Comparative Assessment of Key Physiological Metrics in School Going Children and Young Teens

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ABSTRACT

The principal objective of this study was to compare Heart Rate, Vital Capacity, Respiratory Rate, Total Body Weight, Body fat and Lean body mass among different age groups of 8 to 9 years, 10 to 11 years and 12 to 14 years. A total of 90 students from the Upper Primary School were selected as participants for this study. The participants were selected using a simple random sampling method. Analysis of variance (ANOVA) revealed statistically significant differences among the three age groups across all selected physiological variables. The obtained F-ratios for Resting Heart Rate ($F = 46.50$), Respiratory Rate ($F = 100.00$), Vital Capacity ($F = 377.20$), Body Fat Weight ($F = 60.09$), and Lean Body Weight ($F = 32.70$) all exceeded the critical F-value required for significance at the $\alpha = 0.05$ level, with degrees of freedom (2, 89).

Keywords: Resting Heart Rate, Vital Capacity, Respiratory Rate, Body Composition, Simple Random Sampling, ANOVA, Physiology

INTRODUCTION

The physiological status of an individual is a dynamic entity, influenced by a multitude of factors including genetics, environment, nutrition, and physical activity. Physiological fitness is a fundamental component of overall health and well-being, particularly during childhood and adolescence—critical periods of growth and development. Parameters such as Resting Heart Rate (RHR), Respiratory Rate (RR), Vital Capacity (VC), Body Fat Weight (BFW), and Lean Body Weight (LBW) serve as reliable indicators of cardiovascular and respiratory efficiency, as well as body composition status (American College of Sports Medicine, 2018). During the developmental years, significant physiological changes occur that influence these metrics. Cardiac output increases, lung volumes expand, and body composition undergoes substantial alterations as children progress through puberty and into young adulthood (Malina et al., 2004). These changes are not only age-dependent but are also modulated by physical activity patterns, nutritional status, and genetic factors.

The period of childhood and adolescence represents a critical window of human growth and development, characterized by profound anatomical, physiological, and psychological transformations. During these formative years, the body undergoes significant maturation of various organ systems, particularly the cardiovascular and respiratory systems, which are fundamental to overall health, physical fitness, and functional capacity (Malina et al., 2004; Rowland, 2005). Understanding the normative patterns of physiological development during this phase is essential for educators, healthcare professionals, and policymakers to design appropriate health promotion strategies and physical education programs. Physiological parameters such as Resting Heart Rate (RHR), Respiratory Rate (RR), Vital Capacity (VC), Body Fat Weight (BFW), and Lean Body Weight (LBW) serve as reliable and non-invasive indicators of an individual's cardiopulmonary efficiency and body composition status (American College of Sports Medicine, 2018). These metrics are not only reflective of current health status but also predictive of future health outcomes, including the risk of developing cardiovascular diseases, metabolic disorders, and respiratory conditions in later life (Pecoraro et al., 2018; Ortega et al., 2008).

The transition from childhood to adolescence and subsequently to young adulthood is accompanied by marked changes in physiological parameters. Cardiac output increases progressively with age, primarily due to an

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increase in stroke volume, while Resting Heart Rate tends to decline as the heart becomes more efficient (Plowman & Smith, 2014). Similarly, Respiratory Rate decreases with advancing age as lung volumes—including Vital Capacity—increase in proportion to thoracic cavity dimensions and respiratory muscle strength (West, 2012). Body composition also undergoes substantial alterations during this developmental period. Lean Body Mass increases steadily, particularly in males, due to hormonal influences and the accretion of muscle tissue, while Body Fat Weight may fluctuate depending on dietary habits, physical activity levels, and genetic predisposition (Malina et al., 2004). These changes are not uniform across individuals and are influenced by a multitude of factors, including chronological age, biological maturation, nutritional status, socioeconomic background, and patterns of physical activity engagement (Armstrong & Welsman, 2000).

