Int. J Med. Pharm. Res.
E-ISSN: 2958-3683 | **P-ISSN**: 2958-3675
Available on: https://ijmpr.in/

International Journal of
Medical and Pharmaceutical Research

ORGINAL ARTICLE **OPEN ACCESS**

Growth Patterns and Nutritional Status among Non-Tribal Schoolboys in Rural Dooars Region, West Bengal: An Evaluation

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OPEN ACCESS

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Received: 10-07-2025
Accepted: 13-08-2025
Available Online: 30-08-2025

A B S T R A C T

OBJECTIVE: This study aimed to evaluate growth patterns and nutritional status among non-tribal school boys aged 12–16 years in rural areas of the Dooars region, West Bengal, using height, weight, and Body Mass Index (BMI) as primary anthropometric indicators.
METHODS: A quantitative, cross-sectional study was conducted with 200 purposively sampled participants from five rural schools in Jalpaiguri district. Students were classified into four age groups: 12–13 years, >13–14 years, >14–15 years, and >15–16 years (n = 50 in each). Standardised protocols were used to measure height, weight, and BMI. Data were analysed using descriptive statistics, one-way ANOVA, and Tukey's HSD post-hoc tests, with statistical significance set at $p < .05$.
RESULTS: Mean height and weight increased progressively across age groups, with the most pronounced gains occurring between >14–15 years and >15–16 years. ANOVA revealed significant differences in height [$F(3, 196) = 21.04$, $p < .001$, $\eta^2 = 0.24$] and weight [$F(3, 196) = 11.78$, $p < .001$, $\eta^2 = 0.15$], but no significant difference in BMI [$F(3, 196) = 1.35$, $p = .26$, $\eta^2 = 0.02$]. BMI remained stable ($M \approx 17.6$–17.9 kg/m^2) despite increases in height and weight, suggesting proportional growth. Post-hoc comparisons identified significant height and weight gains only between the oldest two age groups.
CONCLUSION: Non-tribal school boys in rural Jalpaiguri demonstrate age-related increases in height and weight, with late adolescence (14–16 years) emerging as a critical growth period. The stability of BMI across ages suggests generally healthy proportional growth. Targeted nutrition and health interventions during this developmental window may help optimise physical maturation and prevent undernutrition or excess weight gain.
KEYWORDS: Indigenous Physical Activities, Motor Fitness, Tribal School Boys, Adolescence, AAHPERD test, West Bengal, Jalpaiguri, ANOVA, Tukey's HSD, Purposive Sampling.

INTRODUCTION:

Adolescent growth and nutritional status are universally recognised as core determinants of lifelong health, physical development, and socio-educational achievement (Ghosh, 2024). During adolescence—defined by the World Health Organization as ages 10 to 19—individuals undergo rapid somatic and physiological changes, marked most visibly by increments in height and weight, shifts in body composition, and maturation of vital functions (Gupta, et al., 2022). These changes are shaped by an interplay of genetics, nutrition, physical activity, environmental exposures, and socio-economic context (Ghosh and Kathayat, 2023). In India, anthropometric data reveal significant disparities not only across regions but also within communities, reflecting diverse access to nutrition, healthcare, and resources (Kanade, 1999). West Bengal's Dooars region, characterised by its tea gardens, forested terrain, and cultural heterogeneity, provides a unique laboratory to examine patterns of physical growth and nutritional status among adolescents (Mondal, 2012). Children and adolescents in rural Jalpaiguri, where this study is set, face environmental and nutritional constraints that may impede optimal physical development. Past research on rural Indian boys indicates substantial variability in growth trajectory, with undernourished children experiencing delayed onset of growth spurts and lower peak height velocity compared to their well-nourished peers (Kanade, 1999). Similarly, regional studies highlight wide variations in height and weight gains, with growth spurts typically occurring between 12 and 16 years, corresponding to puberty and its hormonal influences (Chatterjee, 1994). Socio-economic and dietary determinants are especially salient in rural settings.

Under nutrition, micronutrient deficiencies, and chronic health issues continue to affect millions of Indian children and adolescents, with profound effects on both physical stature and final adult size (Gupta, et al., 2022; Agarwal and Agarwal, 2020; Adak, et al., 2002). Studies among rural adolescents have also shown marked intra-community variation, suggesting that factors beyond food intake—such as physical activity level, family structure, and environmental stressors—contribute meaningfully to growth differences (Kanade, 1999). Body Mass Index (BMI), integrating both height and weight, provides a widely accepted estimate of nutritional status and metabolic health in adolescents. Cross-sectional and longitudinal studies in India have established that BMI is more stable than height or weight across adolescent age groups, possibly reflecting proportional increases concomitant with pubertal growth (Gupta, et al., 2022; Kanade, 1999). Despite considerable research on tribal and urban populations, non-tribal rural adolescents remain underrepresented in anthropometric surveillance, especially in North Bengal. There is a pressing need to generate robust, region-specific data to inform local interventions and policy. This study, focusing on non-tribal male school boys aged 12–16 years from five purposively sampled rural schools in Jalpaiguri district, aims to evaluate growth patterns (height, weight) and nutritional status (BMI) using validated procedures. Through detailed statistical analyses—including ANOVA and Tukey's post-hoc tests—this research seeks to identify critical periods of rapid growth and assess the consistency of nutritional status among non-tribal cohorts in the Dooars region. By establishing normative reference values and examining group differences, this study aspires to contribute evidence for targeted health and nutrition strategies and to promote the well-being of non-tribal adolescents in rural North Bengal. The findings will be relevant for public health planners, educators, and researchers addressing adolescent health disparities in similar settings across India.

