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Original Article

Monitoring and evaluation of infection control in healthcare organizations: a retrospective study

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ABSTRACT

The foundation of patient and healthcare worker safety depends on Infection prevention and control (IPC) especially when dealing with new infectious diseases and worldwide pandemics like COVID-19. Healthcare institutions need to evaluate their IPC systems because this process reveals important weaknesses that lead to better public health results. The research evaluated IPC practices together with bacteriological risk profiles in public and private healthcare facilities throughout Osh Kyrgyzstan for three years. A retrospective cross-sectional study was conducted across 25 healthcare institutions (18 public and 7 private) in Osh from 2021 to 2023. The facilities were selected through stratified purposive sampling to represent both urban and rural contexts. Quantitative data were obtained from institutional records, laboratory surveillance, and standardized IPC audit checklists developed under the Kyrgyz Ministry of Health's Order No. 1062. Data sources included the Regional State Center for Disease Prevention and the State Sanitary and Epidemiological Surveillance Service. Bacteriological data included microbial culture results, antimicrobial resistance profiles, and infection rates from clinical specimens. Analytical methods included time-series analysis, chi-square tests, multivariate regression, and thematic coding of qualitative audit data. The research showed that IPC compliance remained inconsistent, especially in public healthcare facilities where Staphylococcus aureus and other bacterial contamination levels were high. The private healthcare facilities showed better compliance with IPC standards but instrument sterility and mold growth issues were detected. Osh's public health needs immediate IPC improvements using contemporary sterilisation, staff training, and surveillance. Public health requires IPC framework strengthening in all sectors to prevent hospital-acquired infections.

Keywords: Infection prevention and control (IPC), Healthcare-associated infections (HAIs), Antimicrobial resistance (AMR), Public vs. Private healthcare, Bacteriological surveillance

Introduction

Access this article online	
Website: www.japer.in	**E-ISSN:** 2249-3379

How to cite this article: Akzholtoevna AA, Talgatovich DT, Tilenovna TU, Omurzhanovna MA, Kozmanbetovna TA, Kamalovna AA, et al. Monitoring and evaluation of infection control in healthcare organizations: a retrospective study. J Adv Pharm Educ Res. 2025;15(1):114-23. https://doi.org/10.51847/lKPoGCPw5j

The COVID-19 pandemic permanently transformed worldwide priorities which made infection prevention and control (IPC) essential for building resilient healthcare systems. The implementation of effective IPC serves as a protective measure for society because it prevents healthcare-associated infections (HAIs) which cause economic instability and resource depletion and damage public trust [1]. IPC functions as a scientific policy-based human behavior system that requires both strong infrastructure and widespread attention to safety. The WHO's Infection Prevention and Control Assessment Framework (IPCAF) presents modern frameworks that focus on three-

layered approaches including real-time epidemiological surveillance and adaptive staffing models and environments designed to reduce risks [2, 3]. The pandemic revealed that even sophisticated healthcare systems have weaknesses that airborne pathogens use to penetrate their defenses. The practice of IPC now represents a healthcare system's moral dedication to protecting patients and staff while ensuring fair treatment for all members of society. The combination of past failure lessons with innovative approaches has become essential for IPC development because antimicrobial resistance and new pathogens threaten healthcare systems.

Systemic gaps in IPC continue to exist worldwide which creates obstacles for healthcare safety and efficiency. The 2021 IPCAF evaluation in Armenia revealed this contradiction because hospitals received high scores for structural elements including infrastructure (75.5 points) and staffing (75.2) yet their HAI surveillance (54.7) and staff training (59.5) received low scores. The implementation of IPC protocols in Kazakhstan shows how policy and practice remain separate entities [4, 5]. The ongoing preventable harms result from these shortcomings because HAIs affect millions of patients each year while healthcare systems spend 12% of their budget on patient harm and 2% on staff injuries. The existing workload burden on frontline staff creates two major risks of both occupational infections and emotional exhaustion that intensify staffing shortages. Most IPC programs operate on a reactive basis which means they focus on short-term outbreak responses instead of developing enduring capacity-building initiatives [6]. Underfunded training combined with outdated surveillance tools in resource-limited settings creates larger equity gaps. The consequences of weak IPC reach beyond healthcare because it damages public trust during emergencies as demonstrated by COVID-19 vaccine hesitancy. The existence of these gaps represents an existential requirement for both pandemic readiness and universal health security [7].

