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EXPOSOMICS AS A NEW PARADIGM OF PREVENTIVE MEDICINE: PROSPECTS FOR THE UZBEKISTAN HEALTHCARE SYSTEM

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ABSTRACT: This article examines exposomes as a new paradigm of preventive medicine, focused on a comprehensive assessment of the combined impacts of environmental factors, lifestyle, socioeconomic conditions, and biological processes on human health throughout life. It is demonstrated that the traditional approach, based on the analysis of individual risk factors, does not fully reflect the multifactorial nature of disease development, particularly non-communicable diseases. This review discusses the theoretical foundations of the exposome concept, its structure and main components, as well as modern methods for studying exposure effects. Particular attention is paid to the potential of the exposome approach for the prevention of chronic and infectious diseases, the development of public health, and the development of effective preventive programs. A separate section is devoted to the relevance of exposomes for the healthcare system of Uzbekistan, taking into account the climatic, environmental, and social characteristics of the region. It is concluded that exposomes holds great promise as a tool for modernizing preventive medicine and improving public health.

Keywords: Exposomes, preventive medicine, public health, exposure, risk factors, noncommunicable diseases, environment, social determinants, exposome.

ЭКСПОЗОМИКА КАК НОВАЯ ПАРАДИГМА ПРОФИЛАКТИЧЕСКОЙ МЕДИЦИНЫ: ПЕРСПЕКТИВЫ ДЛЯ СИСТЕМЫ ЗДРАВООХРАНЕНИЯ УЗБЕКИСТАНА

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АННОТАЦИЯ: В статье рассматривается экспозомика как новая парадигма профилактической медицины, ориентированная на комплексную оценку совокупных воздействий факторов окружающей среды, образа жизни, социально-экономических условий и биологических процессов на здоровье человека на протяжении всей жизни. Показано, что традиционный подход, основанный на анализе отдельных факторов риска, не в полной мере отражает многофакторную природу формирования заболеваний, особенно неинфекционной патологии. В обзоре раскрываются теоретические основы концепции экспозома, его структура и основные компоненты, а также современные методы исследования экспозиционных воздействий. Особое внимание уделено потенциалу экспозомного подхода в профилактике хронических и инфекционных заболеваний, развитии общественного здоровья и формировании эффективных профилактических программ. Отдельный раздел посвящён актуальности внедрения экспозомики для системы здравоохранения Узбекистана с учётом климатических, экологических и социальных особенностей региона. Сделан вывод о высокой

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перспективности экспозомики как инструмента модернизации профилактической медицины и укрепления здоровья населения.

Ключевые слова: Экспозомика, профилактическая медицина, общественное здоровье, экспозиция, факторы риска, неинфекционные заболевания, окружающая среда, социальные детерминанты, экспозом.

RELEVANCE: The modern healthcare system is increasingly challenged by the growing prevalence of chronic non-communicable diseases, which are multifactorial in nature and closely associated with environmental conditions, lifestyle patterns, and social determinants of health. Traditional preventive approaches focused on isolated risk factors are often insufficient to capture the complex interactions underlying disease development. In this context, exposomics has emerged as a novel and integrative paradigm that considers the totality of external and internal exposures affecting human health throughout the lifespan. For Uzbekistan, this approach is particularly relevant due to pronounced climatic conditions, rapid urbanization, changes in dietary habits and lifestyle, as well as ongoing environmental pressures. The application of an exposome-based framework provides new opportunities to enhance preventive medicine, strengthen public health strategies, and develop evidence-based prevention programs tailored to regional characteristics. Thus, exploring the potential of exposomics is timely and essential for modernizing the national healthcare system and improving population health outcomes [1].

