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Original Article

Nutritional Status and Anthropometric Variations among Railway Colony Children in North 24 Parganas, West Bengal: A Cross-Sectional Study

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ABSTRACT

Nutrition plays a crucial role in a child's growth that has long-term effect in their health. In India malnutrition in children remain a significant public health concern. The children especially who belongs to economically weaker section suffers in this problem. The study aims to investigate how anthropometric measures and nutritional status varies with age among the children of railway colony. A total of 509 children aged 4-10 years were selected from railway colony of North 24 parganas. Result shows that with the increasing of age the nutritional status decline. Based on one-way ANOVA all anthropometric measures and nutritional indicators varied significantly with age (P<0.001). In the present study it is found that the older age is in nutritionally vulnerable condition than Younger age.

KEYWORDS

• Height • Weight • Head circumference • Chest Circumference • Mid-Upper Arm Circumference Waist Circumference • Hip Circumference • Biceps • Triceps • Body mass index • Weight-for-Age Z-score • Height-for-Age Z-score • Body Mass Index-for-Age Z-score

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INTRODUCTION

The growth and nutritional status of children are pivotal factors for long-term health, affecting physical development, cognitive abilities, and socio-economic outcomes (Poulain *et al*., 2019), (Kumar Patsa, 2021). Certain ages mark significant growth milestones, and the development of these characteristics differs across populations. Anthropometric measurements such as height, weight, waist circumference, hip circumference, head circumference, biceps, triceps, mid-upper arm circumference (MUAC) are widely used to assess growth patterns and nutritional status in children (WHO, 2006). The age range of 4-10 years represents a crucial period of steady linear growth and proper body weight, but it can be disrupted by insufficient nutrition, socio-economic limitations, and environmental influences (Khadilkar & Khadilkar, 2015). In India, malnutrition remains a significant public health concerns, with 38% of children under five experiencing stunting and emerging trends of overnutrition in urbanizing areas (Swaminathan *et al*., 2019). However, children of this age range (4–10 years) who are in distinctive socio-economic contexts like railway colonies have not been extensively studied, especially in areas such as North 24 Parganas in West Bengal. In India, railway colonies, such as those located in North 24 Parganas, represent unique communities characterized by differing socio-economic statuses and limited healthcare and nutritional support, lacking proper sanitation, drinking water facilities, and structural stability. The area reflects patterns of socioeconomic deprivation, with many families engaged in informal or daily wage labor, and living in overcrowded environments. These settings are distinct from rural or urban populations. Recent research reveals east zone of India such as West Bengal exhibit high rates of stunting and thinness than other zones indicating that younger children in railway colonies may face similar nutritional challenges (Kundu *et al*., 2024). As noted by (Jaleel *et al*., 2025) understanding the nutritional status and needs of urban populations, particularly among underprivileged groups such as people living in slums, is crucial. This study investigates the prevalence, characteristics, and determinants of child malnutrition in the urban slums of the Kolkata Municipal Corporation (KMC, environmental influences like inadequate sanitation and poor water quality worsen nutritional deficits, leading to anthropometric failure in similar contexts.

Recent studies emphasize the widespread occurrence of malnutrition and its causes among Indian children, yet it uncovers significant gaps. Research such as (Roy *et al*., 2018)and a major cause of morbidity and mortality in India, hence the present study was conducted to find out the nutritional status of under-five children and to elicit the factors associated with it.

Methods: This community based cross-sectional study was conducted among 142 under-five children during May to June 2017 in the areas under the jurisdiction of Nasibpur Primary Health Centre, Singur, West Bengal, India. Data on socio-demographic characteristics, feeding habits and other biological factors were obtained from structured questionnaire, followed by anthropometric measurement. Assessment of nutritional status of the children was done with the help of Composite Index of Anthropometric Failure (CIAF indicates that the prevalence of the Composite Index of Anthropometric Failure (CIAF) among children under five is 36.1%, influenced by family income and inadequate sanitation, with repercussions for older children in resource-limited environments. A community-based cross-sectional investigation conducted by (Pal *et al*., 2021) in West Bengal highlights this concern, revealing that among children aged 5 to 10 years, 25.51% experienced stunting, 32.99% were classified as underweight, and 26.91% were identified as thin (BMI for-Age Z-score <-2). The research also indicated that the risk of undernutrition increases with age, as older children (8-10 years) and also proved that there is various risk factors associated with child malnutrition. Illiteracy, contaminated drinking water, and inadequate sanitation contributed to undernutrition, each serving as separate risk elements.

