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Aéraulique et COVID-19

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Google Scholar, Lens et WoS

Puglia, M., Ottani, F., Morselli, N., Pedrazzi, S., Allesina, G., Muscio, A.*, et al.*
Airborne pathogens diffusion: A comparison between tracer gas and pigmented aerosols for indoor environment analysis.
Heliyon, Vol. **10** n°(4), (2024)

The evaluation of airborne pathogens diffusion is a crucial practice in preventing airborne diseases like COVID-19, especially in indoor environments. Through this transmission route, pathogens can be carried by droplets, droplet nuclei and aerosols and be conveyed over long distances. Therefore, understanding their diffusion is vital for prevention and curbing disease transmission. There are different techniques used for this purpose, and one of the most common is the utilization of tracer gas, however, it has limitations such as the difference in size between the gas molecules and the respiratory droplets, as well as its incapability to take into account evaporation. For this reason, a new method for evaluating the diffusion of respiratory droplets has been developed. This approach involves the use of an ultrasonic emitter to release and disperse pigmented aerosols, and a colorimeter for the following quantitative evaluation. A comparison with the tracer gas technique has been carried out, showing for the pigmented aerosols methodology a response that is dependent on different relative humidity conditions, while there is no clear difference in the dispersion of tracer gas at high or low humidity.

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Yılmaz, İ. C., Yılmaz, D., Kandemir, O., Tekin, H., Atabay, Ş., Bulut Karaca, Ü.
Barriers to BIM Implementation in the HVAC Industry: An Exploratory Study.
Buildings, Vol. **14** n°(3), (2024)

In recent times, the rise of urbanization, industrialization, population growth, food security, and the COVID-19 pandemic have led to an increased demand for indoor spaces with efficient air conditioning systems. As a result, there is a growing interest in creating more complex HVAC systems to improve indoor spaces. Building information modeling (BIM) offers numerous benefits to the HVAC industry, such as clash detection, budget and time reductions, and increased efficiency. However, its implementation is currently hindered by various challenges. This research aims to identify the major barriers to BIM implementation in the HVAC industry in Turkey, using a questionnaire survey of 224 domain experts working in 42 different companies across various fields of the HVAC industry. The study utilized several statistical analyses to categorize and prioritize the most critical barriers, including reliability tests, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), the Kaiser–Meyer–Olkin (KMO) test, Bartlett's test, and ranking of factors (IRI). The results indicate that the "Deficiencies of Infrastructure and Lack of Qualified Personnel (DIP)" factor group constituted the most significant barrier, followed by "Lack of Documentation and Specifications (LDS)", "Deficiencies of Case Studies and Project Drawings (DCP)", and "Lack of Motivation and Resistance to BIM (LMR)". Moreover, our research revealed that 60% of the participants' companies allocate less than 40% of their budgets to technological infrastructure, which hinders the adoption of BIM. To promote BIM in the HVAC sector, we recommend enhancing personnel capacity building, improving skills and knowledge about BIM, promoting guidelines, and providing free access to documentation for practitioners.

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Saad, M. A., Hassan, A. A., Hanafy, A. A., Salem, M. H., William, M. A.
Can Airflow Manipulation Disrupt the Transmission of COVID-19 Variants and Highly Infectious Droplets?
Research Square, (2024)

In the ongoing battle against new variants of COVID-19 and airborne-transmitted diseases, the focus on indoor air quality, particularly in enclosed spaces, has intensified. This study utilizes computational fluid dynamics (CFD) modelling to investigate how different air distribution setups can impact the spread of airborne COVID-19 particles. Air distribution systems are at the forefront of this research, specifically examining supply and exhaust diffuser placements and their effects on droplet dispersion dynamics. Results reveal a promising reduction (10–21%) in residual droplet mass over a 10-second period when exhaust diffusers are strategically located above cough sources. This underscores the pivotal role of ventilation design in curbing airborne transmission. Furthermore, the analysis sheds light on variations (2.7–8.9%) in droplet Sauter mean diameter across different configurations, underscoring the significance of airflow patterns in dictating droplet size distribution and infection control efficacy. The study also emphasizes the importance of maintaining social distancing measures, showcasing a substantial decrease (82–89%) in viral concentration at a 2-meter distance, despite ventilation imperfections. In summary, this study highlights the critical role of ventilation design in combating airborne COVID-19 transmission within office environments. These findings offer valuable insights into optimizing airflow patterns, enhancing overall safety measures, and informing effective strategies to tackle the pandemic.

