



**HYGIENIC JUSTIFICATION OF MEASURES TO
MINIMIZING CHEMICAL EXPOSURE TO CHILDREN
ASSOCIATED WITH RESIDUAL AMOUNTS OF
AGROCHEMICALS IN VEGETABLES**

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ABSTRACT

The relevance of this problem is due to the widespread use of agrochemicals in vegetable growing and the high vulnerability of children to chemical factors. The objective of this study is to formulate and substantiate a set of hygiene measures aimed at reducing the intake of residual amounts of agrochemicals by children through the consumption of vegetable products. This paper analyzes the sources and routes of agrochemical exposure in the food chain, age-related and physiological characteristics of exposure in children, as well as existing regulatory and technological control measures. Methodologically, the study is based on a systematic analysis of scientific literature, the results of sanitary monitoring, and the principles of risk-based hygiene regulation.

**ГИГИЕНИЧЕСКОЕ ОБОСНОВАНИЕ МЕР ПО МИНИМИЗАЦИИ
ХИМИЧЕСКОЙ НАГРУЗКИ НА ДЕТЕЙ, СВЯЗАННОЙ С
ОСТАТОЧНЫМИ КОЛИЧЕСТВАМИ АГРОХИМИКАТОВ В ОВОЩАХ**

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ориентированное
регулирование.

ABSTRACT

Актуальность проблемы обусловлена широкой распространённостью применения агрохимикатов в овощеводстве и высокой уязвимостью детского организма к химическим факторам. Цель исследования — сформулировать и обосновать комплекс гигиенических мероприятий, направленных на снижение поступления остаточных количеств агрохимикатов в организм детей при употреблении овощной продукции. В работе анализируются источники и пути поступления агрохимикатов в пищевую цепочку, возрастные и



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физиологические особенности экспозиции у детей, а также существующие нормативно-правовые и технологические меры контроля. Методологически исследование опирается на системный анализ научной литературы, результаты санитарного мониторинга и принципы риск-ориентированного гигиенического регулирования.

Introduction. The intensification of agricultural production and the widespread use of chemical plant protection products ensure the stability of vegetable crop yields, but simultaneously create a long-term problem—the spread of residual amounts of agrochemicals in the food chain. The issue of ensuring the safety of children's food is of particular importance: children are characterized by increased sensitivity to xenobiotics due to the incompleteness of biotransformation processes, high relative demand for food products, and critical stages of the formation of physiological systems. These characteristics emphasize the need for targeted hygienic measures aimed not only at compliance with established standards but also at minimizing the total chemical load on the body under conditions of chronic and multicomponent exposure. Preventive measures are presented at three levels: (1) agro-economic—optimization of the use of plant protection products and the introduction of alternative technologies; (2) technological and logistical—control at the stages of storage, transportation, and processing; (3) behavioral and educational—recommendations for parents and educational institutions on reducing the chemical load when

preparing vegetables for consumption. The conclusion substantiates the need to integrate risk-based approaches into the sanitary and hygienic control system, develop national programs to reduce chemical loads, and strengthen intersectoral collaboration between healthcare, agriculture, and education.

Modern research points to a wide range of potential adverse effects from long-term exposure to low doses of agrochemicals: impaired neurodevelopment, endocrine dysfunction, weakened immune response, and potential impacts on metabolic processes. A significant portion of the literature addresses the problem of accumulation and synergism of mixtures of active substances, making risk assessment based on the analysis of individual substances insufficient for practical hygiene regulation. Furthermore, real-world dietary conditions (regional dietary patterns, seasonality of consumption, and product origin) create variability in exposure, requiring adaptive and locally relevant approaches. The hygienic justification of measures to reduce the chemical burden on children should be based on a multi-level strategy: prevention at the agricultural level (reducing the use of hazardous chemicals, implementing integrated plant protection), monitoring



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and optimization of process chains (monitoring residues, improving storage and processing conditions), as well as consumer education and organizing meals for children's groups. An important component is the use of risk-based assessment methods that take into account age-specific exposure factors, the multi-component nature of mixtures, and the duration of exposure. This will allow for the establishment of priorities in the sanitary and hygienic control system and targeted recommendations for reducing the chemical burden on children.

Research Materials and Methods.

