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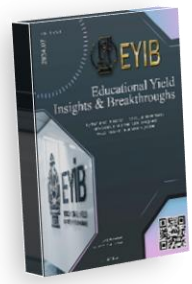

THE IMPACT OF SANITARY AND HYGIENIC CONDITIONS IN EDUCATIONAL INSTITUTIONS ON STUDENTS' HEALTH

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Annotatsiya

sanitary and hygienic conditions within educational institutions play a decisive role in shaping students' physical, mental, and functional health, particularly during periods of intensive growth, cognitive development, and socialization. Inadequate hygiene standards in schools and higher education institutions are associated with increased morbidity, reduced academic performance, chronic fatigue, and long-term health consequences that extend into adulthood. This study aims to comprehensively analyze the influence of sanitary and hygienic conditions in educational environments on students' health status, with particular attention to indoor microclimate parameters, lighting, ventilation, water supply, sanitation infrastructure, classroom density, and compliance with hygienic regulations. The relevance of the research is обусловлена by rapid urbanization, increasing student population density, aging educational infrastructure, and insufficient implementation of preventive hygiene measures in many educational settings. The methodological framework of the study is based on hygienic assessment, sanitary inspection data, health indicators analysis, and comparative evaluation of normative and actual conditions in educational institutions. The findings of this research are expected to provide scientifically substantiated evidence on the relationship between environmental hygiene and student health outcomes, contributing to the improvement of preventive strategies, regulatory compliance, and health-oriented educational policies. The results may be utilized by public health authorities, educational administrators, and healthcare professionals to enhance sanitary supervision systems and create safer, healthier learning environments that support sustainable student development.

Kalit so'zlar: educational institutions; sanitary and hygienic conditions; student health; school hygiene; preventive medicine; indoor environment; public health.

Introduction

The health of students is widely recognized as a fundamental indicator of societal well-being, national development potential, and the effectiveness of public health and education systems, as educational institutions represent environments in which

children, adolescents, and young adults spend a substantial proportion of their daily lives under conditions that directly influence their physical growth, functional capacity, and psycho-emotional stability. Modern educational processes are characterized by increased academic load, prolonged sedentary activities, intensive use of digital technologies, and high cognitive demands, which significantly amplify the role of sanitary and hygienic conditions as determining factors of students' adaptive capacity and resistance to adverse environmental influences. In this context, educational institutions must not only fulfill their pedagogical mission but also function as health-preserving environments that comply with established sanitary norms and hygienic standards aimed at preventing disease, reducing risk factors, and promoting optimal physiological development. Numerous epidemiological studies indicate that violations of sanitary and hygienic requirements in educational settings contribute to higher prevalence of acute respiratory infections, gastrointestinal disorders, visual impairment, musculoskeletal deformities, allergic conditions, and functional disorders of the nervous system among students, thereby emphasizing the critical importance of preventive hygiene as an integral component of educational policy and public health practice.

Sanitary and hygienic conditions in educational institutions encompass a complex set of environmental, organizational, and infrastructural factors, including classroom microclimate parameters such as air temperature, humidity, and air exchange rates; natural and artificial lighting adequacy; noise levels; availability and quality of drinking water; sanitation facilities; waste management; cleanliness of premises; classroom occupancy density; and compliance with hygienic regulations governing school schedules, breaks, and workload distribution. Each of these factors exerts both independent and synergistic effects on students' health, influencing immune function, cognitive performance, visual acuity, posture formation, and overall well-being. Insufficient ventilation and poor air quality lead to accumulation of carbon dioxide and microbial contamination, resulting in decreased attention span, headaches, fatigue, and increased susceptibility to infectious diseases. Inadequate lighting conditions are associated with visual strain and progression of refractive errors, while improper furniture and overcrowded classrooms contribute to postural disorders and chronic musculoskeletal complaints. From a hygienic perspective, the educational environment represents a controlled setting in which preventive measures can be effectively implemented to mitigate health risks, provided that sanitary standards are rigorously enforced and continuously monitored.