(Sengupta *et al*., 2016)conducted a cross-sectional study on 551 school students aged 8–16 years from rural North 24 Parganas, West Bengal, assessing linear growth using height, weight, and BMI. Mean height and weight increased with age. Undernutrition prevalence was 22.1% (stunting), 15.4% (underweight), and 11.7% (thinness), with 7.3% overweight/obese.

In their analysis of National Family Health Survey data (2006–2016) for 266,308 Indian children aged 0–59 months, (Rajpal *et al*., 2020) the global nutrition community has focused on strategies for improving nutritional intake during the first 1000 day period. This is largely justified by the observed steep decline in children's height-for-age z scores from birth to 23 months and presumed growth faltering at later ages as a reflection of earlier deprivation that is accumulated and irreversible. Empirical evidence on the age-stratified burden of child undernutrition is needed to re-evaluate the appropriate age for nutrition interventions to target among children. Using data from two successive rounds of National Family Health Surveys conducted in 2006 and 2016, the objective of this paper was to analyze intertemporal changes in the age-stratified burden of child stunting across socioeconomic groups in India. We found that child stunting in India was significantly concentrated among children entering preschool age (24 or above months discovered that preschoolers had a greater prevalence of stunting (24–59 months, 42.0%) than younger children (0–23 months, 32.6%). The burden of stunting was higher for poorer households (59.0% in the lowest wealth quintile), peaking between 36 and 47 months (43.2% in 2016). (Kaur *et al*., 2008) studied among school-aged children (5-18 years) in Delhi, emphasizing the impact of socio-economic factors on age-related growth variations. (Mukhopadhyay *et al*., 2005) and (Maiti *et al*., 2011) documented significant levels of stunting and thinness among rural adolescents in West Bengal, yet there is a lack of data specifically concerning the 4-10 age group and railway colonies.

The objective of this study is to investigate how anthropometric traits (height, weight, BMI, MUAC) and nutritional status differ with age among children aged 4–10 years living in a railway colony in North 24 Parganas, West Bengal. The research aims to tackle the absence of community-specific data and aid in evidence-based public health interventions by examining growth patterns and nutritional outcomes in this population that has not been thoroughly studied. The findings will guide strategies to reduce malnutrition and foster healthy growth in semi-urban occupational communities throughout India.

MATERIALS AND METHODS

The present study employs a cross-sectional research design to investigate age-specific variations in anthropometric characteristics and nutritional status, along with their associations with socioeconomic factors, among a sample of 509 children (259 boys and 250 girls) aged 4 to 10 years. The participants were selected from railway colonies situated along the Barasat–Bongaon railway section in the North 24 Parganas district of West Bengal, India.

Anthropometric measurements included height (measured with anthropometer, to 0.1 cm), weight (digital weighing machine, to 0.1 kg), mid-upper arm circumference (MUAC, measuring tape, to 0.1 cm), waist and hip circumferences (measuring tape, to 0.1 cm), and biceps and triceps skinfolds (skinfold calliper, to 0.1 mm).All anthropometric measures such as BMI was calculated as weight (kg)/ height (m^2). Nutritional status was evaluated using WHO growth standards (z-scores for height-for-age, weight-for-age, BMI-for-age) to determine stunting, underweight, thinness, and overweight. Socioeconomic data (family income and parents occupation) were collected via scheduled form from parents. Socio-economic variables such as family income divide into three categories such as lower lower income group (<8000 per month), lower middle income group (8000-10000 per month), lower upper income group (>10000 per month).

Data were analysed using SPSS v.16. Descriptive statistics (means, SD) described anthropometric characteristics by age group. Prevalence of stunting, underweight, thinness, and overweight was calculated using WHO z-score cut-offs (<-2 SD for undernutrition, >+2 SD for overweight). Age variations in anthropometrics were assessed using one way ANOVA.