The research study has the power to transform Kyrgyzstan's healthcare system by solving existing problems in infection prevention and control (IPC) which compromise both patient safety and resource efficiency. The WHO's IPCAF promotes multi-component IPC strategies yet Kyrgyzstan's healthcare institutions face challenges from underfunded infrastructure fragmented surveillance and insufficient staff training which the COVID-19 pandemic has intensified. The research evaluates Kyrgyzstan's IPC performance using IPCAF tools to reveal specific challenges such as inadequate HAI monitoring systems and irregular antimicrobial stewardship protocol adherence which result in preventable illnesses and financial losses [8]. The improvement of IPC training for healthcare workers represents a critical area in Kyrgyzstan that needs more attention because it would decrease occupational infections among staff members who face challenges from migration and understaffing [9]. Real-time epidemiological surveillance enhancement would allow for rapid outbreak detection which would prevent expensive hospital-acquired infections that consume 10–15% of limited healthcare budgets in low-resource settings. The research establishes a method to combine Kyrgyzstan's IPC policies with international standards while preserving local requirements. The implementation of digital reporting systems for HAI tracking would resolve data collection issues while international agency partnerships would fund infrastructure improvements including airborne infection control in crowded facilities [10]. The research presents economic data about IPC investments which helps policymakers allocate funds to the most impactful interventions. The research shows how IPC functions as a fundamental element for achieving national health targets including pandemic readiness and antimicrobial resistance (AMR) control which are vital for Kyrgyzstan's aging population and its high tuberculosis prevalence. The research offers Kyrgyzstan operational strategies to develop a resilient healthcare system that will endure future emergencies.

Materials and Methods

Study design and setting

The research used a retrospective cross-sectional design to study 25 medical organizations in Kyrgyzstan which included 18 public facilities and 7 private facilities to assess IPC compliance and bacteriological profiles from 2021 to 2023. The study design used quantitative analysis of secondary data from institutional records and bacteriological laboratories together with standardized checklists for compliance audits. The researchers used stratified purposive sampling to select facilities that included urban and rural areas tertiary care hospitals and primary health centers. The researchers selected this time period to study IPC practices after the pandemic and monitor the development of antimicrobial resistance (AMR).

Data sources and sampling

The research team obtained primary data from two governmental organizations: the Regional State Center for Disease Prevention (RSDC) which supplied aggregated healthcare-associated infections (HAIs) reports and outbreak alerts and staff vaccination rates and the State Sanitary and Epidemiological Surveillance Service (SSES) which handled facility-level infection control audits and AMR surveillance. The bacteriological data consisted of microbial culture results together with antibiotic susceptibility profiles and incidence rates of multidrug-resistant organisms (MDROs) from clinical specimens including blood, urine, and wound swabs.

Data collection instruments and analytical approach

The assessment of IPC protocols followed checklists which the Kyrgyz Ministry of Health established through Order No. 1062 on December 15, 2020, to implement WHO-recommended standards. The analysis of data was performed using SPSS v.28 and RStudio. Time-series analysis evaluated temporal patterns while chi-square tests evaluated IPC adherence differences between public and private sectors. The multivariate regression analysis determined which factors such as staffing ratios or

infrastructure gaps led to non-compliance. The thematic coding of audit report qualitative data provided a contextual understanding of the quantitative research results. The analysis linked bacteriological data to compliance scores to detect relationships between protocol violations and pathogen spread.

Ethical considerations

The Ethical Review Committee at Osh State University in Osh City, Kyrgyzstan, waived ethical approval for this study, which was conducted using retrospective data. All procedures met the ethical standards of both the institutional and national research committees, and they were carried out in accordance with the principles of the Declaration of Helsinki, which ensured the safety of human participants and the confidentiality of their data [11].

