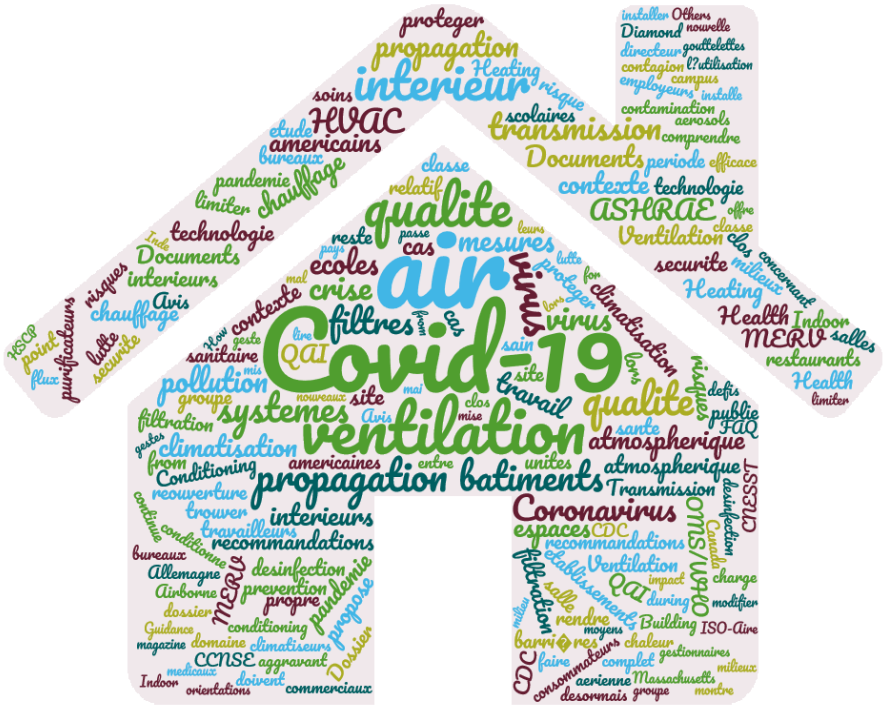

Bulletin de veille AéroCovid
N°131 – 11/02/2026

Objectif : *Air intérieur, ventilation, climatisation et propagation du Covid-19*

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont founis sans garantie d'exhaustivité.

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Hati, F. I., Puteri, S. N. a. I. a. F., Khairunnisya, S.

Airborne Microbial Assessment and Its Implication for Laboratory Safety.

Jurnal Kesehatan, Vol. **16** n°(3), (2025), 482-491 p.

The impact of airborne microbes on laboratory workers is substantial, as exposure to elevated bioaerosol concentrations can lead to respiratory illnesses, allergic sensitization, and an increased risk of laboratory-acquired infections. The air quality in microbiological laboratories is therefore a critical component of occupational health and safety. Previous studies have shown that microbial levels in educational laboratories frequently exceed international and national guidelines. Despite increasing recognition of the importance of indoor air quality, limited data are available on microbiological laboratory conditions outside Java, particularly in South Kalimantan. This study employed a descriptive, cross-sectional, observational design using the midget impinger method to collect air samples at two sampling points in each laboratory before and after ventilation activation, resulting in a total of 12 samples. Airborne bacterial counts were used to quantify microbial load, while temperature and relative humidity were simultaneously measured. Data were analyzed descriptively, and pre–post ventilation differences were assessed using the Wilcoxon Signed-Rank test. All microbial loads remained below the WHO (500CFU/m³) and Ministry of Health Republic Indonesia (700CFU/m³) thresholds. Three laboratories which relied solely on natural ventilation, exhibited the highest microbial counts, whereas laboratories with mechanical ventilation showed consistently lower levels. Although no significant differences were observed between pre-post ventilation conditions, naturally ventilated spaces tended to show higher microbial loads. Overall, airborne microbial levels and environmental parameters across the three laboratories remained within acceptable limits. However, higher humidity was associated with higher microbial concentrations, underscoring the importance of maintaining indoor environmental conditions within recommended ranges to ensure laboratory safety.

