Multidisciplinary Output Research For Actual and International Issue (MORFAI Journal) ISSN (e): 2808-6635
Volumes 5 No. 2 (2025)

MITIGATION STRATEGIES IN INDONESIAN HOSPITALS FOR INFECTIOUS DISEASE PREVENTION

Indra Sari[1*], Pudji Lestari[2]
[1]Department of Health Policy and Administration, Faculty of Public Health, Universitas Airlangga, Indonesia
[2]Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga, Indonesia
Coresponden author: in.sari-2022@fkm.unair.ac.id

Received	: 07 March 2025	Published	: 13 May 2025
Revised	: 21 March 2025	DOI	: https://doi.org/10.54443/morfai.v5i2.2925
Accepted	: 17 April 2025	Link Publish	: https://radjapublika.com/index.php/MORFAI/article/view/2925

Abstract

Background: Indoor air pollution poses significant health risks. Prolonged exposure in contaminated environments heightens disease transmission risks. The COVID-19 pandemic has underscored the urgency for effective ventilation and air quality management in hospitals. Purpose: This study investigates the relationship between environmental factors (temperature, humidity, lighting, occupancy density, and airborne germ counts) and airborne microbiology control in hospital rooms. It aims to establish a secure air management system to reduce infectious disease transmission and provide references for hospital mitigation strategies. Review: This article method uses the systemic review. Information is taken from e-book sources, websites, and search engines. After filtering and adjusting the research variables, 12 articles were analyzed, consisting of 6 from google scholar articles and 6 articles from the Science Direct database. A systematic review examined (1) Airborne Transmission and Mitigation Strategies, (2) Infection Control in Healthcare Settings, (3) Infectious Disease Prevention and Early Detection, and (4) Specific Contexts and Impact of Infectious Diseases. It highlights the importance of ventilation, temperature control, humidity regulation, air cleanliness, and air pressure settings in minimizing infection risks. Result: The review indicates that effective ventilation, appropriate temperature, humidity, and air cleanliness (filtration) are essential for maintaining indoor air quality and reducing infection risks. Conclusion: Environmental factors are critical in controlling infectious disease transmission in hospitals. Effective air management systems are vital for the health and safety of patients, healthcare workers, and visitors. This study provides valuable insights into hospital mitigation strategies and emphasizes the need for continuous attention to air quality standards to prevent future outbreaks.

Keywords: ***Strategy, Hospital mitigation and Infectious diseases.***

INTRODUCTION

Indoor air pollution significantly risks human health, both directly and indirectly. Many office buildings and public facilities rely on air conditioning, which contributes to air pollution. The longer people stay in a contaminated enclosed space, the higher the risk of disease transmission. Immediate health impacts include eye and nasal irritation, sore throat, headaches, nausea, fatigue, and viral diseases like COVID-19. Long-term exposure can increase the risk of cardiorespiratory death and chronic diseases. Whereas in short term exposure and repeated particle pollution has been shown to worsen pre-existing pulmonary and cardiovascular disease and increase the number who became ill, requare medical treatment or die. (Arfin *et al.*, 2023).

According to the United States Environmental Protection Agency (EPA), indoor air pollution is 2 to 10 times more hazardous than outdoor pollution, while the majority of people spend 80 to 90 percent of their time indoors. The previous study indicated that indoor equipment accounts for 17% of pollution, while outdoor pollution contributes 11%, building materials 3%, microbes 5%, ventilation issues 52%, and unknown sources 12%. A WHO study found that approximately 8.7% of 55 hospitals across 14 countries from Europe, the Middle East, Southeast Asia, and the Pacific reported nosocomial infections, with Southeast Asia reporting 10.0%. Additionally, a survey indicated that 1.4 million people worldwide suffer from infections acquired during hospital care(Sarah, Bayhakki and Fathra Annis, 2016).

From 2020 to 2022, there were frequent reports of the deaths of hospital staff due to COVID-19 infections. The Indonesian Medical Association (IDI) noted that the mortality rate of healthcare workers in Indonesia is among the highest in the world. COVID-19 transmission is known to occur primarily through droplets (80-85%) and, to a lesser extent, aerosols(Kohanski, Palmer and Cohen, 2020). The success of transmission is influenced by other factors, such as the air circulation (ventilation) in the area and the duration of exposure. Studies on COVID-19 clusters show that in enclosed spaces, transmission can occur even with a two-meter distance. Key factors are air circulation and length of exposure (Morawska and Cao, 2020).

Virologists used previous virus transmission data to estimate the number of viruses released by different activities. They found that breathing releases 20 virus copies per minute, talking releases 200 copies per minute, and coughing or sneezing releases 200 million copies per instance. About 1000 virus copies are needed for a human infection (Bromage *et al.*, 2020). Masks can reduce virus exposure, but the reduction varies by mask type and exposure time. Therefore, spending an hour in an air-conditioned restaurant with a COVID-19 carrier poses a higher infection risk than briefly passing a carrier in an open park, with air circulation in the restaurant being a critical factor.

The situation in hospitals warrants particular attention regarding the risk of transmission. The risk of transmission is indeed elevated in hospitals, as these are the primary locations for treating patients. In certain hospitals, the highest transmission rates are observed not among those directly caring for patients in specialized isolation rooms, but rather among healthcare workers who had no direct contact with patients, including administrative staff. Although it remains uncertain whether these healthcare workers contracted the virus within the hospital or if the infection source was consistently the patients, there is a consensus that hospitals serve as a 'hotspot' for COVID-19 transmission. The loss of healthcare workers is particularly detrimental, as it not only results in fatalities but also significantly diminishes the healthcare system's capacity to manage the pandemic effectively.

Based on the explanations provided earlier, hospitals play a crucial role in the transmission of various infectious diseases. It's important to study how factors like temperature, humidity, lighting, occupancy density, and airborne germs in hospital rooms affect this spread. This study endeavors to provide an extensive reference for hospital mitigation strategies to manage pandemics and stop the transmission of infectious diseases.