The relevance of this research is further intensified by contemporary socio-economic and urbanization trends, which have led to increased enrollment in educational institutions, especially in urban areas, often exceeding the design capacity of existing facilities. Aging infrastructure, insufficient funding for maintenance and modernization, and limited awareness of hygienic principles among educational staff contribute to persistent violations of sanitary requirements. Additionally, the COVID-19 pandemic has highlighted systemic weaknesses in sanitation, ventilation, and infection control practices within educational institutions, underscoring the necessity of revisiting and strengthening hygiene-based preventive frameworks. Post-pandemic educational environments require heightened attention to sanitation protocols, indoor

air quality, and health surveillance mechanisms to ensure resilience against both infectious and non-communicable health threats. In this regard, hygienic science serves as a critical link between environmental conditions and health outcomes, providing evidence-based guidance for risk assessment, regulation development, and health promotion strategies.

Despite the existence of comprehensive sanitary regulations and normative documents governing educational institutions, practical implementation often remains inconsistent, and compliance levels vary significantly depending on regional, institutional, and administrative factors. This discrepancy between normative requirements and actual conditions necessitates systematic scientific evaluation of sanitary and hygienic environments and their direct impact on students' health indicators. Such evaluation not only enables identification of priority risk factors but also supports the development of targeted interventions aimed at optimizing educational environments. Furthermore, the integration of hygienic assessment results into educational management decisions can enhance the effectiveness of preventive measures and contribute to the formation of health-oriented educational systems that prioritize student well-being alongside academic achievement.

The aim of the present study is to investigate the impact of sanitary and hygienic conditions in educational institutions on students' health by conducting a comprehensive hygienic assessment of learning environments and analyzing health-related indicators associated with environmental exposures. The objectives of the study include evaluating key sanitary parameters within educational facilities, identifying deviations from hygienic norms, assessing the prevalence of health disorders potentially linked to environmental conditions, and substantiating the role of hygiene-based preventive measures in improving student health outcomes. By addressing these objectives, the study seeks to contribute to the scientific evidence base supporting preventive medicine and school hygiene, offering practical recommendations for public health authorities, educational administrators, and healthcare professionals involved in safeguarding student health.

Materials and Methods

This study was designed as a comprehensive hygienic and epidemiological assessment aimed at evaluating the relationship between sanitary and hygienic conditions in educational institutions and students' health status, using a combination of environmental monitoring, sanitary inspections, and health indicator analysis conducted in selected general secondary and higher educational institutions. The research was carried out using a cross-sectional observational design, which allowed for simultaneous assessment of environmental parameters and health-related outcomes within the study population. The study sample included educational institutions differing in architectural design, capacity, and duration of operation, thereby ensuring representativeness of typical educational environments. Sanitary and hygienic assessment was performed in accordance with established national and international hygienic guidelines, focusing on key environmental factors such as indoor air temperature, relative humidity, air exchange rates, carbon dioxide concentration, illumination levels, noise intensity, classroom occupancy density, availability and condition of sanitation facilities, drinking water quality, and general cleanliness of

educational premises. Measurements of microclimate parameters were conducted using calibrated hygienic instruments under standardized conditions during the academic process, while lighting levels were assessed at students' work surfaces to determine compliance with normative illumination standards. Air quality assessment included evaluation of ventilation efficiency and indirect indicators of microbial contamination risk through carbon dioxide concentration analysis.

Health data were obtained through analysis of medical records, routine preventive examinations, and anonymized health reports maintained by educational medical services, ensuring ethical compliance and confidentiality. Health indicators analyzed in the study included incidence of acute respiratory infections, gastrointestinal disorders, visual impairments, musculoskeletal disorders, allergic conditions, and functional disorders associated with fatigue and reduced adaptive capacity. To establish potential associations between environmental conditions and health outcomes, students were grouped according to the level of compliance of their educational environment with sanitary and hygienic standards. Statistical analysis was performed using descriptive and comparative methods, including calculation of mean values, standard deviations, prevalence rates, and relative risk indicators, allowing for identification of significant deviations from hygienic norms and differences in health outcomes between groups exposed to favorable and unfavorable sanitary conditions. The hygienic risk assessment approach was applied to evaluate the contribution of specific environmental factors to observed health deviations, taking into account potential confounding variables such as age, duration of daily exposure, and academic workload.