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Kittikanara, P., Kannirun, M., Bhopdhornangkul, B.

Airflow, behaviors and delayed detection: drivers of a covid-19 outbreak in a Thai military recruit training unit, may-june 2025.

Journal of Southeast Asian Medical Research, Vol. **9**, (2026)

Background: On May 6, 2025, the Epidemiology Unit of Phramongkutklao Hospital was notified of a probable COVID-19 outbreak among recruits and instructors at a recruit training unit in Samut Sakhon Province, Thailand. A joint field investigation was conducted in collaboration with the 11th Medical Unit, the Epidemiology Unit of Phramongkutklao Hospital, and the Armed Forces Research Institute of Medical Sciences (AFRIMS).

Objective: To confirm and characterize the COVID-19 outbreak, identify critical gaps in the existing protocol and transmission factors, and provide recommendations for control and prevention.

Methods: A retrospective cohort study was conducted from May 1 to June 3, 2025. Cases included individuals with at least two COVID-19–compatible symptoms, a positive antigen test kit (ATK) result, or laboratory confirmation by real-time RT-PCR. Structured interviews and standardized questionnaires collected exposure and behavior data. A walk-through survey assessed environmental conditions, including

airflow, temperature, and humidity in the dormitory. Outbreak control measures, including cohorting based on ATK results, were documented.

Results: Among 114 personnel, 47 cases were identified (attack rate 41.2%), with 97.9% symptomatic. Of these, 95.7% had received prior COVID-19 vaccination. Common symptoms were sore throat, headache, and cough. The environmental assessment showed elevated temperatures, humidity, and west-to-east airflow, which correlated with higher attack rates in the eastern sleeping zones. Behavioral factors included shared drinking glasses and proximity during meals; sharing glasses showed the lowest p-value (adjusted OR = 1.99, 95% CI: 0.89–4.48). Delayed detection due to a lack of systematic screening facilitated transmission.

Conclusions: The outbreak was driven by multifactorial causes, including delayed detection and environmental and behavioral factors. Alignment between airflow and attack rates highlights the role of ventilation. Proactive surveillance, systematic ATK screening for all respiratory symptoms, and enforcement of physical distancing are recommended to prevent similar outbreaks in congregate military settings.

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Dos Santos, G. B.

Amostragem e análise de bioaerossóis: revisão histórica.

Universidade Federal de São Carlos. Thèse 2025

The present work aims to review, from a historical and comparative perspective, the sampling strategies and analytical techniques applied to bioaerosols in ambient air, with emphasis on performance, limitations and reported applications. The discussion covers both passive and active samplers, including gravitational collectors, volumetric slit samplers, impactors onto culture plates, liquid-phase devices, high-flow cyclones, filters, cascade impactors and personal samplers, highlighting aspects such as preservation of viability, sampled size range and temporal resolution. On the analytical side, the review encompasses methods ranging from microscopy and conventional culture to immunological assays, the use of chemical biomarkers and modern molecular and spectrometric techniques capable of providing greater taxonomic specificity and sensitivity. The studies examined show that there is no universal method and that each combination of collection and analysis involves trade-offs between temporal resolution, microbial viability, taxonomic detail, detection limit, cost and operational practicality. Therefore, the interpretation of results must consider the study objective, the sampled matrix and the biases associated with each approach, in order to promote data comparability and a critical reading of the findings.

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Ma, J., Chai, A., Shi, F., Liu, M., Li, B., Fan, T.

CFD-guided ventilation design to suppress pathogen spread in a cucumber greenhouse.

