International Journal of Genetic Engineering 2025, 13(8): 159-163
DOI: 10.5923/j.ijge.20251308.03

Physiological and Cognitive Development of Schoolchildren in Andijan: Age-Specific Characteristics, Interrelations, and Regional Anthropo-Physiometric Standards

Feruza Mukhamatnurovna Abduvalieva[1,*], Shunkor Sadullaevich Khushmatov[2]

[1]Lecturer, Department of Normal and Pathological Physiology, Andijan Branch of Kokand University, Uzbekistan
[2]Ministry of Higher Education, Science and Innovation of Republic of Uzbekistan

Abstract This study investigates the age-specific physiological characteristics and the interrelationship between physical and intellectual development in school-aged children in Andijan, Uzbekistan. **Background:** Recognizing that somatic growth and cognitive maturation are interdependent processes shaped by genetic, environmental, socio-economic, and pedagogical factors, the research aimed to generate region-specific anthropo-physiometric standards for pupils aged 7–17 years. **Methods:** A representative sample from ten schools was assessed using standardized anthropometric and physiometric methods, including measurements of body mass, stature, chest circumference, vital lung capacity, heart rate, and functional respiratory indices. Cognitive performance was evaluated through validated psychometric tools such as the Bourdon Correction Test, the Anfimov Table, and the Landolt Rings test. Statistical analysis, with emphasis on Spearman's rank correlation, revealed dynamic age- and gender-specific associations between physical and intellectual indicators. **Results:** Weak correlations were observed at early school age, with progressively stronger relationships emerging during adolescence, peaking in boys aged 15–16 and girls aged 14. The findings highlight critical developmental windows where physical vitality and cognitive capacity are most closely linked, suggesting the necessity of harmonizing educational and sports workloads to optimize growth outcomes. The study's novelty lies in establishing centile-scale reference values tailored to the Andijan school population, offering a valuable tool for developmental assessment in educational and healthcare contexts. **Conclusions:** These results have practical implications for curriculum design, extracurricular activity planning, and preventive health strategies, contributing to the broader national objective of strengthening human capital through evidence-based, context-sensitive educational policy.

Keywords Physical development, Intellectual development, Anthropometry, Physiometry, Cognitive performance, Psychometric assessment, Spearman correlation, Centile standards, School-aged children, Uzbekistan

1. Introduction

In recent decades, the comprehensive study of the interplay between physical growth and cognitive development in school-aged children has acquired an increasingly prominent place in the discourse of both educational research and public health policy [2,19]. This heightened attention reflects the recognition that the quality of human capital—a decisive factor in the socio-economic advancement of nations—depends not only on the accumulation of knowledge but also on the harmonious development of the physical and intellectual capacities of the younger generation [1,5].

* Corresponding author:
Abduvalieva_FM@mail.ru (Feruza Mukhamatnurovna Abduvalieva)
Received: Jul. 25, 2025; Accepted: Aug. 19, 2025; Published: Aug. 30, 2025
Published online at http://journal.sapub.org/ijge

Within the evolving educational paradigm of Uzbekistan, understanding the mechanisms that govern somatic growth and intellectual maturation has become particularly urgent. The ability to map these processes with precision, to discern the nature and extent of their interconnections, and to transform the resulting insights into evidence-based interventions is of fundamental significance for achieving the strategic objective of "strengthening human capital," a priority enshrined in the country's national science and technology development agenda. This objective entails the creation of scientifically grounded, practically implementable frameworks that can foster the emergence of a healthy, intellectually accomplished, and socially proactive generation prepared to meet the demands of contemporary society [3-7].

The conceptual premise underlying this research is that physical and intellectual development do not proceed as

separate, unrelated trajectories; rather, they are mutually dependent dimensions of a unified developmental continuum. This continuum is shaped by a complex interaction of genetic predispositions, environmental exposures, socio-economic conditions, and pedagogical influences, each of which leaves an imprint on the pace, quality, and direction of growth. While genetic factors set certain physiological limits and potentials, environmental and social determinants modulate how these potentials are realized [12,15]. Adequate nutrition, optimal physical activity, access to quality education, and supportive psychosocial environments are essential to ensuring that both somatic and cognitive capacities develop in a balanced manner. Conversely, deficiencies in any of these areas can lead to disparities in development that persist into adulthood, influencing not only immediate educational performance but also long-term health outcomes, professional competencies, and the ability to adapt successfully to the social and economic realities of adult life [8-11].

