

# Assessment of the Double Burden of Malnutrition Among School-Going Adolescent Orphans and Non-Orphans in Chengalpattu District, Tamil Nadu - A Cross-Sectional Study

Dr. Sathyapriya T<sup>1</sup>, Dr. Glannie A.R<sup>2</sup>, Dr. Kaarunya A<sup>3\*</sup>, Dr. Logaraj M<sup>4</sup>, Dr. V.V. Anantharaman<sup>5</sup>

<sup>1</sup>Postgraduate, Department of Community Medicine, SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology, Tamil Nadu, India

<sup>2</sup>Assistant Professor, Department of Community Medicine, SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology, Tamil Nadu, India

<sup>3\*</sup>Postgraduate, Department of Community Medicine, SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology, Tamil Nadu, India  
Email: ka3230@srmist.edu.in

<sup>4</sup>Professor, Department of Community Medicine, SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology, Tamil Nadu, India

<sup>5</sup>Professor, Department of Community Medicine, SRM Medical College Hospital and Research Centre, SRM Institute of Science and Technology, Tamil Nadu, India

## ABSTRACT

### Background

The epidemiological transition in low- and middle-income countries has resulted in the coexistence of undernutrition and overnutrition, referred to as the double burden of malnutrition. Adolescence represents a critical period of growth and development during which nutritional imbalances can have long-term health consequences. Orphaned adolescents may be particularly vulnerable due to social, economic, and caregiving disadvantages. However, evidence comparing the nutritional status of orphaned and non-orphaned adolescents remains limited.

### Objectives

To assess and compare the prevalence of the double burden of malnutrition among school-going adolescent orphans and non-orphans in Chengalpattu district, Tamil Nadu, and to identify selected biosocial and behavioral correlates associated with malnutrition.

### Methods

A community-based cross-sectional analytical study was conducted among 240 school-going adolescents aged 10–19 years, comprising 120 orphans and 120 non-orphans, selected using simple random sampling. Data were collected using a pretested semi-structured questionnaire capturing socio-demographic, dietary, and lifestyle characteristics. Anthropometric measurements were obtained using standardized techniques, and nutritional status was assessed using BMI-for-age Z-scores based on WHO 2007 growth reference standards. Data were analyzed using SPSS version 26.0. Descriptive statistics were used to summarize variables, and associations were assessed using chi-square tests and multinomial logistic regression, with statistical significance set at  $p < 0.05$ .

### Results

Overall, 50.0% of adolescents were affected by some form of malnutrition. Undernutrition was significantly higher among orphans (43.3%) compared to non-orphans (22.5%) ( $p = 0.001$ ). Severe thinness was observed in 15.0% of orphans and 6.7% of non-orphans. Overnutrition affected 16.7% of orphans and 17.5% of non-orphans, indicating a comparable burden across groups ( $p = 0.021$ ). Normal nutritional status was more prevalent among non-orphans (60.0%) than orphans (40.0%). Multinomial logistic regression identified religion as the only factor significantly associated with undernutrition, while other socio-demographic and behavioral variables were not significantly associated. Mean anthropometric measurements were lower among orphans, although differences were not statistically significant.

### Conclusion

The study demonstrates a pronounced double burden of malnutrition among school-going adolescents, with significantly higher undernutrition among orphans and comparable overnutrition across both groups, highlighting the need for integrated adolescent nutrition strategies.

## “Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”

### Keywords:

Double burden of malnutrition, adolescent nutrition, orphaned adolescents, school-going adolescents, undernutrition, overweight and obesity, BMI-for-age, nutritional transition, India.

**How to cite this article:** Sathyapriya T, Glannie AR, Kaarunya A, Logaraj M, Anantharaman VV. Assessment of the Double Burden of Malnutrition Among School-Going Adolescent Orphans and Non-Orphans in Chengalpattu District, Tamil Nadu - A Cross-Sectional Study. *Int J Drug Deliv Technol.* 2026;16(6s): 853-864; DOI: 10.25258/ijddt.16.6s.112

### INTRODUCTION

Malnutrition continues to be one of the most significant public health challenges globally, exerting adverse effects on growth, development, morbidity, and mortality across the life course. In preventive and social medicine, malnutrition is defined as a pathological state resulting from a deficiency, excess, or imbalance of energy, protein, or other nutrients that adversely affects body composition, physiological function, and clinical outcomes [1]. Traditionally, public health nutrition initiatives focused primarily on undernutrition; however, recent decades have witnessed the emergence of a complex epidemiological scenario characterized by the coexistence of undernutrition and overnutrition within the same population, household, or even individual. This phenomenon is now widely recognized as the **double burden of malnutrition** [1].

The World Health Organization (WHO) conceptualizes the double burden of malnutrition as the concurrent presence of undernutrition—manifested as stunting, wasting, thinness, or micronutrient deficiencies—and overnutrition, including overweight and obesity, across different stages of the life course [2]. This coexistence reflects rapid nutrition transition, demographic shifts, urbanization, changing dietary patterns, and reduced physical activity, particularly in low- and middle-income countries. The dual burden poses a unique challenge to health systems, as it necessitates addressing conditions of nutritional deprivation alongside the growing prevalence of diet-related non-communicable diseases.

Adolescence, defined by the WHO as the age group between 10 and 19 years, represents a critical developmental period characterized by rapid linear growth, pubertal maturation, and significant physiological and psychological changes [3]. Approximately 20% of adult height and up to 50% of adult body weight are accrued during adolescence, underscoring the heightened nutritional demands of this stage. Nutritional inadequacies or excesses during adolescence may result in impaired growth, delayed sexual maturation, altered body composition, reduced cognitive potential, and increased long-term risk of obesity, diabetes mellitus, hypertension, and

cardiovascular disease [3]. Consequently, adolescent nutrition has gained increasing recognition as a priority area within public health frameworks.