RESULTS AND DISCUSSION

Table 1 shows the mean and standard deviation of anthropometric variables for children aged 4 to 10 years Average height rose from 101.78±8.74 cm at the age of 4 to 125.91±7.79 cm by age 9, but then fell to 111.38±14.53 cm at age 10. At ages 4 (106.40±8.05 cm compared to 97.03±6.71 cm), 5 (117.26±8.21 cm compared to 113.73±6.63 cm), 6 (125.66±6.16 cm compared to 123.48±7.74 cm), and 9 (127.51±6.95 cm compared to 124.54±8.28 cm), girls were taller than boys. Weight increased from 14.81±2.97 kg at age 4 to 24.09±5.57 kg at age 9, before declining to 18.11±5.37 kg at age 10, with girls being heavier than boys at ages 4 to 6 (for instance, 16.47±2.98 kg compared to 13.11±1.77 kg at age 4). Measurements for mid-upper arm circumference (MUAC), and circumferences (head, chest, waist, hip), as well as skinfolds (biceps, triceps) grew until age 9 (for example, MUAC increased from 14.15±1.03 cm to 16.47±1.42 cm), followed by a decrease at age 10 (e.g., MUAC at 15.17±1.82 cm). Girls exhibited greater dimensions at ages 4 to 6 and at age 9 (for example, chest circumference at age 6 was 59.54±4.29 cm compared to 57.06±2.65 cm for boys). BMI remained consistent, ranging from 14.05±1.42 to 15.15±3.02 kg/m² across different ages.

Table 1: Age and Sex wise Mean and Standard Deviation of all anthropometric variables

Anthropometric Variables		**Age in years**						
(Mean and SD)		**4**	**5**	**6**	**7**	**8**	**9**	**10**
Height	Boys	97.03 (6.71)	113.73 (6.63)	123.48 (7.74)	113.37 (18.03)	112.84 (7.16)	124.54 (8.28)	106.16 (11.74)
	Girls	106.40 (8.05)	117.26 (8.21)	125.66 (6.16)	108.66 (7.08)	118.09 (10.70)	127.51 (6.95)	115.83 (15.31)
	Combined	101.78 (8.74)	115.64 (7.68)	124.59 (7.01)	111.15 (14.01)	115.64 (1.10)	125.91 (7.79)	111.38 (14.53)
Weight	Boys	13.11 (1.77)	17.27 (2.98)	22.31 (2.82)	20.56 (7.94)	17.88 (2.90)	23.74 (6.85)	17.51 (5.44)
	Girls	16.47 (2.98)	20.56 (4.79)	25.92 (4.75)	16.82 (2.76)	19.98 (5.25)	24.51 (3.61)	18.63 (5.32)
	Combined	14.81 (2.97)	19.05 (4.36)	24.14 (4.29)	18.79 (6.32)	19.00 (4.42)	24.09 (5.57)	18.11 (5.37)
Head Circum-ference	Boys	47.21 (2.14)	48.60 (1.72)	49.73 (1.56)	47.88 (2.19)	47.74 (1.64)	48.90 (2.35)	48.78 (3.24)