MATERIALS AND METHODS

This quantitative, cross-sectional study was conducted on April, 2025 among 200 non-tribal school boys aged 12–16 years, purposively sampled from five rural schools in Jalpaiguri district, West Bengal, India. Participants were stratified into four age groups: 12–13 years (n = 50), >13–14 years (n = 50), >14–15 years (n = 50), and >15–16 years (n = 50). Anthropometric measurements—height (cm), weight (kg), and Body Mass Index (BMI, kg/m²)—were obtained following the WHO standardized protocols using calibrated stadiometers and digital weighing scales. BMI was calculated as weight in kilograms divided by the square of height in meters. Data were analyzed using assistance from the online resource Statistics. Descriptive statistics (mean, standard deviation) were calculated for all variables. One-way Analysis of Variance (ANOVA) was used to determine differences across the four age groups, and Tukey's Honestly Significant Difference (HSD) post hoc test was applied to evaluate pairwise group differences. Statistical significance was set at $p < .05$ for all tests.

RESULTS

Table 1. Descriptive Statistics for Height, Weight, and BMI among Non-Tribal School Boys by Age Group (N = 200)

Variables	Age Groups				Statistical Methods
	12-13 (T1) N= 50	>13-14 (T2) N= 50	>14-15 (T3) N= 50	>15-16 (T4) N= 50	
Height (cm.)	157.42	158.88	157.42	165.4	M
	4.74	5.37	4.74	8.02	SD
Weight (Kg.)	44.54	45.3	45.34	48.2	M
	3.32	1.94	3.19	4.38	SD
BMI (Kg/m²)	17.97	17.96	17.86	17.62	M
	1.05	0.92	0.97	1.05	SD

M=Mean, SD=Standard Deviation

Table 2. One-Way ANOVA for Height, Weight, and BMI by Age Group

Variable	df	F	p	η^2
Height	(3, 196)	21.04	< .001	0.24
Weight	(3, 196)	11.78	< .001	0.15
BMI	(3, 196)	1.35	.26	0.02

df= degree of freedom (3= between-groups, 196= within-group), F= calculated F-value (between the age groups compared to the variance within the age groups), p= p-value, η2= SS effect/SS total, SS effect = the sum of squares attributable to the effect (e.g., age group), SS total = the total sum of squares in the analysis.

Table 3. Tukey's HSD Post-Hoc Comparisons for Height, Weight, and BMI Scores by Age Group

Variable	PC	MD	p	Significant
Height	12-13 vs >13-14	-1.46	.64	Not Significant
	>13-14 vs >14-15	1.46	.72	Not Significant
	>14-15 vs >15-16	-7.98	< .001	Significant

Weight	12-13 vs >13-14	-0.76	.81	Not Significant
	>13-14 vs >14-15	-0.04	.90	Not Significant
	>14-15 vs >15-16	-2.86	.002	Significant
BMI	All pairs	_	>.05	Not Significant

PC= Pairwise Comparison, MD= Mean Differences

Descriptive statistics for height, weight, and BMI by age group are presented in Table 1. Height showed an overall upward trend with age, from M = 157.42 cm, SD = 4.74 at 12–13 years to M = 165.40 cm, SD = 8.02 at >15–16 years. Variability in height was largest for the oldest group, indicating differences in the timing of pubertal growth spurts. Weight also increased progressively with age, from M = 44.54 kg, SD = 3.32 at 12–13 years to M = 48.20 kg, SD = 4.38 at >15–16 years. BMI values remained relatively stable across the four age groups (range M = 17.62–17.97; SD ≈ 1.0), suggesting proportional height and weight increases during adolescence.

One-way ANOVA results (Table 2) revealed a significant effect of age on height, F (3, 196) = 21.04, $p < .001$, $\eta^2 = 0.24$, indicating a large effect size. A significant effect of age was also found for weight, F (3, 196) = 11.78, $p < .001$, $\eta^2 = 0.15$, reflecting a moderate effect size. In contrast, there was no statistically significant difference in BMI across age groups, F(3, 196) = 1.35, p = .26, $\eta^2 = 0.02$.