The research was divided into two separate sections which worked together to evaluate the development of infection control practices in Kyrgyzstan's healthcare system. Stage 1 evaluated infection control compliance at 25 public and private medical organizations through standardized checklists based on the Kyrgyz Ministry of Health's Order No. 1062 (2020). The research period covered both pandemic years (2021–2022) and post-pandemic year (2023) to evaluate institutional preparedness and adaptability and sustainability of protocols over time. The audit process used checklists to evaluate eight fundamental areas including hand hygiene and sterilization PPE use waste management, environmental cleaning, HAI reporting, staff training, and antimicrobial stewardship. The State Sanitary and Epidemiological Surveillance Service (SSES) inspectors who received training performed unanticipated site visits to reduce observation bias while documenting actual protocol adherence.

Results and Discussion

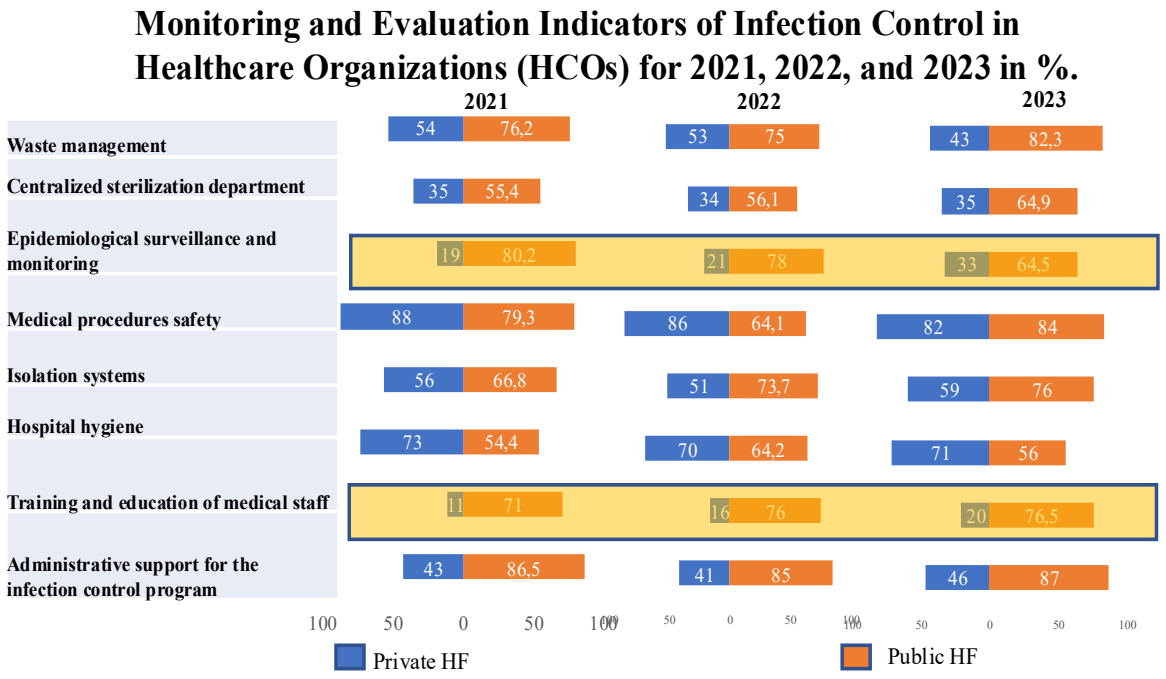

Figure 1. Indicators of monitoring and evaluation of IC in healthcare for 2021, 2022, and 2023 in %.

Administrative support for infection control (IC) programs

The administrative support for IC initiatives followed different paths between public healthcare organizations and private healthcare organizations **(Figure 1)**. The public institutions maintained strong support for IC initiatives as their compliance rates remained steady at 86.5% in 2021 before decreasing slightly to 85% in 2022 because of pandemic-related resource shifts and then recovering to 87% in 2023. The health system's continuous support for IC reflects its established position in national healthcare strategies which gained additional backing from post-pandemic policy changes. Private medical centers started with lower IC compliance at 42.5% in 2021 but showed increasing awareness of IC operational and reputational benefits through their progress to 46% by 2023. The ongoing difference between public and private healthcare institutions demonstrates how public institutions receive centralized mandates yet private entities lack corresponding accountability systems [12].