Given the importance of these developmental processes, the task of identifying age-related physiological patterns that characterize both physical and intellectual growth acquires strategic relevance. Such identification makes it possible to detect deviations from expected norms at an early stage and to tailor interventions that address the specific needs of children in distinct developmental phases. Moreover, the recognition of regional specificities—differences in growth and cognitive indicators attributable to local climatic, nutritional, socio-cultural, and infrastructural factors—allows for the creation of standards that are not merely imported from generalized or foreign datasets, but rather are rooted in the lived realities of the target population. In the context of Andijan city, with its unique socio-economic profile and demographic composition, the establishment of such region-specific benchmarks is crucial for guiding educational planning, designing sports and physical training programs, and implementing preventive healthcare strategies that are both effective and culturally appropriate [16-19].

Against this backdrop, the present study was conceived to investigate the physiological age-specific characteristics and the degree of interrelation between physical growth and cognitive performance among pupils aged seven to seventeen years in a representative selection of Andijan schools. The research was structured to generate a comprehensive dataset encompassing both anthropometric and physiometric measurements —parameters such as body mass, stature, chest circumference, vital lung capacity, heart rate, and various indices reflecting functional capacity—and validated psychometric assessments designed to capture different aspects of cognitive functioning, including sustained attention, processing speed, and accuracy of information handling. The schools selected for participation, including institutions numbered 1, 5, 6, 11, 13, 15, 24, 30, 31, and 48, provided a broad cross-section of the city's school-age population, thereby enhancing the representativeness and generalizability of the findings [18-20].

The methodological approach combined rigorous field measurement procedures with robust statistical analysis, ensuring that the conclusions drawn rested on a solid empirical foundation. Physical development was documented through standardized anthropometric techniques, while physiometric evaluations involved the use of spirometry and functional tests to assess the state of the respiratory and cardiovascular systems. Intellectual performance was evaluated through established psychometric tools—the Bourdon Correction Test, the Anfimov Table, and the Landolt Rings test—chosen for their reliability, validity, and sensitivity to developmental differences across the targeted age range. By applying statistical methods, and in particular Spearman's rank correlation analysis, it became possible to quantify the strength and direction of associations between physical and cognitive parameters, revealing patterns that might otherwise remain obscured in purely descriptive accounts [3,9,11].

The findings of the research underscored the complex and dynamic nature of the relationship between somatic and intellectual development. At the younger end of the age spectrum, particularly around the age of seven, the correlations between anthropometric parameters and measures of cognitive performance were generally weak, suggesting that at this stage, the influence of physical growth on cognitive functioning may be overshadowed by other developmental factors, such as the rapid acquisition of foundational learning skills and the initial adaptation to formal schooling [3-5,12-15]. As children progressed into middle childhood, certain associations began to emerge, particularly between chest circumference and indices of task accuracy, hinting at the possible role of improved respiratory efficiency and overall vitality in supporting sustained cognitive effort. In adolescence, especially among boys aged fifteen to sixteen and girls around the age of fourteen, the correlations between physical and cognitive indicators reached their highest levels, with values of the correlation coefficient approaching or exceeding 0.70. These results suggest that during these critical developmental windows, when rapid physical growth coincides with heightened cognitive demands, the interplay between somatic and intellectual capacities becomes particularly pronounced. This finding has direct implications for educational and athletic scheduling, as it points to the need for careful balancing of cognitive workload and physical activity to avoid overstrain and to maximize developmental gains [12,14,16-20].

The scientific novelty of the present work lies in the derivation of centile-scale reference values for the anthropo-physiometric indicators of Andijan's school-age population, disaggregated by age and gender. These benchmarks provide a much-needed tool for educators, healthcare practitioners, and policy-makers, enabling them to assess individual developmental trajectories against a backdrop of regionally appropriate norms. From a practical perspective, the application of these standards can inform the adaptation of teaching methods, the structuring of extracurricular and sports programs, and the design of nutritional and health interventions, thereby promoting an individualized, or anthropocentric, approach to education. By aligning educational practice with the biological and cognitive readiness of students, it becomes

possible to enhance learning outcomes while safeguarding health and well-being [2-7].

In sum, this research contributes to the growing body of evidence affirming the necessity of an integrated view of child development, one that acknowledges the interdependence of physical and intellectual growth and seeks to optimize both within the educational system. The results not only illuminate the specific developmental patterns of Andijan's schoolchildren but also offer a methodological template for similar investigations in other regions. Ultimately, the work reinforces the imperative of grounding educational and health policy in region-specific empirical data, thus ensuring that strategies for nurturing the next generation are both scientifically sound and contextually relevant [5,8,13-18].