Post-hoc analysis (Table 3) showed:
Height: No significant differences between 12–13 years and >13–14 years (p = .64), or between >13–14 years and >14–15 years (p = .72). A statistically significant increase was observed between >14–15 years and >15–16 years ($p < .001$).
Weight: No significant differences between pairs 12–13 vs >13–14 years (p = .81) or >13–14 vs >14–15 years (p = .90). A significant increase was observed between >14–15 years and >15–16 years (p = .002). BMI: No significant pairwise differences were found among any age groups (all p > .05).

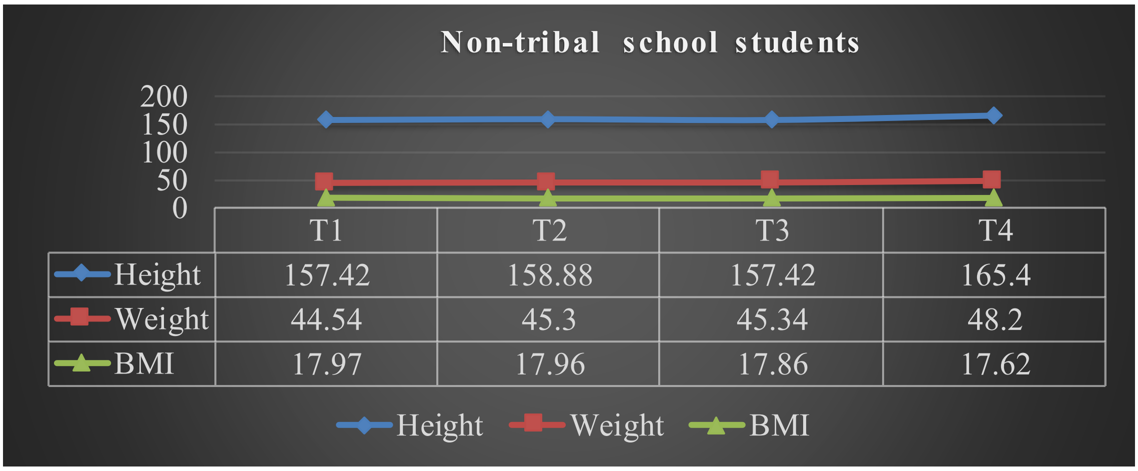

Figure1. Comparison of Mean Height, Weight, and BMI across Four Age Groups

DISCUSSION

The present study demonstrates a clear pattern of progressive increases in height and weight among non-tribal school boys in rural Jalpaiguri between the ages of 12 and 16 years. The most notable gains emerged in late adolescence (beyond 14 years), consistent with well-established adolescent growth spurts documented in the literature (Ghosh, 2024; Malina et al., 2004). This trajectory is in line with the timing of pubertal development and the hormonal changes that drive rapid increases in stature and body mass during mid- to late adolescence (Ghosh and Roy, 2025; Biswas, et al., 2021; Mandal, et al., 2021). Despite these increases in both height and weight, BMI remained relatively stable across all age groups, suggesting proportional growth whereby weight gains are matched by increases in height (Bose and Bisai, 2008; Ghosh, 2007). This finding mirrors results from other Indian adolescent populations and supports prior work seeing BMI as a robust, age-independent indicator of nutritional status in this developmental period (Saavedra and Prentice, 2023; Gupta et al., 2022; Singh and Sharma, 2021). The heightened standard deviation in height noted among the oldest group (>15–16 years) reflects greater variability in the timing and tempo of puberty onset (Sen, et al., 2021; Rogol, et al., 2000). Such variation is well documented in adolescent anthropometric studies, highlighting how biological factors and environmental influences produce divergent growth patterns (Prakash, et al., 2016; Taras, 2005; Malina et al., 2004). From a health perspective, these differences require targeted monitoring as individuals experiencing unusually early or delayed growth may have distinctive nutritional and health support needs (Ojo, 2016; Sil, 2012). The results overall reinforce that anthropometric improvements in this rural non-tribal cohort are largely synchronous with expected developmental milestones. This suggests that, despite potential socioeconomic and environmental challenges in rural Jalpaiguri, these adolescents are achieving growth rates comparable to other regions when matched for age and ethnicity. Possible contributing factors may include state-run nutrition programs, mid-day meal schemes, and evolving rural dietary patterns — though these require targeted investigation. The finding of stable BMI across age cohorts, even against a backdrop of rising height and weight, indicates no subset of this group is disproportionately at risk for acute undernutrition or overweight. Nevertheless, BMI is a general indicator and cannot distinguish between increases in lean mass and adiposity, underscoring the value of body composition measurements in future research. Limitations should be recognised. The cross-sectional design prevents assessment of individual growth trajectories. The modest sample size ($n = 200$) may limit generalisability. Additionally, relevant confounding factors — including pubertal stage, physical activity patterns, dietary habits, and socioeconomic status — were not measured directly. Future work should use longitudinal designs and integrate biological, behavioural, and environmental variables for a more nuanced understanding of adolescent growth in rural contexts. Despite these limitations, this study provides valuable region-specific normative data and affirms the importance of targeted growth monitoring and nutritional support during adolescence in rural Indian populations.