Method:

Participants

A total of 90 students were selected from Alipurduar district Upper Primary School using a simple random sampling technique. The participants were divided into three distinct age- based groups, with 30 students in each group: Group A (8-9 years), Group B (10-11 years) and Group C (12-14 years).

Tool and Techniques

Resting Heart Rate (Carotid Pulse) was measured by putting middle fingers on the side of windpipe just below the jawbone to get the beats of the subjects and total number of beats counted in one minute was recorded. Wet Spirometer was used to measure Vital Capacity and score were recorded in Liters. Respiratory rate was assessed by visually observing the rise and fall of the chest or abdomen, with each complete rise counted as one breath. The number of breaths occurring over a one-minute period was recorded as the respiratory rate (breaths per minute). Body weight was measured using a calibrated digital weighing scale. Participants were instructed to remove heavy outer clothing, footwear, and any objects from their pockets prior to measurement. The scale was zeroed before each use. Participants stood upright and motionless on the center of the platform, with weight evenly distributed between both feet. Weight was recorded to the nearest 0.1 kg after the reading had stabilized. Body fat weight was estimated using skinfold thickness measurements obtained from four standard anatomical sites: biceps, triceps, subscapular, and suprailiac. All measurements were taken from the right side of the body using a calibrated skinfold caliper. The sum of the four skinfold thicknesses was calculated and then compared against the age- and sex-specific normative reference tables of Durnin and Womersley (1974) to derive body density. Body fat percentage was subsequently estimated using the appropriate prediction equations, and body fat weight (in kg) was calculated by multiplying total body weight by the derived body fat percentage. Lean Body mass was calculated by subtracting the weight of body fat from total body weight.

FINDINGS

The physiological parameters of the three selected groups were compared using a one-way analysis of variance (ANOVA). Upon obtaining a significant F-ratio, indicating the presence of overall group differences, Fisher's Least Significant Difference (LSD) post hoc test was subsequently applied to identify specific pairwise mean differences among the groups.

Table – 1

Summary of Analysis of Variance for the Data on Selected Physiological Metrics in School Going Children and Young Teens of Three Different Age Groups

Variables	Sources of variance	df	Sum of Square	Mean of Sum of Square	F-ratio
Heart Rate	Between Group	2	1403.49	701.74	46.59*
	Within Groups	87	1340.47	15.06	

Respiratory Rate	Between Group Within Groups	2 89	746.50 331.71	373.25 3.73	100.06*
Vital Capacity	Between Group Within Groups	2 89	18.86 2.26	9.43 0.025	377.2*
Fat Weight	Between Group Within Groups	2 89	12.18 9.32	6.09 0.10	60.09*
Lean Body Weight	Between Group Within Groups	2 89	400.93 542.3	260.47 6.13	32.70*

*Significant at 0.05 level Tabulated $F_{0.05}$ (2,89) = 3.10

As presented in Table 1, significant differences were observed among the selected physiological parameters across the groups. The obtained F-ratios for Resting Heart Rate (F = 46.59), Respiratory Rate (F = 100.06), Vital Capacity (F = 377.2), Body Fat Weight (F = 60.09), and Lean Body Weight (F = 32.70) all exceeded the critical value of 3.10 at the 0.05 significance level, indicating statistical significance. Consequently, a Fisher's Least Significant Difference (LSD) post hoc test was conducted to determine the specific pairwise mean differences for each variable.

Table – 2

Differences between the Paired Means of Resting Heart Rate among the Three Different Age Groups

8-9 Years	**10-11 Years**	**12-14 Years**	**Differences of Mean**	**C.D.**
	80.13	73.97	6.13*	2.41
83.3	80.13		3.13*	2.46
83.3		73.97	9.33*	2.41

*Significant Difference at 0.05 level

As shown in Table no. 4 significant differences in Resting Heart Rate were observed across the three different age groups. The corresponding mean differences are graphically illustrated in figure no 1.