Education and training of medical personnel in IC

The public healthcare facilities made continuous progress in IC training through compliance growth from 71% in 2021 to 76.5% in 2023 because of established post-COVID-19 capacity-building programs. The private centers showed alarming low engagement levels through their declining participation rates

from 11.2% to 10% during this period. The different educational frameworks between public and private sectors reveal systemic inequalities because private sector training depends on sporadic programs which profit-driven goals make less important thus creating essential knowledge deficits. The stagnation demonstrates an immediate requirement for standardized IC curricula to be mandated in private institutions because it will reduce the risks of protocol nonadherence [13].

Hospital hygiene standards

Public institutions showed unstable hygiene compliance rates which increased from 54.4% in 2021 to 64.3% in 2022 because of pandemic-era sanitation infrastructure investments but then decreased to 56% in 2023 when emergency funding ended. Private facilities demonstrated steadily higher adherence levels from 73% in 2021 to 71% in 2023 because of their smaller operational size and strict internal audit processes. The public sector's decline in hygiene compliance reveals long-term sustainability issues in areas with limited resources because their aging infrastructure and staffing shortages make it difficult to achieve lasting hygiene improvements [14].

Isolation protocol implementation

Public institutions made significant progress in isolation measures because they increased their isolation rates from 66.8% in 2021 to 76% in 2023 to address airborne transmission after the pandemic. The compliance rates of private centers showed inconsistent patterns between 2021 and 2023 (56% in 2021, 51% in 2022, and 58.7% in 2023) because of changing patient numbers and different levels of spatial protocol enforcement. The public sector achieved better results in implementing WHO-recommended isolation frameworks but private facilities need adaptable modular strategies to handle changing clinical requirements [15].

Safety of medical procedures

Public hospital procedural safety experienced significant changes between 2021 and 2023 with 79.3% in 2021, 64.1% in 2022, and 84% in 2023 due to pandemic-related disruptions in staffing and supply chains which were later recovered through standardized safety checklists. The private institutions showed high but decreasing compliance rates from 87.8% to 82% which could be due to post-pandemic complacency or resource reallocation to non-IC priorities. The trends demonstrate how safety improvements remain vulnerable to collapse when protocol monitoring receives inadequate ongoing financial support [16].

Epidemiological surveillance systems

The compliance rate for public sector surveillance decreased from 80.2% in 2021 to 64.5% in 2023 because reporting systems became overwhelmed and funding decreased after the pandemic. Private centers demonstrated limited improvement from their 2021 baseline of 9% to reach 12.5% in 2023 yet their ongoing poor performance indicates that profit-driven models do not adequately value data-driven IC management [17].

Centralized sterilization infrastructure

The public healthcare system showed a severe deficiency because centralized sterilization remained almost non-existent due to inadequate funding and poor infrastructure maintenance [18, 19]. The private facilities reached a stable yet incomplete level of compliance at 35% which focused on profitable departments thus requiring sterilization hubs that unite public and private sectors to reduce iatrogenic transmission risks [20].

Medical waste management

Public institutions made steady improvements (76.2% to 82.3%) because of national waste disposal regulations and donor-supported incinerator installations. The private centers showed a decline (53.6% to 43.3%) which might be caused by cost reduction strategies or weak regulatory enforcement. The difference between these two groups demonstrates how policy enforcement affects the maintenance of IC advancements [21].

In the second stage of the study, swab samples were analyzed from different surfaces and instruments to detect coliform bacteria mold and Staphylococcus aureus. The selected microbial indicators served as indicators for hygiene and infection control practices in healthcare settings [22-27]. The laboratory results showed that private medical organizations had better epidemiological profiles because they maintained lower contamination levels in most parameters. The sterilization protocols at private institutions failed to meet expectations because their sterile instrument contamination rates exceeded expected levels. Public medical institutions showed higher microbial contamination levels than private institutions which emphasizes the immediate need to strengthen sanitary and hygienic practices. The implementation of ongoing training for healthcare staff combined with modern sterilization and disinfection methods and improved medical tool processing equipment and clinical environment infrastructure is essential to reduce healthcare-associated infections and enhance patient safety **(Figure 2)** [28].