Sanitary inspection data were analyzed to identify common violations of hygienic requirements and to assess the effectiveness of existing preventive measures within educational institutions. The methodological framework also included comparative analysis of normative sanitary requirements and actual measured values to determine the degree of compliance and identify priority areas for intervention. Ethical principles of biomedical research were strictly observed throughout the study, with all procedures conducted in accordance with applicable regulations and without direct intervention in the educational process. The chosen methodology ensured scientific validity, reproducibility, and relevance of the results, providing a robust basis for evaluating the impact of sanitary and hygienic conditions on students' health and for developing evidence-based recommendations aimed at improving preventive hygiene practices in educational institutions.

Results

The results of the hygienic assessment revealed that a substantial proportion of the examined educational institutions demonstrated partial or significant non-compliance with established sanitary and hygienic standards, which was reflected in both environmental parameters and students' health indicators. Analysis of indoor microclimate conditions showed that optimal air temperature and relative humidity levels were maintained in only a limited number of classrooms, while deviations from normative values were frequently observed, particularly during the cold season, when insufficient heating regulation and inadequate ventilation resulted in reduced air exchange rates and elevated carbon dioxide concentrations. In several institutions,

carbon dioxide levels exceeded recommended hygienic thresholds during prolonged classroom occupancy, indicating poor ventilation efficiency and increased risk of functional fatigue, reduced cognitive performance, and susceptibility to respiratory infections among students. Illumination measurements demonstrated that a considerable number of classrooms failed to meet hygienic requirements for natural and artificial lighting, with insufficient illumination at students' work surfaces being associated with increased prevalence of visual strain and early signs of refractive disorders. Noise level assessment indicated periodic exceedance of permissible limits in institutions located in densely populated urban areas, particularly those situated near major transportation routes, which contributed to heightened psycho-emotional stress and reduced concentration during the educational process.

The evaluation of sanitation infrastructure revealed variability in the availability and condition of sanitary facilities, including washrooms and drinking water supply systems, with deficiencies more pronounced in older buildings characterized by outdated engineering systems. In institutions where sanitation facilities were insufficient or poorly maintained, a higher incidence of gastrointestinal disorders and hygiene-related complaints was documented. Comparative analysis of classroom occupancy density indicated that overcrowding was a common issue, especially in urban schools with high enrollment rates, leading to reduced per-student space and unfavorable ergonomic conditions that negatively affected posture formation and musculoskeletal health. Health data analysis demonstrated that students exposed to educational environments with multiple sanitary violations exhibited higher prevalence rates of acute respiratory infections, functional fatigue syndromes, musculoskeletal complaints, and visual impairments compared to students studying in institutions with satisfactory hygienic conditions. Statistical comparison revealed a consistent trend of increased relative risk for selected health outcomes among students in environments characterized by poor air quality, inadequate lighting, and excessive classroom density.

Furthermore, the results indicated that institutions with systematic sanitary supervision and regular implementation of preventive hygiene measures showed significantly better compliance with hygienic standards and more favorable student health indicators. The application of hygienic risk assessment methods allowed for identification of priority environmental factors contributing most significantly to adverse health outcomes, with indoor air quality, lighting conditions, and classroom occupancy density emerging as the most influential determinants. The findings highlight a clear association between the level of sanitary and hygienic compliance in educational institutions and the health status of students, underscoring the importance of continuous environmental monitoring, timely corrective measures, and integration of hygienic principles into educational management practices. Overall, the results provide empirical evidence supporting the critical role of sanitary and hygienic conditions in shaping students' health and functional capacity, thereby justifying the need for strengthened preventive strategies within educational systems.