Globally, adolescents constitute nearly one-sixth of the world's population, with a substantial proportion residing in low- and middle-income countries where nutritional disparities are most pronounced. The *State of the World's Children 2019* emphasizes that adolescents across the globe are increasingly exposed to unhealthy food environments characterized by high availability of energy-dense, nutrient-poor foods, while simultaneously facing persistent undernutrition and micronutrient deficiencies [4]. This convergence has resulted in rising levels of thinness, stunting, overweight, and obesity among adolescents, often within the same communities and socioeconomic strata.

India, home to the largest adolescent population in the world, is undergoing a rapid nutrition transition marked by persistent undernutrition alongside a steady rise in overweight and obesity. According to national dietary recommendations, balanced intake of macronutrients and micronutrients is essential during adolescence to support optimal growth and development [5]. However, deviations from recommended dietary practices, coupled with sedentary lifestyles and socioeconomic inequalities, have contributed to the emergence of the double burden of malnutrition among Indian adolescents. National and subnational evidence suggests that adolescents from both rural and urban settings are increasingly affected by thinness and excess adiposity, reflecting the heterogeneous nutritional challenges faced by the country.

At the global level, the *Global Nutrition Report 2021* underscores that no country is currently on track to address all forms of malnutrition, highlighting the urgency of integrated strategies targeting both undernutrition and overnutrition [6]. The report further emphasizes that adolescents remain a neglected demographic in nutrition programming, despite their heightened vulnerability and the intergenerational consequences of adolescent malnutrition. Failure to address nutritional problems during adolescence may perpetuate cycles of poor health, reduced productivity,

## “Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”

and increased burden of non-communicable diseases in adulthood.

Evidence from India demonstrates a substantial prevalence of the double burden of malnutrition among school-going adolescents. A cross-sectional study conducted in North India reported a high prevalence of underweight alongside a notable proportion of overweight and obese adolescents, indicating the coexistence of nutritional deficiency and excess within the same population [7]. The study further identified socioeconomic status, urban residence, and lifestyle factors as important determinants of nutritional status, underscoring the multifactorial nature of adolescent malnutrition.

Similarly, research from South India has highlighted socio-demographic patterning of the individual-level double burden of malnutrition. A community-based cross-sectional study reported the coexistence of anemia with overweight and obesity, particularly among socially disadvantaged groups, reflecting the complex interplay between dietary inadequacy and excess energy intake [8]. These findings reinforce the need for context-specific assessments of nutritional status to inform targeted interventions.

At the international level, pooled analyses from multiple low- and middle-income countries have demonstrated that adolescents are increasingly affected by the double burden of malnutrition. Analysis of data from the Global School-Based Student Health Survey and Health Behaviour in School-Aged Children survey across 57 countries revealed a significant prevalence of concurrent thinness and overweight among adolescents, with marked regional and socioeconomic variations [9]. These findings suggest that the double burden of malnutrition among adolescents is not confined to specific geographic regions but represents a global public health concern.

Within India, systematic reviews have documented a rising prevalence of childhood and adolescent overweight and obesity alongside persistent undernutrition. A comprehensive review of epidemiological studies highlighted wide regional variations in the prevalence of overweight and obesity among Indian children and adolescents, reflecting disparities in socioeconomic development, dietary practices, and physical activity patterns [10]. The coexistence of undernutrition and overnutrition within the same population underscores the inadequacy of conventional nutrition programs that focus exclusively on one form of malnutrition.

Despite the growing body of evidence on adolescent malnutrition, there remains a paucity of data focusing

on **vulnerable subgroups**, particularly orphaned adolescents. Orphans may be at increased risk of malnutrition due to factors such as loss of parental care, emotional stress, institutional living conditions, food insecurity, and limited access to healthcare services. Comparative assessment of nutritional status between orphaned and non-orphaned adolescents is essential to identify inequities and inform targeted public health interventions.

Chengalpattu district in Tamil Nadu represents a unique setting with a mix of urban and rural populations, diverse socioeconomic conditions, and a substantial adolescent population. However, there is limited empirical evidence on the magnitude and determinants of the double burden of malnutrition among school-going adolescents in this region, particularly among orphans. Addressing this evidence gap is crucial for guiding local nutrition programs, strengthening adolescent health initiatives, and informing policy decisions.

In this context, the present study aims to assess the double burden of malnutrition among school-going adolescent orphans and non-orphans in Chengalpattu district, Tamil Nadu. By generating context-specific evidence on the prevalence and patterns of undernutrition and overnutrition, this study seeks to contribute to the growing literature on adolescent nutrition and support the development of comprehensive, equity-oriented strategies to address all forms of malnutrition.

### **METHODOLOGY**

The present study was a community-based cross-sectional analytical study conducted among school-going adolescents aged 10–19 years to assess the double burden of malnutrition among orphans and non-orphans in selected schools and orphanages of Chengalpattu district, Tamil Nadu, during a three-month period from August 2025 to October 2025. The study population included adolescents classified as orphans (single or double) residing in orphanages and non-orphans attending regular schools, and a total sample size of 240 participants was determined using two-proportion hypothesis testing with equal allocation, comprising 120 orphans and 120 non-orphans, selected by a simple random sampling technique. Data were collected using a pretested semi-structured questionnaire administered by the investigator, which captured information on socio-demographic characteristics, dietary habits, meal frequency, physical activity patterns, screen time, and lifestyle factors. Anthropometric assessment was carried out following standardized techniques, wherein

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

height was measured using a stadiometer to the nearest 0.1 cm, weight was recorded using a calibrated digital weighing scale to the nearest 0.1 kg, and body mass index was calculated as weight in kilograms divided by height in meters squared. Nutritional status was assessed using BMI-for-age Z-scores based on the WHO 2007 growth reference standards, and additional measurements including mid-upper arm circumference, waist circumference, hip circumference, and waist-hip ratio were recorded to assess body composition. Data entry was performed using Microsoft Excel, and statistical analysis was carried out using SPSS version 26.0. Descriptive statistics such as mean, standard deviation, frequencies, and percentages were used to summarize the study variables, while inferential statistics were applied using the chi-square test to assess associations between nutritional status and selected socio-demographic and lifestyle factors, with a p-value of less than 0.05 considered statistically significant. Ethical clearance was obtained from the Institutional Ethics Committee prior to initiation of the study, written informed consent was obtained from parents or guardians along with assent from adolescent participants, confidentiality of data was maintained, and participation was entirely voluntary with the option to withdraw at any stage of the study.