LITERATURE STUDY

This study employs a systematic review method to address questions concerning air quality standards and health requirements for hospital rooms in Indonesia. A systematic review was conducted by searching the PubMed and MEDLINE databases using keywords related to "mitigation strategies," "hospital management," and "infectious disease." The research is a systematic review with a literature approach. It is done by collecting information from the library, reading it, evaluating it, and pouring it into written form. The information and citations used come from textbooks, literature reviews, scientific publications in domestic and foreign journals, and other sources. The writing of this method uses literature searching. Information is taken from E-book sources, websites and search engines. The source of the E-book used is one that contains information about hospital mitigation strategies in Indonesia in the prevention of infectious diseases. In terms of searching for data on hospital mitigation strategies in Indonesia in the prevention of infectious diseases used comes from Google Scholar. The final list of references was compiled based on the following classifications: (1) Airborne Transmission and Mitigation Strategies, (2) Infection Control in Healthcare Settings, (3) Infectious Disease Prevention and Early Detection, and (4) Specific Contexts and Impact of Infectious Diseases. Then, the mitigation strategy for air management standards of hospital rooms in Indonesia was reviewed based on aspects related to the four classifications of mitigation strategies for the spread of infectious diseases.

Airborne transmission and mitigation strategies

The literature on airborne transmission and mitigation strategies is extensive. Morawska and Cao (2020) stress the importance of national authorities recognizing the airborne transmission of SARS-CoV-2 and improving ventilation to remove virus-laden droplets indoors. Kek et al. (2023) highlight the need for optimized ventilation, Computational Fluid Dynamics (CFD) analysis, and understanding airborne particle behavior to reduce infections in healthcare settings. Wang et al. (2022) show how patient flow, medical service capacity, and clinic layout impact infection risks, especially in fever clinics. Enwemeka, Bumah, and Masson-Meyers (2020) explore using blue and red light technologies to reduce coronavirus infections, suggesting these could enhance healthcare strategies. Together, these studies offer a comprehensive view of effective ways to mitigate airborne transmission in healthcare environments.

The keywords used from the research question are 'Hospital Mitigation Strategy in Indonesia in Prevention of Infectious Diseases'. The inclusion criteria for the search for scientific articles include: (1) Articles from peer-reviewed journals that present original research results discussing hospital mitigation strategies and prevention of infectious diseases, (2) Written in English, (3) Published in >2020; and (4) Available as full-text articles. The article search was conducted on two databases, namely ScienceDirect and Google Scholar. After filtering and adjusting the research variables, 12 articles were obtained for analysis, consisting of 6 articles from Google Scholar and 6 articles from the Science Direct database (Figure 1).

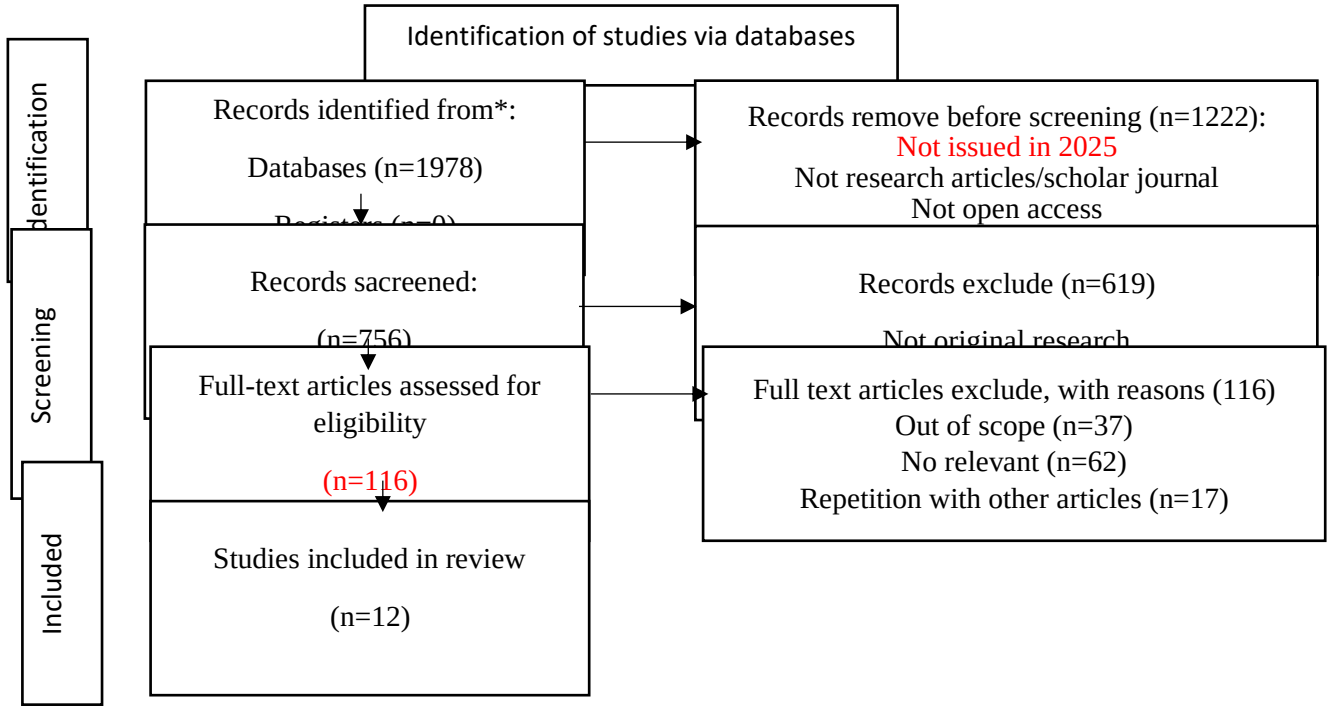

Figure 1. The summary of Identification and selection of studies

Infection control in healthcare settings

Comprehensive literature on preventing intra-hospital infection among healthcare workers emphasizes various strategies and measures. The study by (Gan, Lim and Koh, 2020) discusses the Systems Engineering Initiative for Patient Safety model, focusing on work tasks, technologies, tools, environmental factors, and organizational conditions to achieve zero occupational infection. (Yen *et al.*, 2020) highlights the use of enhanced traffic control bundling (eTCB) to protect residents and staff in long-term care facilities, adapting hospital strategies to these settings.

Further exploring infection control, (Alqahtani *et al.*, 2020) exploring the impact of training programs and guidelines related to hand hygiene compliance and reducing the prevalence of HCAIs (healthcare – assosiated infections) can reduce costs and prevent infections in healthcare. Similarly, (Garcia *et al.*, 2022) identify 3 practices as important facilitators in preventing HAIs. First, executive leadership which emphasizes open communication between leadership and staff to make changes. Second, share information through the system in conveying, displaying and discussing relevant infection data. and the third involves management coaching by providing feedback to staff to carry out management care to carry out the correct clinical care process.