Discussion

The findings of the present study confirm that sanitary and hygienic conditions in educational institutions constitute a critical determinant of students' health status and functional capacity, which is consistent with the fundamental principles of

preventive medicine and school hygiene. The observed associations between unfavorable indoor microclimate parameters, inadequate lighting, excessive classroom occupancy density, and increased prevalence of respiratory, visual, musculoskeletal, and functional disorders align with previously reported evidence indicating that prolonged exposure to substandard educational environments undermines adaptive mechanisms and contributes to the development of both acute and chronic health conditions. Poor ventilation and elevated carbon dioxide concentrations, identified as prevalent issues in the examined institutions, have been widely recognized as factors that impair cognitive performance, increase fatigue, and facilitate the spread of infectious agents, particularly in densely populated classrooms. Similarly, insufficient illumination and improper lighting design are well-established contributors to visual strain and the progression of refractive errors, especially among school-aged children and adolescents whose visual systems are still developing. The results of this study reinforce the concept that environmental hygiene in educational settings should be regarded not merely as a technical or regulatory requirement but as a fundamental component of health promotion and disease prevention strategies.

The discussion of sanitation infrastructure and water supply conditions further emphasizes the importance of basic hygienic amenities in safeguarding student health, as deficiencies in these areas were associated with higher rates of gastrointestinal disorders and hygiene-related complaints. This finding underscores the interconnected nature of environmental and behavioral hygiene, whereby inadequate facilities limit students' ability to maintain personal hygiene and increase vulnerability to preventable diseases. Overcrowding and insufficient ergonomic conditions, identified as common challenges in urban educational institutions, were shown to negatively influence musculoskeletal health and posture formation, highlighting the long-term implications of educational environment design on physical development. From a public health perspective, these issues are particularly concerning, as early musculoskeletal disorders and functional impairments may persist into adulthood, contributing to reduced quality of life and increased healthcare burden.

The comparative analysis of institutions with varying levels of sanitary supervision revealed that systematic monitoring and timely implementation of preventive measures significantly improve compliance with hygienic standards and mitigate health risks. This observation supports the effectiveness of hygiene-based management approaches and the role of interdisciplinary collaboration between public health authorities, educational administrators, and medical professionals. The COVID-19 pandemic has further demonstrated the vulnerability of educational institutions to health crises when sanitation and ventilation systems are inadequate, thereby reinforcing the relevance of the present findings in the context of post-pandemic recovery and resilience building. Strengthening indoor air quality management, enhancing sanitation protocols, and reducing classroom overcrowding should therefore be considered priority interventions in the development of health-oriented educational policies.

Despite the strengths of the study, including its comprehensive hygienic assessment and integration of environmental and health data, certain limitations should be acknowledged. The cross-sectional design precludes definitive conclusions

regarding causality, and the influence of individual behavioral factors and socio-economic variables could not be fully controlled. Nevertheless, the consistency of the observed associations and their alignment with established hygienic principles provide strong support for the validity of the findings. Future research should focus on longitudinal studies and intervention-based designs to further elucidate causal relationships and evaluate the effectiveness of targeted hygiene improvement measures. Overall, the discussion highlights that ensuring optimal sanitary and hygienic conditions in educational institutions is a scientifically substantiated and economically justified strategy for protecting student health, enhancing academic performance, and promoting sustainable human development.

Conclusion

The present study demonstrates that sanitary and hygienic conditions in educational institutions exert a significant and multifaceted influence on students' health, functional capacity, and overall well-being, confirming the central role of environmental hygiene in preventive medicine and public health practice. The findings indicate that deviations from hygienic standards in indoor microclimate parameters, lighting, ventilation, sanitation infrastructure, and classroom occupancy density are associated with increased prevalence of respiratory infections, visual impairments, musculoskeletal disorders, functional fatigue, and reduced adaptive capacity among students. These results underscore that educational environments should be regarded as critical determinants of health rather than neutral settings for academic activity. The study highlights that systematic sanitary supervision, regular environmental monitoring, and timely implementation of preventive measures substantially improve compliance with hygienic norms and contribute to more favorable health outcomes. From a strategic perspective, improving sanitary and hygienic conditions in educational institutions represents a cost-effective and scientifically justified investment in human capital, as it supports healthy development, enhances academic performance, and reduces long-term healthcare burdens. The integration of hygiene-based principles into educational management and public health policy is therefore essential for creating sustainable, health-oriented educational systems capable of meeting contemporary challenges, including increased urbanization and post-pandemic resilience requirements.

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