**RESULTS :**

**Table 1. Socio-demographic Characteristics of Study Participants (N = 240)**

Variables	Non-Orphan (n=120) n (%)	Orphan (n=120) n (%)
<b>Age</b>		
Early adolescence (10–13)	34 (28.33)	26 (21.67)
Late adolescence (17–19)	28 (23.33)	41 (34.17)
Mid adolescence (14–16)	58 (48.33)	53 (44.17)
<b>Sex</b>		
Female	59 (49.17)	60 (50)
Male	61 (50.83)	60 (50)
<b>Residence</b>		
Rural	72 (60)	71 (59.17)
Urban	48 (40)	49 (40.83)

Religion		
Christian	14 (11.67)	11 (9.17)
Hindu	86 (71.67)	85 (70.83)
Muslim	17 (14.17)	22 (18.33)
Others	3 (2.5)	2 (1.67)

Table 1 presents the socio-demographic profile of the study participants, with equal representation of orphans and non-orphans. The majority of adolescents in both groups belonged to the mid-adolescent age category, while relatively more orphans were in the late-adolescent group compared to non-orphans.

The sex distribution was nearly equal across both groups, indicating balanced gender representation. Most participants were from rural areas, with a similar urban–rural distribution observed between orphans and non-orphans.

In terms of religion, Hinduism constituted the predominant faith in both groups, followed by Islam and Christianity. Overall, the socio-demographic characteristics of the two groups were broadly comparable, suggesting that differences in nutritional outcomes are less likely to be explained by major demographic imbalances.

**Table 2. Prevalence of Double Burden of Malnutrition Among Study Participants (N = 240)**

Nutritional Status	Orphans (n = 120) n (%)	Non-Orphans (n = 120) n (%)	Total (N = 240) n (%)	$\chi^2$ value	p-value
<b>Undernutrition</b>					
Severe thinness (< -3 SD)	18 (15.0)	8 (6.7)	26 (10.8)	<b>11.79</b>	<b>0.001</b>
Thinness (-3 to < -2 SD)	34 (28.3)	19 (15.8)	53 (22.1)		
<b>Total undernutrition</b>	<b>52 (43.3)</b>	<b>27 (22.5)</b>	<b>79 (32.9)</b>		
<b>Normal nutrition</b>	48 (40.0)	72 (60.0)	120 (50.0)		

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

(-2 to +1 SD)					
<b>Overnutrition</b>					
Overweight (+1 to +2 SD)	14 (11.7)	16 (13.3)	30 (12.5)	<b>9.81</b>	<b>0.021</b>
Obese (> +2 SD)	6 (5.0)	5 (4.2)	11 (4.6)		
<b>Total overnutrition</b>	<b>20 (16.7)</b>	<b>21 (17.5)</b>	<b>41 (17.1)</b>		
<b>Double burden (total malnutrition)</b>	<b>72 (60.0)</b>	<b>48 (40.0)</b>	<b>120 (50.0)</b>		

Table 2 highlights a considerable burden of malnutrition among the study population, demonstrating the coexistence of both nutritional deficiency and excess within the same group of adolescents. This reflects the emerging double burden of malnutrition in the region.

Undernutrition was significantly more common among orphaned adolescents compared to non-orphans, indicating greater nutritional vulnerability in this subgroup. The higher occurrence of severe thinness among orphans suggests possible chronic nutritional deprivation and social disadvantage. The statistically significant association between orphan status and undernutrition reinforces the influence of caregiving environment and socioeconomic factors on adolescent nutritional outcomes.

In contrast, normal nutritional status was more frequently observed among non-orphans, suggesting relatively better nutritional adequacy and support systems in family settings.

Overnutrition was observed in both groups at comparable levels. Although the distribution across overweight and obesity categories showed statistical significance, the overall burden appeared similar between orphans and non-orphans. This suggests that lifestyle transitions and exposure to energy-dense diets may be affecting adolescents irrespective of orphan status.

Overall, the findings demonstrate a clear double burden of malnutrition, characterized by disproportionately higher undernutrition among orphans alongside a shared burden of overnutrition across both groups. These results highlight the need for balanced nutrition

interventions that address both extremes of malnutrition while prioritizing vulnerable populations. **Table 3. Biosocial and behavioral correlates of double burden malnutrition among school-going adolescent**

Variables	Normal (n=20) (%)	Obese (n=11) (%)	Overnutrition (n=30) (%)	Undernutrition (n=79) (%)
<b>Age</b>				
Early adolescence (10–13)	29 (24.17)	2 (18.18)	6 (20)	23 (29.11)
Late adolescence (17–19)	37 (30.83)	5 (45.45)	8 (5)	19 (24.05)
Mid adolescence (14–16)	54 (45)	4 (36.36)	16 (4)	37 (46.84)
<b>Religion</b>				
Christian	12 (10)	3 (27.27)	3 (10)	7 (8.86)
Hindu	92 (76.67)	8 (72.73)	22 (8)	49 (62.03)
Muslim	16 (13.33)	0 (0)	2 (0)	21 (26.58)
Others	0 (0)	0 (0)	3 (0)	2 (2.53)
<b>Caste</b>				
General	38 (31.67)	3 (27.27)	10 (33.33)	24 (30.38)
OBC / SC / ST	82 (68.33)	8 (72.73)	20 (8)	55 (69.62)
<b>Family Type</b>				
Joint	67 (55.83)	5 (45.45)	21 (70)	36 (45.57)
Nuclear	53 (44.17)	6 (54.55)	9 (6)	43 (54.43)
<b>SES</b>				
Lower / Lower middle	59 (49.17)	4 (36.36)	17 (56.67)	39 (49.37)