MATERIALS AND METHODS: This review was conducted using a comprehensive analysis of contemporary scientific literature focused on the concept of exposomics and its application in preventive medicine and public health. Relevant publications were identified through systematic searches of international electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search strategy employed combinations of keywords such as exposome, exposomics, preventive medicine, public health, environmental exposure, and non-communicable diseases. Articles published mainly within the last 10–15 years were prioritized to ensure the inclusion of up-to-date theoretical frameworks and methodological approaches, while seminal earlier works were also considered to provide historical and conceptual context.
The selection criteria included review articles, original research papers, reports from international health organizations, and methodological studies addressing exposome structure, assessment tools, and preventive implications. Publications not directly related to human health or lacking relevance to preventive medicine were excluded. The collected materials were analyzed using qualitative content analysis, allowing for the synthesis of key concepts, classifications of exposures, and methodological advances in exposome research. Particular attention was paid to studies highlighting the relevance of exposomics for population-based prevention and its potential applicability to regional healthcare systems, including countries with environmental and climatic characteristics similar to those of Uzbekistan.
RESULTS AND DISCUSSION: Preventive medicine has become one of the central priorities of healthcare systems in the twenty-first century due to the global shift in the structure of morbidity and mortality. According to the World Health Organization, non-communicable diseases account for approximately 74% of all deaths worldwide, with cardiovascular diseases, diabetes, cancer, and chronic respiratory disorders representing the leading causes. These conditions are largely preventable and strongly influenced by environmental, behavioral, and social determinants, which underscores the critical role of preventive strategies. However, despite significant progress in risk factor identification, the effectiveness of prevention remains

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limited in many populations, particularly in regions experiencing rapid urbanization and environmental change.

Traditional preventive medicine has been predominantly based on a factor-specific approach, focusing on isolated risk elements such as smoking, poor diet, physical inactivity, or air pollution. While this model has contributed to measurable reductions in certain health risks, it fails to capture the complex, cumulative, and interactive nature of real-life exposures. Epidemiological data indicate that combined environmental and lifestyle exposures may explain up to 70–80% of the variability in the incidence of chronic diseases, whereas genetic factors account for a substantially smaller proportion. This gap highlights the limitations of analyzing single exposures independently and necessitates a transition toward integrative analytical frameworks.

In response to these challenges, modern preventive medicine is increasingly shifting from the study of isolated risk factors to comprehensive exposure assessment across the life course. This transition has led to the emergence of exposomics, a concept that encompasses the totality of environmental, behavioral, social, and biological exposures from conception to old age. The term "exposome" was first introduced in 2005 by Christopher P. Wild to complement the genome and provide a more complete understanding of disease etiology. Since then, the concept has evolved to include internal biological responses, such as metabolism, inflammation, and microbiota composition, as well as external factors related to climate, urban environment, and digital lifestyle.

Exposomics occupies an interdisciplinary position within modern biomedical sciences, integrating epidemiology, environmental health, omics technologies, and public health. As a complement to genomics and epigenetics, it offers a dynamic perspective on how external exposures interact with biological systems to influence health outcomes. The exposome approach holds particular significance for preventive medicine, as it enables early identification of high-risk exposure patterns and supports the development of targeted, population-level prevention strategies. The aim of this review is to analyze the theoretical foundations of exposomics, examine its relevance for preventive medicine, and explore its potential application in strengthening public health systems [3].

The structure of the exposome reflects the complexity and multidimensional nature of environmental and biological influences on human health. It is commonly classified into internal and external components, which interact dynamically throughout the life course and collectively determine disease susceptibility and health outcomes. This comprehensive framework allows preventive medicine to move beyond isolated exposures and address the cumulative burden of multiple determinants.

The internal exposome encompasses endogenous biological processes that mediate the effects of external exposures. These include metabolic pathways, immune and inflammatory responses, hormonal regulation, and the composition and function of the human microbiota. Metabolic alterations induced by diet, pollutants, or stress can contribute to oxidative stress, insulin resistance, and chronic inflammation. The gut microbiota, in particular, plays a critical role in modulating immune function and metabolic homeostasis, with dysbiosis being associated with obesity, cardiovascular diseases, and inflammatory disorders. Chronic low-grade inflammation and hormonal imbalances represent key internal mechanisms through which long-term exposures translate into disease development.

The external exposome comprises a wide range of environmental, social, and behavioral factors. Environmental exposures include air, water, and soil pollution, which are responsible for an estimated 6.7 million premature deaths annually worldwide, according to global health estimates.

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Climatic and geographical conditions, such as extreme heat, ultraviolet radiation, and arid environments, significantly influence cardiovascular, renal, and respiratory health, particularly in regions with harsh climates. Social and socioeconomic determinants, including income level, education, occupational conditions, and lifestyle behaviors, further shape exposure patterns and health inequalities.

In recent years, the digital environment has emerged as a distinct component of the modern exposome. Prolonged screen time, digital stress, and disrupted circadian rhythms associated with excessive use of electronic devices have been linked to sleep disorders, mental health disturbances, and metabolic dysregulation. These exposures are increasingly relevant in younger populations and urban settings.

