Proximus Journal of Sports Science and Physical Education
Volume 2, Issue 12, December, 2025
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

THE USE OF ULTRAVIOLET RADIATION IN THE FIELD OF PHYSICAL EDUCATION AND SPORTS

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Abstract

In all levels of the existing sports education system in Uzbekistan, as well as in sports clubs and privately operated sports facilities, ensuring the disinfection of air and equipment surfaces through the use of ultraviolet radiation, creating a hygienic and healthy environment free from microbes and infections for participants with minimal labor input, preventing the spread of infectious diseases, and educating young people to comply with general and personal hygiene rules are among the most pressing issues of today.

To address these challenges, the technology titled "The Use of Ultraviolet Radiation in the Field of Physical Education and Sports" has been developed.

Keywords: Ultraviolet radiation, Light waves, Biochemical, Radiation spectrum, Wavelength range, Atmosphere, Bacteria and microbes, Hygiene, Standards, Regulations, Hygienic standards, Hygienic norms, Sanitary regulations, Sanitation rules, Sterilization, Ultraviolet (UV) irradiation, Quartz lamp irradiation, Skin diseases, Depression.

Practical Significance and Relevance

Ultraviolet (UV) radiation ensures the proper functioning of the immune system, combats disease-causing bacteria and microbes, and improves the body's endocrine system. The use of ultraviolet radiation is widely applied in the treatment of skin diseases and muscle inflammations, as well as in the purification of air and water in sports facilities and gymnasiums, and in creating a hygienic and healthy environment for athletes. Its significance lies in its broad applicability, cost-effectiveness, and the fact that it does not require excessive labor resources.

Providing a scientific solution to existing challenges demonstrates that ultraviolet radiation can be widely used in the sports sector, including:

- Preschool educational institutions;
- General secondary schools;
- Sports schools;
- Olympic and Paralympic training centers;
- Higher education institutions;
- Private sector facilities (fitness centers, gyms, and sports wellness centers);
- Swimming pools, where it serves as an effective and economically efficient method for water purification and the elimination of various microbes, bacteria, and viruses.

Expected Results and Their Significance

Within the framework of the project, a scientifically grounded database on the microclimate and hygienic conditions of Olympic and Paralympic sports facilities in Uzbekistan will be created. Based on this data, a methodology adapted to local conditions will be developed for the application of highly effective ultraviolet radiation technologies widely used in international practice without chemical agents. Clear practical recommendations for implementation will also be formulated.

Scientific Significance

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The scientific significance of the project results lies in conducting comprehensive studies in various regions of the republic focusing on sports education institutions, sports facilities, and the medical condition of athletes. The hygienic condition of sports facilities will be determined based on laboratory analysis of collected samples. As a result of scientific research and experimental studies, data on athletes' health status, the hygienic condition of sports facilities, and air purity within these facilities will be obtained. Guidelines will be developed for coaches, instructors, and methodologists working with different sports disciplines. This will enable the identification of hygienic conditions in sports facilities, the resolution of existing hygiene-related problems, and the establishment of a scientifically grounded software-based system aimed at ensuring hygienic preparation of athletes for national and international competitions. The project is aligned with international "green technology" trends and expands the scientific and practical foundations for reducing the use of chemical reagents in sports hygiene. A justified solution for creating a safe environment to protect athletes' health and enhance performance outcomes will be proposed.

Technological Significance

A scientifically based methodology for disinfecting water, air, and surfaces using ultraviolet radiation will be developed, taking into account the type, size, and intensity of use of sports facilities. Optimal radiation doses, exposure times, and safety measures will be precisely defined. The project will result in the creation of a ready-to-use ultraviolet-based disinfection technology tailored for Olympic and Paralympic sports facilities. This technology will include scientific analyses based on laboratory data regarding the microbiological condition of sports halls and swimming pools, optimal operational modes, and practical safety recommendations. Additionally, a pilot-scale experimental and industrial prototype tested under local conditions will be developed. The methodology will be supported by modern modeling and testing approaches, ensuring consistency between theoretical and applied research results. This will contribute to preparing sports facilities for training activities and creating the necessary hygienic conditions for athletes to achieve high sports performance.