The study by (Risma and Popi, 2023) identifies key factors for successful infection prevention and Control (IPC) programs is by improving their knowledge of IPC and be trained in firmness of attitude, maintaining support from the environment to maintain and increase their ability to apply IPC. IPC programs are supported by adequate human resources that meet their competencies and supported by the implementation of evidence-based strategies. Complementing this, (Robinson *et al.*, 2023) concluding there are 5 main factors that are very important of infection prevention and control (IPC) services to prevent threats from healthcare-associated infections and improve the quality of health services in hospitals. Namely service priorities, service supporting factors for success, required skills, expertise, and effective IPC services.

(Shang *et al.*, 2014) expands the focus to home health care settings, identifying high infection rates associated with indwelling devices and complex illnesses, and stressing the need for tailored infection control

measures and improved communication between healthcare facilities. Meanwhile, (Bennett *et al.*, 2023)examines the impact of the Delta variant on LTCFs, highlighting the role of vaccination and adherence to mitigation measures in controlling outbreaks.

Finally, the (Wee *et al.*, 2021) demonstrates the effectiveness of a comprehensive infection control strategy implemented across a large healthcare campus, successfully reducing nosocomial transmission of COVID-19 and other respiratory viruses. The study by (Kubde *et al.*, 2023), there is a need for a strong strategy to protect patients, health workers and the public from HAIs with best practices such as strict hand hygiene, use of PPE, environmental cleanliness, surveillance and innovative technology with AI systems and UV disinfection.

Collectively, these studies provide a robust understanding of effective strategies to mitigate intra-hospital infection, emphasizing the importance of tailored infection control measures, education, and infrastructure in various healthcare settings.

Infectious disease prevention and early detection

Preventing emerging infectious diseases is crucial for infectious disease control. A mini review emphasizes the need to invest in three key areas: animals, human sentinels for spillover events, and the general population. These areas address different surveillance gaps and together form a strong prevention strategy (Ellwanger, Kaminski, and Chies, 2019). Early detection of outbreaks is vital to reduce illness and death. A systematic review identified factors affecting how quickly outbreaks are detected, but despite significant investments, more research is needed to improve surveillance systems and guide interventions (Steele, Orefuwa, and Dickmann, 2016).

Effective public health responses require timely data and predictive models. Studies optimized infectious disease models to predict COVID-19 (Xiong, Hu and Wang, 2021). Singapore's three-pronged approach—covering travel, healthcare, and community—was effective in curbing the virus(Lee and Ong, 2020; Koo *et al.*, 2020). China's success can be attributed to adaptive government to change situation, built the culture of moral compliance with rules, trusted collaboration between the government and their people, and collaborate the advance technical framework with AI, block chain, cloud computing ang big data. (Wang, Yan and Boasson, 2020).

Specific contexts and impact of infectious diseases

In the context of infection control standards, a study from the Royal Prima Marelan Hospital describes the process of establishing and implementing these standards, highlighting the involvement of Infection Control Teams (ICTs) and relevant healthcare are the variables of knowledge, motivation, supervision and workload (Sahputra, Girsang and Napiah Nasution, 2023). This study emphasizes the importance of extensive consultation and collaboration among healthcare professionals in developing robust infection control protocols.

Furthermore, a population-based study conducted in Western Australia investigated the long-term effects of burns on immune function and subsequent infectious disease morbidity(Duke *et al.*, 2017). This research found that individuals with burn injuries experienced significantly higher rates of hospital admissions and longer hospital stays due to infectious diseases compared to uninjured individuals.

Another innovative approach to managing infectious disease outbreaks is the drive-through model for patient evaluation during pandemics. A study tested this model during the H1N1 influenza outbreak, demonstrating its feasibility and effectiveness in reducing cross-infection risks by using patients' vehicles as placed in single isolation, room with airborne precaution. Besides that, prevent contact with body fluids and aerosols generated, and strict adherence to hand hygiene protocols. Open communication amoung members the interpersonal health care is essential to reduce morbidity and mortality (Jilani *et al.*, 2024).

Lastly, the impact of climate change on human infectious diseases has been a subject of significant research. A comprehensive review of empirical evidence reveals that climate change exacerbates existing health threats, influencing the spread and incidence of infectious diseases(Wu *et al.*, 2016). The review highlights the need for adaptive measures, such as improved prediction models, early warning systems, and proactive public health strategies to mitigate the health impacts of climate change.

RESULT

The results of the analysis of the 12 articles are described in several sub-discussions, including: (1) Airborne Transmission and Mitigation Strategies, (2) Infection Control in Healthcare Settings, (3) Infectious Disease Prevention and Early Detection, and (4) Specific Contexts and Impact of Infectious Diseases. It highlights the importance of ventilation, temperature control, humidity regulation, air cleanliness, and air pressure settings in minimizing infection risks. It appears that the articles analyzed focused more on research on hospital mitigation strategies in preventing infectious diseases.

Judging from the research method, it can be seen that almost half of all articles discussing hospital mitigation strategies and prevention of infectious diseases using qualitative methods and comprehensive literature searches using databases. The results of the analysis of the year of writing of the articles studied were limited to original peer-reviewed articles in English. The literature highlights various factors influencing infectious disease control and underscores the need for innovative approaches in healthcare settings. In response to COVID-19, the Indonesian government has reorganized the hospital air management system through Minister of Health Regulation Number 7 of 2019 (Kementerian Kesehatan Republik, 2019) which regulates air quality standards and air health requirements, which consist of several parameters that need to be controlled, namely the amount of ventilation air/Air Change per Hour (ACH), temperature regulation, air humidity, air cleanliness level (filtration) and positive and/or negative air pressure in the room as well as air distribution in the room. The following sub-section will explained each of these parameters.