A defining characteristic of the exposome is the cumulative and synergistic nature of exposures. Individuals are simultaneously subjected to multiple interacting factors, whose combined effects often exceed the impact of single exposures. Understanding these interactions is essential for developing effective preventive strategies and advancing precision public health. The cumulative nature of exposome-related influences implies that health outcomes are shaped not by short-term or isolated exposures, but by their long-term accumulation across critical periods of life, including prenatal development, childhood, adolescence, and adulthood. Epidemiological studies suggest that early-life exposures may account for up to 40% of the lifetime risk of chronic non-communicable diseases, emphasizing the importance of a life-course perspective in preventive medicine. Repeated or persistent exposure to low-intensity environmental stressors—such as moderate air pollution, suboptimal nutrition, or chronic psychosocial stress—can gradually overwhelm adaptive mechanisms and lead to pathological changes.

Equally important is the synergistic character of exposome components. Different exposures often interact at molecular, cellular, and systemic levels, producing combined effects that are greater than the sum of individual influences. For example, exposure to air pollutants may exacerbate the adverse metabolic effects of poor diet, while psychosocial stress can amplify inflammatory responses triggered by environmental toxins. Such interactions partly explain why individuals with similar genetic backgrounds may experience markedly different health trajectories under comparable conditions. From a preventive standpoint, this synergy highlights the limitations of single-intervention strategies and supports the need for integrated, multisectoral approaches.

The exposome framework also provides a scientific basis for stratifying populations according to complex exposure profiles rather than single risk markers. This allows public health systems to identify vulnerable groups more accurately and design targeted preventive measures. In addition, advances in omics technologies, digital monitoring, and data integration have made it increasingly feasible to capture and analyze cumulative exposures at both individual and population levels.

Overall, recognizing the structured, cumulative, and interactive nature of the exposome represents a fundamental shift in preventive medicine. It enables a more comprehensive understanding of disease causation and supports the development of evidence-based interventions aimed at reducing overall exposure burden, thereby improving long-term population health outcomes.

Methods and tools for exposome research are inherently multidisciplinary and aim to capture the complexity, variability, and dynamics of human exposures over time. One of the fundamental approaches is **biomonitoring**, which involves the measurement of chemicals, metabolites, or biological responses in human tissues and fluids such as blood, urine, saliva, or hair. Biomarkers

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of exposure, effect, and susceptibility allow researchers to objectively assess both external exposures and internal biological responses. For example, biomarkers of air pollution exposure, oxidative stress, or endocrine disruption provide quantitative links between environmental factors and health outcomes, making biomonitoring a cornerstone of exposome studies.

A central role in exposome research is played by **omics technologies**, which enable high-throughput and comprehensive characterization of biological systems. Metabolomics allows the detection of thousands of small molecules reflecting metabolic responses to environmental and lifestyle factors. Proteomics provides insight into protein expression and signaling pathways affected by exposures, while microbiomics focuses on the composition and functional activity of the human microbiota as a mediator between environment and host health. Together, these approaches facilitate the identification of exposure-related biological signatures and early markers of disease risk.

Geographic Information Systems (GIS) are widely used to assess spatial and temporal patterns of environmental exposures. GIS-based models integrate data on air quality, water contamination, land use, climate variables, and population density, enabling precise estimation of individual and community-level exposures. This approach is particularly valuable for large-scale population studies and environmental health surveillance.

In recent years, **digital and wearable technologies** have emerged as innovative tools for real-time monitoring of the exposome. Wearable sensors can track physical activity, temperature, noise, sleep patterns, and even certain environmental pollutants, providing continuous and personalized exposure data [6,8].

The integration of these diverse data sources relies heavily on **big data analytics and artificial intelligence**. Machine learning algorithms enable the analysis of complex, high-dimensional datasets, uncover hidden exposure patterns, and model interactions between multiple factors. Artificial intelligence thus plays a crucial role in translating exposome data into actionable insights for preventive medicine and public health decision-making.

Exposomics has become increasingly important in the prevention of non-communicable diseases (NCDs), which represent the leading cause of morbidity and mortality worldwide. According to global health statistics, non-communicable diseases are responsible for approximately 74% of all deaths, with cardiovascular diseases, metabolic disorders, and cancer accounting for the majority of cases. The exposome framework provides a comprehensive understanding of how cumulative environmental, behavioral, and biological exposures contribute to the development of these conditions and offers new opportunities for effective prevention.