Socio-Economic Significance

Based on the project results, an environmentally clean and hygienically safe system will be developed for preparing athletes in sports facilities and gyms free from microbes and bacteria. This system will be economically efficient and will not require extensive labor resources. The project will promote broader participation of individuals with disabilities in parasports, support their social inclusion, and enhance integration into society. It will also foster the development of national values, ethical behavior, general and personal hygiene practices, and patriotism among youth. A software-based hygienic management system for athlete preparation will be created. Economically, the project will reduce expenses by minimizing the purchase of costly imported chemical disinfectants such as chlorine and biocides. Frequent water replacement in swimming pools will no longer be necessary, while modern ultraviolet devices consume minimal electrical energy. The ultraviolet-based process also saves human resources and time.

Commercialization Prospects

Commercialization of the project involves transforming its scientific results into market-oriented, revenue-generating services and products. The primary commercial product will be the establishment of a hygienic safety audit service. This service will include laboratory sampling of water, air, and surfaces at sports facilities, data analysis, risk assessment, and the provision of scientifically justified conclusions. Facilities that successfully pass the audit will receive a "Safety Passport/Certificate" confirming compliance with high sanitary standards, which will serve as an effective marketing and image-building tool. Additionally, consulting services for modernization will be offered, providing technical recommendations and project-based solutions to address identified deficiencies.

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Plan for Intellectual Property Creation and Protection

Within the project, a technology for ultraviolet-based disinfection will be developed, taking into account the specific characteristics of sports facilities. An original name and logo will be created for the developed technology or service, and registration documents will be prepared and submitted to the Intellectual Property Agency to ensure legal protection.

Project Objectives and Tasks

The main objective of the project is to address a critical scientific problem associated with the negative impact of traditional chemical disinfection methods on athletes' health and their insufficient effectiveness in physical education and sports facilities. Specifically, the project aims to develop an innovative, highly effective, safe, and resource-efficient ultraviolet (UV) radiation–based disinfection technology, fully adapted to the specific operating conditions of sports facilities (high humidity, intensive air circulation, and high human traffic), along with a practical methodology for its application.

The target structure of the project demonstrates a comprehensive approach to solving an urgent scientific problem related to ensuring hygienic safety in sports facilities. Each objective is aimed at achieving clearly defined and measurable outcomes at specific stages of the project. The overarching goal envisions transforming scientific knowledge into a practical, commercially viable, and socially significant product. To achieve this main objective, the project requires the sequential implementation of four interrelated tactical objectives.

First Objective: Establishing the Scientific Basis of the Problem

Any technological solution must be grounded in precise scientific data. Within this objective, the project focuses on an in-depth study of the hygienic conditions of sports facilities. Research activities include collecting air, water, and surface samples from sports halls, swimming pools, and auxiliary premises of Olympic and Paralympic training centers. These samples will be analyzed using modern laboratory methods, including bacteriological culturing and microscopy, to identify the types, concentrations, and distribution patterns of pathogenic and opportunistic microorganisms.

The expected outcome of this objective is the creation of a new, systematized scientific database on the level and composition of microbiological contamination in sports facilities across Uzbekistan. This database will serve as a scientific foundation to ensure that the developed technology is data-driven, targeted, and effective.

Second Objective: Development of an Innovative Technological Solution

Based on the scientific data obtained under the first objective, a tangible technological solution to the problem will be developed. This includes calculating and defining optimal ultraviolet radiation parameters (wavelength, dose, and exposure time) for different zones of sports facilities.

Unlike standard approaches, a two-stage hybrid disinfection technology will be developed. The first stage involves targeted ultraviolet radiation emitted directly from the device. The second, innovative stage involves the use of photocatalytic nanocoatings (e.g., titanium dioxide, TiO_2) applied to the device itself and to high-risk surfaces within sports facilities (such as door handles and sports equipment). Under UV exposure, these coatings create a strong oxidative environment on surfaces, providing a long-term, residual (prolonged) antimicrobial effect. This enables continuous low-intensity operation without sensors, effectively eliminating microorganisms on surfaces.

