JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

CORRELATION BETWEEN BODY MASS INDEX (BMI) AND CHEST EXPANSION AMONG SCHOOL-ATTENDING CHILDREN: A CROSS-SECTIONAL STUDY

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ABSTRACT

Chest expansion is an important clinical indicator of thoracic mobility and respiratory mechanics, particularly during childhood when rapid growth and physiological changes occur. Body Mass Index (BMI) has been shown to influence respiratory function due to variations in adiposity, muscle strength, and chest wall compliance; however, limited evidence exists in early adolescent females. This cross-sectional observational study aimed to evaluate the association between BMI and chest expansion among school-going adolescent females aged 9–11 years. A total of 63 participants were included in the study, and data were collected on March 12, 2025. Participants were categorized into underweight (n=21), normal weight (n=20), overweight (n=13), and obese (n=7) groups based on BMI classification. Chest expansion during inspiration was measured using a measuring tape at the axillary, nipple, and xiphisternal levels. Statistical analysis revealed significant differences in chest expansion across BMI categories at all three levels, with one-way ANOVA showing statistical significance at the axillary ($F=17.885$, $p<0.001$), nipple ($F=15.202$, $p<0.001$), and xiphisternal ($F=7.540$, $p<0.001$) levels. Post-hoc LSD analysis demonstrated that obese participants exhibited significantly greater chest expansion compared to underweight and normal BMI groups, while underweight participants consistently showed the lowest expansion values. The study concludes that BMI significantly influences chest expansion in early adolescent females, emphasizing the need for early screening and targeted physiotherapeutic interventions to promote optimal respiratory health.

Keywords: Body Mass Index, Chest expansion, Obesity, Young adults, Correlation, Cross-sectional study

Introduction

Adolescence is a dynamic phase of growth characterized by rapid physical, musculoskeletal, and physiological changes, particularly in females during the early pubertal period[2]. The age group of 9–11 years represents a transitional stage in which thoracic cage development, respiratory muscle maturation, and body composition undergo notable changes[3]. Chest expansion reflects thoracic mobility and provides valuable information regarding rib cage movement, respiratory muscle efficiency, and pulmonary mechanics[4].

Body Mass Index is widely used to assess nutritional status in children and adolescents. Both undernutrition and overnutrition have been shown to influence respiratory function and chest wall mechanics[5]. Increased adiposity may restrict thoracic compliance and diaphragmatic excursion, whereas low BMI may be associated with reduced muscle mass and decreased respiratory muscle strength[6]. Although several studies have examined the effect of BMI on pulmonary function parameters such as lung volumes and airflow, limited literature exists focusing specifically on chest expansion in early adolescent females[7]. Understanding this relationship is essential for early identification of respiratory limitations and for guiding preventive physiotherapy strategies.

Need of the Study

The global rise in childhood obesity and persistent prevalence of undernutrition have raised concerns regarding their impact on respiratory and musculoskeletal health[8]. Chest expansion measurement is a cost-effective, non-invasive tool that can be easily implemented in school health programs[9]. However, normative and comparative data correlating BMI and chest expansion in young adolescent females are scarce, particularly in developing countries[10]. Studying this association can aid in early detection of thoracic mobility impairments and facilitate timely physiotherapeutic intervention to prevent long-term complications.

Aim and Objectives

The study aimed to determine the correlation between Body Mass Index and chest expansion among school-going adolescent females aged 9–11 years.

OBJECTIVES

1. To calculate BMI using height and weight measurements.
2. To measure chest expansion using a tape method.
3. To evaluate the correlation between BMI and chest expansion at the axillary level.
4. To evaluate the correlation between BMI and chest expansion at the nipple level.
5. To evaluate the correlation between BMI and chest expansion at the xiphisternal level.

Inclusion and Exclusion Criteria

The study included apparently healthy school-going adolescent females aged 9–11 years whose parents provided informed consent. Participants with a history of respiratory disorders, musculoskeletal deformities affecting the thoracic cage, neurological conditions, recent thoracic or abdominal surgery, or systemic illnesses influencing growth and respiration were excluded[11].