Cardiovascular diseases (CVDs) remain the leading cause of death globally, accounting for an estimated 20.5 million deaths annually. Exposome-related factors such as air pollution, noise exposure, chronic psychosocial stress, physical inactivity, and dietary patterns significantly influence cardiovascular risk. Long-term exposure to fine particulate matter (PM2.5) has been associated with a 10–15% increase in cardiovascular mortality for each 10 μg/m³ rise in concentration. In addition, combined exposure to environmental pollutants and lifestyle-related stressors has been shown to accelerate endothelial dysfunction, systemic inflammation, and atherosclerosis, highlighting the synergistic nature of exposome components in cardiovascular disease formation.

Metabolic disorders, including obesity and type 2 diabetes mellitus, are also strongly influenced by exposome factors. The global prevalence of obesity has nearly tripled since 1975, with over 1 billion adults currently classified as obese. Exposomic contributors include excessive caloric intake, sedentary behavior, endocrine-disrupting chemicals, sleep deprivation, and alterations in

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gut microbiota. Studies indicate that exposure to obesogenic environmental chemicals may increase the risk of obesity by 20–30%, particularly when combined with unhealthy dietary patterns. These findings underscore the importance of considering multiple interacting exposures rather than isolated lifestyle factors.

Oncological diseases represent another major area where the exposome plays a critical role. It is estimated that up to 40% of cancers worldwide are preventable through modification of environmental and lifestyle exposures. Tobacco smoke, occupational hazards, air pollution, ultraviolet radiation, and dietary factors interact with internal biological processes to influence carcinogenesis. Exposomic research demonstrates that combined low-dose exposures over long periods may be more harmful than single high-intensity exposures, contributing to cumulative DNA damage, epigenetic alterations, and chronic inflammation.

The exposome approach is particularly valuable for early prevention of chronic diseases, as it enables the identification of harmful exposure patterns before clinical symptoms emerge. By integrating exposure assessment with biological markers, exposomics supports early intervention strategies aimed at reducing overall exposure burden, thereby improving long-term health outcomes and reducing the societal and economic burden of non-communicable diseases [8,9].

Exposomics offers new perspectives for understanding and preventing infectious diseases by integrating environmental, biological, and social determinants that influence host susceptibility and disease transmission. Although infectious diseases account for a smaller proportion of global mortality compared to non-communicable diseases, they remain a major public health challenge, particularly in low- and middle-income countries. According to the World Health Organization, infectious diseases are responsible for approximately 13–15% of global deaths, with environmental and social exposures playing a decisive role in their distribution and severity [5].

Environmental conditions significantly affect susceptibility to infections. Air pollution, poor water quality, inadequate sanitation, and overcrowded living environments increase the risk of respiratory and gastrointestinal infections. For example, long-term exposure to particulate air pollution has been associated with increased incidence and severity of respiratory infections, while unsafe drinking water contributes to millions of cases of enteric diseases annually. Climatic factors such as temperature extremes, humidity, and seasonal variability also influence pathogen survival and transmission dynamics, particularly for vector-borne and zoonotic infections.

The exposome strongly modulates the immune response, which determines an individual's ability to resist infectious agents. Chronic exposure to environmental stressors, including pollutants, psychosocial stress, and nutritional deficiencies, can impair innate and adaptive immunity. Studies suggest that prolonged low-grade inflammation and endocrine disruption reduce immune resilience, increasing susceptibility to infections and worsening disease outcomes. In contrast, favorable exposome profiles characterized by balanced nutrition, physical activity, and low environmental stress are associated with enhanced immune competence.

The human microbiota plays a pivotal role as a mediator of exposomic effects in infectious pathology. Environmental exposures, antibiotic use, diet, and lifestyle shape microbial composition, which in turn influences mucosal immunity and pathogen resistance. Dysbiosis has been linked to increased vulnerability to respiratory, gastrointestinal, and opportunistic infections, highlighting the preventive potential of microbiota-targeted interventions.

From a public health perspective, the exposome approach holds significant promise for epidemiological surveillance. Integrating environmental monitoring, biological data, and digital technologies enables more accurate prediction of infection risk, identification of vulnerable

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populations, and development of targeted preventive measures. Exposomics thus represents an innovative tool for strengthening infection prevention and enhancing preparedness within modern public health systems [4].

Exposomics introduces a transformative framework within the system of public health by redefining how health risks are identified, assessed, and managed at the population level. Traditional public health models have relied heavily on discrete risk factors and relatively static definitions of "risk groups," often based on age, sex, occupation, or single behavioral characteristics. However, growing evidence indicates that health outcomes are shaped by complex, cumulative exposure profiles rather than isolated determinants. Within the exposome paradigm, the concept of a "risk factor" is expanded to encompass interacting environmental, social, behavioral, and biological exposures acting across the life course, while "risk groups" are redefined based on shared exposure patterns rather than demographic criteria alone.

