IMPACT OF PULMONARY PATHOLOGY ON THE MORPHOFUNCTIONAL DEVELOPMENT OF THE CHEST IN CHILDREN AGED 0–3 YEARS

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Abstract. *Pulmonary pathology in early childhood may significantly affect the morphofunctional development of the chest by disrupting normal growth and functional maturation processes. This study aimed to investigate the influence of pulmonary pathology on chest development in children aged 0–3 years. A total of 376 children from Tashkent with clinically diagnosed bronchopulmonary pathology, attending preschool institutions and pediatric healthcare facilities, were examined. Anthropometric assessment included measurements of chest circumference at rest, during maximal inspiration, and during full expiration, as well as calculation of chest excursion. Centile analysis and the standard deviation method using Z-scores were also applied. The results showed that children with pulmonary pathology had a reduced rate of chest circumference growth, decreased chest excursion to 1.0–1.2 cm, a shift of indicators toward lower centile intervals, and negative Z-score values. These findings indicate impaired chest mobility, reduced pulmonary ventilation, and delayed morphofunctional development of the respiratory system. The study concludes that bronchopulmonary pathology has a pronounced negative effect on chest development in children aged 0–3 years, contributing to disharmonious physical development and reduced adaptive capacity of the organism. The results support the need for early diagnosis, dynamic anthropometric monitoring, and timely correction of respiratory system diseases.*

Keywords: *chest, early childhood, pulmonary pathology, anthropometry, chest excursion, centile analysis, Z-score.*

INTRODUCTION AND LITERATURE REVIEW

Early childhood (0–3 years) represents a critical stage in the formation of morphofunctional characteristics of the organism, particularly the respiratory system and the chest. During this period, intensive growth of osteochondral structures, development of respiratory musculature, and maturation of external respiration mechanisms occur. In this regard, anthropometric indicators, especially chest circumference, acquire particular importance as objective markers of physical development and functional status of the respiratory system.

Modern studies demonstrate that the dynamics of children’s physical development are determined by a combination of endogenous and exogenous factors, including hereditary characteristics, nutritional patterns, climatic and geographical conditions, and the level of medical care [1,2,4]. At the same time, pronounced secular trends have been identified within pediatric

populations, reflecting changes in growth rates and somatic development across different regions and populations [5].

A number of authors emphasize the importance of regional differences in the assessment of anthropometric indicators. It has been established that body length and weight parameters of children living in different climatic zones vary significantly, which necessitates the development of local standards for physical development [6,17]. Similar findings have been reported in Central Asian countries, where distinctive features of physical development in early childhood have been identified based on basic anthropometric criteria [5,9].

A special place in contemporary literature is occupied by the assessment of the harmony of physical development and morphofunctional adaptation of the child's organism. The application of index-based methods and integral evaluation approaches allows for the identification of deviations from normative values and for the quantitative characterization of the degree of disharmony in somatic development [3,4,15]. It has been shown that frequently ill children exhibit more pronounced deviations in anthropometric indicators compared to healthy peers, indicating the adverse influence of chronic pathological conditions on growth and development processes [8,9].

In recent years, considerable attention has been paid to the study of morphological characteristics of children in urban environments. It has been demonstrated that the rate of change in anthropometric parameters depends on environmental factors, the level of physical activity, and living conditions [11,12]. In addition, age-related patterns in the change of body proportions and levels of harmony in physical development have been identified [7,10,14].

At the same time, despite the large number of studies devoted to the general assessment of physical development in children, the influence of pulmonary pathology on the morphofunctional state of the chest in early childhood remains insufficiently investigated. Meanwhile, respiratory diseases such as bronchitis, pneumonia, and bronchiolitis occupy a leading place in the structure of morbidity among children in the first years of life and are accompanied by impaired ventilation function, reduced elasticity of lung tissue, and limitation of chest excursion.

These changes can significantly affect the formation of the chest, slowing its growth, reducing its mobility, and creating conditions for the development of morphofunctional disharmony. However, comprehensive studies aimed at assessing the relationship between chest anthropometric parameters, centile distribution, Z-score, and pulmonary pathology in children aged 0–3 years are insufficiently represented in the literature.

Thus, the analysis of the literature indicates the high relevance of studying the influence of pulmonary pathology on the morphofunctional development of the chest in early childhood, which determined the direction of the present study.

OBJECTIVE

To assess the influence of pulmonary pathology on the morphofunctional development of the chest in children aged 0–3 years based on anthropometric indicators, centile analysis, and Z-score.

MATERIALS AND METHODS

The study was conducted on the basis of preschool educational and medical institutions in Tashkent and had an observational analytical design. It included 376 children aged 0–3 years with clinically confirmed pulmonary pathology attending kindergartens and pediatric hospitals. The examination was carried out with informed voluntary consent from parents or legal guardians, in compliance with ethical standards adopted in biomedical research.