Smart Agricultural Technology, (2026)

Ventilation strategies critically regulate thermal dynamics and pathogen dispersion in solar greenhouses. This study integrates in-situ monitoring and CFD simulations to analyze how natural ventilation modes and crop height jointly govern airflow patterns, temperature distribution, and Corynespora cassiicola spore dispersion in cucumber greenhouses. Through multi-scenario simulations validated by field measurements, we quantified interactions between three ventilation modes (top-only, bottom-only, fully open), crop heights (1.0 m vs. 1.8 m), and wind speeds (1–3 m/s). Key findings reveal that fully open vents achieved maximum cooling (ΔT=13.2°C under 3.0 m/s wind speed and 1.0 m crop height), while taller crops (1.8 m) reduced cooling efficiency. Ventilation modes determined spore pathways: closed/top-only vents restricted longitudinal spread, whereas full/bottom-open configurations enabled vertical escape and cross-facility transmission. The proposed hybrid ventilation strategy—alternating full and bottom openings—achieves dual benefits: effective cooling and pathogen containment through blocked aerial routes. These results establish an operational framework for optimizing greenhouse climate and fungal spore transfer, and shed light on vegetable disease control from empirical practice to predictive science.

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Inamdar, A. V., Gupta, S. K., Sharma, U.

COVID-19 as the New Normal: Evolution, Endemicity, and Public Health Strategies.

Global journal of medicine & public health, Vol. **14** n°(5), (2025)

As COVID-19 transitions from a pandemic to an endemic disease, public health efforts must increasingly focus on sustainable surveillance systems, adaptive prevention strategies, and long-term health system preparedness to mitigate ongoing population-level impact. The emergence of new Omicron subvariants such as LF. 7 and NB. 1.8 in Southeast Asia—often an early indicator of global SARS-CoV-2 transmission trends—highlights the virus's continued evolution and its capacity for periodic surges. Waning population immunity and the limited effectiveness of current vaccines in preventing transmission have altered the epidemiological profile of COVID-19. As a result, its transmission dynamics now resemble those of other seasonal respiratory viruses such as influenza and respiratory syncytial virus (RSV). This communication outlines the public health implications of COVID-19's endemic nature and proposes long-term preparedness strategies for policymakers, health systems, and public health professionals.

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Li, J., Bot, M., Liu, X., Yao, Y., Ophoff, R. A., Zhu, Y.

Detection of SARS-CoV-2 RNA on air purifier filters in university spaces without symptomatic or confirmed cases.

Aerosol Science and Technology, (2025), 1-10 p.

Understanding the seasonality and prevalence of respiratory viruses in indoor environments is essential for protecting public health in the post-pandemic era. This study investigated the presence of airborne SARS-CoV-2 in university indoor spaces where no symptomatic or confirmed positive individuals were supposed to be present. A total of 127 high-efficiency particulate air (HEPA) filter samples were analyzed from air purifiers installed in classrooms, conference rooms, and a community room within a university building across different seasons from Fall 2022 to Summer 2023. Viral RNA was extracted and quantified using RT-qPCR for each sample. SARS-CoV-2 RNA was detected in 21% of the samples, with the positivity rate varying significantly by room type but not by season. Among the 27 positive samples, viral RNA concentrations were significantly higher in fall-winter compared to summer, with no significant differences across room types. Additionally, respiratory syncytial virus (RSV) and influenza A virus (IAV) were detected in far fewer samples (positive rates: 2% and 4%, respectively) and at much lower concentrations than SARS-CoV-2. These findings provide evidence of the potential for airborne SARS-CoV-2 transmission in shared indoor spaces, even in the absence of known infectious individuals. They also suggest that SARS-CoV-2 may circulate in each season, underscoring the continued need for interventions to reduce indoor viral exposure.

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Bang, J.-I., Choi, A., Rim, D., Sung, M.

Disinfection performance of upper-room UVGI in a multi-bed patient room: Experimental assessment using equivalent clean airflow.