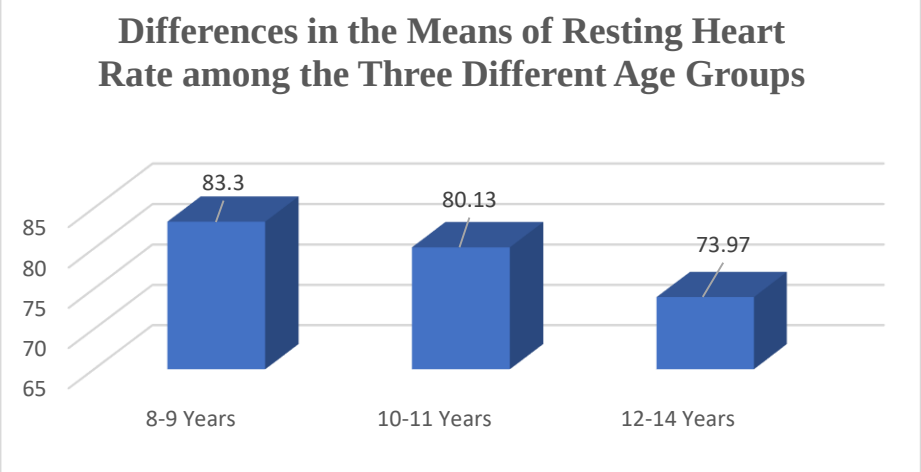

Figure – 1 Differences in the means of Resting Heart Rate among the three groups.

Table – 3

Differences between the Paired Means of Resting Respiratory Rate among the Three Different Age Groups

8-9 Years	**10-11 Years**	**12-14 Years**	**Differences of Mean**	**C.D.**
	26.27	21.54	4.73*	1.19
28.26	26.27		1.99*	1.22
28.26		21.54	6.72*	1.19

*Significant Difference at 0.05 level

As presented in Table 3, significant differences in Resting Respiratory Rate were observed across the three different age groups. The corresponding mean differences are graphically illustrated in Figure 2.

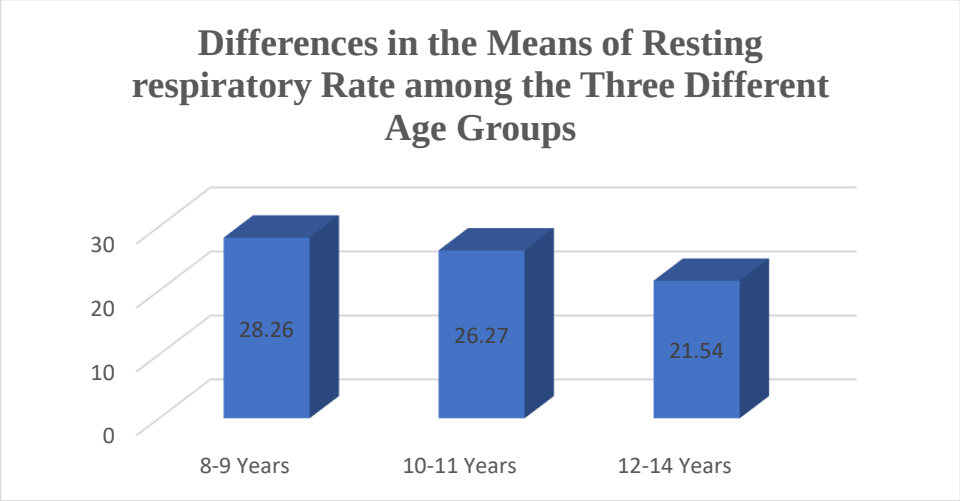

Figure-2

Figure-2 Differences in the means of Resting Respiratory Rate among the three different age groups.