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Armani Khatibi, E., Farshbaf Moghimi, N., Rahimpour, E.
COVID-19: An overview on possible transmission ways, sampling matrices and diagnosis.
Bioimpacts, Vol. **14** n°(6), (2024)

COVID-19 is an RNA virus belonging to the SARS family of viruses and includes a wide range of symptoms along with effects on other body organs in addition to the respiratory system. The high speed of transmission, severe complications, and high death rate caused scientists to focus on this disease. Today, many different investigation types are performed on COVID-19 from various points of view in the literature. This review summarizes most of them to provide a useful guideline for researchers in this field. After a general introduction, this review is divided into three parts. In the first one, various transmission ways COVID-19 are classified and explained in detail. The second part reviews the used biological samples for the detection of virus and the final section describes the various methods reported for the diagnosis of COVID-19 in various biological matrices.

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Paralovo, S. L., Vanden Driessche, K., Cartuyvels, R., Lazarov, B., Vlieghe, E., Vanstraelen, L.*, et al.*
Development of a Bioaerosol Sampling Method for Airborne Pathogen Detection with Focus on SARS-CoV-2.
Indoor Air, Vol. **2024**, (2024)

As worldwide evidence shows that the predominant transmission route of SARS-CoV-2 and other respiratory pathogens is airborne, the need for suitable methods for the sampling of bioparticles directly from the air is more urgent than ever. The present paper describes the development of a method for the collection of biological aerosols, using a preexisting cyclonic impinger, the Coriolis µ, combined with a lysis buffer and subsequent qPCR analysis of the generated samples in lab. Four phases of method development are described: exploratory, validation, blank tests, and application. The application phase consisted of a field experiment in which the method was simultaneously applied at two daycare facilities. The method achieved a good level of accuracy and reliability in detecting different types of infectious agents in the air, with a global uncertainty of 19.6%. Furthermore, our method allows the simultaneous detection of 26 different respiratory pathogens in air samples, it is relatively simple, and the equipment is easy to use. Additionally, the time to collect a representative sample is short compared to other methods. The method does not cause significant disturbance to those present in the sampled rooms, and it is safe for operators and flexible, meaning it can be used in virtually any environment regardless of use, size, or occupancy. Further research is being developed to

allow quantitative analysis of the collected samples and to test the methods' ability to assess the viability of the microorganisms collected in the sample.

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Nakagawa, M., Fujishiro, Y., Doi, Y., Yamakami, J., Honda, H.
Differences in the incidence of nosocomial-onset COVID-19 among hospitalized patients with exposure to SARS-CoV-2.
Infection Control & Hospital Epidemiology, Vol., (2024), 1-3 p.

We evaluated the secondary COVID-19 incidence among uninfected hospitalized patients after nosocomial COVID-19 exposure. An exposure source of SARS-CoV-2 was hospitalized patients or healthcare personnel (HCP) newly diagnosed as having COVID-19. Patients exposed to a COVID-19-infected patient in a shared room more frequently developed COVID-19 than those exposed to an infected HCP.

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Van Tongeren, M., Canham, R., Coleman, A., Clabon, K., Coll., E.
An epidemiological and modelling analysis of transmission of SARS-CoV-2 at a United Kingdom electricity generating company.
PROTECT National Core Study Report 2023

This report, from theme 3 researchers on the PROTECT NCS, describes the application of epidemiological and mathematical modelling to investigate factors influencing infection and transmission in the electricity generating sector using an extensive and detailed database of COVID-19 workforce test results complied by one large generating company. Electricity generation is part of the national critical infrastructure and has been required to keep operating throughout the pandemic.

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Sandra, C., Alexandra, F.
Indoor Risk Estimation Model for Health Protection from COVID-19.
In: Advancements in Indoor Environmental Quality and Health. IntechOpen; 2024. Ch. 6 p.

In this chapter, a conceptual framework for assessing the probability of COVID-19 transmission is presented and discussed. The Wells-Riley probabilistic methodology for indoor environments is adopted, by integrating updated clinical data, thereby ensuring a reliable estimation of the probability of infection, through the model implementation on a specific Android platform. Notifications are sent to the user when detecting a high probability of infection and high carbon dioxide concentration levels. In addition, the Bluetooth signal is exploited to accurately determine the proximity between devices, thus facilitating the efficient enforcement of social distancing protocols among individuals. The effectiveness of the proposed model is validated through the application on different test scenarios.