Table 1. Results of literature review

No	Authors	Title	Method	Result
1	Alqahtani, A. N., Almaghrabi, R. H., Albaadani, M. M., & Almossa, K. (2020).	Impact of Infection Control Training Program in Improving the Quality of Healthcare	Qualitative research methods. This study Applied to many health institutions and healthcare employees in the Kingdom of Saudi Arabia,	Analysis that improve quality of healthcare through control training program, IPC training program improve hand hygiene compliance and reduces the HAIs prevalence, improves patient outcomes and reduces healthcare costs, training of all the persons involved in primary healthcare may fill the IPC gaps.
2	Bennett, C. C., Welton, M., Bos, J., Moon, G., Berkley, A., Kavlak, L., Pearson, J., Turabelidze, G., Frazier, J., Fehrenbach, N. and Brown, C. K. (2023)	'Assessment of COVID-19 outbreaks in long-term care facilities',	Outbreaks of COVID-19 in 178 LTCFs were identified by the Missouri Department of Health and Senior Services. Case data from LTCFs with the highest burden of disease were analysed to assess disease transmission, vaccination status, and outcomes among residents and staff.	During April 22nd to July 29th, 2021, 159 COVID-19 cases among 72 staff members and 87 residents were identified in 10 LTCFs. More than 74.7% of resident cases were vaccinated compared to 23.6% of staff cases. Vaccinated residents had a lower proportion of hospitalizations and deaths reported compared to unvaccinated residents. Data analysis and contact-tracing efforts from a sample of the facilities suggest that staff members were likely a major factor in introducing SARS-CoV-2 virus into the facilities. Adherence to COVID-19 mitigation measures varied at the visited facilities.
3	Gan, W. H., Lim, J. W. and Koh, D. (2020)	'Preventing Intra-hospital Infection and Transmission of Coronavirus Disease 2019 in Health-care Workers'	Qualitative research methods. This study was conducted on Thousands of health care workers have been infected, mainly in China.	Based on the Systems Engineering Initiative for Patient Safety model, the strategies and measures to protect health-care workers in an acute tertiary hospital are described along the domains of work task, technologies and tools, work environmental factors, and organizational conditions. The principle of zero occupational infection remains an achievable goal that all health-care systems need to strive for in the face of a potential pandemic.
4	(Tan et al. 2023)	Mitigating the impacts of the COVID-19 pandemic on vulnerable populations: Lessons for improving health and social equity	This study examines various programmatic tools and policy measures used by governments to support vulnerable populations during the pandemic. A comparative case study of 15 countries	While a spectrum of mitigation strategies has been deployed to address different vulnerabilities, these efforts within countries were rarely enough to protect vulnerable populations comprehensively. Notably, less visible and hidden populations such as migrant workers, refugees, sex workers, prisoners and people with disabilities were largely neglected in formal policy responses.

No	Authors	Title	Method	Result
			representing all World Health Organization's regions offers a comprehensive picture of countries with varying income statuses, health system arrangements and COVID-19 public health measures.	This paper presents specific recommendations that are focused and targeted when approaching different types of vulnerabilities impacting different vulnerable populations. Instrumentally, countries need to use this pandemic as a window of opportunity to prioritise the right to UHC for vulnerable populations, including determining the basic level of health services that should be made available, accessible and acceptable by all. The overlapping vulnerabilities experienced by the vulnerable populations also call for more policy attention toward the social, economic and political determinants of health during the pandemic. This should include follow-up interventions to strengthen social protection policies to safeguard the vulnerable populations' social, economic and cultural rights guided by equity principles. Only by positioning vulnerable populations at the forefront of national responses and equitably integrating them into health systems can we build a more resilient health system that can ably and effectively withstand external shocks resulting from future public health emergencies.
5	Koo, J. R., Cook, A. R., Park, M., Sun, Y., Sun, H., Lim, J. T., Tam, C. and Dickens, B. L. (2020)	'Interventions to mitigate early spread of SARS-CoV-2 in Singapore: a modelling study'	We adapted an influenza epidemic simulation model to estimate the likelihood of human-to-human transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in a simulated Singaporean population. Using this model, we estimated the cumulative number of SARS-CoV-2 infections at 80 days, after detection of 100 cases of community transmission, under three infectivity scenarios (basic reproduction number [R_0] of 1·5, 2·0, or 2·5) and assuming 7·5% of infections are asymptomatic	For the baseline scenario, when R_0 was 1·5, the median cumulative number of infections at day 80 was 279 000 (IQR 245 000-320 000), corresponding to 7·4% (IQR 6·5-8·5) of the resident population of Singapore. The median number of infections increased with higher infectivity: 727 000 cases (670 000-776 000) when R_0 was 2·0, corresponding to 19·3% (17·8-20·6) of the Singaporean population, and 1 207 000 cases (1 164 000-1 249 000) when R_0 was 2·5, corresponding to 32% (30·9-33·1) of the Singaporean population. Compared with the baseline scenario, the combined intervention was the most effective, reducing the estimated median number of infections by 99·3% (IQR 92·6-99·9) when R_0 was 1·5, by 93·0% (81·5-99·7) when R_0 was 2·0, and by 78·2% (59·0 -94·4) when R_0 was 2·5. Assuming increasing asymptomatic fractions up to 50·0%, up to 277 000 infections were estimated to occur at day 80 with the combined intervention relative to 1800 for the baseline at R_0 of 1·5. Implementing the combined intervention of quarantining infected individuals and their family members, workplace distancing, and school closure once community transmission has been detected could substantially reduce

No	Authors	Title	Method	Result
				the number of SARS-CoV-2 infections. We therefore recommend immediate deployment of this strategy if local secondary transmission is confirmed within Singapore. However, quarantine and workplace distancing should be prioritised over school closure because at this early stage, symptomatic children have higher withdrawal rates from school than do symptomatic adults from work. At higher asymptomatic proportions, intervention effectiveness might be substantially reduced requiring the need for effective case management and treatments, and preventive measures such as vaccines.
6	(Park et al. 2024)	Supporting patients and their carers to participate in infection prevention and control activities: The views of patients, family members, and hospital staff from Bangladesh, Indonesia, and South Korea	In-depth interviews were conducted in 5 tertiary-level hospitals in Bangladesh, Indonesia, and South Korea. A total of 64 participants were interviewed through 57 interviews, including 6 group interviews, comprising 2 groups: (1) patients and their family and private carers; and (2) HCWs.	The study identified barriers to engaging patients and family carers in IPC measures. These included concerns about the patient-HCW hierarchical relationship, lack of knowledge about healthcare-associated infection, IPC, and patient zone, perceptions of IPC as a barrier to family connections, and disempowerment of patients in IPC due to family bonds.
7	(Suwantika et al. 2022)	The cost-effectiveness of social distancing measures for mitigating the COVID-19 pandemic in a highly-populated country: A case study in Indonesia	Two mitigation scenarios of SD for 1 month and continuous SD were compared with the baseline (no intervention). A modified Susceptible-Exposed-Infected-Recovered (SEIR) compartmental model accounting for disease spread during the latent period was applied by considering a 1-year time horizon. The costs of healthcare, school closures, and productivity loss due to disease as well as intervention were considered to estimate the total pandemic cost among all scenarios.	In a comparison with the baseline, the result showed that total savings in scenarios of SD for 1 month and continuous SD was approximately $415 billion and $699 billion, respectively, while the averted deaths were 4.6 million and 8.5 million, respectively. Sensitivity analysis showed that basic reproduction number, infectious period, daily wage, incubation period, daily ICU admission cost, and case fatality rate were the most influential parameters affecting the savings and the number of averted deaths.
8	(Rois et al. 2024)	Modeling and optimal control of	Different authors formulated the	In this paper, we have proposed a mathematical model of COVID-19 infection by considering