	Girls	48.40 (1.98)	50.07 (2.91)	49.72 (1.86)	48.01 (1.58)	47.73 (1.15)	49.47 (2.66)	48.56 (2.41)
	Combined	47.81(2.13)	49.40 (2.53)	49.73 (1.71)	47.94 (1.91)	47.73 (1.39)	49.16 (2.49)	48.66 (2.81)
Chest Circum-ference	Boys	50.25 (2.78)	54.11 (4.56)	57.06 (2.65)	54.25 (7.02)	53.09 (2.31)	56.43 (2.89)	53.19 (5.44)
	Girls	52.98 (3.54)	55.97 (3.74)	59.54 (4.29)	52.66 (2.22)	53.56 (2.41)	59.45 (4.47)	54.15 (5.20)
	Combined	51.64 (3.45)	55.12 (4.21)	58.32 (3.76)	53.50 (5.35)	53.34 (2.36)	57.82 (3.98)	53.71 (5.30)
MUAC	Boy	13.92 (1.03)	14.65 (1.19)	15.83 (0.85)	15.87 (2.29)	15.10 (1.07)	16.25 (1.37)	14.66 (1.74)
	Girls	14.37 (1.00)	15.95 (1.16)	16.63 (1.92)	16.69 (7.95)	15.49 (1.16)	16.72 (1.45)	15.60 (1.78)
	Combined	14.15 (1.03)	15.35 (1.34	16.23 (1.53)	16.25 (5.68)	15.30 (1.13))	16.47 (1.42)	15.17 (1.82
Waist Circum-ference	Boy	48.64 (3.81)	49.64 (3.65)	53.12 (3.27)	51.28 (5.38)	51.48 (3.86)	53.76 (4.76)	50.24 (4.91)
	Girl	50.85 (2.97)	53.51 (4.38)	55.33 (4.94)	50.84 (3.33)	51.85 (4.76)	54.47 (5.22)	51.60 (4.46)
	Combined	49.76 (3.56)	51.73 (4.48)	54.24 (4.32)	54.24 (4.32)	51.68 (4.34)	54.08 (4.95)	50.97 (4.69)
Hip Circum-ference	Boy	49.06 (5.86)	53.03 (3.56)	57.98 (3.66)	55.03 (8.60)	54.58 (3.57)	59.65 (4.57)	52.52 (6.18)
	Girl	53.06 (4.47)	56.47 (5.40)	60.62 (6.32)	54.39 (5.81)	56.29 (4.72)	61.17 (5.51)	55.43 (6.34)
	Combined	51.09 (5.54)	54.89 (4.93)	59.32 (5.32)	54.73 (7.37)	55.49 (4.28)	60.35 (5.05)	54.09 (6.39)
Biceps	Boy	3.81 (1.18)	3.65 (1.36)	4.42 (1.37)	4.82 (2.18)	3.63 (1.01)	4.44 (1.33)	4.51 (1.68)
	Girl	3.66 (1.21)	4.83 (1.45)	5.06(1.95)	3.92 (1.29)	3.93 (1.02)	5.81(1.64)	4.35 (1.80)
	Combined	3.74 (1.19)	4.29 (1.52)	4.74 (1.70)	4.40 (1.86)	4.40 (1.86)	5.07 (1.63)	4.42 (1.74)
Triceps	Boy	6.80 (1.39)	6.44 (1.83)	7.51 (2.09)	7.85 (2.92)	6.33 (1.77)	7.71 (2.21)	7.48 (2.19)
	Girl	6.28 (1.80)	8.29 (2.50)	8.20 (2.95)	6.60 (1.50)	6.84 (1.90)	9.23 (1.83)	7.39 (2.33)
	Combined	6.53 (1.62)	7.45 (2.39)	7.86 (2.57)	7.25 (2.42)	6.60 (1.84)	8.41 (2.17)	7.43 (2.17)
BMI	Boy	13.94 (1.37)	13.34 (2.01)	14.41 (1.16)	14.70 (1.97)	14.05 (1.56)	15.23 (3.80)	14.32 (1.68)
	Girl	14.16 (1.49)	14.16 (2.02)	14.82 (1.64)	14.20 (1.57)	14.12 (1.21)	15.06 (1.74)	14.27 (1.34)
	Combined	14.05 (1.42)	13.78 (2.04)	14.62 (1.43)	14.46 (1.80)	14.08 (1.38)	15.15 (3.02)	14.30 (1.49)