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

Upper / Middle	61 (50.83)	7 (63.64)	13 (7)	40 (50.63)
<b>Residence</b>				
Rural	75 (62.5)	8 (72.73)	15 (50)	45 (56.96)
Urban	45 (37.5)	3 (27.27)	15 (3)	34 (43.04)
<b>Type of School</b>				
Government / Aided	80 (66.67)	8 (72.73)	20 (66.67)	59 (74.68)
Private	40 (33.33)	3 (27.27)	10 (3)	20 (25.32)
<b>Outdoor activity</b>				
Absent	52 (43.33)	3 (27.27)	13 (43.33)	34 (43.04)
Present	68 (56.67)	8 (72.73)	17 (8)	45 (56.96)
<b>Soft Drink</b>				
No	68 (56.67)	6 (54.55)	22 (73.33)	48 (60.76)
Yes	52 (43.33)	5 (45.45)	8 (5)	31 (39.24)
<b>Street Food</b>				
No	102 (85)	8 (72.73)	23 (76.67)	69 (87.34)
Yes	18 (15)	3 (27.27)	7 (3)	10 (12.66)
<b>Father Education</b>				
Middle school and above	63 (52.5)	7 (63.64)	12 (40)	43 (54.43)
Up to primary	57 (47.5)	4 (36.36)	18 (4)	36 (45.57)
<b>Mother Education</b>				

Middle school and above	63 (52.5)	7 (63.64)	16 (53.33)	41 (51.9)
Up to primary	57 (47.5)	4 (36.36)	14 (4)	38 (48.1)
<b>Father Occupation</b>				
Professional / Service / Business	55 (45.83)	4 (36.36)	16 (53.33)	37 (46.84)
Unemployed / Labor / Farmer	65 (54.17)	7 (63.64)	14 (7)	42 (53.16)
<b>Mother Occupation</b>				
Employed	76 (63.33)	7 (63.64)	17 (56.67)	47 (59.49)
Unemployed	44 (36.67)	4 (36.36)	13 (4)	32 (40.51)

Table 3 presents the distribution of biosocial and behavioral factors across different nutritional categories. Undernutrition was observed across all age groups, with a greater concentration during mid-adolescence, suggesting that rapid growth demands during this stage may contribute to nutritional vulnerability. Obesity appeared relatively more common in late adolescence compared to earlier age groups.

With respect to religion, a relatively higher proportion of undernourished adolescents belonged to the Muslim community, while most overweight and obese adolescents were from the Hindu community. However, variations across religious groups may reflect underlying socio-cultural and dietary patterns rather than direct causal relationships.

Nutritional status did not show marked differences across caste categories, socioeconomic status, or parental education levels, indicating that malnutrition was distributed across social strata rather than being confined to a specific socioeconomic group. Similarly, both joint and nuclear family structures included adolescents across all nutritional categories, suggesting that family type alone may not be a strong determinant. Rural residence accounted for a larger share of undernutrition cases, whereas overnutrition was observed in both rural and urban settings, reflecting the spread of lifestyle-related risk factors beyond urban populations. Government school students constituted a

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

higher proportion of undernourished adolescents, which may reflect broader socioeconomic influences. Behavioral factors such as outdoor physical activity, soft drink intake, and street food consumption showed variation across nutritional categories, but no clear pattern emerged to suggest a strong univariate association. Overall, the findings indicate that malnutrition among adolescents is multifactorial and distributed across diverse demographic and behavioral backgrounds rather than being restricted to a single risk group.

**Table 4: Multinomial logistic regression for the factors associated with underweight and obesity among school-going adolescent**

Variables	Undernutriti on OR (95% CI)	Overweig ht OR (95% CI)	Obes e OR (95 % CI)
<b>Age</b>			
Younger adolescents	1.16 (0.59–2.29)	0.63 (0.22–1.84)	0.68 (0.13 – 3.48)
Older adolescents	Ref	Ref	Ref
<b>Religion</b>			
Non-Hindu	0.49 (0.26–0.94)	0.80 (0.31–2.08)	0.77 (0.18 – 3.30)
Hindu	Ref	Ref	Ref
<b>Caste category</b>			
General	1.19 (0.62–2.29)	0.76 (0.30–1.88)	1.26 (0.29 – 5.46)
OBC / SC / ST	Ref	Ref	Ref
<b>Family type</b>			
Nuclear	0.61 (0.34–1.10)	1.67 (0.69–4.04)	0.55 (0.15 – 2.03)
Joint	Ref	Ref	Ref
<b>Socioeconomic status</b>			
Upper / Middle	0.94 (0.52–1.71)	1.37 (0.58–3.25)	0.55 (0.15