Table – 4

Differences between the Paired Means of Vital Capacity among the Three Different Age Groups

8-9 Years	**10-11 Years**	**12-14 Years**	**Differences of Mean**	**C.D.**
	1.14	1.70	0.56*	0.0996
0.60	1.14		0.54*	0.101
0.60		1.70	1.10*	0.0996

*Significant Difference at 0.05 level

As shown in Table no. 4 significant differences in Vital Capacity were observed across the three different age groups. The corresponding mean differences are graphically illustrated in figure no 3

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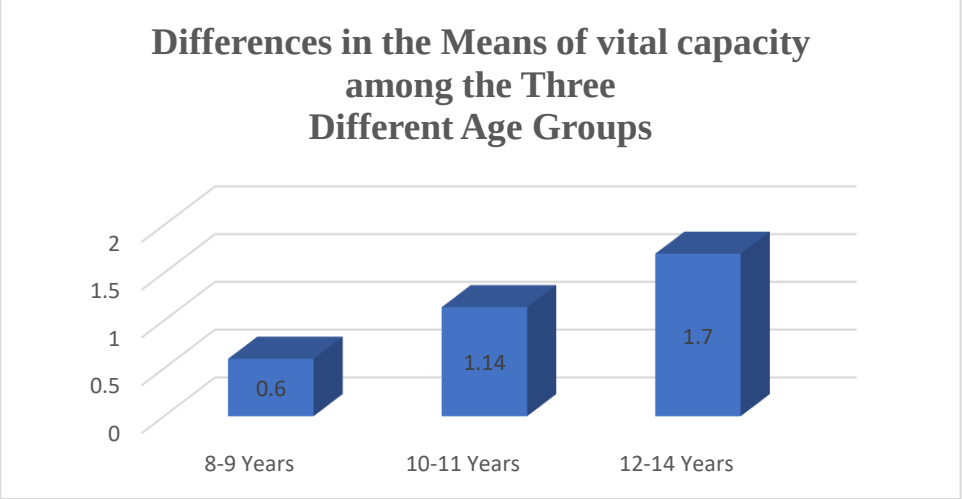

Figure-3

Figure-3 Differences in the means of Vital Capacity among the three different age groups.

Table – 5

Differences between the Paired Means of Body Fat Weight among the Three Different Age Groups

8-9 Years	**10-11 Years**	**12-14 Years**	**Differences of Mean**	**C.D.**
	2.6	3.39	0.79*	0.19
2.63	2.6		0.03	0.20
2.63		3.39	0.76*	0.19

*Significant Difference at 0.05 level

As shown in Table 5, significant differences in Body Fat Weight were observed across the three different age groups. The corresponding mean differences are graphically presented in Figure 4.

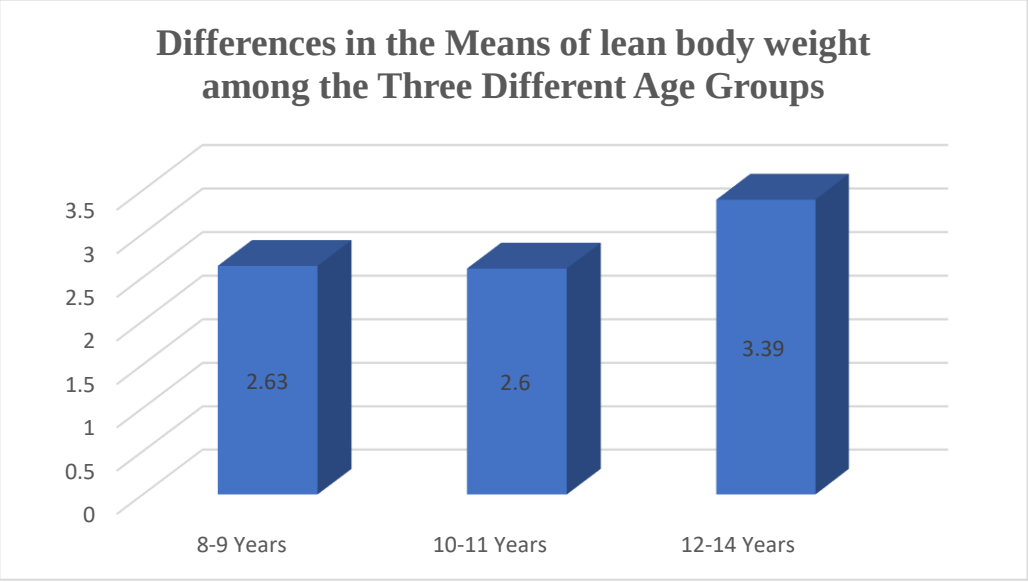

Figure-4

Figure-4 Differences in the means of Body Fat Weight among the three different age groups.