The study was comprehensive in its hygienic aspects and aimed to scientifically substantiate measures to minimize the chemical load on children associated with the intake of residual amounts of agrochemicals with vegetable products. The methodological basis was a systematic analysis of sanitary and hygienic monitoring data, scientific publications, and regulatory documents in the field of food safety and child health. The study focused on vegetables widely consumed by children of various age groups, taking into account regional and seasonal consumption patterns. The chemical load assessment considered the main groups of agrochemicals used in vegetable growing, including pesticides with various modes of action and auxiliary chemicals. The analysis focused on chronic low-dose exposure, which is most typical for the food-borne route of chemical intake.

The hygienic assessment was based on a comparison of the calculated exposure to agrochemicals with reference safety levels established based

on toxicological studies. The calculations took into account average daily vegetable consumption, age-specific factors, children's body weight, and duration of exposure. Particular attention was paid to analyzing the total chemical load and the potential cumulative effect of simultaneous exposure to multiple active ingredients from different types of vegetable products.

To justify preventive measures, a risk-based approach was used, identifying priority risk factors at the stages of agricultural production, storage, transportation, processing, and consumption of vegetable products. The effectiveness of the proposed hygiene measures was assessed based on their potential contribution to reducing exposure to agrochemicals and reducing the overall chemical load on children's bodies. The results were interpreted taking into account the principles of preventive medicine and intersectoral collaboration between healthcare, agriculture, and education.

Study Results. A hygienic analysis revealed that the main factor contributing to the chemical load on children's bodies is the regular intake of residual amounts of agrochemicals with vegetable products. The study showed that even without exceeding established hygienic standards for the content of individual chemicals in vegetables, the total exposure with regular consumption can reach significant levels, especially in younger children.

An assessment of chronic low-dose exposure revealed that the largest contribution to the total chemical load comes from the regular consumption of vegetables as part of the daily diet. When



calculating exposure based on body weight and age-related factors, it was found that the relative intake of agrochemicals in children is significantly higher than that of adults. In conditions of multicomponent contamination of vegetable products, the total load approached the reference safety levels, indicating the presence of a potential risk with long-term exposure. An analysis of the stages of agrochemical residue formation revealed that the key risk factors are the agronomic practices of plant protection chemical application, as well as the storage and transportation conditions of vegetable produce. The data obtained indicate that chemical loads do not develop suddenly, but are the result of cumulative exposure over a long period, which is particularly significant for children during critical periods of growth and development.

Discussion. These results confirm the relevance of shifting from the traditional regulatory approach to a risk-based hygienic assessment system that takes into account the actual nutritional conditions and the characteristics of children. Despite compliance with maximum permissible levels of agrochemicals in vegetable produce, chronic exposure to low doses of chemicals can lead to a cumulative effect and an increase in the overall chemical load.

Of particular significance is the multicomponent nature of agrochemical exposure, in which the simultaneous administration of several active ingredients can enhance the adverse effects through additive or synergistic effects. This circumstance requires a revision of approaches to sanitary and

hygienic control and the expansion of the practice of total risk assessment, especially for vulnerable population groups such as children. From a hygiene perspective, the need to implement a comprehensive set of preventive measures at all stages of the food chain—from agricultural production to vegetable consumption—is justified. The most effective approaches include optimizing the use of agrochemicals, developing integrated plant protection systems, strengthening residue monitoring, and improving public health literacy. Implementing these measures will reduce the chemical load on children's bodies and improve the safety of baby food.

Conclusion. The study showed that residual amounts of agrochemicals in vegetable products, when consumed regularly, can create a significant chemical load on children's bodies, primarily due to chronic low-dose exposure. Even if current hygiene standards are met, the total exposure to chemicals, due to the multi-component nature of the contamination and the characteristics of children's diets, can pose a potential health risk.

These results confirm the increased vulnerability of children to the effects of agrochemicals, which is associated with age-related physiological characteristics, immature detoxification mechanisms, and the high relative consumption of vegetable products. Chronic exposure to chemical factors can have the greatest impact on the functioning of the nervous, endocrine, and immune systems, disruption of which can have long-term health consequences.



The hygienic rationale for measures to minimize chemical loads demonstrates the advisability of implementing a multi-level preventative approach encompassing the stages of agricultural production, storage, processing, and consumption of vegetable products. Optimizing the use of agrochemicals, developing integrated plant protection systems, strengthening sanitary and hygienic monitoring, and

raising public awareness are considered priority areas for reducing risks to children.

Implementing risk-based hygiene measures and intersectoral collaboration between the healthcare system, the agricultural sector, and educational institutions will improve the effectiveness of prevention, reduce the chemical load on children, and ensure safer baby food.

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