ANALYSIS

The descriptive statistics show progressive gains in mean height and weight across age groups, with stability in BMI. This pattern supports established models of adolescent growth (George, et al., 2025; Patton et al., 2016), wherein height and weight increase proportionally as adolescents mature (Ranjan, et al., 2021; Das, et al., 2020). The ANOVA results confirm significant main effects of age on both height ($F = 21.04$, $p < .001$, $\eta^2 = 0.24$) and weight ($F = 11.78$, $p < .001$, $\eta^2 = 0.15$), indicating substantial and systematic anthropometric growth (Lewis, 2022). Conversely, the lack of significant variation in BMI ($F = 1.35$, $p = .26$, $\eta^2 = 0.02$) suggests balanced somatic development without disproportionate weight gain (Xie, et al., 2021). Post-hoc Tukey's HSD tests reveal that significant anthropometric gains occur almost entirely in the transition from >14–15 years to >15–16 years, pinpointing late adolescence as a period of accelerated growth in this population (Sarkar and Paul, 2015). Earlier age group comparisons yielded no significant differences.

The stability of BMI alongside rising height and weight implies a maintained ratio of fat mass to fat-free mass (Kshatri, et al., 2025). This is consistent with hypotheses that pubertal development entails parallel increases in both height and muscle mass (Sabzi, et al., 2023; Jain, et al., 2018). Future longitudinal research should confirm these inferences with direct measures of body composition. Overall, the analysis shows that growth patterns in this non-tribal cohort conform to expected biological norms despite the rural, resource-limited setting (Larsen and Luna, 2018). This reinforces the importance of late adolescence as a critical intervention window for optimizing physical development (Malek, et al., 2022; Su, et al., 2022).

CONCLUSION

This investigation assessed growth patterns and nutritional status among 200 non-tribal school boys aged 12–16 years from five rural schools in Jalpaiguri district, West Bengal. Significant age-related increases in height and weight were observed, with the most rapid gains occurring after 14 years of age. In contrast, BMI remained stable, indicating proportional growth across all age groups studied. The highest variability in height was seen among older adolescents, reflecting differences in the timing of pubertal onset. These findings emphasise the importance of age-specific growth monitoring, particularly between ages 14–16, when physical changes are most pronounced. From a public health perspective, this research establishes region-specific growth benchmarks for rural, non-tribal adolescent boys, offering a valuable evidence base for targeted health and nutrition strategies. While the overall pattern suggests a generally healthy cohort, BMI alone is an imperfect measure; future studies should integrate body composition, diet, and activity assessment for a fuller picture of adolescent health.

RECOMMENDATIONS

(i) Age-Specific Growth Monitoring: Implement regular health assessments in rural schools, particularly for boys aged 14–16 years. (ii) Tailor mid-day meal programs to meet the elevated caloric and protein needs of late adolescents. (iii) Body Composition Assessment: Complement BMI with measures such as skinfold thickness or bioelectrical impedance. (iv) Longitudinal tracking: Follow individuals over time to capture full growth trajectories. (v) Holistic data collection:

Integrate socioeconomic data, dietary surveys, and activity tracking to identify growth determinants. (vi) Community engagement: Conduct awareness campaigns on adolescent nutrition, hydration, physical activity, and adequate rest.

IMPLICATIONS FOR PRACTICE AND POLICY

The outcomes of this study have direct implications for both educational and public health sectors- (i) Schools: Incorporate nutrition and health education into the curriculum and institutionalise periodic anthropometric checks. (ii) Healthcare providers: Prioritise targeted nutrition and health screening during ages 14–16. (iii) Policy makers: Use results to guide adolescent health policy in North Bengal, strengthen programs like RKSK (Rashtriya Kishor Swasthya Karyakram), and allocate resources towards late-adolescence growth support. (iv) NGOs: Develop rural youth-focused initiatives based on identified growth patterns and needs.

CONFLICT OF INTEREST

The authors declare no conflict of interest. This study received no external funding and was undertaken without any commercial or financial ties that could influence the findings.

ACKNOWLEDGEMENT

The researcher thanks the Head Masters and teaching staff of the five rural schools in Jalpaiguri district for facilitating data collection and their cooperation. Gratitude is extended to the 200 non-tribal school boys for their enthusiastic participation. The author also acknowledges the encouragement and support from academic mentors, colleagues, and family throughout the course of the study.

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