer from stunted growth, even with plenty of healthy food. Children who struggle with poor growth usually also encounter a wide range of medical problems. Studies have reported mixed results about how the nutritional status of orphans varies from their non-orphan counterparts.¹⁰⁻¹² However, dietary pattern of orphans has received little attention. Data are also scanty on the nutritional status and supplied diet to orphans in Indian context. Understanding the disparities in nutritional status and diet of orphan and non-orphan children could be useful to nutrition policy makers and intervention planners to target children who are more vulnerable to under nutrition and inadequate dietary intake.

The objective of the present study was to evaluate the anthropometric data, nutritional status, and growth of orphan children in Kolkata and its suburban regions, aged 8-12 years, and compare the data with their non-orphan counterparts. Additionally, the study aimed to assess the personal hygiene and sanitation practices of the orphan children, and correlate their nutritional status with physiological parameters, in order to gain a comprehensive understanding of the health and well-being of orphan children in this region. This is also to be mentioned that no such data is presently available from Kolkata or surrounding areas.

METHODS

Four orphanages and three schools were selected in this cross-sectional study from different parts of Kolkata and its surrounding regions to select the orphan and non-orphan boys, respectively. This study was conducted over a period of 13 months, from January 2023 to February 2024.

In this study sample size was calculated by using the method of Dupont & Plummer 1998 where the input of confidence interval was set at 95% and the computed sample size was 79 per group.¹³

Different schools and orphanages were approached for data collection. Three schools and four orphanages provided their consent to conduct the study. In the age group of 8-12 years of 85 orphans and 160 non-orphan boys (control group) were selected after exclusion of several subjects due to either of their unwillingness or physical disabilities and otherwise health conditions.

Age was calculated in nearest years from their date of birth as recorded in the concerned orphanage or school registers.

The whole procedure and the purpose of the study were explained to all the subjects in lucid language. Written informed consent was obtained from the concerned authority of the orphanages and parents of the school boys (control group).

The body mass and body height were measured by using weighing scale and anthropometric rod. Body mass index (BMI) was calculated from the following equation:

$$\text{BMI (kg/m}^2\text{)} = (\text{Body weight in kg}) / (\text{Body height in meter}^2).^{14}$$

Weight for age was calculated from the following equation:

$$\text{Weight for Age} = [(\text{Age} \times 7 - 5) / 2]^{13}$$

Body surface area was calculated by using the following equation¹⁴

$$\text{BSA (m}^2\text{)} = (\text{Body height in cm})^{0.725} \times (\text{Body mass in kg})^{0.425} \times 0.007184$$

Weight and height percentage ratio was calculated from the following equation¹⁴

$$\text{Weight/Height \%} = (\text{Weight of the child/Weight of a normal child at same age}) \times 100$$

And the grade of wasting is

>90 is Normal, 80-90 is mildly wasted, 70-80 is moderately wasted and <70 is severely wasted

Height and age percentage ratio was calculated from the following equation

$$\text{Height/Age} = (\text{Height of the child/Height of a normal child at same age}) \times 100$$

The grade of the percentage of stunting is

>95 is Normal growth, 87.5-95 is mildly stunted, 80-87.5 moderately stunted, <80 severely stunted.¹⁵

Body composition was evaluated by using the skinfold measurement method. Triceps, abdomen, and sub scapular skinfolds were measured by using standard procedure with the help of calibrated skinfold caliper (Mitutoyo, Japan). Following equations were used to calculate the values of different components of body composition.

Body density (gm/cc) = $1.09556 - 0.00062 \times (\text{Sum of triceps, sub-scapular, and abdominal skinfolds in mm}) - (0.00028 \times \text{age})$ ¹⁶

%body fat = $(495/\text{Body Density} - 450)$ ¹⁷

Diet survey was performed to evaluate the nutritional status of the subjects by using the questionnaire method of ICMR (2017), that involved assessment of 7 days' food intake by using 24 hr dietary recall method. Nutritive value was calculated by using the food value table recommended by ICMR.¹⁴

Values were expressed as mean $\pm$ SD. Un-paired two tail t-test was performed to compute the level of significance of difference between the mean values obtained in orphan and non-orphan boys. Level of significance was set at $p < 0.05$. For statistical analysis IBM SPSS 29.0.2.0 version was used.

RESULTS

Body weight for age, body height and body weight showed significant difference between orphan and non-orphan boys (Table 1).