			– 2.07)
Lower / Lower middle	Ref	Ref	Ref
<b>Place of residence</b>			
Urban	1.31 (0.72–2.38)	1.60 (0.70–3.68)	0.67 (0.16 – 2.75)
Rural	Ref	Ref	Ref
<b>Type of school</b>			
Private	1.52 (0.78–2.95)	1.08 (0.44–2.64)	1.15 (0.27 – 4.88)
Government / Aided	Ref	Ref	Ref
<b>Father’s education</b>			
Middle school and above	1.02 (0.56–1.85)	0.58 (0.25–1.36)	1.49 (0.39 – 5.65)
Up to primary	Ref	Ref	Ref
<b>Mother’s education</b>			
Middle school and above	0.94 (0.52–1.70)	1.00 (0.43–2.31)	1.61 (0.42 – 6.19)
Up to primary	Ref	Ref	Ref
<b>Father’s occupation</b>			
Professional / Service / Business	1.12 (0.62–2.03)	1.44 (0.61–3.40)	0.79 (0.21 – 2.98)
Unemployed / Labor / Farmer	Ref	Ref	Ref
<b>Mother’s occupation</b>			
Engaged in any occupation	1.21 (0.66–2.21)	1.25 (0.54–2.93)	1.00 (0.26 – 3.88)
Unemployed	Ref	Ref	Ref

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

<b>Outdoor physical activity (&gt;2 h/day)</b>			
Absent	1.00 (0.55–1.82)	0.78 (0.32–1.90)	0.56 (0.14 – 2.27)
Present	Ref	Ref	Ref
<b>Frequent soft drink intake (&gt;3 times/week)</b>			
Yes	1.28 (0.70–2.33)	1.97 (0.78–4.96)	0.96 (0.25 – 3.60)
No	Ref	Ref	Ref
<b>Frequent street food intake (&gt;5 times/week)</b>			
Yes	1.29 (0.54–3.06)	0.59 (0.21–1.68)	0.48 (0.11 – 2.11)
No	Ref	Ref	Ref

Table 4 presents the multinomial logistic regression analysis identifying factors associated with undernutrition, overweight, and obesity among school-going adolescent, with normal nutritional status as the reference category.

Age did not show a statistically significant association with any form of malnutrition. Younger adolescents had slightly higher odds of undernutrition and lower odds of overweight and obesity compared to older adolescents; however, the confidence intervals crossed unity, indicating no significant relationship. Religion emerged as an important factor for undernutrition. Non-Hindu adolescents had significantly lower odds of being undernourished compared to Hindu adolescents (OR = 0.49; 95% CI: 0.26–0.94). Religion was not significantly associated with overweight or obesity. Caste category showed no significant association with undernutrition, overweight, or obesity. Similarly, family type and socioeconomic status were not significantly related to any nutritional outcome, although adolescents from nuclear families showed a non-significant trend toward lower odds of

undernutrition and higher odds of overweight. Place of residence did not demonstrate a significant association with nutritional status. Urban residence showed slightly higher odds of undernutrition and overweight compared to rural residence, but these associations were not statistically significant. Type of school, parental education, and parental occupation also did not show significant associations with undernutrition, overweight, or obesity.

Behavioral factors such as outdoor physical activity, frequent soft drink intake, and frequent street food consumption were not significantly associated with nutritional outcomes. Although frequent soft drink intake showed higher odds of overweight, and frequent street food intake showed higher odds of undernutrition, none of these associations reached statistical significance. Overall, the multinomial logistic regression analysis indicates that most socio-demographic, parental, and behavioral factors were not significantly associated with undernutrition, overweight, or obesity among adolescent. Religion was the only factor significantly associated with undernutrition, with non-Hindu adolescents having lower odds of being undernourished. These findings suggest that determinants of malnutrition in this population may be multifactorial and influenced by factors beyond those assessed in the present model.

**Table 5: Dietary Habits and Anthropometric Measurements by Orphan Status (N=240)**

Parameters	Orphans (n=120) n (%)	Non-Orphans (n=120) n (%)	p-value
<b>Anthropometric Measurements (Mean ± SD)</b>			
Height (cm)	152.4 ± 10.8	154.11 ± 9.6	0.853
Weight (kg)	40.07 ± 10.25	46.83 ± 10.2	0.822
BMI (kg/m <sup>2</sup> )	17.6 ± 5.08	19.95 ± 4.98	0.591
MUAC (cm)	20.57 ± 2.56	22.79 ± 3.02	0.064
Waist circumference (cm)	65.17 ± 8.62	69.80 ± 9.09	0.189
Hip circumference (cm)	79.17± 8.48	82.19 ± 10.55	0.524

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

Waist-Hip ratio	0.83 ± 0.15	0.87 ± 0.18	0.530
-----------------	-------------	-------------	-------

Table 5 compares anthropometric measurements between orphan and non-orphan adolescents. Overall, non-orphans demonstrated relatively higher mean values across most anthropometric indicators; however, none of the observed differences reached statistical significance.

Although orphans tended to have lower height, weight, and body mass index compared to non-orphans, these variations were not statistically meaningful, suggesting broadly comparable growth patterns between the two groups. Similarly, indicators of body composition including mid-upper arm circumference, waist circumference, hip circumference, and waist-hip ratio were generally lower among orphans.

The difference in mid-upper arm circumference approached statistical significance, indicating a possible trend toward lower peripheral muscle mass among orphaned adolescents. However, this finding did not meet conventional levels of statistical significance and should be interpreted cautiously.

Overall, while a consistent pattern of relatively lower anthropometric measures was observed among orphans, the absence of statistically significant differences suggests that anthropometric disparities between the groups may be modest and influenced by multiple contextual factors.

**DISCUSSION**

In the present study, the overall prevalence of malnutrition among school-going adolescents was **50.0%**, reflecting a substantial nutritional burden. This overall magnitude is broadly consistent with evidence from developing country settings, where childhood and adolescent malnutrition remains a significant public health concern despite socioeconomic progress. Gupta et al. reported that in developing countries, undernutrition continues to coexist with emerging obesity, with combined malnutrition prevalence frequently exceeding **40%** in adolescent populations, supporting the magnitude observed in the present study [11]. However, the slightly higher overall burden in the present study may be attributable to inclusion of a vulnerable subgroup, namely orphaned adolescents.

