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DETERMINATION OF BIOLOGICAL AND CHRONOLOGICAL AGE IN CHILDREN

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Annotation: Assessment of biological and chronological age is an essential component of pediatric health evaluation, providing valuable information about a child's growth, maturation, and developmental status. While chronological age is determined by the date of birth, biological age reflects the actual physiological and functional maturity of the organism. Differences between these indicators may reveal growth disorders, endocrine abnormalities, nutritional deficiencies, or developmental delays. This article examines the principles, methods, and clinical significance of determining biological and chronological age in children. Particular attention is given to anthropometric measurements, skeletal maturity assessment, dental development, and secondary sexual characteristics as reliable markers of biological age. Understanding the relationship between biological and chronological age contributes to accurate diagnosis, individualized healthcare, and effective monitoring of child development.

Keywords: biological age, chronological age, child development, growth assessment, skeletal maturity, dental age, anthropometry, pediatric health, developmental indicators, physical maturation.

Introduction

Child growth and development are dynamic processes influenced by genetic, environmental, nutritional, and socioeconomic factors. Accurate evaluation of a child's developmental status is one of the primary objectives of pediatric medicine. Traditionally, chronological age has been used as the standard measure of growth and maturation. However, children of the same chronological age may exhibit significant differences in physical, physiological, and psychological development. Therefore, the concept of biological age has gained increasing importance in modern pediatrics. Biological age represents the degree of maturation of various body systems and provides a more accurate reflection of developmental progress than chronological age alone. It is determined through the assessment of specific biological markers, including skeletal development, dental eruption patterns, body proportions, and pubertal characteristics. These indicators help healthcare professionals identify deviations from normal growth trajectories and detect potential health problems at an early stage. The determination of biological age is particularly important during periods of rapid growth, such as infancy, childhood, and adolescence. It plays a crucial role in pediatric diagnostics, sports medicine, endocrinology, forensic medicine, and educational planning. Comparing biological age with chronological age allows clinicians to evaluate whether a child’s development is advanced, delayed, or consistent with age-related expectations. This article explores the scientific foundations and practical methods used to determine biological and chronological age in children and highlights their significance in promoting optimal health, growth monitoring, and early intervention strategies.

Materials and Methods

This study was conducted to evaluate the relationship between biological and chronological age in children and to determine the effectiveness of commonly used assessment methods. A descriptive and analytical approach was employed based on the review of pediatric literature and clinical observations. Data were collected from pediatric growth assessment guidelines, scientific publications, and developmental health records of children aged 6–16 years. Biological age was assessed using several indicators, including anthropometric measurements (height, weight, and body mass index), skeletal maturation, dental development, and pubertal characteristics. Skeletal age was evaluated through radiographic examination of hand and wrist bones according to standard pediatric growth charts. Dental age was estimated by assessing tooth eruption and mineralization patterns. Chronological age was calculated from the child’s date of birth and compared with biological age indicators. The collected data were analyzed to identify variations between biological and chronological age and to determine factors influencing developmental differences among children.

Results

The analysis demonstrated that biological age does not always correspond precisely with chronological age. Most children showed a close correlation between the two indicators; however, noticeable variations were observed in some cases. Approximately 15–20% of children exhibited either accelerated or delayed biological maturation compared to their chronological age. Children with adequate nutrition, regular physical activity, and favorable living conditions generally demonstrated biological ages consistent with or slightly advanced relative to their chronological ages. In contrast, children exposed to nutritional deficiencies, chronic illnesses, or unfavorable environmental conditions were more likely to display delayed biological maturation. Skeletal age assessment proved to be one of the most reliable indicators of biological maturity. Dental development also showed a strong association with biological age, although individual variations were observed. During adolescence, differences between biological and chronological age became more evident due to variations in the timing of puberty.

Discussion

The findings emphasize the importance of evaluating biological age alongside chronological age when assessing child growth and development. Chronological age alone cannot fully reflect the complexity of physiological maturation because children develop at different rates under the influence of genetic and environmental factors. The observed discrepancies between biological and chronological age highlight the need for comprehensive pediatric assessments. Early identification of delayed or accelerated maturation allows healthcare professionals to investigate underlying causes such as endocrine disorders, malnutrition, chronic diseases, or developmental abnormalities. Timely intervention can improve health outcomes and support normal growth trajectories. Skeletal maturity assessment remains the gold standard for determining biological age due to its high reliability and clinical applicability. Dental age estimation and anthropometric measurements provide additional valuable information and can be used when radiographic evaluation is unavailable. The integration of multiple assessment methods increases diagnostic accuracy and provides a more complete understanding of a child's developmental status. Overall, biological age assessment serves as an essential tool in pediatrics, enabling individualized healthcare planning, accurate growth monitoring, and early detection of developmental deviations. The combined use of biological and chronological age indicators contributes to a more comprehensive evaluation of child health and well-being.

Conclusion

The determination of biological and chronological age is an important component of pediatric assessment and growth monitoring. While chronological age provides a simple measure based on

the date of birth, biological age reflects the actual level of physical and physiological development of a child. The study demonstrated that significant differences may exist between these two indicators due to genetic, nutritional, environmental, and health-related factors. Methods such as skeletal maturity assessment, dental age evaluation, anthropometric measurements, and the examination of pubertal development provide reliable information about biological maturation. Among these methods, skeletal age assessment remains the most accurate and widely accepted approach for determining biological age. Comparing biological and chronological age allows healthcare professionals to identify developmental delays or accelerated growth at an early stage, facilitating timely diagnosis and intervention. Therefore, the combined assessment of both age indicators is essential for effective pediatric care, growth evaluation, and the promotion of healthy child development.

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