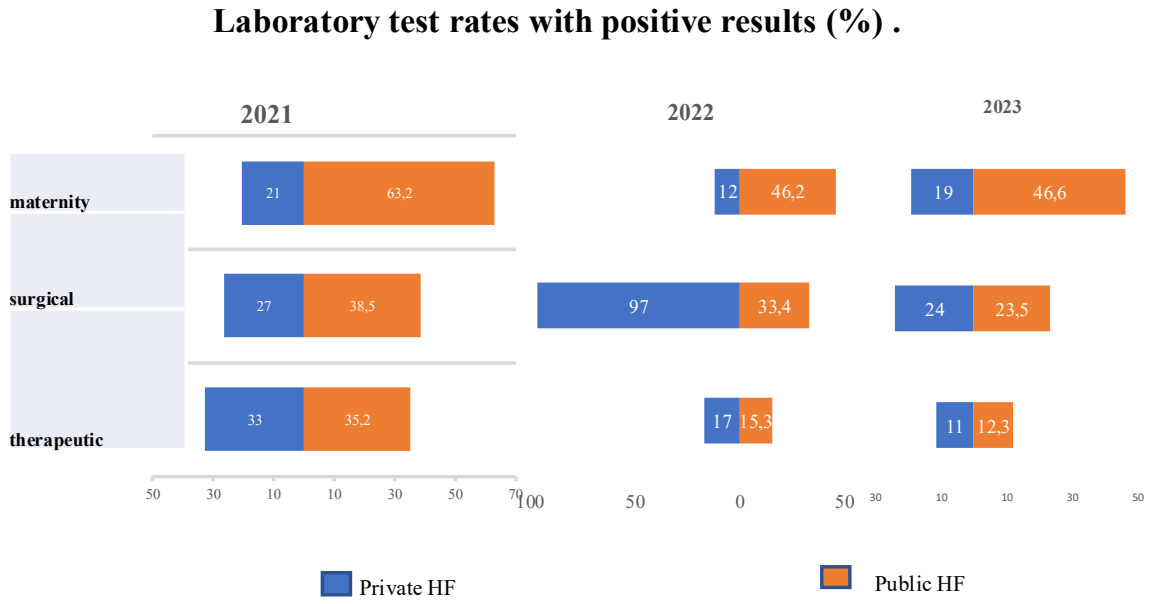

Figure 2. The figure presents comparative laboratory test positivity rates (%) for maternity, surgical, and therapeutic departments in public and private healthcare facilities (HF) from 2021 to 2023. The values show annual trends and sector-specific differences in infection control efficacy.

Our findings show that public and private healthcare facilities have significantly different approaches to infection control program implementation **(Figure 2)**. Public facilities perform better in administrative support, staff training, and waste management, but sterilization procedures and epidemiological surveillance could be improved. Private facilities consistently outperform public facilities in terms of hospital hygiene and medical procedure safety, but educational programs and epidemiological monitoring require significant improvement.