Table 2 presents the nutritional status of children according to WAZ (weight-for-age), HAZ (height-for-age), and BAZ (BMI-for-age) classifications.The percentage of underweight children increased as they got older, especially among boys. At the age of 10, 88.6% of boys and 80.5% of girls were identified as underweight. inversely, there were no reported cases of underweight children at age 6. The average WAZ scores decreased with age, with combined figures ranging from -0.89 ± 1.52 at age 4 to -3.32 ± 1.75 at age 10. Stunting was most commonly observed at age 10, impacting 94.3% of boys and 65.9% of girls. The highest percentage of children with tall stature occurred at age 6, with a combined rate of 55.2%. Mean HAZ values indicated this pattern, showing positive scores during early childhood followed by sharp decreases later on. The lowest mean HAZ recorded was at age 10, with a score of -3.00 ± 1.69. BAZ scores indicated that the prevalence of undernutrition among boys increased with age. The highest rates of undernutrition were recorded at age 8 for boys (42.9%) and at age 10 for girls (29.3%). Mean BAZ scores varied from -0.96 ± 0.99 at age 4 to -1.59 ± 1.16 at age 10.

Table 2: Age and sex wise distribution of all nutritional indicators

	Nutritional indicators		**Age in years**						
			4	**5**	**6**	**7**	**8**	**9**	**10**
WAZ	Underweight	Boys (%)	28.60	12.10	00	50	71.40	48.80	88.60
		Girls (%)	19.40	5.10	00	47.10	60	5.70	80.50
		Combined (%)	23.90	8.30	00	48.60	65.30	28.90	84.20
	Normal	Boys (%)	71.40	87.90	93.90	36.80	28.60	46.30	11.40
		Girls (%)	75.00	84.60	73.50	52.90	35.00	94.30	19.50
		Combined (%)	73.20	86.10	83.60	44.40	32.00	68.40	15.80
	Overweight	Boys (%)	00	00	6.10	13.2	00	4.90	00
		Girls (%)	5.60	10.30	26.50	00	5.0	00	00
		Combined (%)	2.80	5.60	16.40	6.90	2.70	2.60	00
	Mean (SD)	Boys	-1.34(1.30)	-0.57(1.31)	0.54(0.88)	-1.43(2.71)	-2.77(1.19)	-1.52(1.67)	-3.09(1.86)
		Girls	-0.43(1.60)	0.61(1.45)	1.46(1.02)	-2.09(1.17)	-1.74(1.37)	-0.97(0.89)	-3.51(1.65)
		Combined	-0.89(1.52)	0 .06(1.49)	1.07(1.05)	-1.74(2.14)	-2.22(1.38)	-1.26(1.39)	-3.32(1.75)
HAZ	Stunted	Boys (%)	17.10	3.0	00	50	77.10	36.60	94.30
		Girls (%)	16.70	5.10	00	64.70	45.00	17.10	65.90
		Combined (%)	16.90	4.20	00	56.90	60.00	27.60	78.90
	Normal	Boys (%)	71.40	84.80	60.60	21.10	22.90	58.50	5.70
		Girls (%)	61.10	56.40	29.40	35.30	50.00	82.90	34.10
	Tall	Boys (%)	11.40	12.10	39.40	28.90	00	4.90	00
		Girls (%)	22.20	38.50	70.60	00	5.00	00	00
		Combined (%)	16.90	26.40	55.20	15.30	2.70	2.60	00
	Mean (SD)	Boys	-0.53(2.02)	0.819(1.43)	1.52(1.57)	-1.14(3.67)	-2.55(1.26)	-1.33(1.38)	-3.53(1.13)
		Girls	0.03(2.11)	1.70(1.69)	12.08(1.19)	-2.22(1.29)	-1.45(1.84)	-0.81(1.13)	-2.54(1.95)
		Combined	-0.24(2.07)	1.29(1.63)	1.81(1.41)	-1.65(2.84)	-1.97(1.68)	-1.09(1.29)	-3.00(1.69)
BAZ	Undernutrition	Boys (%)	22.90	42.40	6.10	18.40	42.90	29.30	31.40
		Girls (%)	11.10	10.30	8.80	14.70	10.00	5.70	29.30
		Combined (%)	16.90	25.00	7.50	16.70	25.30	18.40	30.30

Normal	Boys (%)	77.10	57.60	93.90	78.90	57.10	65.90	68.60
	Girls (%)	88.90	89.70	88.20	85.30	90.00	94.30	70.70
	Combined (%)	83.10	75.00	91.00	81.90	74.70	78.90	69.70
Overweight/	Boys (%)	00	00	00	2.60	00	4.90	00
Obese	Girls (%)	00	00	2.90	00	00	00	00
	Combined (%)	00	00	1.50	1.40	00	2.60	00
Mean (SD)	Boys	-1.14(1.12)	-1.74(1.81)	-0.78(1.00)	-0.77(1.59)	-1.42(1.25)	-0.98(1.72)	-1.66(1.34)
	Girls	-0.79(0.83)	-0.87(1.45)	-0.41(1.11)	-0.92(1.20)	-1.08(0.85)	-0.72(0.95)	-1.52(0.99)
	Combined	-0.96(0.99)	-1.27(1.67)	-0.59(1.07)	-0.84(1.41)	-1.24(1.06)	-0.86(1.41)	-1.59(1.16)

Table 3 The results of the ANOVA confirmed that all anthropometric variables varied significantly with age ($p < 0.001$). ANOVA analysis revealed highly significant variations in WAZ scores based on age ($F = 60.12$, $p < 0.001$) and also in HAZ across different ages was statistically highly significant ($F = 63.42$, $p < 0.001$).