Based on this approach, optimal UV radiation parameters (wavelength, dose, exposure time, and photocatalytic reaction efficiency) will be calculated and developed for various zones of sports facilities. The expected result is a functional prototype of an innovative UV-based disinfection technology capable of automatically disinfecting air, water, and surfaces safely and without human involvement.

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Third Objective: Experimental Validation of Technological Effectiveness

The third objective involves scientifically validating the effectiveness of the developed prototype by verifying its compliance with theoretical calculations and specified requirements through experimental testing. The prototype will be tested under laboratory conditions against various strains of microorganisms. Additionally, the technology will be tested in real sports facilities (pilot sites) to assess its bactericidal effectiveness.

Based on the obtained results, hygienic standards, technical regulations, and methodological guidelines for the use of the technology will be developed. Within the project framework, test reports confirming high efficiency (up to 99.9%) will be prepared, along with practical recommendations for large-scale implementation.

Fourth Objective: Commercialization and Protection of Results

To ensure the long-term economic sustainability of the developed scientific and technological solution, internal and external markets for the technology will be studied, and its import substitution and export potential will be assessed. Patents for inventions, copyrights for software and databases, and trademarks for the technology brand will be registered. The economic efficiency of the innovation will be calculated, and a business plan for market entry will be developed.

The intellectual property portfolio and the products developed based on it will be commercialized. The consistent and interrelated implementation of these four tactical objectives guarantees the achievement of the project's main strategic goal. This approach ensures a complete innovation cycle—from scientific research to the creation of a market-ready, competitive, and legally protected product.

Project Tasks

The primary task of the project team is to develop a scientifically grounded technology that ensures epidemiological safety in sports facilities without relying on traditional chemical methods that have adverse effects.

As a result, a new scientific and technological product will be obtained: a UV radiation–based disinfection technology adapted to the specific conditions of sports facilities (humidity, airflow, and microorganism types), along with its functional prototypes.

To achieve this, the following interrelated tasks are defined:

- Conduct comprehensive laboratory analyses to determine microbiological contamination levels and pathogenic microflora composition of air, water, and surfaces in various Olympic and Paralympic sports facilities (sports halls, swimming pools, locker rooms).
- Analyze global best practices and scientific literature on UV-based disinfection technologies to identify the most effective technical and technological solutions.
- Scientifically substantiate hygienic standards by determining optimal bactericidal UV doses, wavelengths, and exposure times under specific sports facility conditions (humidity, airflow, temperature).
- Design and develop an experimental UV disinfection device capable of comprehensive air, water, and surface treatment based on identified parameters.
- Test the developed prototype under laboratory and real operating conditions to scientifically and practically validate its technical characteristics and bactericidal effectiveness.
- Achieve technical effectiveness (up to 99.9% bactericidal efficiency), automatic operation without human involvement, and transition from labor-intensive chemical methods to safe, environmentally friendly physical technologies.
- Ensure technical and economic efficiency by reducing the use of expensive chemical reagents, saving water and electricity, and lowering facility maintenance costs.

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- Conduct market analysis and commercialization activities for the technology and related services within domestic sectors (sports complexes, fitness clubs, swimming pools, educational and medical institutions).
- Develop a competitive local product to replace imported high-tech equipment currently supplied from countries such as Germany, China, and Russia, with future export potential to Central Asian markets.
- Formulate a market strategy based on a comprehensive service package: "Sanitary and Hygienic Audit + Technology Training + Service Support."
- Secure intellectual property rights through patents for technical solutions, copyright protection for databases, and trademark registration for the technology name.

The developed UV-based disinfection technology demonstrates high efficiency by eliminating up to 99.9% of pathogenic microorganisms (bacteria, viruses, fungi) from air, water, and surfaces while operating automatically in a safe mode. The technology allows automatic adjustment of UV dose and exposure time based on facility size and type, enables simultaneous disinfection of air, surfaces, and water, and reduces operational costs through energy-efficient UV lamps and optimized operating modes.

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