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Tsang, T.-W., Mui, K.-W., Wong, L.-T., Wong, Y.-S.
The influence of ventilation on airborne transmission between stacking toilets.
Journal of Building Engineering, Vol. **87**, (2024)

Multiple COVID-19 outbreaks in high-rise residential buildings have been linked to the vertical spread of the virus along the building. This study aimed to provide empirical evidence and experimental results to evaluate the effects of toilet ventilation on the spread of bathroom aerosols in high-rise residential buildings. This study explored potential transmission pathways by conducting tracer gas experiments in a full-scale mock-up toilet facility and identified effective strategies to minimize tracer gas surge and overall exposure. A novel IoT-

enabled tracer gas sensing network was used to evaluate tracer gas dispersion from a lower-floor toilet to an upper-floor toilet and the roof under 32 different ventilation conditions of windows, exhaust fans, and forward-facing wind. The findings confirmed the potential for vertical airborne transmission through toilet ventilation and suggested effective ventilation strategies for forward-facing wind and no-wind conditions. This study provided novel experimental results on vertical aerosol transmission, contributing to further analysis and validation in this field. Appropriate ventilation measures were also discussed to ensure clean, virus-free air intake, reducing the risk of airborne cross-infection via the vertical transmission pathway.

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Ballesteros Álvarez, J. M., Romero Barriuso, A., Villena Escribano, B. M., Rodríguez Sáiz, A., González-Gaya, C.
Investigating the effectiveness of a new indoor ventilation model in reducing the spread of disease: A case of sports centres amid the COVID-19 pandemic.
Heliyon, Vol. **10** n°(6), (2024)

The ventilation of buildings is crucial to ensure indoor health, especially when demanding physical activities are carried out indoors, and the pandemic has highlighted the need to develop new management methods to ensure adequate ventilation. In Spain, there are no specific ventilation regulations to prevent the spread of pathogens such as the coronavirus. Therefore, it is necessary to have a theoretical tool for calculating occupancy to maintain sports facilities in optimal safety conditions. The proposed theoretical method is based on the analysis of mathematical expressions from European standardisation documents and uses the concentration of CO2 as a bioeffluent. It is also based on the concept of background and critical concentration, which allows its application to be extrapolated to future crises caused by pathogens. This study presents a unique and novel dataset for sports centres. For this purpose, the calculation methods were applied to the data set provided by Mostoles City Council, Spain, during the pandemic years with the highest incidence of COVID-19, when the government introduced the assimilation of COVID-19 sick leave to occupational accidents. The data on this type of sick leave provided by the City Council correspond to the period between March 2020 and February 2022. Similarly, the data on the average use of sports facilities by activity, provided by the Sports Department, correspond to the years 2020 and 2021. In this way, it was possible to verify the effectiveness in preventing the spread of any type of coronavirus. In conclusion, the implementation of a theoretical occupancy calculation method based on the concentration of carbon dioxide as a bioeffluent can be an effective tool for the management of future crises caused by pathogens or hazardous chemicals in the air, and demonstrated its effectiveness in sports centres such as gyms, sports fields, and indoor swimming pools during the COVID-19 pandemic.

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Jiang, C., Liu, Z., Wang, Y., Yao, G., Li, S., Rong, R.*, et al.*
Investigation of pathogen-laden aerosol aerodynamics and ventilation rates on their long-range transmission: A study on the Fangcang shelter hospital.
Journal of Cleaner Production, (2024)

Although it is clear that respiratory pathogens are transmitted through droplets and physical contact in Fangcang shelter hospitals (FSHs), the potential for long-range transmission is poorly understood (Offord, 2020; WHO, 2020), and the effective ventilation rate for epidemic prevention in large public spaces is also not yet known. We investigated the pathogen-laden aerosol aerodynamics for the first time in the FSH using a model bacteria indication of the pathogen, concurrently examining ventilation rates on their long-range transmission. The study found that aerosols with sizes smaller than 3.3 μm could facilitate the long-range transmission of pathogens. Poor ventilation results in an increase in contamination levels, but excessive ventilation (12 ACH) may trigger a diminishing return phenomenon of ventilation within the FSH, and worsen aerosol deposition. For this FSH, an ideal ventilation rate was close to 10 ACH, and pathogen-laden aerosols were reduced by 29.54% and 26.77% in the pollution zone and surveyed patient shelter block (PSB),

respectively, compared to the design values. Our study contributes to cleaner production in the FSH, as well as to the sustainability of healthcare services and the environment. Some of the findings can be generalized to some extent for similar large public spaces.

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Wisdom, E., Kehinde Andrew, O.-L., Nwakamma, N.-E., Danny Jose Portillo, M., Favour Oluwadamilare, U., Emmanuel Chigozie, A.
Leveraging project management tools for energy efficiency in hvac operations: a path to climate resilience.
Engineering Science & Technology Journal, Vol. **5** n°(3), (2024), 653-661 p.