The overarching purpose of this study is to identify the physiological age-specific features and the interrelationships between physical growth and intellectual performance in school-aged children. Focusing on pupils aged 7–17 years from selected schools in Andijan city, the research seeks to produce region-specific anthropo-physiometric reference standards. In doing so, the study aims to provide a scientific foundation for tailoring educational strategies, optimizing sports and physical training programs, and implementing preventive healthcare measures. The investigation also intends to clarify developmental trends that can inform national policy on child health and education.

2. Materials and Methods

The research was conducted among pupils from ten general education schools in Andijan city: No. 1, 5, 6, 11, 13, 15, 24, 30, 31, and 48. A total sample of 2,200 students (both male and female, aged 7–17 years) participated in the study. The sample was stratified by age and gender to enable the analysis of developmental patterns across specific physiological age intervals.

Physical Development Assessment

Anthropometric measurements included:

- Body weight (BW) in kilograms;
- Stature (height) in centimeters;
- Chest circumference (CC) in centimeters.

These measurements were taken using standardized equipment and protocols in accordance with WHO recommendations. The following anthropo-physiometric indices were calculated: Quetelet II (BMI), Pine Index, Brugsch Index, Vervek Index, and Rohrer Index.

Physiometric parameters included:

- Vital lung capacity (VLC), measured in milliliters;
- Heart rate (HR) in beats per minute;
- Vital Index (VLC per kilogram of body mass);
- Spirometric parameters (ml/cm);
- Functional cardiovascular-respiratory tests (Skibinski Test, Ruffier Test).

Intellectual Development Assessment

Cognitive performance was evaluated using three standardized psychometric tools:

1. Bourdon Correction Test – measuring concentration, stability of attention, and switching ability;
2. Anfimov Table – assessing accuracy, productivity, visual information volume, and information processing speed;
3. Landolt Rings Test – measuring visual information processing volume and speed in adolescents.

Statistical Analysis

Data were processed using descriptive statistics (means, standard deviations, standard errors) and comparative analysis. Spearman's rank correlation coefficient was applied to examine relationships between physical and intellectual development indicators. Statistical significance was set at $p < 0.05$.

3. Research Results

Specific Features of Physical and Cognitive Development in Schoolchildren

Analysis of the scientific literature confirms that children's somatic growth and mental performance are closely linked to age-dependent physiological changes. Anthropometric traits such as body weight, height, and chest circumference show a steady upward trend throughout childhood and adolescence, although the rate of increase differs across developmental stages.

Empirical data from the present study demonstrate that in boys, the most pronounced gains in body mass occur between ages 7–8 and 16–17, whereas girls display peak increases between ages 12–13. In terms of stature, rapid growth in boys is observed at ages 7–8 and 12–13, while in girls it is most marked at ages 9–10 and 12–13. Chest circumference grows fastest in boys during ages 7–8 and 15–16, and in girls between ages 11–13. The level of physical development is influenced by dietary adequacy, physical activity levels, and genetic predisposition. In parallel, intellectual progress — encompassing attentional control, memory function, and information processing speed — is largely determined by the maturation of the central nervous system and the intensity and structure of academic workloads. The balance between physical and mental growth is also strongly associated with the performance of the cardiorespiratory system.

Methods for Assessing Physical and Cognitive Development

The study employed an anthropo-physiometric approach, recording measurements of body mass, height, and chest circumference, and calculating indices such as Quetelet II, Pine, Brugsch, Vervek, and Rohrer. Physiometric assessment included determination of lung vital capacity, heart rate, vital index, spirometric outcomes, and performance on functional tests (Skibinski and Ruffier). Cognitive capabilities were evaluated through standardized instruments — the Bourdon Correction Test, Anfimov Table, and Landolt Rings test. All collected data underwent statistical processing, with Spearman's rank correlation coefficient used to analyze the

degree and direction of association between physical and intellectual development parameters.

Analysis of the Relationship Between Physical and Cognitive Development

The correlation analysis revealed that among 7-year-olds, associations between attentional measures and core anthropometric variables were negligible to weak. In the 8–12 age group, a weak yet notable correlation (r = 0.657) emerged in some cases between chest circumference and "Task Accuracy." For adolescents aged 13–17 — particularly boys aged 15–16 — strong correlations (r = 0.703–0.762) were detected between chest circumference and measures of "Visual Information Volume" and "Information Processing Speed." Among girls, this pattern appeared at age 14, with correlation coefficients reaching 0.707–0.717. These findings suggest that during specific developmental windows, physical and intellectual growth are most tightly linked, underscoring the need for coordinated management of academic and physical training loads.