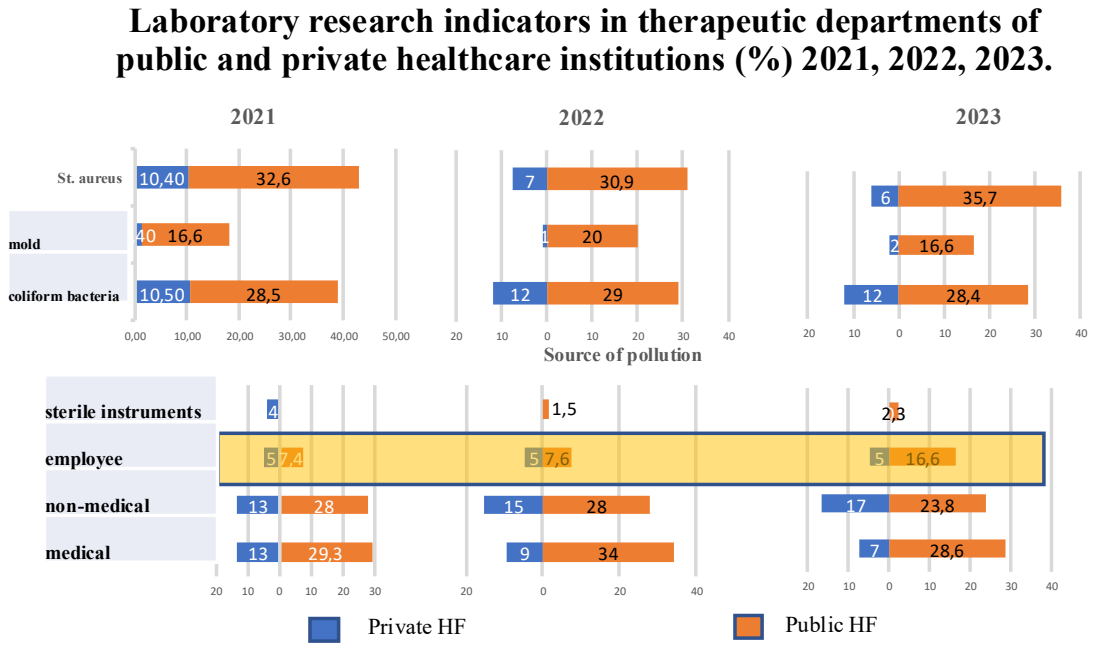

Figure 3. Laboratory test indicators in therapeutic departments of public and private healthcare institutions (%) for the years 2021, 2022, and 2023.

Medical equipment remains the primary source of bacterial contamination, with contamination rates in public institutions significantly higher (up to 39.1%) than in private institutions (up to 35%). If we discuss the sources of bacterial contamination, non-medical surfaces in public institutions are also more frequently contaminated than in private institutions, necessitating better cleaning and treatment of the premises. Contamination from employees and sterile instruments was most common in public institutions, albeit on a small scale **(Figure 3)**.

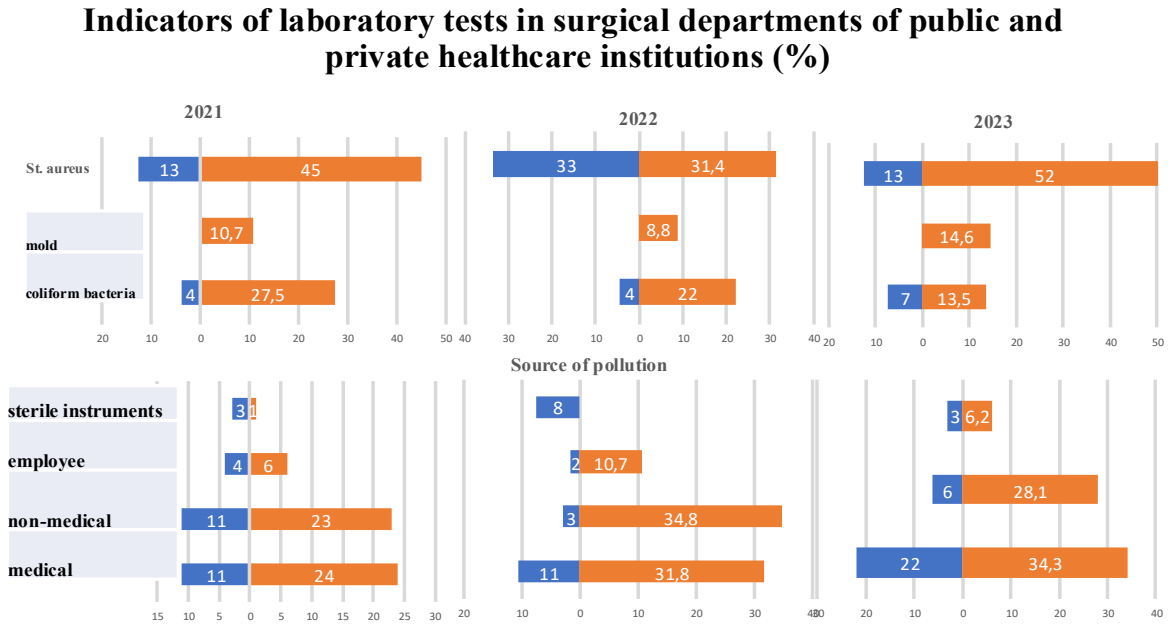

Figure 4. Laboratory test indicators in surgical departments of public and private healthcare facilities (%).