Journal of Building Engineering, Vol. **119**, (2026)

Upper-room ultraviolet germicidal irradiation (UR-UVGI) is an established technology for controlling airborne pathogens, and its application has gained renewed attention following the COVID-19 pandemic. In hospital environments, both safety and quantitative performance should be carefully considered. This study experimentally evaluated the effectiveness of UR-UVGI in a full-scale multi-bed patient room using Bacillus subtilis (ATCC 6633) as a surrogate for airborne pathogens. Viable airborne bacteria were cultured and quantified to determine the equivalent air change rate (eACH), which was converted into equivalent clean airflow (ECAi) according to ASHRAE Standard 241. Experiments were conducted under two ventilation

rates (2.5 h−1 and 6.9 h−1) and three UR-UVGI conditions: 1) OFF, 2) one-lamp, and 3) two-lamps. Considering the effect of UR-UVGI alone, relative improvements were approximately 44 % at 2.5 h−1 and 26 % at 6.9 h−1. Using the measured ventilation rates as a baseline, incremental eACH due to UR-UVGI ranged from 2.94 to 2.98 h−1 at 2.5 h−1 and 1.43–1.99 h−1 at 6.9 h−1. When accounting for total clean-air delivery, the 6.9 h−1 condition met the ASHRAE 241 criterion, while the 2.5 h−1 condition showed meaningful improvement and approached the criterion. Overall, these results demonstrate that UR-UVGI can significantly enhance clean-air delivery in under-ventilated patient rooms operating below the ASHRAE Standard 170 minimum requirement for healthcare buildings (≥4 ACH) and serves as an effective supplementary strategy. In practice, its performance may be further optimized when combined with improved air distribution and filtration.

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Kang, L., Zhang, X., Zhang, C., Cao, B., Zhu, Y., Jia, X.

Droplet fate and infection risk under ceiling fan integrated air conditioning: cough and speech scenarios.

Energy and Built Environment, (2026)

Ceiling Fan-Integrated Air Conditioning (CFIAC) is a coupling configuration of air conditioning ventilation systems and ceiling fans that combines fresh air supply (from the air conditioning system) with indoor airflow distribution adjustment (via ceiling fans). This study employed Computational Fluid Dynamics to simulate the transient respiratory droplet dispersion under CFIAC systems. By combining infection risk for the exposed person and droplet fate indicators (suspension, sedimentation, escape), the impacts of different ventilation configurations, ceiling fan speeds, and exhalation types on droplet transmission were investigated. Ceiling fan activation was found to either mitigate local infection risk or enhance airflow circulation: downward operation at 72 rpm reduced local infection risk by 96.6%, while upward rotation decreased the fraction of suspended droplets by 39.29% (boosting droplet escape by 10.88-fold relative to fan-off conditions). Excessively high fan speeds (122 rpm) negated these benefits, increasing infection risk by 4.25-fold compared to the 72 rpm condition. CFIAC systems exhibited more effective control over coughing droplets than over speaking droplets, with the infection risk associated with speaking being 15.5% higher than that of coughing. Among the tested configurations, upper-supply and ceiling-exhaust ventilation excelled in reducing local infection risk, while upper-supply and lower-exhaust ventilation optimized overall respiratory droplet control. These results provide practical guidance for optimizing CFIAC operation and formulating targeted infection prevention strategies.

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Kulmala, I., Karvinen, A., Hakala, J., Kultanen, M., Säämänen, A.

Dynamics of Aerosol Dispersion Between Occupants in an Office Space.

Indoor Air, Vol. **2025** n°(1), (2025)

This study experimentally investigated the transport dynamics of exhaled aerosols, which may carry infectious pathogens, in a mixing-ventilated test room using three heated dummies as human simulators. Two dummies were seated at desks separated by a partition wall, while the third stood nearby. Each dummy acted as an infector one at a time, releasing test aerosols through a low-momentum horizontal jet simulating continuous mouth exhalation. Aerosol concentrations were monitored using 28 sensors to provide high-resolution data on aerosol spread dynamics. The mixing ventilation air change rates were 1.8 and 3.2 1/h, and additional measurements were conducted with an air cleaner in operation. CFD simulations revealed that particles from the low-momentum exhalation jet were deflected upwards by the dummy's thermal plume and quickly mixed with supply air from a circular ceiling diffuser. The results showed that the exhaled particles reached the exposed person's breathing zone within 20-100 s. Particle concentrations were relatively uniform throughout the room, indicating that a well-mixed approximation is suitable for estimating airborne infection transmission risk from indirect exposure in small spaces. Relative transmission risks were analysed under various conditions. While the partition wall delayed initial exposure,

it had minimal impact on long-term risk. Air cleaners increased air mixing and reduced the delay between aerosol release and exposure, potentially elevating short-term risk. However, the long-term benefits of enhanced ventilation outweighed the initial increase in risk, reducing overall airborne infection transmission over extended durations.