4. Conclusions

The study confirms that the physical and cognitive development trajectories of schoolchildren in Andijan vary considerably by age and gender. Certain developmental stages are characterized by abrupt changes in growth rate and cognitive performance, influenced by physiological maturation, endocrine shifts, and the specific demands of the educational environment. The creation of localized centile norms provides a scientifically robust tool for developmental monitoring and targeted intervention in both educational and healthcare contexts.

Practical Recommendations

- Implement personalized, anthropocentric educational strategies that align teaching methods and curricular content with each student's developmental profile.
- Integrate region-specific anthropo-physiometric standards into the health and education sectors.
- Conduct biannual monitoring of both physical and cognitive growth in school populations.
- Adjust athletic workloads for 15–16-year-olds, considering the observed peak correlation between somatic and cognitive performance in this age group.
- Modify dietary and exercise regimens in cases where underweight or overweight conditions are detected.

REFERENCES

[1] Adam, C., Klissouras, V., Ravazzolo, M., Renson, R., & Tuxworth, W. (1988). *Eurofit: European test of physical fitness*. Rome: Council of Europe, Committee for the Development of Sport.

[2] Ahn, S., & Fedewa, A. L. (2011). A meta-analysis of the relationship between children's physical activity and mental health. *Journal of Pediatric Psychology, 36*(4), 385–397. https://doi.org/10.1093/jpepsy/jsq107.

[3] Bar-Or, O., & Rowland, T. W. (2004). Pediatric exercise medicine: From physiologic principles to health care application. Champaign, IL: Human Kinetics.

[4] Bourdon, B. (1955). *Bourdon-Wiersma test*. Paris: Les Éditions du Centre de Psychologie Appliquée.

[5] Cole, T. J., & Green, P. J. (1992). Smoothing reference centile curves: The LMS method and penalized likelihood. *Statistics in Medicine, 11*(10), 1305–1319. https://doi.org/10.1002/sim.4780111005.

[6] Gallahue, D. L., & Ozmun, J. C. (2012). *Understanding motor development: Infants, children, adolescents, adults* (7th ed.). Boston, MA: McGraw-Hill.

[7] Gabbard, C. (2018). *Lifelong motor development* (7th ed.). Burlington, MA: Jones & Bartlett Learning.

[8] Landolt, H. (1960). *Landolt Ring Test*. Zürich: Hans Huber.

[9] Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation, and physical activity* (2nd ed.). Champaign, IL: Human Kinetics.

[10] Ministry of Public Education of the Republic of Uzbekistan. (2020). *National curriculum standards for general secondary education*. Tashkent: Author.

[11] Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32*(1), 1–11. https://doi.org/10.1038/sj.ijo.0803774.

[12] Piaget, J. (1972). *Intellectual evolution from adolescence to adulthood*. Human Development, 15(1), 1–12. https://doi.org/10.1159/000271225.

[13] Reilly, J. J., & Kelly, J. (2011). Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: Systematic review. *International Journal of Obesity, 35*(7), 891–898. https://doi.org/10.1038/ijo.2010.222.

[14] Rogol, A. D., Clark, P. A., & Roemmich, J. N. (2000). Growth and pubertal development in children and adolescents: Effects of diet and physical activity. *The American Journal of Clinical Nutrition, 72*(2), 521S–528S. https://doi.org/10.1093/ajcn/72.2.521S.

[15] Spearman, C. (1904). The proof and measurement of association between two things. *The American Journal of Psychology, 15*(1), 72–101. https://doi.org/10.2307/1412159.

[16] Tanner, J. M. (1990). *Foetus into man: Physical growth from conception to maturity* (2nd ed.). Cambridge, MA: Harvard University Press.

[17] UNESCO. (2015). *Quality physical education: Guidelines for policy-makers*. Paris: United Nations Educational, Scientific and Cultural Organization.

[18] WHO. (2007). *Growth reference data for 5–19 years*. Geneva: World Health Organization.

[19] WHO. (2010). Global recommendations on physical activity for health. Geneva: World Health Organization.

[20] Zaporozhets, A. V., & Elkonin, D. B. (1971). *Child development and learning*. Moscow: Prosveshchenie.