No	Authors	Title	Method	Result
		COVID-19 with comorbidity and three-dose vaccination in Indonesia	COVID-19 model by incorporating the population with comorbidities. Authors in25 proposed a mathematical model of COVID-19 transmission with comorbidity and its optimal control strategies. The research in presented a COVID-19 model with prior comorbidity (specifically, diabetes mellitus) on COVID-19 complications. The authors in devoted the COVID-19 fractional model by considering the co-infected COVID-19 and comorbidity. In, the authors analysed the COVID-19 with comorbidity sub-populations and two Isolation treatments in Indonesia.	comorbidities and up to three vaccine doses. We used data on COVID-19's incidence in Indonesia to estimate the model parameters. The mathematical analysis included the equilibria, the basic reproduction number (R0), local and global stability. We found that the disease can be be eliminated from the population if R0<1, while the disease will persists if R0>1. Thus, we have conducted an important study of vaccine effectiveness based on a herd immunity analysis. Herd immunity is determined by the effectiveness of the vaccine and the disease's basic reproduction number in the absence of vaccination. Furthermore, a sensitivity analysis was carried out to identify the most sensitive parameter, which was the contact rate of infected individuals. We extended the COVID-19 model by incorporating the different control strategies with educational prevention and individual treatment as interventions. Pontryagin's maximum principle was adopted to accomplish the greatest possible control by minimizing the spread of COVID-19 among the population. The control simulation results showed that each strategy used can reduce total infections. However, a combined strategy is the most effective or significant for reducing total infections. Moreover, a cost analysis of the optimal control problem demonstrated that a combined strategy is the more economically efficient approach compared to using just one strategy.
9	(Vasquez et al. 2024)	COVID-19 policies and tuberculosis services in private health sectors of India, Indonesia, and Nigeria	Qualitative, in-depth interviews were conducted among a purposive sample of 11 national and sub-national policymakers in each country. Thematic content analysis was conducted on the data collected using an adapted WHO Health Equity Policy Framework.	Results revealed three policy dimensions under costs, access, and quality. Under healthcare costs, policymakers highlighted resource allocation and diversion of TB resources to COVID response, and increased operational costs for private provider. Under healthcare access, key themes included reduced TB case detection due to fear of COVID-19, disrupted diagnostic services, and adaptations such as extended medicine supplies and tele-consultations. Under healthcare quality, themes included compromised TB diagnostic accuracy due to similar respiratory symptoms with COVID-19, and strain on laboratory infrastructure due to competing demands from both diseases. Policymakers across the three countries pointed to the need for strengthening private–public partnerships (PPP) for healthcare service delivery and continued private sector investment to facilitate the continuity of TB

No	Authors	Title	Method	Result
				care within a pandemic context.
10	(Cini et al. 2023)	Towards responsive policy and actions to address non-communicable disease risks amongst adolescents in Indonesia: insights from key stakeholders	Qualitative in-depth interviews over videoconference (n = 21) were conducted in English or Bahasa with stakeholders in Indonesia. Participants included policymakers, implementation partners, and advocates who were focused on adolescent health or NCDs. Interviews were recorded, transcribed, translated, and thematically analysed using NVivo12. Findings were disseminated to participants for validation and feedback. Youth participants (n = 7) attended an additional workshop and considered recommendations and actions arising from this research.	Participants identified that government and non-government organisations are acting on NCDs in Indonesia, but few of the existing initiatives target adolescents, and adolescent services rarely addressed NCD risks. Participants also felt that policies to protect adolescents from NCD risks (i.e., smoke-free areas in public) were not always enforced. For programs or initiatives focused on adolescent health, those that had engaged adolescents as co-creators and leaders were perceived to be more successful. As such, participants recommended more meaningful engagement of young people, including young people's leadership of initiatives. Additional recommendations included the need for intersectoral engagement and a 'whole-of-government' approach to prevention given the complex determinants of NCD risks, and the need for evidence-based actions that are underpinned by quality data to enable monitoring of progress.
11	(Giwangkancana, Harlasgunawan, and Hidayat 2021)	Managing surgical patients with a COVID-19 infection in the operating room: An experience from Indonesia	This study focused on the process of preparation for COVID-19 surgery from March 2020-March 2021. We also described the available facilities in terms of equipment and human resources.	Steps of COVID-19 surgery preparations were described, such as the setup of general and infectious triage in the emergency department, development of preoperative screening protocol for COVID-19, designation of a specialized COVID-19 operating room and surgical staff, changes in preoperative surgery and anesthesia workflow, development of checklists and postoperative monitoring on staff health.
12	(Nuraini et al. 2023)	Assessing potential surge of COVID-19 cases and the need for booster vaccine amid emerging SARS-CoV-2 variants in Indonesia: A modelling study from West Java	We used a modified SEIR compartment model to assess different scenarios in booster coverage across West Java population: 35%, 50%, and 70%. We fitted the model, then we calculated the potential active cases in 2023 if each scenario was met before 2022 ends. A heat map of predicted cases from various booster	A minimum of 70% booster coverage in West Java is needed to reduce 90% of potential COVID-19 cases and avert possible surge in 2023. The booster doses should be distributed before February 2023 to achieve its optimum preventive effect. Delays in achieving minimum booster coverage is acceptable, but higher booster coverage will be required.

No	Authors	Title	Method	Result
			coverages and time frames was produced and matched with vaccination rate's function to determine feasible time frames.	

DISCUSSION

Air change per hour in ventilation control

Ventilation replaces indoor air with outdoor air, which can be natural (through gaps or windows) or artificial (using mechanical equipment like fans or ACs). Key indicators include Air Supply (M^3/Hour/Person), Air Exchange (Times/Hour), Air Speed (m/sec), and air quality metrics such as CO2 concentration, temperature, and humidity (Savanti, Setyowati, and Hardiman 2022). Air Change per Hour (ACH) measures the number of air changes in a room per hour, essential for thermal comfort and indoor air quality (IAQ). In hospitals, the standard ACH is about 12 x/hour to prevent contaminated air buildup (Nair et al. 2022). The WHO recommends 12 ACH for isolation rooms, 6-10 ACH for patient rooms without aerosol procedures, and 16 ACH for rooms producing aerosols. Mechanical ventilation in such rooms should maintain negative pressure of 6-12 ACH. Airlock rooms and dirty utilities should use 100% fresh air with constant airflow.