**Undernutrition: Similarities and Discrepancies**

Undernutrition was a dominant component of malnutrition in the present study, affecting **32.9%** of adolescents overall and **43.3% of orphans**, compared to **22.5% among non-orphans**. This pattern is consistent with the conceptual model of the double

burden of malnutrition described by Popkin et al., wherein persistent undernutrition remains prevalent even as populations transition toward higher energy intake and sedentary behaviors [12]. The higher undernutrition prevalence among orphans in the present study highlights the role of social vulnerability in shaping nutritional outcomes.

The biological plausibility of this observation is supported by Wells et al., who described that chronic nutritional deprivation during early life stages, particularly in socially disadvantaged groups, predisposes individuals to sustained thinness and altered growth trajectories [13]. The orphan-specific undernutrition prevalence of **43.3%** in the present study exceeds figures reported in several community-based adolescent studies, suggesting compounded vulnerability due to institutional living and absence of parental care.

At a global level, Black et al. demonstrated that undernutrition remains a major contributor to disease burden in low- and middle-income countries, with prevalence estimates among children and adolescents frequently exceeding **30%** [14]. The overall undernutrition prevalence observed in the present study aligns with these global estimates; however, the disproportionately higher burden among orphans represents a notable discrepancy that may reflect contextual and caregiving differences not captured in broader population-based analyses.

Dietary inadequacy during adolescence has been identified as a key driver of undernutrition. Keats et al., in their systematic review, reported widespread inadequacy of protein, micronutrients, and dietary diversity among adolescent in low- and middle-income countries, with undernutrition prevalence ranging from **20% to 50%** across regions [15]. While the overall undernutrition prevalence in the present study falls within this range, the orphan subgroup demonstrates a higher prevalence, indicating that dietary insufficiency may be more pronounced in institutional settings.

Indian evidence further contextualizes these findings. Ramachandran and Snehalatha highlighted that despite economic growth, undernutrition persists in Asian populations, particularly among socially disadvantaged groups [16]. This observation is consistent with the present study, where orphaned adolescents exhibited substantially higher undernutrition compared to their non-orphan counterparts.

A study from rural West Bengal reported undernutrition prevalence of approximately **35–40%**

## “Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”

among adolescents [17], which closely approximates the **43.3% prevalence among orphans** in the present study but exceeds the prevalence among non-orphans. This discrepancy suggests that orphanhood may confer additional nutritional risk beyond rural residence alone.

### **Overnutrition: Similarities and Discrepancies**

In the present study, **overnutrition (overweight + obesity)** affected **17.1%** of adolescents, with comparable prevalence among orphans (**16.7%**) and non-orphans (**17.5%**). This finding is consistent with the growing body of evidence demonstrating that overweight and obesity are no longer confined to affluent populations. Gupta et al. reported adolescent overweight and obesity prevalence ranging from **10% to 20%** in developing countries, aligning closely with the proportions observed in the present study [11].

School-based evidence from India further supports this similarity. Daga et al. documented combined overweight and obesity prevalence of approximately **14%** among Indian schoolchildren [18], slightly lower than the **17.1%** observed in the present study. This discrepancy may reflect increasing obesogenic exposure in peri-urban districts such as Chengalpattu compared to single-school or more rural settings.

National-level data from the Comprehensive National Nutrition Survey reported overweight and obesity prevalence of **8–12%** among Indian adolescents [19], which is lower than the prevalence observed in the present study. This difference may be attributable to regional variation, urban–rural mix, and temporal trends, as the present study reflects more recent nutritional patterns.

The coexistence of overnutrition with undernutrition in the present study mirrors findings from Subramanian et al., who demonstrated that underweight and overweight frequently coexist even among lower socioeconomic groups in India [20]. The comparable prevalence of overnutrition among orphans and non-orphans in the present study further supports this observation, suggesting that obesogenic environmental influences may operate independently of household structure.

### **Double Burden of Malnutrition: Comparative Perspective**

The simultaneous presence of undernutrition and overnutrition observed in the present study exemplifies the double burden of malnutrition described in the literature. Jaacks et al. proposed the concept of an obesity transition, wherein overweight progressively affects lower socioeconomic groups as countries develop [21]. The present study’s finding of similar

overnutrition prevalence across orphan and non-orphan groups may represent an early stage of this transition.

International studies have reported comparable patterns. Oddo et al. identified coexistence of undernutrition and overweight at household and individual levels in low-income settings, with prevalence estimates similar to those observed in the present study [22]. However, the higher undernutrition burden among orphans represents a discrepancy that underscores the importance of subgroup-specific analyses.

Household-level analyses from Indonesia demonstrated intra-household nutritional inequality, with undernourished and overweight individuals coexisting within the same households [23]. While the present study did not assess household-level dynamics, similar mechanisms may be operative within institutional environments such as orphanages.

A critical review by Tzioumis and Adair emphasized that adolescence is a key period during which the dual burden of malnutrition becomes evident, with reported prevalence ranges overlapping those observed in the present study [24]. The consistency of these findings across diverse settings reinforces the validity of the present study results.

### **Contextualizing Findings within the Nutrition Transition**

From a public health perspective, the observed patterns are consistent with the broader nutrition transition described in developing countries. Kapoor and Anand highlighted that dietary shifts toward energy-dense foods, coupled with reduced physical activity, have resulted in concurrent undernutrition and overnutrition [25]. Evidence from urban poor settings in Kenya also documented coexistence of thinness and overweight, supporting the patterns observed in the present study [26].

Long-term trend analyses from Brazil demonstrated rising obesity prevalence alongside persistent undernutrition, particularly among disadvantaged groups [27]. Comparable trends were evident in the present study, where a substantial proportion of adolescents remained undernourished despite emerging overnutrition.

Studies from Mexico have shown that concurrent stunting and overweight in early life are associated with adverse health trajectories [28]. Although the present study focused on adolescents rather than younger children, similar mechanisms may underlie the coexistence of malnutrition forms observed.