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Wilson, N. J., Moore, C., Lee, C. E., Tuite, A. R., Fisman, D. N.

Insights from a Ventilation-Aware Pandemic and Outbreak Risk model (VAPOR).

Epidemics, Vol. **54**, (2026)

Transmission of airborne pathogens in indoor spaces is strongly modulated by heterogeneity in ventilation. Understanding the role indoor air plays in pandemic risk is limited in part due to differing modeling approaches used in engineering and epidemiology. Here we present the VAPOR (Ventilation-Aware Pandemic and Outbreak Risk) model, a hybrid transmission framework that integrates Reed-Frost close-contact dynamics with Wells-Riley aerosol-mediated risk. Using a meta-population structure to simulate multi-patch environments (e.g., separate workplaces or schools), we explore how ventilation disparities shape epidemic potential. A fixed minority of individuals are modeled as “aerosolizers,” consistent with overdispersed real-world transmission patterns (e.g., SARS-CoV-2). Simulations reveal that both improving ventilation in high-risk patches and raising baseline ventilation across environments independently reduces risk. Parameter sweeps across air changes per hour (ACH, 2–12) demonstrate non-linear benefits with early saturation. These findings emphasize the need for targeted ventilation strategies and show how small-world effects amplify heterogeneity-driven transmission. VAPOR offers a framework for linking ventilation equity to epidemic control.

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Klausmann, J., Holderied, P., Kastner, D., Küperkoch, M., Ratovo, K., Mutschler, T.*, et al.*

New innovative textile sealing systems for natural ventilation of buildings.

Communications in Development and Assembling of Textile Products, Vol. **6** n°(2), (2025), 160-169 p.

In the construction sector, elastic plastic seals are used for windows and doors. They seal against cold, draughts and moisture. The aim of this research is to develop innovative textile sealing concepts which guarantee conventional sealing properties as well as offering filtered gap ventilation. Knitted spacer fabrics offer air permeability due to their porous structure and have an adjustable structural elasticity. The innovation aims to offer another ventilation concept and reduce the needed artificial room ventilation, thereby reducing investment and operating costs. Their suitability for seals is evaluated in the research presented. Initially, a requirements profile for sealing systems is developed and appropriate testing methods are selected. To determine a suitable structure, a variety of different textiles are tested. Therefore, knitted spacer fabrics with different spacer yarns are developed. Two monofilaments with different diameters and a high-volume yarn are used as spacers. The fabrics are investigated based on the requirement profile for their grammage, thickness, compressibility, shape recovery, air permeability, thermal resistance, and thermal conductivity. The results show that the spacer fabric with the finer monofilament exhibits the greatest thickness, as well as the highest compressibility and air permeability. The fabric with the coarser monofilament achieves the highest values for thermal resistance, as well as the lowest thermal conductivity. The suitability of the developed seals and their influence on the indoor climate will furthermore be investigated using a self-developed test bench. The test bench determines the tightness of the sealing profiles with regard to moisture, air and particle (pollen) permeability.

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Mahmoud, M.

Numerical modelling of aerosol and CO2 transport for indoor air quality and infection risk assessment.

UNSW Sydney. School of Mechanical and Manufacturing Engineering. Thèse 2025

This thesis makes a significant contribution by providing a realistic, predictive method for evaluating ventilation and filtration strategies in mitigating airborne infection risk. Its novelty lies in the development of a numerical model capable of realistically simulating the exhalation of aerosols and CO2 from occupants, as well as the integration of real-time aerosol measurements with an infection risk model, providing a practical tool for optimising indoor air quality interventions.

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Zhang, S., Jiang, J., Cheng, Y., Lin, Z.

Overview of Ventilation Performance Indices for Thermal Comfort, Indoor Air Quality, and Energy Efficiency.