Public surgical departments experienced a significant decline in sanitary conditions during 2023 because Staphylococcus aureus contamination increased among medical staff and equipment. The observed trend demonstrates increasing worries about infection control measures and hospital-acquired infections in these facilities. Private healthcare institutions maintained lower bacteriological contamination levels because they followed better general hygiene practices. The facilities need enhanced oversight to maintain surgical instrument sterility while preventing mold growth which continues to be a problem. The research data shows a concerning rise in nosocomial infection risks that affect public surgical departments. The situation demands immediate implementation of complete infection prevention strategies which must include enhanced sterilization protocol enforcement regular microbial testing continuous staff training and modernized infection control systems to protect patients and enhance clinical results **(Figure 4)**.

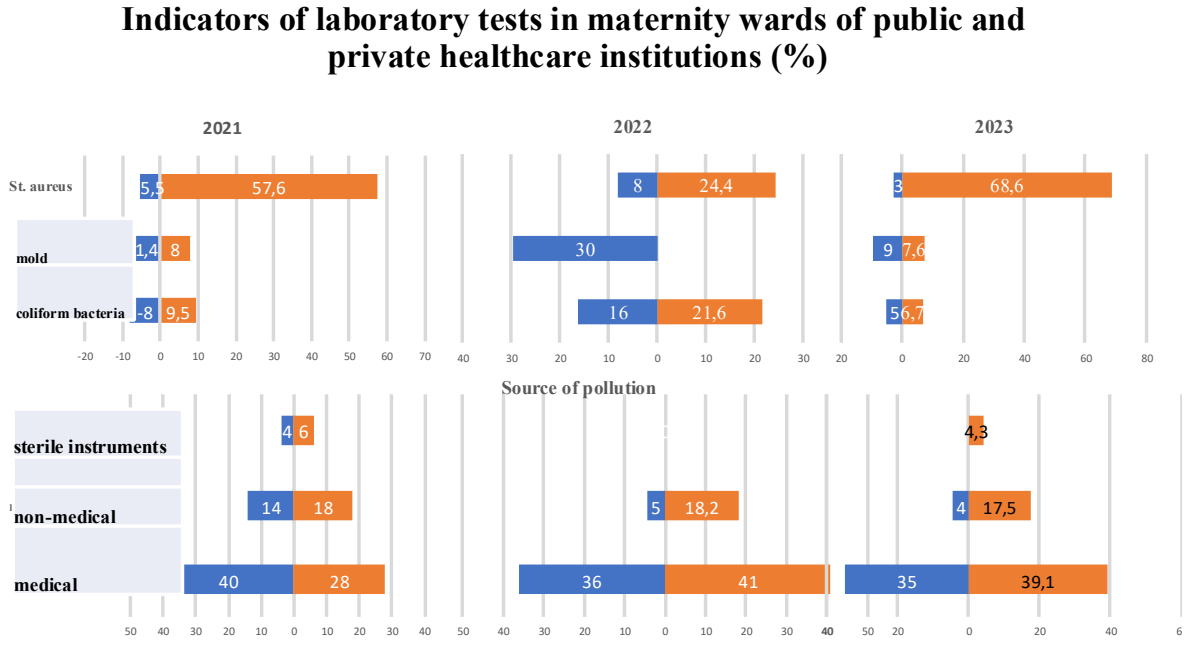

Figure 5. Laboratory test indicators in maternity wards of public and private healthcare facilities (%).

The continued presence of Staphylococcus aureus bacteria in maternity hospitals creates a major public health problem. The percentage of positive test samples showed an upward trend from 57.5% in 2021 to 68.6% in 2023 throughout the study period. The rising numbers show that maternity care facilities are experiencing deteriorating epidemiological conditions. Medical instruments serve as the main source of contamination because they make up more than 40% of bacterial presence cases which

demonstrates inadequate sterilization and equipment handling procedures. The bacteriological contamination in public maternity wards showed a significant increase in 2023 according to the data which included Staphylococcus aureus and coliform bacteria. The research demonstrates that healthcare facilities need immediate implementation of enhanced infection prevention and control (IPC) measures through better disinfection practices microbiological monitoring and ongoing staff training **(Figure 5)** [29].