As a tool for population-level prevention, exposomics enables a more nuanced understanding of health disparities and vulnerability. By integrating environmental monitoring, socioeconomic data, and biological markers, public health systems can identify communities with high cumulative exposure burdens and prioritize preventive interventions accordingly. This approach supports the development of targeted population strategies aimed at reducing overall exposure load, rather than addressing single hazards in isolation. Such strategies are particularly relevant in urbanized and environmentally stressed settings, where multiple exposures often co-occur [6,7].

The application of an exposome-based approach also influences the design and implementation of preventive programs. Instead of focusing solely on individual behavior change, exposomics promotes integrated interventions that address environmental quality, social conditions, and lifestyle simultaneously. This shift enhances the effectiveness and sustainability of prevention programs and aligns with the principles of precision public health.

Effective management of exposome-related risks requires strong intersectoral collaboration. Health outcomes are influenced by policies in environmental protection, urban planning, transportation, education, and labor. Exposomics provides a common evidence-based framework that facilitates coordination between sectors, enabling comprehensive exposure management and contributing to long-term improvements in population health.

The implementation of exposomics within the healthcare system of Uzbekistan represents a promising strategic direction for strengthening preventive medicine and public health. The country is currently experiencing a steady increase in the burden of non-communicable diseases, which account for more than 70% of total mortality, while environmental and lifestyle-related risk factors continue to intensify due to urbanization, climate change, and socioeconomic transformation. Integrating an exposome-based approach into preventive medicine would allow for a more comprehensive assessment of cumulative health risks and support evidence-based decision-making [5].

One of the key opportunities lies in incorporating exposomics into existing preventive healthcare frameworks. Uzbekistan has an established system of preventive examinations and population screening, which could be expanded to include exposure assessment tools, environmental data, and selected biological markers. The sanitary and epidemiological service plays a central role in this process, as it already conducts environmental monitoring of air, water, and soil quality. By integrating exposome-oriented data analysis, this service could move from hazard-specific surveillance to cumulative exposure assessment, improving early risk detection and prevention

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planning. For example, linking environmental monitoring data with health outcomes could help identify high-risk regions and population groups more accurately.

Exposomics also holds significant potential within primary healthcare. Primary care facilities are the first point of contact for the majority of the population, covering more than 85–90% of healthcare interactions annually. Integrating exposure history assessment, lifestyle monitoring, and digital health tools into primary care practice could enable early identification of harmful exposure patterns and timely preventive interventions. This approach aligns with the principles of people-centered care and could reduce long-term healthcare costs, as studies suggest that effective prevention may lower expenditures related to chronic disease management by up to 20–30%.

Successful implementation of exposomics requires substantial investment in human capital and interdisciplinary collaboration. Training healthcare professionals in environmental health, data analysis, and systems thinking is essential. Currently, limited exposure to exposomics-related disciplines exists in medical education curricula. Developing specialized training programs and fostering collaboration between clinicians, epidemiologists, environmental scientists, and data analysts would significantly enhance national capacity in this field.

Despite its promise, the adoption of exposomics faces several challenges. Methodological and technical complexities remain a major barrier, as exposome research relies on large-scale data integration, advanced analytical tools, and standardized protocols. Ethical and legal considerations related to data privacy, informed consent, and the use of personal health and environmental data also require careful regulation. Resource limitations, including insufficient laboratory infrastructure and limited access to advanced omics technologies, may further constrain large-scale implementation. Additionally, international exposomics frameworks must be adapted to local environmental, cultural, and socioeconomic contexts to ensure relevance and feasibility.

Looking ahead, future research priorities should focus on establishing national exposome studies tailored to Uzbekistan's regional characteristics. Developing exposome-oriented preventive programs that address environmental quality, lifestyle factors, and social determinants simultaneously could significantly enhance population health outcomes. The use of digital platforms, electronic health records, and national exposure registries would facilitate data integration and long-term monitoring. Ultimately, exposomics has the potential to support the sustainable development of the healthcare system by shifting the focus from disease treatment to comprehensive prevention, reducing health inequalities, and improving the overall resilience of public health in Uzbekistan [10, 11, 12].