In: Ventilation Performance Indices with Elevated Air Movement for Health, Thermal Comfort, and Energy Efficiency. Springer Nature Singapore; 2025. 1-5 p.

Convective ventilation systems are pivotal for creating thermally comfortable, healthy, and energy-efficient built environments. While advanced air distribution strategies have emerged to meet stringent demands for energy saving and airborne infection control, their development is hindered by inadequate evaluation tools. Traditional ventilation performance indices fail to account for the cooling effects of elevated air movement on both thermal comfort and energy efficiency, and cannot accurately assess the airborne infection risk of diseases like COVID-19. This book systematically addresses these gaps by presenting a comprehensive framework of novel ventilation performance indices. It is structured into three parts: Part I develops indices for thermal comfort that fully incorporate the effects of air temperature, velocity, and humidity; Part II introduces indices for indoor air quality, focusing on models and metrics for airborne infection risk control; Part III proposes indices for energy efficiency that explicitly quantify the impact of air movement. Collectively, these indices provide essential tools for the optimized design and operation of advanced air distribution systems, facilitating the creation of sustainable and livable indoor spaces.

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Alavy, E. H., Jung, W.

Performance Evaluation of Electrified Office Buildings Under Infection Risk Management Mode.

ASHRAE 2025 Annual Conference, Phoenix, AZ

Building electrification represents a nationwide U.S. effort to achieve decarbonization and enhance energy efficiency. While this transition reduces fossil fuel dependence, improves energy efficiency, and facilitates renewable energy integration, buildings must also ensure occupant protection from airborne pathogens. In response to COVID-19, ASHRAE Standard 241 introduced the Infection Risk Management Mode (IRMM), which mandates the Minimum Equivalent Clean Airflow Rate (VECAi) through mechanical and natural ventilation during high-risk periods. To date, limited research has explored maintaining energy efficiency in electrified buildings while complying with the IRMM.

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Oswin, H. P., Tellier, R., Groth, R., Silvonen, V., Bull, R., Macintyre, C. R., *et al.*

Quantification of airborne respiratory microflora provides insights into airborne infection risk.

International Journal of Infectious Diseases, Vol. **164**, (2026)

Objectives To develop airborne respiratory microflora quantification as a method of quantifying airborne infection risk that is more readily applicable than airborne pathogen sampling, without being subject to the limitations and caveats of CO2 monitoring. Methods Digital polymerase chain reaction targeting a mixture of Streptococcus and Haemophilus genera common to the respiratory tract was first tested under laboratory conditions and then tested on aerosol sampled from around a hospital in Sydney, with polymerase chain

reaction quantification of SARS-CoV-2 genome copies also being carried out on the samples. Results Clear signals were obtained from every location within the hospital, with a significantly higher signal being observed in more densely crowded, less well-ventilated areas. When SARS-CoV-2 was present within the aerosol samples, the respiratory microflora signal correlated with the number of SARS-CoV-2 copies. Conclusions Airborne respiratory microflora can be used as a marker for airborne infection risk. Using the value in conjunction with pathogen sampling provides in-depth insights into the relative infection risk of a space, and a clear marker which can be used to compare between different pathogen sampling studies.

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Sahu, M. V., Shrivastava, R.

Seasonal Dynamics and Statistical Patterns of Indoor-Outdoor Aeromycoflora in a Primary Health Centre (Baghera), Chhattisgarh.

Journal of Basic and Applied Research International, Vol. **31** n°(6), (2025), 181-193 p.