Inclusion criteria were age from 0 to 3 years, clinically confirmed bronchopulmonary pathology (including acute and chronic bronchitis, pneumonia, and bronchiolitis), and the possibility of regular anthropometric examination. Exclusion criteria included congenital anomalies of chest development, severe systemic diseases, and genetic syndromes that could significantly influence physical development indicators.

The main research method was anthropometric analysis. In all children, chest circumference was measured in three functional states: at rest, at maximal inspiration, and at full expiration. Measurements were performed using a standard measuring tape according to generally accepted methodology: posteriorly at the level of the inferior angles of the scapulae and anteriorly along the nipple line. To ensure accuracy, each measurement was performed at least twice, followed by calculation of the average value.

Chest excursion was calculated as the difference between inspiratory and expiratory chest circumference values and was used as an indicator of the functional state of the respiratory system.

Additionally, centile analysis and Z-score calculations were performed. The centile method allowed assessment of each parameter relative to age norms and determination of the degree of physical development harmony. Z-score was calculated using the formula:

$$Z = (X - M)/\sigma$$

where X is the individual value, M is the mean of the reference group, and σ is the standard deviation.

Statistical analysis was performed using methods of variation statistics with calculation of mean values (M), standard deviation (σ), and standard error (m). Statistical significance was assessed at $p<0.05$.

RESULTS

The conducted anthropometric analysis demonstrated that healthy children in early childhood (0–3 years) exhibit a pronounced positive dynamic of chest circumference in all functional states. In particular, at rest, the values increase from 33.3 cm in the first year of life to 52.7–53.0 cm by the age of three; at maximal inspiration, from 33.9 cm to 53.6–54.0 cm; and at expiration, from 32.3 cm to 51.6–52.0 cm. This dynamic reflects harmonious morphological development of the chest, a gradual increase in its dimensions, and the formation of functional mobility, which is confirmed by the correspondence of the obtained mean values (M±σ).

The average values of chest excursion in healthy children range from 1.5 to 2.0 cm, with a tendency to increase as the child grows. This indicates normal development of the elastic properties of lung tissue, adequate functioning of the respiratory musculature, and sufficient ventilatory capacity of the lungs. Variation analysis showed a relatively narrow range of fluctuations (σ≈0.2–0.3), which indicates homogeneity of the studied group and stability of physiological processes.

In children with pulmonary pathology, statistically significant deviations from age-related norms were identified. A decrease in the rate of increase in chest circumference was observed, with mean values being on average 2.5–3.5 cm lower than physiological norms. At the same time, an increase in variability (σ≈0.3–0.5) was noted, reflecting heterogeneity in the severity of pathological changes.

A decrease in chest excursion to 1.0–1.2 cm was also established, which is significantly lower than normal values ($p<0.05$). This reduction indicates limited chest mobility and impaired ventilatory function of the lungs. These changes are associated with decreased elasticity of lung tissue, bronchial obstruction, inflammatory processes, and the formation of shallow breathing.

Centile analysis allowed for a more detailed assessment of the distribution of indicators. In healthy children, chest circumference values were predominantly located within the 25th–75th percentile range, with the highest concentration around the 50th percentile, which corresponds to harmonious physical development. In contrast, in children with pulmonary pathology, a pronounced shift toward lower centile intervals was observed. A significant proportion of values were located within the 10th–25th percentiles, and in some cases below the 10th percentile, indicating morphological deficiency and the formation of disharmonious physical development.

Additional quantitative assessment using Z-score analysis demonstrated that in healthy children, values were within the range of $-1 \leq Z \leq +1$, corresponding to normal physical development. In children with pulmonary pathology, a shift toward negative values was observed, averaging between –1.5 and –2.0, indicating moderate developmental delay. In some cases, Z values below –2 were recorded, reflecting pronounced morphofunctional insufficiency and a high risk of pathological changes in the respiratory system.

The most pronounced deviations in both centile distribution and Z-score were observed in chest excursion parameters, emphasizing the predominantly functional nature of disorders in bronchopulmonary pathology. This indicates that even with moderate reductions in chest size, respiratory function is affected to a greater extent.

Comparative analysis showed that the most significant changes were observed in children with chronic and recurrent forms of bronchopulmonary pathology. In this group, not only a decrease in absolute anthropometric values was noted, but also a disruption of age-related growth dynamics, manifested by flattening of growth curves, stable displacement toward lower centile ranges (below the 25th percentile), and persistent negative Z-score values.

Thus, the results of the comprehensive analysis, including anthropometric evaluation, variation statistics, centile distribution, and Z-score, indicate the presence of pronounced morphofunctional disorders of the chest in children with pulmonary pathology. These changes are characterized by reduced chest dimensions, decreased mobility, displacement into lower centile intervals, and negative Z-score values, reflecting delayed growth and impaired functional development of the respiratory system.