## “Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”

Evidence from rural South Africa further demonstrated that rural populations are not protected from obesity, with documented coexistence of undernutrition and overweight [29]. This aligns with the present study findings, where adolescents from both orphan and non-orphan groups exhibited overnutrition.

Finally, longstanding evidence indicates that India is well advanced in its nutrition transition, with simultaneous persistence of undernutrition and rising obesity [30]. The present study findings are concordant with this broader national pattern while highlighting notable subgroup disparities, particularly among orphaned adolescents.

### LIMITATIONS

This study has certain limitations that should be considered when interpreting the findings. As a cross-sectional study, causal relationships between nutritional status and associated factors could not be established. The reliance on BMI-for-age as the primary indicator of nutritional status may not fully capture body composition differences, particularly lean mass and fat distribution. Dietary intake and physical activity data were self-reported, which may be subject to recall bias and social desirability bias. The study was conducted in a single district, which may limit the generalizability of findings to other geographic settings. Additionally, biochemical assessments for micronutrient deficiencies were not performed, which may have underestimated the overall burden of malnutrition.

### CONCLUSION

The present study highlights the coexistence of undernutrition and overnutrition among school-going adolescents in Chengalpattu district, underscoring the reality of the double burden of malnutrition in this population. Half of the adolescents studied were affected by some form of malnutrition, indicating a substantial public health challenge. Undernutrition emerged as the predominant concern among orphaned adolescents, with nearly two-fifths exhibiting thinness or severe thinness, reflecting heightened vulnerability linked to orphan status. In contrast, overnutrition affected orphans and non-orphans at similar levels, suggesting that exposure to obesogenic environments and lifestyle transitions extends across social groups. The comparable prevalence of overweight and obesity among both groups reflects ongoing nutrition transition, while the marked disparity in undernutrition emphasizes persistent social and nutritional inequities. The absence of significant associations with most

socio-demographic and behavioral variables suggests that adolescent malnutrition may be driven by complex and context-specific factors beyond those traditionally assessed. Overall, the findings reinforce the importance of adopting comprehensive adolescent nutrition approaches that simultaneously address nutritional deficiency and excess, with special attention to socially vulnerable subgroups such as orphans.

### References :

1. Park K. *Park's Textbook of Preventive and Social Medicine*. 27th ed. Jabalpur: Banarsidas Bhanot; 2023.
2. World Health Organization. *WHO Child Growth Standards: Growth Reference Data for 5–19 Years*. Geneva: World Health Organization; 2007. Available from: <https://www.who.int/tools/growth-reference-data-for-5to19-years>
3. World Health Organization. *Adolescent Health*. Geneva: World Health Organization; 2019. Available from: <https://www.who.int/health-topics/adolescent-health>
4. UNICEF. *The State of the World's Children 2019: Children, Food and Nutrition*. New York: United Nations Children's Fund; 2019.
5. Indian Council of Medical Research – National Institute of Nutrition. *Dietary Guidelines for Indians*. Hyderabad: ICMR–NIN; 2020.
6. Development Initiatives. *Global Nutrition Report 2021: The State of Global Nutrition*. Bristol: Development Initiatives; 2021. Available from: <https://globalnutritionreport.org>
7. Ahmad S, Shukla NK, Singh JV, Shukla R, Shukla M. Double burden of malnutrition among school-going adolescent in North India: A cross-sectional study. *J Family Med Prim Care*. 2018 Nov-Dec;7(6):1417-1424. doi: 10.4103/jfmpc.jfmpc\_185\_18. PMID: 30613535; PMCID: PMC6293888.
8. Little M, Humphries S, Dodd W, Patel K, Dewey C. Socio-demographic patterning of the individual-level double burden of malnutrition in a rural population in South India: a cross-sectional study. *BMC Public Health*. 2020 May 13;20(1):675. doi: 10.1186/s12889-020-08679-5. PMID: 32404080; PMCID: PMC7218837.

