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EPIDEMIOLOGICAL FEATURES OF POSTNATAL ONTOGENETIC DEVELOPMENT OF YOUNG CHILDREN (1–3 YEARS OLD) IN THE ARAL SEA REGION

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Abstract

This study provides a comprehensive epidemiological analysis of the postnatal ontogenesis of young children (1–3 years) living in the unique conditions of the southern Aral Sea region. The period from one to three years is a critical "window of vulnerability," when the foundations for physical and psychoneurological health are laid. The study is based on comparative monitoring of three representative districts of the Republic of Karakalpakstan (Muynak, Takhtakupir, and Beruni), which differ in the degree of environmental stress [1].
The authors analyzed the dynamics of anthropometric indicators (height, weight, and body composition indices), as well as the structure of comorbidities limiting normal development [2]. It was found that under conditions of chronic intoxication with salt and dust aerosols and consumption of highly mineralized water, the phenomenon of "environmental retardation"—a persistent slowdown in the rate of physical development—is observed. This article provides scientific evidence for a direct correlation between environmental quality and specific developmental abnormalities, such as micronutrient deficiencies, anemia, and decreased cardiovascular adaptability. Conclusions are drawn regarding the need to revise regional standards for assessing the health of young children in the environmental disaster zone [3].

Keywords

Aral Sea region, postnatal ontogenesis, early childhood, environmental factors, physical development, Muynak, Republic of Karakalpakstan.

Relevance of the topic. The Aral Sea region is recognized as a zone of global environmental disaster. The combination of a shortage of quality drinking water, highly mineralized soil, and the constant discharge of salt dust from the dried bed of the Aral Sea creates an extreme environment for human development. The early childhood period (1–3 years) is a critical stage of postnatal ontogenesis. During this time, intensive maturation of organ systems, the development of the immune response, and cognitive functions occur. Any negative impact during this period has a long-term effect, determining the level of disability and morbidity in the adult population in the future. The issue of maternal and child health in the Aral Sea region has remained one of the most pressing medical and environmental challenges globally over the past decades. The Aral Sea crisis has led to the formation of an extreme habitat in the southern Aral Sea region, characterized by a combination of an arid climate and high anthropogenic load. Postnatal ontogenesis between the ages of 1 and 3 is characterized by extremely high rates of cellular proliferation and tissue differentiation [4]. It is during this period that the mechanisms of immunological tolerance are formed and active myelination of brain structures is completed. Any disruption to homeostasis caused by external toxicants during this period leads to irreversible changes that cannot be fully compensated for in later life. The dried-up Aral Seabed has become a source of over 75 million tons of toxic salts and dust containing residual pesticides

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and heavy metals annually. These particles, entering children's bodies through the respiratory and digestive tracts, act as powerful xenobiotics. Chronic microelement imbalances (excess magnesium and sulfates in the water with a deficiency of iodine and selenium in the soil) create conditions for the widespread development of eco-related diseases [5]. Traditional pediatric standards developed for affluent regions often fail to reflect the actual adaptation status of children in Karakalpakstan. There is an urgent need for epidemiologically substantiated new regional development standards that would allow for the early detection of developmental delays and timely nutritional and medicinal interventions [6].

The purpose of the study was to examine and systematize epidemiological data on the physical and psychomotor development of children aged 1–3 years in various regions of the Aral Sea region to identify regional ontogenetic patterns.

Materials and Methods: The study was conducted at medical associations in three districts: Muynak District (high-risk, coastal zone); Takhtakupir District (high-salt zone); and Beruni District (a relatively remote region used as a comparison group).

Methodology:

• Anthropometry: measurement of body weight, height, and chest circumference (according to WHO standards).

• Clinical laboratory tests: analysis of hemoglobin and serum iron levels.

• Statistical analysis: use of Student's t-test and Pearson correlation analysis [7].

Results. A comparative analysis revealed that the health of young children (1-3 years) is directly and exponentially related to their distance from the dried bed of the Aral Sea.

Comparative analysis of anthropometric data. Physical development (PD) is the most sensitive indicator of environmental well-being. Significant deviations from the WHO median values were found in the surveyed areas.

Table 1. Distribution of children by level of physical development (in %)

Region	Harmonious development	Risk group (delayed growth factor)	Severe pathology (growth/weight deficiency)
Muynak	38.5%	33.1%	28.4%
Takhtakupir	52.4%	26.4%	21.2%
Beruni	74.8%	12.7%	12.5%

Interpretation: In the Muynak district, only one in three children demonstrates harmonious development. The main type of deviation is stenting (short stature), which indicates chronic nutritional deficiency and metabolic stress throughout postnatal development.

Regional patterns of morbidity. The pattern of somatic pathologies, which underlie the child's development, deserves special attention.

Factor analysis: The high rate of recurrent respiratory infections in Muynak (every second child) is explained by the damaging effect of salt and dust aerosols on mucociliary clearance. Constant irritation of the mucous membranes by sodium and magnesium salts leads to a decrease in local immunity (IgA), leaving children vulnerable to viral infections.

Table 2. Epidemiological incidence rates (per 100 children).

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Indicator	Muynak (disaster zone)	Beruniy (control)	Coefficient of difference
Frequently ill children (FSC)	54.2	18.6	2.9
Chronic enterocolitis	12.4	4.1	3.0
Congenital anomalies (minor)	8.7	2.3	3.8
Allergic dermatitis	22.1	9.5	2.3

Hematological Status. Anemia in the Aral Sea region is widespread and is a key factor impeding psychomotor development [8]. Muynak District: The average hemoglobin level in 2-year-old children was 94 pm 4.2 g/L. Moderate hypochromic anemia is prevalent. Beruni District: The average level is 112 pm 3.1 g/L. In Muynak, anemia is often resistant to standard iron therapy. This is due to "malabsorption syndrome" caused by the consumption of hard water, which blocks intestinal transport proteins.

Conclusions: Spatial gradient: The rate of ontogenetic development slows as one approaches the epicenter of the environmental disaster (the Aral Sea).

Developmental disharmonies: Children aged 1–3 in the Aral Sea region are characterized by a predominance of the microsomatic type of development (short stature with low body weight).

Critical factor: The leading risk factor is not only water quality but also the high incidence of respiratory diseases caused by salt and dust storms, which leads to chronic tissue hypoxia.

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