Temperature settings

Air temperature is one of the environmental factors that greatly determines the quality, comfort and distribution of indoor air (Ferdyn-Grygierek and Grygierek 2024). The room temperature is conditioned as the best environment to speed up patient recovery and comfort patients, doctors and paramedics in the hospital. The room is conditioned to a temperature of 21 to 24 degrees Celsius with paramedics providing an RH (Relative Humidity) of 40%-60.

Humidity Settings

The Decree of the Minister of Health of Indonesia Number 1204/MENKES/SK/X/2004 outlines air temperature and humidity requirements for hospitals. Proper control is crucial to prevent bacterial growth and ensure safety (Bulto and Hendriks 2024). Operating rooms should be 19-24°C with 45-60% humidity, while other rooms should be 18-28°C with 40-60% humidity. ICUs require 22-23°C with 35-60% humidity and positive pressure.

Air cleanliness level (filtration)

According to the RI Minister of Health Decree Number 1204/Menkes/SK/2004, the dust content in hospitals must not exceed 150 mg/M^3. HEPA filters, which remove particles larger than 0.3 microns, are required (Kementerian Kesehatan Republik, 2004). All filter efficiencies are based on ASHRAE 52.1 standards, requiring HEPA filters with a 99.9% DOP test for air supply systems. Filters must be installed correctly to prevent leaks and contamination. A manometer should be used to measure pressure drops, indicating when filters need replacement(Ashrae, 2017).

Air pressure settings

Air pressure criteria must follow ASHRAE 62 for acceptable indoor air quality, especially in specific places. ASHRAE 62-1989 regulates building air quality, and higher outdoor air requirements must be prioritized(Ashrae, 2019). In critical care areas, constant volume systems should ensure proper ventilation and pressure differentials, except when spaces are empty. For non-critical areas and staff rooms, Variable Air Volume (VAV) systems can save energy (Kim, Jo, and Sung 2024). VAV systems in hospitals must maintain minimum ventilation rates and pressure differences. Tracking air volume between supply and exhaust/return can control pressure differences. Areas needing continuous control are marked P for positive pressure, N for negative pressure, and E for no pressure difference. The notation ± indicates no need for continuous flow direction control.

CONCLUSION

In conclusion, strategies for mitigating infectious diseases in hospital rooms in Indonesia must include improving and monitoring ventilation, adjusting the work duration of health workers, implementing strict health protocols, and preventing and early detection of infections. The combination of these approaches can increase the effectiveness of infection control and protect healthcare workers and patients in hospitals. Ventilation is crucial for reducing airborne transmission of diseases like COVID-19 in closed spaces. Effective monitoring of air changes per hour (ACH) and adherence to standards is essential. Hospitals should ensure proper ventilation, potentially including it in the SNARS checklist and considering specific standards for Emergency Units. Infection control in hospitals requires managing healthcare worker exposure, using PPE, and ensuring effective ventilation. Research highlights that a proper work environment and strict health protocols prevent infections and protect staff. Good ventilation is a primary prevention measure, while PPE and other controls are secondary. Infectious disease prevention and early detection are an integral part of mitigation strategies in hospitals. Close monitoring of ventilation and implementation of environmental health standards can help detect and prevent the spread of infection early. This is in line with the literature discussing investment in prevention and early detection of infectious diseases to improve responses to disease outbreaks. During the COVID-19 pandemic, proper ventilation and work policies are crucial for reducing exposure to infectious diseases in hospitals. Research shows that improving ventilation and managing exposure duration can significantly prevent infections. With health worker deaths rising to 89 and nearly 900 infections by July, reconsidering shift lengths to reduce exposure is necessary.

ACKNOWLEDGMENTS

The authors state there is no conflict of interest with the parties involved in this study.

REFERENCES

Alqahtani, A. N., Almaghrabi, R. H., Albaadani, M. M. and Almossa, K. (2020) 'Impact of Infection Control Training Program in Improving the Quality of Healthcare', *European Journal of Medical and Health Sciences*, 2(5).

Arfin, T., Pillai, A. M., Mathew, N., Tirpude, A., Bang, R. and Mondal, P. (2023) 'An overview of atmospheric aerosol and their effects on human health', *Environ Sci Pollut Res Int*, 30(60), pp. 125347-125369.

Ashrae (2017) *ANSI/ASHRAE Standard 52.2-2017: Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size*, Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Available at: https://www.ashrae.org/File%20Library/Technical%20Resources/COVID-19/52_2_2017_COVID-19_20200401.pdf.

Ashrae (2019) *ANSI/ASHRAE Standard 62.1-2019 and 62.2-2019: Ventilation for Acceptable Indoor Air Quality*. Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

Arzilli, Guglielmo et al. 2024. "Innovative Techniques for Infection Control and Surveillance in Hospital Settings and Long-Term Care Facilities: A Scoping Review." *Antibiotics* 13(1).

Bennett, C. C., Welton, M., Bos, J., Moon, G., Berkley, A., Kavlak, L., Pearson, J., Turabelidze, G., Frazier, J., Fehrenbach, N. and Brown, C. K. (2023) 'Assessment of COVID-19 outbreaks in long-term care facilities', *Journal of Hospital Infection*, 134, pp. 7-10.

Bromage, D. I., Cannatà, A., Rind, I. A., Gregorio, C., Piper, S., Shah, A. M. and McDonagh, T. A. (2020) 'The impact of COVID-19 on heart failure hospitalization and management: report from a Heart Failure Unit in London during the peak of the pandemic', *European Journal of Heart Failure*, 22(6), pp. 978-984.

Bulto, Lemma N., and Jeroen M. Hendriks. 2024. "The Burden of Cardiovascular Disease in Africa: Prevention Challenges and Opportunities for Mitigation." *European Journal of Cardiovascular Nursing* 23(6): e88–90. https://doi.org/10.1093/eurjcn/zvad134.

Cini, Karly I., Nisaa R. Wulan, Dorothea Dumuid, Alifah Nurjannah Triputri, Iffat Abbsar, Luo Li, Diandra A. Priambodo, Grace E. Sameve, Artha Camellia, Kate L. Francis, Susan M. Sawyer, George C. Patton, Ansariadi Ansariadi, and Peter S. Azzopardi. 2023. "Towards Responsive Policy and Actions to Address Non-Communicable Disease Risks amongst Adolescents in Indonesia: Insights from Key Stakeholders." *The Lancet Regional Health - Southeast Asia* 18(August). doi: 10.1016/j.lansea.2023.100260.

Duke, J. M., Randall, S. M., Wood, F. M., Boyd, J. H. and Fear, M. W. (2017) 'Burns and long-term infectious disease morbidity: A population-based study', *Burns*, 43(2), pp. 273-281.