Comparison of nutritional status was analyzed between orphan and non-orphan groups, by using two potential indicators that are mildly stunted and moderately wasted. These indicators were analyzed based on the ratio between body height and body weight and age for orphan and non-orphan boys belonging to the studied age group of 8-12 years. Under nourishment was more prevalent among orphan boys. Stunting and wasting were found to be higher among orphans. Among the orphans, 95.24% (age 8 years), 55.56% (age 9 years), 97.14% (age 10 years), 84.62% (age 11 years), 60% (age 12 years) is found to be wasted as compared to 4.35% (age 8 years), 5.49% (age 10 years), 5.88% (age 11 years), 36.36% (age 12 years) in their non-orphan counterpart. For stunting, the age wise categorization in orphan population is almost 90% (age 8 and 10 years), 100% (age 9 and 12 years), 31.46% (age 11 years). In comparison, the non-orphan group has about 26% (age 8 and 10 years), 35.29% (age 11 years) and 100% (age 12 years) stunted children. The increased prevalence of stunting and wasting in non-orphan children in the age group of 12 years might be due to the increased demand of macro and micro nutrients as they approach their adolescence (Table 2).

Table 1: Physical parameters of the 8-12 years non-orphan and orphan boys.

Groups	Body weight (kg)	Body height (cm)	BMI (kg/m ²)	Weight for age (kg)	BSA (m ²)
Control (n=160)	36.08 $\pm$ 5.60	133.91 $\pm$ 5.39	20.01 $\pm$ 2.14	32.95 $\pm$ 3.95	1.15 $\pm$ 0.10
Orphan (n=85)	24.64 $\pm$ 5.48*	125.63 $\pm$ 8.24***	15.48 $\pm$ 2.39	30.28 $\pm$ 7.59***	0.94 $\pm$ 0.12***

Values are mean $\pm$ SD BMI = Body mass index, BSA= Body surface area, * $p < 0.05$, *** $p < 0.001$

Table 2: Stunting and wasting of non-orphan and orphan boys of 8-12 years of age.

W/H%	8yrs	9yrs	10yrs	11yrs	12yrs
Control	108.5	134.7	123.7	136.0	85.5
Remarks	Normal	normal	Normal	Normal	Mildly wasted
Orphan	78.9	79.6	79.9	90.2	87.5
Remarks	Moderately wasted	Moderately wasted	Moderately wasted	Mildly wasted	Mildly wasted
H/A%	8yrs	9yrs	10yrs	11yrs	12yrs
Control	98.8	101.1	99.5	99.9	90.7
Remarks	Normal	Normal	Normal	Normal	Mildly Stunted
Orphan	91.55	92.4	91.7	95.6	89.7
Remarks	Mildly Stunted	Mildly stunted	Mildly Stunted	Normal	Mildly Stunted

Different skinfold thickness included in the table 3 which helps to derive the body composition and the skinfold thickness of triceps, subs scapular and abdomen of orphan children is significantly ($p < 0.001$) lower than their non-orphan counterparts. Sum of these skinfold thicknesses helped to derive the body composition of orphan and non-

orphan boys which also showed a significant result. Orphan boys also showed lower body fat percentage and lean body mass whereas their control counterparts showed significantly ($p < 0.001$) higher values in body fat percentage and lean body mass ($p < 0.01$) (Table 4).

The comparative analysis between orphan and non-orphan boys showed undernourishment among orphans in almost every indicator. Nutritional assessment of macronutrients also depicted significant ($p<0.001$)

difference in carbohydrate, protein and fat intakes between two groups. Macronutrients intake of orphan children was also significantly ($p<0.001$) lower (Table 5).

Table 3: Values of different skinfold measurement in the studied groups.

Groups	Triceps (mm)	Subscapular (mm)	Abdomen (mm)	Sum of skinfold (mm)
Control (n=160)	2.48±0.6	2.32±0.68	2.69±0.98	7.49±2.26
Orphan (n=85)	1.50±0.31***	1.91±0.42***	2.20±0.42***	5.61±1.15***

Values are mean±SD, *** $p<0.001$

Table 4: Values of different components of body composition in non-orphan and orphan boys.

Groups	Body density (gm/cc)	Percentage of body fat (%)	Total body fat (kg)	Lean body mass (kg)
Control (n=160)	1.096±0.0006	3.87±0.27	1.39±0.21	34.68±5.40
Orphan (n=85)	1.090±0.00008***	3.75±0.03***	0.92±0.20	23.86±5.33**

Values are mean±SD, ** $p<0.01$, *** $p<0.001$

Table 5: Macro-nutrient intake of non-orphan and orphan boys.

Group	Carbohydrate (gm)	Protein (gm)	Lipid (gm)	Energy (kcal)
Control (n=160)	217.35±31.55	22.30±5.89	18.62±5.04	1163.73±171.05
Orphan (n=85)	183.83±7.69***	26.52±3.02***	13.52±1.34***	986.91±55.36***

Values are mean±SD, *** $p<0.001$

DISCUSSION

Poverty and social exclusion were two of the main reasons why children are unable to live at home. Families often felt that placing their children into care was the only way to ensure they get an education and enough food and other essential supports, but poor standard of care has been reported in many orphanages where many children were abused and neglected.^{18,19} Long-term staying in orphanages exerted negative impact on children. It has been found that the institutional care could be the cause of harm for the orphan children and that has been documented since the early 20th century.²⁰

The present study depicted significantly lower body weight ($p<0.05$) and body height ($p<0.001$) among institutional orphans compared to non-orphan boys. Similar finding for body weight and height had already been reported by Varshney.²¹ BMI of orphan boys is below the normal category as per WHO classification and did not show any inter group variation.²² Thus, it could be deduced that the orphans suffer from malnourishment. Subedi also reported the same range of BMI in this population which is in agreement with this study.²³ Similarly, the weight for age was found to be significantly higher ($p<0.001$) in non-orphan boys compared to orphans.