Airborne fungal contamination poses significant public health risks in healthcare settings, particularly in primary health centres serving rural and semi-urban populations. The present study investigated the seasonal distribution, diversity, and statistical variation of aeromycoflora at the Primary Health Centre (PHC), Baghera, Durg, Chhattisgarh, over a one-year period (March 2022–February 2023). Air samples from indoor and outdoor environments were collected using the settle plate technique and analyzed season-wise. A total of 54 fungal taxa indoors and 48 taxa outdoors, belonging to Zygomycotina, Ascomycotina, Basidiomycota, and anamorphic fungi, were recorded. Anamorphic fungi dominated both environments, contributing more than 70% of indoor and approximately 65% of outdoor fungal populations. The rainy and winter seasons showed relatively higher fungal abundance compared to summer. Dominant fungi included Cladosporium oxysporum, Cladosporium cladosporioides, Alternaria alternata, Aspergillus niger, Fusarium oxysporum, and Candida albicans. The detection of allergenic and clinically important fungi, including Candida, Aspergillus, and dermatophytes, highlights potential health risks in healthcare environments. While ANOVA revealed no significant seasonal differences, but confirmed year-round persistence. This study provides essential baseline data for aeromycological assessment in primary healthcare facilities and emphasizes the need for routine air quality monitoring and effective environmental management strategies.

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Hamid, E. A., Ahmad, S., Kamaludin, N. F., Ithnin, A., Awang, N.

The Silent Threat to Patient Safety: Combating Airborne Pathogens by Investigating Natural Ventilation's Impact on Indoor Air Quality in Hospital Wards.

Oriental Journal Of Chemistry, Vol. **6** n°(41), (2025)

Indoor air quality (IAQ) within hospitals is a critical factor in patient safety and infection prevention, since airborne pathogens can spread rapidly in poorly-ventilated environments. The type of ventilation system, whether natural or mechanical, has a significant impact in air dilution efficiency, pollutant dispersion, and microbial distribution. This is particularly important in tropical hospital settings, in which temperature and humidity are highly variable. This study aimed to investigate the impact of natural ventilation versus mechanical ventilation on IAQ and airborne microbial concentrations in eleven hospital wards encompassing medical, surgical, orthopaedic, and emergency disciplines in Klang Valley, Malaysia. Standard instruments were used to measure physical (temperature, humidity, air movement), chemical (CO, O_3, TVOC, CH2O, PM10), including CO_2, and biological (bacterial and fungal CFU/m^3) parameters in the morning and evening. We used Kruskal–Wallis, Mann–Whitney, and multiple linear regression tests to identify significant differences and predictors influencing microbial variability. There were significant differences ($p<0.01$) observed in IAQ parameters between ventilation types. Naturally ventilated wards experienced higher airflow (0.13–0.37 m/s) and slightly elevated temperatures (30.2–33.1°C), enhancing pollutant dilution. In contrast, mechanically ventilated wards accumulated higher CO2 (476–918 ppm) and TVOC (up to 545 ppm) levels. Regression analysis identified temperature ($\beta = 2.823$, $p = 0.019$) and

formaldehyde (β = –154.249, p = 0.041) as significant predictors of fungal variability (R^2 = 0.162, p = 0.0047). All microbial concentrations remained within the ICOP IAQ (2010) standard limits. In the context of emerging and unidentified respiratory diseases, this study confirms that natural ventilation enhances indoor air renewal, reduces pollutant buildup, and limits microbial growth. It is a long-term strategy to combat airborne pathogens in tropical hospitals, which will help with stronger infection control and healthier indoor air environments. Natural ventilation should be combined with hybrid systems to strengthen resilience against future indoor air threats.

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Bennett, J. S., Mccarthy, J. E., Dewitt, B., Dumas, B.

A superposition model of droplet exposure to SARS-CoV-2.

Science and Technology for the Built Environment, Vol. **32** n°(2), (2026), 281-291 p.

The relative role of droplets and aerosols in SARS-CoV-2 infection has been debated. We seek to quantify virion exposure in an enclosed space via short-range and long-range airborne transmission to inform public health decision making. Data from five published studies were analyzed to predict relative exposure at distances of 1m and farther. A droplet size of 8μm was used to compare data from published studies, while not defining particle transport behavior in terms of size. Results at 1m from an infectious individual were a boundary condition to model infection risk at shorter and longer distances. At all distances, exposure was treated as the sum of all air routes. Number of virions was assumed proportional to particle volume. The largest exposure occurred close to the infectious individual, and out to approximately 1m, direct deposition and airborne routes both contributed. Farther away, the largest exposure was airborne. For one model, short-range exposure disappeared at 1.8m. Policy concerning physical distancing for infection reduction relies on exposure as a function of distance, yet within this construct, deposition varies. This two-fold distance effect can be used to evaluate control technology such as plexiglass barriers, masking, and ventilation.