Materials and Methodology

A cross-sectional observational study design was adopted. A total of 63 school-going adolescent females were included, exceeding the initially calculated sample size of 55. Data were collected on March 12, 2025 from SIMS MY SCHOOL Guntur . Height was measured using a stadiometer and weight using a calibrated weighing scale, following standardized procedures. BMI was calculated as weight in kilograms divided by height in meters squared and categorized according to established BMI classification standards[12].

Chest expansion was measured using a non-stretchable measuring tape at three anatomical levels: axillary, nipple, and xiphisternal. Measurements were taken in a standing position during maximal inspiration and expiration, and the difference between the two values was recorded as chest expansion. All measurements were performed by trained examiners to ensure consistency and reliability[13].

Statistical Analysis

Data were entered and analyzed using statistical software. Descriptive statistics were expressed as mean and standard deviation. Normality of the data was assessed using the Kolmogorov–Smirnov test, which confirmed normal distribution. One-way Analysis of Variance (ANOVA) was used to compare chest expansion values across BMI categories at each anatomical level. Post-hoc multiple comparisons were performed using the Least Significant Difference (LSD) test. Statistical significance was set at $p<0.05$.

Results

The study included 63 participants aged 9–11 years. One-way ANOVA revealed statistically significant differences in chest expansion across BMI categories at the axillary ($F=17.885$, $p<0.001$), nipple ($F=15.202$, $p<0.001$), and xiphisternal ($F=7.540$, $p<0.001$) levels. Post-hoc analysis indicated that obese participants demonstrated significantly greater chest expansion compared to underweight and normal BMI groups at all three levels. Overweight participants also showed higher expansion values than underweight and normal groups at axillary and nipple levels. Underweight participants consistently exhibited the lowest chest expansion values, particularly at the xiphisternal level.

Discussion

The present study demonstrated a significant association between BMI and chest expansion among school-going adolescent females aged 9–11 years. The progressive increase in chest expansion across BMI categories suggests that body composition plays an important role in thoracic mobility during early adolescence. Similar findings were reported by Santamaria et al., who observed altered chest wall mechanics in obese children as a compensatory response to increased respiratory load[14].

Underweight participants in the present study showed the least chest expansion, which may be attributed to reduced respiratory muscle strength and lower thoracic mobility. Harikumar and Usha Rani reported that low BMI in children is associated with diminished respiratory muscle performance, leading to restricted chest wall movement[15]. Spathopoulos et al. also highlighted that BMI-related changes in thoracic compliance significantly influence breathing patterns in school-aged children[3].

The significant differences observed at the xiphisternal level may reflect the influence of abdominal mass and diaphragmatic mechanics on lower thoracic expansion. Previous studies have shown that abdominal fat distribution can alter diaphragmatic excursion, thereby affecting chest expansion[6]. These findings emphasize the importance of considering BMI during respiratory assessment in early adolescence.

Conclusion

The study concludes that Body Mass Index significantly influences chest expansion among school-going adolescent females aged 9–11 years. Chest expansion varied significantly across BMI categories, with obese participants demonstrating the greatest expansion and underweight participants exhibiting the least. Early assessment of BMI and chest expansion may help identify children at risk of respiratory and musculoskeletal limitations and guide preventive physiotherapy interventions.

Limitations

The study was limited by its cross-sectional design, which restricts causal inference. The sample was drawn from a single geographic region, limiting generalizability. Additionally, pulmonary function tests and respiratory muscle strength assessments were not included.

Future Scope of Study

Future research should involve larger, multi-center samples and longitudinal designs to evaluate developmental changes over time. Inclusion of spirometric parameters, respiratory muscle strength, and interventional physiotherapy programs would provide a more comprehensive understanding of the relationship between BMI and respiratory function in children.

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