Age wise body height and body weight to body height ratio percentage was poor in orphan group indicating moderate stunting and mild wasting in orphan children. In the present study, 85.88% of the orphan population was found to be wasted and 82.35% was found to be stunted

as compared to 9.38% and 36.25% respectively, in the non-orphan population. This study highlights that the prevalence of malnutrition among orphans is more in Kolkata as compared to Bangladesh, which reported that 50-60% of the orphans in Dhaka and Khulna, and less than 40% in Tangail city suffer from malnutrition.^{4,24,25} The prevalence of underweight and stunting among orphans of Rawalpindi, Pakistan were also reported to be about 17% and 49% respectively, which showed much less than that found in Kolkata.²⁶ In contrast to our findings, several studies reported about 50% or less orphans being undernourished in different states of India.^{4,27,28} However, it ought to be kept in mind that most of the studies reported above had been conducted before the outbreak of Covid pandemic.

Body fat percentage and lean body mass of orphan boys were significantly lower than non-orphan boys. The results of this study for lean body mass of non-orphan boys are slightly higher than the study reported by Kriemler et al on estimation of percentage of body fat in 6 to 13 years old children by skinfold thickness, but the body fat amount of non-orphan children of this study was found to be much lower than the report of Kriemler's et al.²⁹ This observation might be attributed to the significantly lower ($p<0.001$) consumption of fat in both orphan and non-orphan children compared to RDA. The low body fat percentage and lean body mass in orphans, despite comparatively higher consumption of protein than non-orphan children might be owing to low carbohydrate and fat consumption, along with suggestive micronutrient deficiency.

Usually body composition and the anthropometric parameters were dependent on nutrient consumption. Astoundingly, the present study showed significantly low consumption of carbohydrate and fat in both orphan and non-orphan groups as compared to RDA. However, protein consumption was adequate in the non-orphan group and those in orphan children the protein consumption was significantly higher than their non-orphan counterpart. The result from diet survey in this study, critically showed that carbohydrate and fat consumption of orphan boys were significantly lower ($p < 0.001$) than non-orphan boys. Carbohydrate intake was higher in the study of Riaz et al but the findings of the present study are in contrast to the findings of Islam et al 2021, which stated no significant difference in food intake pattern among orphan and non-orphans.^{30,4} Concomitantly, several studies reported low consumption of all macronutrients and energy as well, along with other micronutrients in orphan children compared to non-orphan children.^{26,31,32} These nutritional deficiencies might be due to nutritional ignorance and lack of awareness about dietary diversity and nutritional knowledge. This definitely would affect the health status of orphan boys in near future as they were approaching their adolescent period of life.

The study concludes that orphan boys aged 8-12 years in Kolkata, India; face significant nutritional challenges compared to non-orphan boys. Orphans showed lower body weight, height, and body mass index, and also higher prevalence of stunting (82.35%) and wasting (85.88%) as well as lower body fat percentage and lean body mass. Significantly lower carbohydrate and fat consumption also noticed in orphan boys.

The findings highlight the need for comprehensive nutrition programmes in orphanages, increased awareness about dietary diversity, and regular health check-ups. Policy interventions and government support are crucial to address the nutritional vulnerabilities of orphaned children.

However, the present study has certain limitations. Firstly, the sample size varied due to the mixed population of the orphanage, which may affect the general findings. Secondly, the non-orphan subjects sometimes provided incomplete or inaccurate data about their diet, including missing foods and phantom foods, which may have introduced biasedness into the results. Moreover, the present study is focused only on boys and the growth and nutritional status of orphan girls at their pre-teen is not considered. Keeping in mind that the nutritional requirements specially in females vary as they approach their adolescence, determining their nutritional and health status is also important in accessing the reproductive health and general well-being. These limitations should be taken into consideration in future studies to have a more clear and broad view of the health status of children, both of orphans and non-orphans.

CONCLUSION

The present study provides valuable insights into the nutritional status and health outcomes of orphan boys in Kolkata, India. The findings of this study advance our knowledge of the nutritional vulnerabilities of orphan children, highlighting the need for comprehensive nutrition programmes, increased awareness about dietary diversity, and regular health check-ups. This study contributes to the existing literature by providing a comprehensive assessment of the anthropometric, nutritional, and health status of orphan boys, and underscores the importance of policy interventions and government support to address the nutritional challenges faced by this vulnerable population. Ultimately, this study aims to inform the development of targeted interventions to improve the health and well-being of orphan children, and to contribute to the advancement of knowledge in the field of nutrition and public health.

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