David Oche Idoko et al. 2024. "The Role of HSE Risk Assessments in Mitigating Occupational Hazards and Infectious Disease Spread: A Public Health Review." *Open Access Research Journal of Biology and Pharmacy* 11(2): 011–030.

Fishman, Jay A., and Nicolas J. Mueller. 2024. "Infectious Diseases and Clinical Xenotransplantation." *Emerging Infectious Diseases* 30(7): 1311–18.

Ferdyn-Grygierek, Joanna, and Krzysztof Grygierek. 2024. "Ventilation Methods for Improving the Indoor Air Quality and Energy Efficiency of Multi-Family Buildings in Central Europe." *Energies* 17(9):1–20. doi: 10.3390/en17092232.

Giwangkancana, Gezy, Alia Rahmi Harlasgunawan, and Dr Nucki Nursjamsi Hidayat. 2021. "Managing Surgical Patients with a COVID-19 Infection in the Operating Room: An Experience from Indonesia." *Perioperative Care and Operating Room Management* 24(June). doi: 10.1016/j.pcorm.2021.100198.

Gan, W. H., Lim, J. W. and Koh, D. (2020) 'Preventing Intra-hospital Infection and Transmission of Coronavirus Disease 2019 in Health-care Workers', *Safety and Health at Work*, 11(2), pp. 241-243.

Garcia, R., Barnes, S., Boukidjian, R., Goss, L. K., Spencer, M., Septimus, E. J., Wright, M. O., Munro, S., Reese, S. M., Fakih, M. G., Edmiston, C. E. and Levesque, M. (2022) 'Recommendations for change in infection prevention programs and practice', *Am J Infect Control*, 50(12), pp. 1281-1295.

Jilani, T. N., Jamil, R. T., Nguyen, A. D. and et al. (2024) *H1N1 Influenza*
StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing.

Kementerian Kesehatan Republik, I. (2004) *Persyaratan Kesehatan Lingkungan Rumah Sakit*, Jakarta: Keputusan Menteri Kesehatan Republik Indonesia Nomor 1204/MENKES/SK/X/2004. Available at: https://www.persi.or.id/images/regulasi/kepmenkes/kmk12042004.pdf.

Kementerian Kesehatan Republik, I. (2019) *Standar Mutu Udara dan Persyaratan Kesehatan Udara*, Jakarta: Kementerian Kesehatan Republik Indonesia. Available at: https://yankes.kemkes.go.id/unduhan/fileunduhan_1658478203_829878.pdf.

Kim, Gihoon, Seongmin Jo, and Minki Sung. 2024. "Impact of Medical Staff Movement, Airflow Rate Difference, and Door Leakage Area on Particle Outflow in an Airborne Infection Isolation Room." *Journal of Building Engineering* 95. doi: https://doi.org/10.1016/j.jobe.2024.110306.

Kohanski, M. A., Palmer, J. N. and Cohen, N. A. (2020) 'Aerosol or droplet: critical definitions in the COVID-19 era', *International Forum of Allergy & Rhinology*, 10(8), pp. 968-969.

Koo, J. R., Cook, A. R., Park, M., Sun, Y., Sun, H., Lim, J. T., Tam, C. and Dickens, B. L. (2020) 'Interventions to mitigate early spread of SARS-CoV-2 in Singapore: a modelling study', *The Lancet Infectious Diseases*, 20(6), pp. 678-688.

Kubde, D., Badge, A. K., Ugemuge, S. and Shahu, S. (2023) 'Importance of Hospital Infection Control', *Cureus*, 15(12), pp. e50931.

Lee, W. C. and Ong, C. Y. (2020) 'Overview of rapid mitigating strategies in Singapore during the COVID-19 pandemic', *Public Health*, 185, pp. 15-17.

Morawska, L. and Cao, J. (2020) 'Airborne transmission of SARS-CoV-2: The world should face the reality', *Environment International*, 139, pp. 105730.

Marou, Valia et al. 2024. "The Impact of Conflict on Infectious Disease: A Systematic Literature Review." *Conflict and Health* 18(1): 1–32.

Nair, AN, P. Anand, A. George, and N. Mondal. 2022. "A Review of Strategies and Their Effectiveness in Reducing Indoor Airborne Transmission and Improving Indoor Air Quality." *Environ Res* 14. doi: 10.1016/j.envres.2022.113579.

Nuraini, Nuning, Fadiya Nadhilah Soekotjo, Almira Alifia, Kamal Khairudin Sukandar, and Bony Wiem Lestari. 2023. "Assessing Potential Surge of COVID-19 Cases and the Need for Booster Vaccine amid Emerging SARS-CoV-2 Variants in Indonesia: A Modelling Study from West Java." *Heliyon* 9(9). doi:

10.1016/j.heliyon.2023.e20009.

Olatunji, Aliu Olalekan; Janet Aderonke Olaboye, Chukwudi Cosmos Maha, Tolulope Olagoke Kolawole, & Samira Abdul. (2024) Environmental microbiology and public health: Advanced strategies for mitigating waterborne and airborne pathogens to prevent disease. *International Medical Science Research Journal,* 4(7), 756-770.

Park, Ji Yeon, Jerico Franciscus Pardosi, Saiful Islam, Titik Respati, Eka Nurhayati, Nadia Charania, Kamal Ibne Amin Chowdhury, and Holly Seale. 2024. "Supporting Patients and Their Carers to Participate in Infection Prevention and Control Activities: The Views of Patients, Family Members, and Hospital Staff from Bangladesh, Indonesia, and South Korea." *American Journal of Infection Control* 52:200–206. doi: 10.1016/j.ajic.2010.10.002.

Rois, Muhammad Abdurrahman, Fatmawati, Cicik Alfiniyah, Santi Martini, Dipo Aldila, and Farai Nyabadza. 2024. "Modeling and Optimal Control of COVID-19 with Comorbidity and Three-Dose Vaccination in Indonesia." *Journal of Biosafety and Biosecurity* 6(3):181–95. doi: 10.1016/j.jobb.2024.06.004.

Risma, A. and Popi, O. (2023) 'An Analysis of Knowledge, Attitudes and Support Effects on the Implementation of Infection Control Prevention at the Public Health Center in Bengkulu Province', *International Journal of Medical Science and Clinical Research Studies,* 3(4), pp. 651-654.

Robinson, J., Price, L., Otter, J. and Burnett, E. (2023) 'Designing an optimal infection prevention service: Part 2', *J Infect Prev,* 24(1), pp. 11-22.