In the long term, the integration of exposomics into the national healthcare strategy may contribute to measurable improvements in population health indicators and system efficiency. International evidence suggests that countries investing in exposure-oriented prevention achieve not only better health outcomes but also economic benefits. According to public health economic models, every unit of investment in preventive and environmental health interventions can yield a return of three to five units through reduced healthcare costs and increased productivity. For Uzbekistan, where healthcare expenditures related to chronic disease management are steadily increasing, the adoption of an exposome-based preventive framework could play a critical role in optimizing resource allocation [11,12].

Another important strategic direction is the gradual institutionalization of exposomics within national health policy. This includes incorporating exposure assessment indicators into public health reporting systems, integrating exposome-related metrics into national disease prevention

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programs, and supporting pilot projects at the regional level. Such initiatives would allow the feasibility and effectiveness of exposome-based interventions to be evaluated under real-world conditions. In addition, collaboration with international research networks and participation in multicenter exposome studies would facilitate knowledge transfer and methodological harmonization while ensuring alignment with global scientific standards.

From a sustainability perspective, exposomics aligns closely with the principles of the Sustainable Development Goals, particularly those related to health, environmental protection, and social equity. By addressing upstream determinants of health and reducing cumulative exposure burdens, exposomics supports long-term resilience of the healthcare system and contributes to narrowing health inequalities between regions and population groups. In this context, exposomics should be viewed not merely as a research innovation but as a strategic public health tool capable of guiding evidence-based policy, strengthening preventive medicine, and supporting the sustainable development of the healthcare system in Uzbekistan [13].

CONCLUSIONS: Exposomics represents a fundamental shift in the understanding and practice of preventive medicine by moving beyond traditional, reductionist models toward a comprehensive, life-course–oriented assessment of health determinants. This review demonstrates that the exposome framework, which integrates environmental, behavioral, social, and biological exposures, offers a more accurate and holistic explanation of disease etiology than approaches based solely on isolated risk factors. In the context of the twenty-first century, characterized by rapid urbanization, climate change, environmental degradation, and lifestyle transformation, exposomics provides a timely and scientifically robust response to emerging public health challenges.

The growing burden of non-communicable diseases, which account for more than 70% of global mortality, highlights the urgent need for innovative preventive strategies. Evidence discussed in this review indicates that cumulative and synergistic exposures contribute substantially to the development of cardiovascular diseases, metabolic disorders, cancer, and infectious pathology. By capturing these complex interactions, exposomics enables earlier identification of vulnerable populations and supports targeted interventions aimed at reducing overall exposure burden rather than addressing individual hazards in isolation. This paradigm shift has significant implications for improving the effectiveness and sustainability of prevention programs.

Importantly, exposomics also extends the scope of preventive medicine to include infectious diseases and immune-related conditions. Environmental quality, nutritional status, psychosocial stress, and microbiota composition collectively influence immune competence and susceptibility to infections. Integrating exposome data into epidemiological surveillance and public health monitoring systems enhances the ability to predict disease risks, respond to emerging threats, and design context-specific preventive measures. Thus, exposomics strengthens both chronic disease prevention and infectious disease control within a unified framework.

For Uzbekistan, the potential application of exposomics is particularly relevant. The country faces distinct environmental and climatic challenges, ongoing socioeconomic changes, and an increasing prevalence of chronic diseases. Adopting an exposome-based approach could enhance the existing preventive healthcare system by improving risk assessment, supporting evidence-based policy development, and optimizing resource allocation. The integration of exposomics into sanitary-epidemiological surveillance, primary healthcare, and national prevention programs may contribute to more equitable and efficient health outcomes across regions and population groups.

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Nevertheless, the implementation of exposomics requires careful consideration of methodological, technical, ethical, and organizational challenges. Limitations related to data availability, infrastructure, workforce capacity, and regulatory frameworks must be addressed through phased implementation, capacity building, and adaptation of international experience to local conditions. Interdisciplinary collaboration and investment in digital technologies, biomonitoring, and data analytics are essential to realize the full potential of exposomics.

In conclusion, exposomics should be regarded not only as an emerging research field but also as a strategic tool for modernizing preventive medicine and public health systems. Its adoption can facilitate a transition from reactive, disease-centered healthcare to proactive, prevention-oriented models focused on long-term population health. By embracing the exposome paradigm, Uzbekistan has the opportunity to strengthen preventive medicine, reduce health inequalities, and promote the sustainable development of its healthcare system in alignment with global public health priorities.

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