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Razavi, N., Jafari, A.

Towards Intelligent Facility Management: Autonomous Robotic Sensing for Enhanced Indoor Environmental Quality.

In: Computing in Civil Engineering 2025. 2026. 489-498 p.

Optimizing indoor air quality (IAQ) requires continuous monitoring of environmental factors to meet or exceed established standards. Automated sensing has emerged as a transformative solution, leveraging advanced robotic capabilities to overcome the limitations of static sensor networks. This study presents an innovative framework for intelligent IAQ monitoring, utilizing autonomous robotic sensing. A TurtleBot 4 equipped with a Greywolf IAQ sensor was developed and tested, enabling seamless navigation of indoor spaces while collecting spatial and temporal data, including location coordinates, timestamps, and temperature, humidity, and CO2 readings. Data collected in real time are transmitted to a processing unit for analysis and visualized as dynamic real-time heatmaps, providing an evolving snapshot of indoor conditions. The framework was tested in a small residential building to validate its capability to effectively monitor and analyze IAQ conditions. By integrating these components, the study demonstrates the potential of autonomous robotic systems to revolutionize facility management practices.

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Wang, Y., Wang, J., Yao, W., Ren, J., Chen, L., Ban, Q.

Ventilation and indoor air quality management in operating rooms: A systematic review of pollutant sources, transmission, and control techniques.

Journal of Building Engineering, Vol. **120**, (2026)

The COVID-19 pandemic has heightened global awareness of environmental control within healthcare facilities, particularly focusing on methods for managing airborne contaminants in operating rooms. However, a systematic synthesis of theoretical approaches in this domain remains lacking. This review first identifies the sources of airborne pollutants in operating rooms. Subsequently, based on contaminant types and origins, it introduces, compares, and analyzes current control methods and research techniques, highlighting existing gaps and proposing directions to advance knowledge in the field. Furthermore, as airborne contaminants pose significant yet often invisible risks to operating room personnel, researchers are increasingly prioritizing the validation and investigation of the effectiveness of control methods. Finally, managing these contaminants necessitates consideration of technical, logistical, and ethical aspects, driving a shift towards more precise evaluation frameworks. This review systematically summarizes operating room airborne contaminant control strategies, aligning with national health initiatives and offering valuable references for developing rapid-response measures during future major public health crises.

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Zhang, S., Jiang, J., Cheng, Y., Lin, Z.

Ventilation Indices for Evaluation of Airborne Infection Risk Control Performance of Air Distribution.

In: Ventilation Performance Indices with Elevated Air Movement for Health, Thermal Comfort, and Energy Efficiency. Springer Nature Singapore; 2025. 181-204 p.

The management of airflow distribution is crucial in preventing respiratory infections like COVID-19, with ventilation metrics serving as key indicators to assess airborne infection risks and evaluate the effectiveness of air distribution systems. This chapter examines the correlation between ventilation metrics and airborne infection risk, proposing new indices to measure the efficacy of infection control strategies within these systems. Alongside traditional metrics such as age of air (AoA), air change effectiveness (ACE), and contaminant removal effectiveness (CRE), this chapter introduces air utilization effectiveness (AUE) and contaminant dispersion index (CDI) as innovative indices. Computational fluid dynamics (CFD) simulations are carried out in hospital wards and classrooms to apply different ventilation strategies, compute these indices, and evaluate airborne infection risk. A three-stage correlation analysis, using statistical methods, is developed to validate these ventilation indices. The results support the combined use of AUE and CDI as a comprehensive indicator of airborne infection risk, with CDI particularly emphasized for local risk assessment, regardless of factors like the influence of air distribution, airflow rates, infectiousness levels, room configurations, and occupant distributions. This chapter makes a significant contribution to enhancing control measures against the airborne spread of respiratory diseases by optimizing air distribution strategies.

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