Sahputra, F., Girsang, E. and Napiah Nasution, A. (2023) 'Analysis of Implementation of Infection Prevention and Control at Royal Prima Marelan General Hospital', *Jurnal Penelitian Pendidikan IPA,* 9(12), pp. 11790-11795.

Savanti, Fisa, Erni Setyowati, and Gagoek Hardiman. 2022. "The Impact of Ventilation on Indoor Air Quality and Air Change Rate." *Evergreen* 9(1):219–25. doi: 10.5109/4774237.

Shmueli, M., Lendner, I. & Ben-Shimol, S. (2024).Effect of the COVID-19 pandemic on the pediatric infectious disease landscape. *Eur J Pediatr* **183**, 1001–1009

Sarah, A., Bayhakki and Fathra Annis, N. (2016) 'Pengaruh Aromaterapi Inhalasi Lavender Terhadap Kecemasan Pasien Gagal Ginjal Kronik Yang Menjalani Hemodialisis', *Jurnal Online Mahasiswa Program Studi Ilmu Keperawatan Universitas Riau,* 2(2), pp. 1510-1519.

Shang, J., Ma, C., Poghosyan, L., Dowding, D. and Stone, P. (2014) 'The prevalence of infections and patient risk factors in home health care: A systematic review', *American Journal of Infection Control,* 42(5), pp. 479-484.

Mutiara Cipta, D. ., & Alvin, S. (2023). Safeguarding Personal Information: Communication Privacy Management By Gen-Z Influencers. *International Journal of Educational Research &Amp; Social Sciences*, *4*(3), 465–471. https://doi.org/10.51601/ijersc.v4i3.653.

Mohammad Solekhan, Kunarto, & Mahmuda Pancawisma Febriharini. (2022). Forest And Land Fire Management Strategies : Prevention And Law Enforcement. *International Journal of Educational Research &Amp; Social Sciences*, *3*(2), 567–580. https://doi.org/10.51601/ijersc.v3i2.306.

D. Yuliana Sinaga. (2022). The Effect Of Ralistic Mathematics Learning Model And Project-Based Learning Model On Problem Solving Ability And Motivation Of Students In Class V Private Sd Markus Medan Helvetia. *International Journal of Educational Research &Amp; Social Sciences*, *3*(2), 590–600. https://doi.org/10.51601/ijersc.v3i2.268.

Nugroho, A. . (2022). Principle of Balance of Relationship Between Banks and Customers in Mudharabah Agreements. *International Journal of Educational Research &Amp; Social Sciences*, *3*(2), 645–652. https://doi.org/10.51601/ijersc.v3i2.325.

Nugraha, B., Sianturi, I., & Aini Rakhman, R. (2023). The Effect Of Supply Chain Management And Corporate Communication Skills On Production Performance At PT. Berlian Manyar Sejahtera. *International Journal of Science, Technology & Management*, *4*(6), 1477-1485. https://doi.org/10.46729/ijstm.v4i6.966.

Parulian Simanjuntak, G., & Sensi W, L. (2023). Evaluation Of The Implementation Of The Internal Audit Capability Model (IACM) Level 3 In The Supervision System Of The Inspectorate General Of The Ministry Of Agriculture. *International Journal of Science, Technology & Management*, *4*(6), 1581-1602. https://doi.org/10.46729/ijstm.v4i6.1011

Hanif Triyana, M., & Indah Fianty, M. (2023). Optimizing Educational Institutions: Web-Based Document Management . *International Journal of Science, Technology & Management*, *4*(6), 1653-1659. https://doi.org/10.46729/ijstm.v4i6.976.

Akiria Santi, A., & Sukarni, S. (2023). The Effectiveness Of Using Corsets On Reducing Pain Scale In Post SC Patients At Eka Hospital, South Tangerang In 2022. *International Journal of Health and Pharmaceutical (IJHP)*, *3*(4), 677–682. https://doi.org/10.51601/ijhp.v3i4.225

Laia, O. ., Lestari Nasution, S. ., & Ginting, . J. . (2023). Evaluation Of The Implementation Of Primary Care (P-Care) Application At Puskesmas Onolalu Nias Selatan In 2022. International Journal of Health and Pharmaceutical (IJHP), 3(4), 629–636. https://doi.org/10.51601/ijhp.v3i4.224

Duha, K. B., Lestari Ramadhani Nasution, S. ., Girsang, E. ., & Suyono, T. . (2022). Analysis of Efficiency Of KDT-OAT and Removal Preparations on The Recovery of Pulmonary Tuberculosis. *International Journal of Health and Pharmaceutical (IJHP)*, *2*(2), 284–289. https://doi.org/10.51601/ijhp.v2i2.43

Rachmi Yuana, S., Girsang, E. ., & Ginting, . L. . (2023). Analysis Of The Influence Of Leader Behavior And Public Health Center Management Processes On Immunization Program Performance At Kuala Bali Public Health Center, Serdang Bedagai. International Journal of Health and Pharmaceutical (IJHP), 3(4), 594–601. https://doi.org/10.51601/ijhp.v3i4.211

Wang, L., Yan, B. and Boasson, V. (2020) 'A national fight against COVID-19: lessons and experiences from China', *Aust N Z J Public Health*, 44(6), pp. 502-507.

Wee, L. E., Venkatachalam, I., Sim, X. Y. J., Tan, K. B.-K., Wen, R., Tham, C. K., Gan, W. H., Ko, K. K. K., Ho, W. Q., Kwek, G. T. C., Conceicao, E. P., Sng, C. Y. E., Ng, X. H. J., Ong, J. Y., Chiang, J. L., Chua, Y. Y., Ling, M. L., Tan, T. T. and Wijaya, L. (2021) 'Containment of COVID-19 and reduction in healthcare-associated respiratory viral infections through a multi-tiered infection control strategy', *Infection, Disease & Health*, 26(2), pp. 123-131.

Wu, X., Lu, Y., Zhou, S., Chen, L. and Xu, B. (2016) 'Impact of climate change on human infectious diseases: Empirical evidence and human adaptation', *Environment International*, 86, pp. 14-23.

Xiong, L., Hu, P. and Wang, H. (2021) 'Establishment of epidemic early warning index system and optimization of infectious disease model: Analysis on monitoring data of public health emergencies', *International Journal of Disaster Risk Reduction*, 65, pp. 102547.

Yen, M.-Y., Schwartz, J., King, C.-C., Lee, C.-M. and Hsueh, P.-R. (2020) 'Recommendations for protecting against and mitigating the COVID-19 pandemic in long-term care facilities', *Journal of Microbiology, Immunology and Infection*, 53(3), pp. 447-453.