Table – 6

Differences between the Paired Means of Lean Body Weight among the Three Different Age Groups

8-9 Years	**10-11 Years**	**12-14 Years**	**Differences of Mean**	**C.D.**
	20.23	25.31	5.08*	1.57
22.5	20.23		2.27*	0.64
22.5		25.31	2.81*	1.57

*Significant Difference at 0.05 level

As shown in Table 6, significant differences in Lean Body Weight were observed across the three different age groups. The corresponding mean differences are graphically presented in Figure 5.

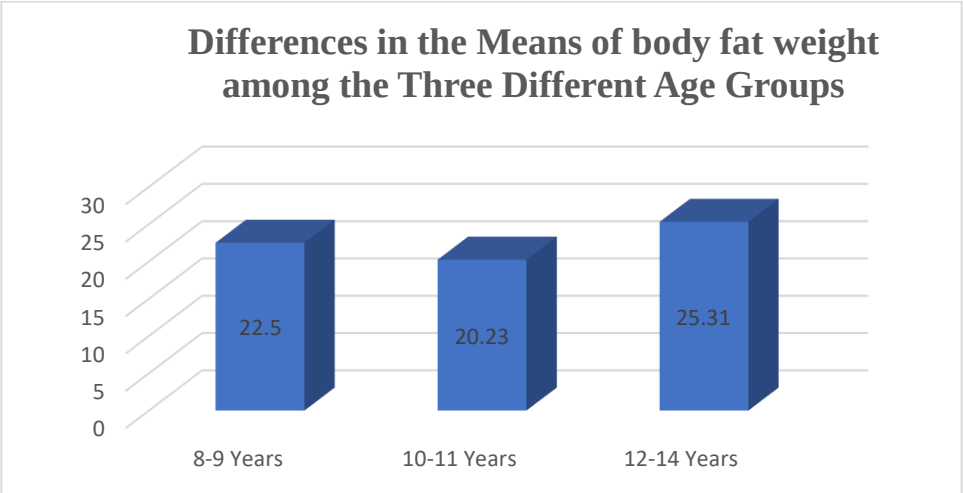

Figure 5

Figure-5 Differences in the means of Lean Body Weight among the three different age groups.

DISCUSSION

The results of the statistical analysis revealed significant differences among the three age groups of male students with respect to the selected physiological variables, namely Resting Heart Rate, Resting Respiratory Rate, Vital Capacity, Body Fat Weight, and Lean Body Weight. These differences may be attributed to the fact that all selected physiological parameters are largely influenced by individual physical characteristics and the nature of physical activities undertaken. Consequently, the observed significant variations are justifiable within the context of this study. Furthermore, the findings indicated that students in the 12–14 years age group demonstrated relatively superior performance across the selected variables. This may be due to their greater cardiac and pulmonary dimensions, enhanced respiratory muscle strength, and more regular engagement in physical activities, as compared to the other two groups. These factors likely contributed to the significant improvement in physiological efficiency observed in this particular age group.

CONCLUSION

The present study concludes that there are significant differences in the selected physiological parameters—Resting Heart Rate, Respiratory Rate, Vital Capacity, Body Fat Weight, and Lean Body Weight—among the three age groups of school-going male students. The 12–14 years age group demonstrated comparatively better physiological efficiency, likely due to favorable growth patterns and regular physical activity engagement. These findings highlight the importance of age-appropriate physical education programs and regular physiological monitoring to promote optimal health and physical development during the formative years.

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