Table 3: One-way ANOVA of anthropometic measures and nutritional indicators in all ages

Anthropometric variables	F value	p value
Height	46.04	<0.001*
Weight	33.58	<0.001*
Head Circumference	9.84	<0.001
Chest Circumference	24.87	<0.001*
MUAC	7.67	<0.001
Waist Circumference	9.93	<0.001*
Hip Circumference	22.78	<0.001*
Biceps	6.99	<0.001*
Triceps	6.65	<0.001*
Body mass index	4.15	<0.001*
Nutritional indicators		
WAZ	60.12	<0.001*
HAZ	63.42	<0.001*
BAZ	4.93	<0.001

Table 4 Shows Chi-square tests also showed strong links between age and the prevalence of underweight in both boys and girls ($p < 0.001$).HAZ significant chi-square results for both genders ($p < 0.001$). Nevertheless, the chi-square test revealed a significant correlation with age only in boys ($p = 0.015$), while the results for girls did not reach statistical significance ($p = 0.089$).

Table 4: Association between Age and Nutritional indicators by Sex

Nutritional indicators	Pearson Chi square(x2)		P value	
	Boys	Girls	Boys	Girls
WAZ	100.12	127.52	<0.001*	<0.001*
HAZ	142.22	150.32	<0.001*	<0.001*
BAZ	25.04	18.98	0.015*	0.089

Figure 1 shows that height-for-age z-score is slightly higher in the lower upper income group. In the age group 5–6, z-score value is positive, which indicates children are taller in these age cohorts in all income groups. In age group 7–8, the opposite happens. A similar case is observed in weight-for-age z-score, which indicates underweight prevalence in this population. The lower upper income group generally maintains slightly higher z-score values than others.The key difference is seen between income groups throughout all age groups. The lower income group fares slightly better. BMI-for-age z-score also maintains a similar trend like WAZ and HAZ. Around age 6–7, BAZ is at its peak and then declines. The upper income group maintains a better BAZ score across all ages. **In Figure 2**, negative z-score values indicate stunted growth in all groups. Across age 6, stunted growth is more seen in children whose fathers are daily labourers and unemployed. But HAZ score is higher where fathers are in other occupations c**ategory** that suggests better nutritional status. A similar pattern is observed in WAZ score that is, underweight is prevalent in unemployed fathers' children in the age group

6–10. In all age groups, negative BAZ is seen in the daily labourer and unemployed group. Figure 3 also exhibit the similar tendency of nutritional status with mothers occupation alike fathers occupation. Therefore, it indicates that parents occupation plays a crucial role in child's nutritional status.

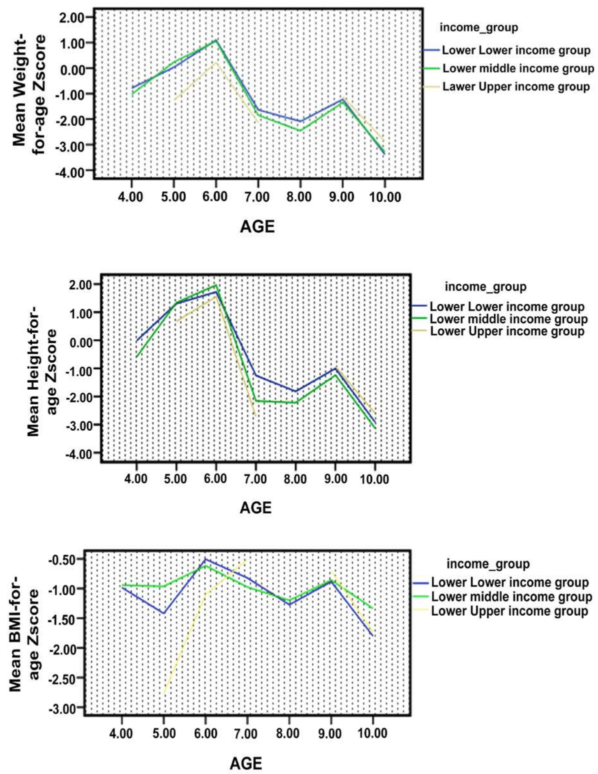
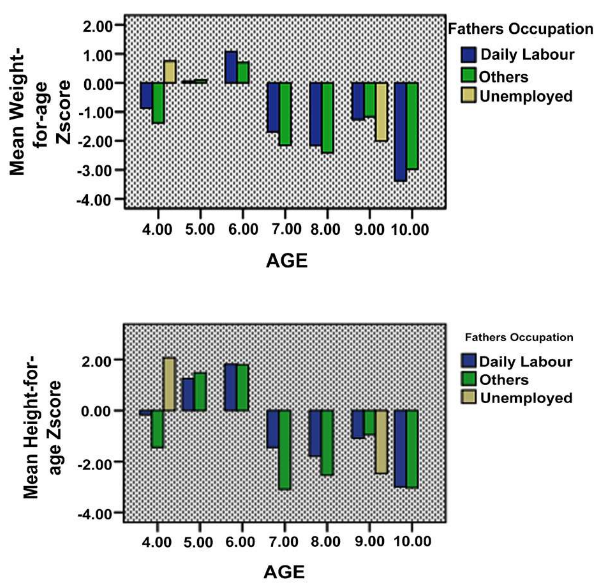