DISCUSSION

The obtained results convincingly demonstrate that pulmonary pathology exerts a significant and multifactorial impact on the morphofunctional development of the chest in early childhood. The identified decrease in chest circumference growth rates, reduction in chest excursion, and shift of indicators toward lower centile ranges collectively indicate the presence of both structural (morphological) and functional impairments.

Under physiological conditions, early childhood is characterized by rapid growth of the thoracic cage and progressive enhancement of its functional mobility, which is reflected in a gradual increase in chest excursion. These processes are closely associated with the maturation of lung tissue, strengthening of respiratory musculature, and improvement of ventilatory capacity. The findings obtained in the group of healthy children are fully consistent with these established developmental patterns and confirm the normal trajectory of morphofunctional maturation [2,4].

In contrast, the alterations observed in children with pulmonary pathology are in agreement with previously reported data indicating the negative influence of chronic and recurrent diseases on physical development. It has been demonstrated that frequently ill children exhibit more pronounced anthropometric deviations, reduced growth rates, and decreased harmony of somatic

development, which may be attributed to persistent inflammatory processes and impaired metabolic regulation [8,15,16].

From a morphological perspective, the reduction in chest circumference and slowing of its growth may be explained by disturbances in the development of osteochondral structures, as well as insufficient stimulation of the thoracic cage due to limited respiratory movements. Chronic hypoventilation and reduced mechanical expansion of the lungs may negatively affect the growth of the rib cage, leading to relative hypoplasia. Similar mechanisms have been described in studies of children with chronic respiratory diseases and unfavorable environmental conditions [6,13,17].

From a functional standpoint, the detected changes are closely associated with decreased elasticity of lung tissue, bronchial obstruction, inflammatory infiltration, and impaired airway patency. These factors contribute to the development of hypoventilation and shallow breathing patterns, ultimately reducing the efficiency of gas exchange. The reduction in chest excursion to 1.0–1.2 cm observed in the present study represents a critical functional indicator, reflecting limited respiratory mobility and diminished ventilatory capacity.

Particular importance should be attributed to chest excursion as an integrative parameter reflecting both structural and functional characteristics of the respiratory system. Its reduction indicates not only mechanical limitation of thoracic movements but also underlying disturbances in pulmonary compliance and respiratory muscle function. This finding is consistent with previous studies emphasizing the diagnostic value of chest excursion in assessing respiratory dysfunction in pediatric populations.

The application of centile analysis and Z-score methodology significantly enhanced the objectivity of the assessment. These approaches allowed not only qualitative but also quantitative evaluation of deviations from normative values. The shift of anthropometric indicators toward lower percentiles (below the 25th and, in some cases, below the 10th percentile), along with negative Z-score values (–1.5 to –2.0 and lower), confirms the presence of systemic developmental delay and morphofunctional insufficiency. These results highlight the importance of integrating statistical growth assessment tools into clinical and research practice.

Importantly, the most pronounced deviations were observed in children with chronic and recurrent forms of bronchopulmonary pathology, suggesting a cumulative effect of prolonged disease duration on growth processes. This finding supports the concept that repeated episodes of respiratory illness may lead to persistent alterations in both structural development and functional capacity of the chest.

The identified morphofunctional disturbances may have significant long-term implications. Impaired development of the thoracic cage during early childhood can result in persistent disharmony of physical development, reduced adaptive capacity of the organism, and increased susceptibility to chronic respiratory diseases in later life. Moreover, these changes may negatively affect overall physical performance and quality of life.

Thus, the results of the present study expand current understanding of the impact of pulmonary pathology on child development and emphasize the necessity of a comprehensive and multidisciplinary assessment approach. The integration of anthropometric measurements, functional indicators, and standardized statistical evaluation methods (centile analysis and Z-score) provides a reliable basis for early diagnosis and monitoring of developmental disturbances.

In this context, timely identification and correction of respiratory pathology should be considered a priority in pediatric healthcare, as early intervention may prevent the progression of morphofunctional abnormalities and improve long-term health outcomes.

CONCLUSION

It has been established that in children aged 0–3 years, normal development is characterized by a progressive and harmonious increase in chest circumference across all functional states, reflecting proper morphofunctional development of the respiratory system.

Children with pulmonary pathology demonstrate a significant reduction in the rate of chest circumference growth, indicating delayed morphological development.

A marked decrease in chest excursion (to 1.0–1.2 cm) was identified, reflecting reduced chest mobility and impaired ventilatory function.

Centile analysis revealed a shift of indicators toward lower percentile ranges, while Z-score assessment confirmed moderate to severe developmental delay.

Pulmonary pathology in early childhood is a significant factor contributing to morphofunctional imbalance and may have long-term consequences for respiratory health.

The obtained results highlight the importance of early diagnosis, continuous monitoring, and timely correction of respiratory disorders to prevent persistent developmental impairments.

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