METHODOLOGY FOR DEVELOPING PREVENTIVE THINKING AND EPIDEMIOLOGICAL RISK MANAGEMENT COMPETENCE IN TEACHING INFECTIOUS DISEASES TO FUTURE DOCTORS

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Abstract. *The rapid global spread of infectious diseases and emerging epidemiological threats necessitate the development of preventive thinking and epidemiological risk management competencies among future physicians. This study aims to design and evaluate an integrative pedagogical methodology based on digital technologies, simulation training, and clinical-epidemiological case analysis. A quasi-experimental study was conducted among 320 medical students divided into control (n=160) and experimental (n=160) groups. The intervention incorporated problem-based learning (PBL), virtual patient simulations, and AI-supported epidemiological modeling tools. Results demonstrated a statistically significant improvement in preventive thinking (from 48% to 81%) and epidemiological risk assessment skills (from 45% to 78%) in the experimental group compared to the control group. The proposed methodology enhances clinical reasoning, decision-making, and preparedness for public health emergencies.*

Keywords: *preventive thinking, epidemiological risk management, infectious diseases education, digital learning, simulation, medical pedagogy.*

Introduction

In the context of globalization, increased population mobility, and the emergence of pandemics such as COVID-19, infectious diseases remain a critical challenge for healthcare systems worldwide. According to the World Health Organization, over 60% of emerging infectious diseases are zoonotic, and nearly 75% of new pathogens have epidemic potential. These trends highlight the urgent need to reform medical education, shifting from knowledge-based models toward competency-based frameworks that prioritize preventive and epidemiological thinking. Traditional teaching approaches in infectious diseases often focus on theoretical knowledge and clinical treatment, while insufficient attention is paid to prevention strategies, risk assessment, and epidemiological decision-making.

Therefore, integrating modern pedagogical approaches—such as competency-based medical education (CBME), digital simulation, and data-driven epidemiology—is essential. Objective: To develop and evaluate a methodology for enhancing preventive thinking and epidemiological risk management competence among medical students through integrative and digital pedagogical technologies.

Methods

This study was conducted using a quasi-experimental design during the 2024–2025 academic year. A total of 320 medical students were divided into control (n=160) and experimental (n=160) groups. The control group was taught using traditional methods, while the experimental group was trained through an integrative methodology based on competency-based medical

education, problem-based learning, simulation technologies, and AI-supported epidemiological tools.

The intervention focused on developing preventive thinking and epidemiological risk management through a stepwise approach: data analysis, problem identification, risk assessment, clinical decision-making, and reflection. Digital tools such as virtual patients, epidemiological dashboards, and simulation platforms were actively used in the learning process. Students' competencies were assessed using OSCE, scenario-based tests, and analytical rubrics. The collected data were analyzed using statistical methods (t-test) with a significance level of $p < 0.05$.

Scientific novelty: The methodology integrates digital simulation and AI-based epidemiological modeling into infectious diseases education, providing a structured approach to developing preventive and decision-making competencies.

Results

The implementation of the integrative, competency-based methodology demonstrated a statistically significant improvement in the development of preventive thinking and epidemiological risk management competencies among students in the experimental group compared to the control group. Specifically, the level of preventive thinking in the experimental group increased from 48% at baseline to 81% after the intervention, while epidemiological risk assessment skills improved from 45% to 78%. Clinical decision-making competence in infectious disease scenarios also showed notable growth, rising from 47% to 80%. In contrast, the control group, which followed traditional teaching methods, exhibited only moderate improvements ranging between 10–15% across all measured indicators.

In OSCE-based assessments, students in the experimental group demonstrated significantly higher performance, particularly in tasks related to outbreak investigation, infection control planning, and risk stratification. Their responses were more structured, evidence-based, and aligned with epidemiological principles. Additionally, scenario-based testing revealed that experimental group students were more effective in identifying sources of infection, predicting transmission pathways, and selecting appropriate preventive strategies. Digital learning analytics further indicated higher engagement and faster decision-making among students exposed to simulation and AI-supported tools. Over 75–80% of participants reported increased confidence in managing infectious disease risks and applying preventive measures in clinical practice.

Scientific significance: The results confirm that the integration of simulation technologies, problem-based learning, and AI-supported epidemiological modeling significantly enhances not only knowledge acquisition but also higher-order competencies such as predictive analysis, risk evaluation, and evidence-based clinical decision-making in infectious diseases education.

Discussion

The findings of this study confirm that developing preventive thinking and epidemiological risk management competence requires a shift from traditional knowledge-based teaching to an integrative, competency-oriented approach. The results are consistent with modern concepts of competency-based medical education (CBME) and constructivist learning theory, where students actively construct knowledge through clinical and epidemiological problem-solving.

From a methodological perspective, the proposed approach functions through a sequential learning cycle: data analysis, risk identification, decision-making, reflection. This structure mirrors real clinical and public health workflows, enabling students to integrate theoretical knowledge with practical application. The inclusion of simulation technologies and AI-based tools enhances situational awareness and supports evidence-based decision-making in complex epidemiological

contexts. Compared to conventional teaching methods, which are often limited to passive learning, the integrative methodology promotes higher-order cognitive skills, including analytical thinking, prediction, and risk evaluation. This explains the significant improvement observed in the experimental group.

Scientific novelty: The study demonstrates the effectiveness of combining simulation-based learning with AI-supported epidemiological modeling within a unified pedagogical framework. This approach not only improves clinical competence but also prepares future doctors for real-world challenges such as pandemics and public health emergencies.

Conclusion

The study demonstrates that the integrative methodology based on digital technologies, simulation, and competency-based approaches significantly enhances preventive thinking and epidemiological risk management competencies among future doctors. The proposed model ensures effective integration of theoretical knowledge with practical clinical and epidemiological decision-making. The methodological approach operates through a structured sequence—data analysis, risk assessment, decision-making, and reflection—thereby aligning the educational process with real-world healthcare practice. As a result, students develop not only clinical reasoning but also predictive and preventive skills essential for managing infectious diseases. Scientific significance: The novelty of the study lies in the integration of AI-supported epidemiological modeling and simulation-based learning into infectious diseases education, providing a modern, scalable, and effective framework for training future physicians in conditions of global epidemiological challenges.

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