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

9. Caleyachetty R, Thomas GN, Kengne AP, Echouffo-Tcheugui JB, Schilsky S, Khodabocus J, Uauy R. The double burden of malnutrition among adolescents: analysis of data from the Global School-Based Student Health and Health Behavior in School-Aged Children surveys in 57 low- and middle-income countries. *Am J Clin Nutr.* 2018 Aug 1;108(2):414-424. doi: 10.1093/ajcn/nqy105. PMID: 29947727.
10. Ranjani H, Mehreen TS, Pradeepa R, Anjana RM, Garg R, Anand K, Mohan V. Epidemiology of childhood overweight & obesity in India: A systematic review. *Indian J Med Res.* 2016 Feb;143(2):160-74. doi: 10.4103/0971-5916.180203. PMID: 27121514; PMCID: PMC4859125.
11. Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries: epidemiology, determinants, and prevention. *Endocr Rev.* 2012 Feb;33(1):48-70. doi: 10.1210/er.2010-0028. Epub 2012 Jan 12. PMID: 22240243.
12. Popkin BM, Corvalan C, Grummer-Strawn LM. Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet.* 2020 Jan 4;395(10217):65-74. doi: 10.1016/S0140-6736(19)32497-3. Epub 2019 Dec 15. PMID: 31852602; PMCID: PMC7179702.
13. Wells JC, Sawaya AL, Wibaek R, Mwangome M, Poullas MS, Yajnik CS, Demaio A. The double burden of malnutrition: aetiological pathways and consequences for health. *Lancet.* 2020 Jan 4;395(10217):75-88. doi: 10.1016/S0140-6736(19)32472-9. Epub 2019 Dec 15. PMID: 31852605; PMCID: PMC7613491.
14. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R; Maternal and Child Nutrition Study Group. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet.* 2013 Aug 3;382(9890):427-451. doi: 10.1016/S0140-6736(13)60937-X. Epub 2013 Jun 6. Erratum in: *Lancet.* 2013. 2013 Aug 3;382(9890):396. PMID: 23746772.
15. Keats EC, Rappaport AI, Shah S, Oh C, Jain R, Bhutta ZA. The Dietary Intake and Practices of Adolescent in Low- and Middle-Income Countries: A Systematic Review. *Nutrients.* 2018 Dec 14;10(12):1978. doi: 10.3390/nu10121978. PMID: 30558128; PMCID: PMC6315365.
16. Ramachandran A, Snehalatha C. Rising burden of obesity in Asia. *J Obes.* 2010;2010:868573. doi: 10.1155/2010/868573. Epub 2010 Aug 30. PMID: 20871654; PMCID: PMC2939400.
17. Pal A, Pari AK, Sinha A, Dhara PC. Prevalence of undernutrition and associated factors: A cross-sectional study among rural adolescents in West Bengal, India. *Int J Pediatr Adolesc Med.* 2017 Mar;4(1):9-18. doi: 10.1016/j.ijpam.2016.08.009. Epub 2016 Sep 13. PMID: 30805494; PMCID: PMC6372453.
18. Daga S, Mhatre S, Kasbe A, Dsouza E. Double burden of malnutrition among Indian schoolchildren and its measurement: a cross-sectional study in a single school. *BMJ Paediatr Open.* 2020 Feb 2;4(1):e000505. doi: 10.1136/bmjpo-2019-000505. PMID: 32099905; PMCID: PMC7015044.
19. Pandurangi R, Mummadi MK, Challa S, Reddy NS, Kaliaperumal V, Khadar Babu C, Telikicherla UR, Pullakandham R, Geddam JJB, Hemalatha R. Burden and Predictors of Malnutrition Among Indian Adolescents (10-19 Years): Insights From Comprehensive National Nutrition Survey Data. *Front Public Health.* 2022 Jun 15;10:877073. doi: 10.3389/fpubh.2022.877073. PMID: 35784251; PMCID: PMC9240318.
20. Subramanian SV, Perkins JM, Khan KT. Do burdens of underweight and overweight coexist among lower socioeconomic groups in India? *Am J Clin Nutr.* 2009 Aug;90(2):369-76. doi: 10.3945/ajcn.2009.27487. Epub 2009 Jun 10. PMID: 19515733; PMCID: PMC2709313.
21. Jaacks LM, Vandevijvere S, Pan A, McGowan CJ, Wallace C, Imamura F, Mozaffarian D, Swinburn B, Ezzati M. The obesity transition: stages of the global epidemic. *Lancet Diabetes Endocrinol.* 2019 Mar;7(3):231-240. doi: 10.1016/S2213-8587(19)30026-9. Epub 2019 Jan 28. PMID: 30704950; PMCID: PMC7360432.
22. Oddo VM, Rah JH, Semba RD, Sun K, Akhter N, Sari M, de Pee S, Moench-Pfanner R, Bloem M, Kraemer K. Predictors of maternal

**“Assessment of the double burden of malnutrition among school-going adolescent orphans and non-orphans in chengalpattu district, tamil nadu- a cross-sectional study”**

- and child double burden of malnutrition in rural Indonesia and Bangladesh. *Am J Clin Nutr.* 2012 Apr;95(4):951-8. doi: 10.3945/ajcn.111.026070. Epub 2012 Feb 22. PMID: 22357721.
23. Roemling C, Qaim M. Dual burden households and intra-household nutritional inequality in Indonesia. *Econ Hum Biol.* 2013 Dec;11(4):563-73. doi: 10.1016/j.ehb.2013.07.001. Epub 2013 Jul 12. PMID: 23890671.
  24. Tzioumis E, Adair LS. Childhood dual burden of under- and overnutrition in low- and middle-income countries: a critical review. *Food Nutr Bull.* 2014 Jun;35(2):230-43. doi: 10.1177/156482651403500210. PMID: 25076771; PMCID: PMC4313560.
  25. Kapoor SK, Anand K. Nutritional transition: a public health challenge in developing countries. *J Epidemiol Community Health.* 2002 Nov;56(11):804-5. doi: 10.1136/jech.56.11.804. PMID: 12388563; PMCID: PMC1732057.
  26. Kimani-Murage EW, Muthuri SK, Oti SO, Mutua MK, van de Vijver S, Kyobutungi C. Evidence of a Double Burden of Malnutrition in Urban Poor Settings in Nairobi, Kenya. *PLoS One.* 2015 Jun 22;10(6):e0129943. doi: 10.1371/journal.pone.0129943. PMID: 26098561; PMCID: PMC4476587.
  27. Monteiro CA, Conde WL, Popkin BM. Income-specific trends in obesity in Brazil: 1975-2003. *Am J Public Health.* 2007 Oct;97(10):1808-12. doi: 10.2105/AJPH.2006.099630. Epub 2007 Aug 29. PMID: 17761560; PMCID: PMC1994168.
  28. Fernald LC, Neufeld LM. Overweight with concurrent stunting in very young children from rural Mexico: prevalence and associated factors. *Eur J Clin Nutr.* 2007 May;61(5):623-32. doi: 10.1038/sj.ejcn.1602558. Epub 2006 Nov 29. PMID: 17136036.
  29. Kimani-Murage EW. Exploring the paradox: double burden of malnutrition in rural South Africa. *Glob Health Action.* 2013 Jan 24;6:19249. doi: 10.3402/gha.v6i0.19249. PMID: 23364082; PMCID: PMC3556706.
  30. Griffiths PL, Bentley ME. The nutrition transition is underway in India. *J Nutr.* 2001 Oct;131(10):2692-700. doi: 10.1093/jn/131.10.2692. PMID: 11584092.