Figure 1: Age-wise comparison of Nutritional Indicators by various Income group



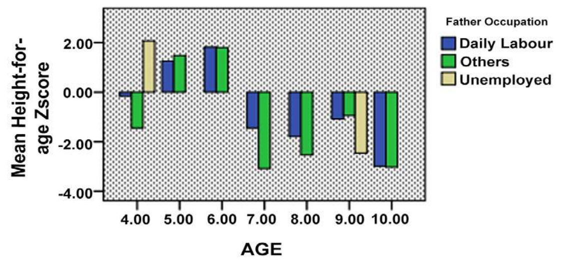


Figure 2: Age-wise comparison of Nutritional Indicators by Fathers Occupation

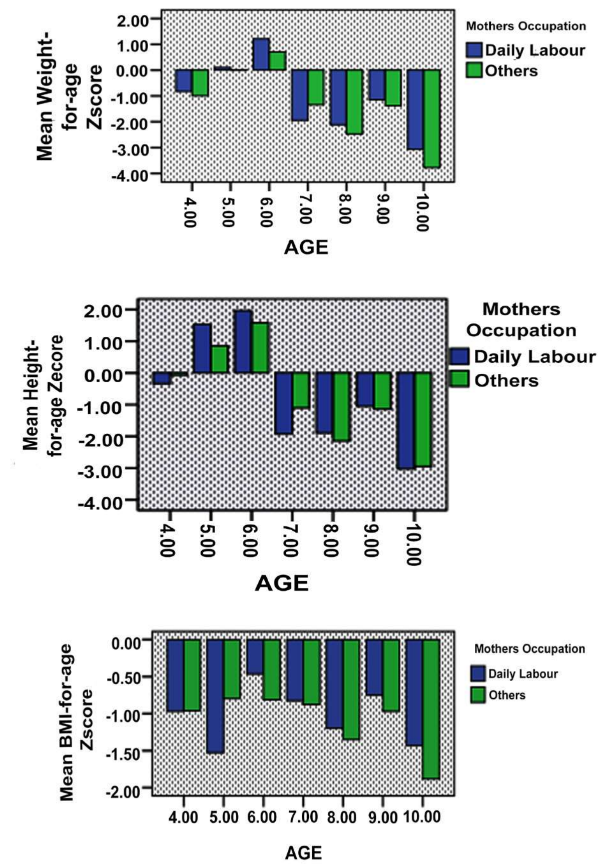


Figure 3: Age-wise comparison of Nutritional Indicators by Mothers Occupation

CONCLUSION

In this study, we find that children between the ages of 4 and 10 identified notable variation in anthropometric measurements (height, weight, circumferences) and nutritional status (WAZ, HAZ, BAZ). Physical growth shows to an anticipated pattern, the alarming prevalence of undernutrition, being underweight, and stunting particularly among older children points to underlying systemic issues. Economic inequalities, particularly relating to income levels and the occupations of fathers, are closely associated with nutritional results. Children from families struggling with lower and lower middle incomes and whose fathers hold daily labour or unemployed consistently exhibit inferior growth and poorer nutritional health. These results highlight the urgent need for specific nutritional and health initiatives in economically disadvantaged communities, which include regular screening, nutrition programs in schools, and awareness campaigns at the community level.

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