Private maternity facilities maintained better bacteriological results through lower pathogenic contamination rates across all measured indicators [30-36]. The mold proliferation during 2022 exceeded previous years which indicated environmental control and maintenance practice failures at that time [37-41]. The main sources of microbial contamination in public institutions were medical equipment and non-medical surfaces which demonstrate widespread hygiene challenges throughout maternity care facilities. Public sector facilities require a comprehensive strategy to enhance IPC infrastructure and practice because of their current limitations [42].

Future recommendations

The research results demonstrate both institutional inequalities and widespread problems that affect healthcare facility infection control throughout Kyrgyzstan. The higher contamination rates in public institutions indicate multiple barriers including insufficient funding insufficient staff-to-patient ratios outdated equipment and weak IPC guideline enforcement. Private institutions generally show better results but the 2022 mold outbreak demonstrates that well-funded facilities remain vulnerable to environmental health threats. A comprehensive solution must integrate infrastructure development with policy changes staff training and continuous assessment to achieve lasting improvements in patient safety and infection control practices.

Strengthening sterilization protocols

Public health institutions need to focus on modernizing sterilization units to achieve international standards for autoclaving and other disinfection technologies. The implementation of regular audits and sterilization procedure certification should be established [43].

Regular microbiological monitoring

The organization should establish a required testing schedule for swabs and bacteriological assessments that includes medical and environmental surfaces. The collected data needs to be sent to a central location for quality improvement planning purposes [44].

Capacity building and staff training

Public healthcare facilities need to establish continuous professional development programs that focus on infection control as a standard practice. The programs should concentrate on hand hygiene practices equipment handling methods and contamination risk education [45].

Infrastructure improvement

Public health facilities require investment to modernize their maternity and surgical wards. The facilities need updated ventilation systems new equipment and better clinical environment designs to enhance infection control practices [46].

Environmental controls

Private institutions need to establish strong systems for air and humidity control to stop mold growth. The environmental surveillance system needs to expand its monitoring to include fungi together with other airborne pathogens [47].

Conclusion

Healthcare institutions in Osh city use infection control as their fundamental patient safety practice. The research findings demonstrate the operational excellence and operational challenges between public and private healthcare facilities through their evaluation of healthcare systems that aim to minimize harm during patient care delivery. The study results show that public healthcare facilities in Osh City need complete improvements in their infection control planning and execution along with monitoring practices. Medical institutions require immediate action to enhance their sanitation protocols equipment sterilization procedures staff training and epidemiological surveillance systems. Public facilities show continued contamination of medical instruments together with non-medical surfaces because their operational systems lack proper oversight which threatens patient safety. The COVID-19 pandemic established a critical moment for improving infection control standards in both public and private healthcare facilities. The pandemic triggered both public and private healthcare facilities to increase their compliance with infection control procedures which became more noticeable after the crisis. The present forward movement needs to continue while policy-makers should support this development through sustained investment in infection control infrastructure. Bacteriological surveillance data revealed that private clinics showed lower rates of opportunistic pathogens due to their consistent sterilization and environmental hygiene practices. The detection of Staphylococcus aureus and coliform bacteria continued to be a problem in public facilities indicating a need for specific interventions. The wide differences in infection control effectiveness demonstrate why Kyrgyzstan needs a single national healthcare strategy. Evidence-based standardized protocols along with administrative oversight and regular performance audits will help eliminate existing quality differences. Medical institutions should establish an educational framework that turns infection control into a core professional practice for enhancing clinical excellence. Maintaining ongoing training in infection control is a basic custom that public and private healthcare

facilities have to follow to guarantee the health safety of patients and medical staff as well as newborns. By applying consistent policies with improved training and unified monitoring systems, Kyrgyzstan's healthcare system can advance safety and equity in medical treatment delivery.

Acknowledgments: All authors would like to thank Osh State University for providing support and research infrastructure.

Conflict of interest: None

Financial support: None

Ethics statement: This study was performed in line with the principles of the Declaration of Helsinki.

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