Efficient management of heating, ventilation, and air conditioning (HVAC) systems is paramount for mitigating energy consumption and enhancing climate resilience in modern infrastructure. This review explores the significance of leveraging project management tools to optimize energy efficiency within HVAC operations, thus fostering a pathway towards climate resilience. The integration of project management methodologies offers a systematic approach to address challenges associated with energy consumption in HVAC systems, thereby facilitating informed decision-making processes. Firstly, the review delves into the pressing need for energy conservation in HVAC operations amidst escalating concerns over climate change and its adverse impacts. The imperative to minimize energy consumption in buildings, particularly through HVAC systems, is highlighted as a pivotal step towards achieving climate resilience and sustainability goals. Subsequently, the review outlines the role of project management tools in orchestrating effective strategies to enhance energy efficiency within HVAC operations. By employing techniques such as project scheduling, risk management, and resource allocation, project managers can streamline the implementation of energy-efficient measures, thereby optimizing HVAC system performance and reducing carbon emissions. Moreover, the review underscores the importance of data analytics and technological advancements in augmenting the efficacy of project management tools for energy efficiency in HVAC operations. Leveraging real-time data monitoring, predictive analytics, and IoT-enabled devices enables proactive maintenance and continuous optimization of HVAC systems, thereby maximizing energy savings and bolstering climate resilience. Furthermore, the review elucidates the potential benefits and challenges associated with the adoption of project management tools for energy efficiency in HVAC operations. While improved cost-effectiveness, environmental sustainability, and operational performance emerge as primary benefits, challenges such as initial investment costs, technological complexities, and organizational inertia necessitate careful consideration. This review advocates for the integration of project management tools as a viable approach to foster energy efficiency in HVAC operations, thereby paving the way towards enhanced climate resilience and sustainability in built environments. By embracing innovative methodologies and technological solutions, stakeholders can mitigate energy consumption, reduce greenhouse gas emissions, and fortify infrastructure against the impacts of climate change.

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Banholzer, N., Bittel, P., Philipp Jent, P., Furrer, L., Zurcher, K., Egger, M.*, et al.*
Molecular detection of SARS-CoV-2 and other respiratory viruses in saliva and classroom air: a two winters tale.
Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases, (2024)

OBJECTIVES: To compare the prevalence of SARS-CoV-2 and other respiratory viruses in saliva and bioaerosols between two winters and model the probability of virus detection in classroom air for different viruses. METHODS: We analyze saliva, air, and air cleaner filter samples from studies conducted in two Swiss secondary schools (age 14-17years) over seven weeks during the winters of 2021/22 and 2022/23. Two bioaerosol sampling devices and HEPA filters from air cleaners were used to collect airborne virus particles in five classrooms. Daily bioaerosol samples were pooled for each sampling device before PCR analysis of a panel

of 19 respiratory viruses and viral subtypes. The probability of detection of airborne viruses was modelled using an adjusted Bayesian logistic regression model. RESULTS: Three classes (58 students) participated in 2021/22, and two classes (38 students) in 2022/23. During winter 2021/22, SARS-CoV-2 dominated in saliva (19 of 21 positive samples) and bioaerosols (9 of 10). One year later, there were 50 positive saliva samples, mostly influenza B, rhinovirus, and adenovirus, and two positive bioaerosol samples, one rhinovirus and one adenovirus. The weekly probability of airborne detection was 34% (95%-credible interval [CrI] 22%-47%) for SARS-CoV-2 and 10% (95%-CrI 5%-16%) for other respiratory viruses. CONCLUSIONS: There was a distinct shift in the distribution of respiratory viruses from SARS-CoV-2 during the Omicron wave to other respiratory viruses one year later. SARS-CoV-2 is more likely to be detected in the air than other endemic respiratory viruses, possibly reflecting differences in viral characteristics and the composition of virus-carrying particles that facilitate airborne long-range transmission.

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Chillón, S. A., Fernandez-Gamiz, U., Zulueta, E., Ugarte-Anero, A., Blanco, J. M.
Numerical performance of CO2 accumulation and droplet dispersion from a cough inside a hospital lift under different ventilation strategies.
Scientific Reports, Vol. **14** n°(1), (2024)

The impact of mechanical ventilation on airborne diseases is not completely known. The recent pandemic of COVID-19 clearly showed that additional investigations are necessary. The use of computational tools is an advantage that needs to be included in the study of designing safe places. The current study focused on a hospital lift where two subjects were included: a healthy passenger and an infected one. The elevator was modelled with a fan placed on the middle of the ceiling and racks for supplying air at the bottom of the lateral wall. Three ventilation strategies were evaluated: a without ventilation case, an upwards-blowing exhausting fan case and a downwards-blowing fan case. Five seconds after the elevator journey began, the infected person coughed. For the risk assessment, the CO2 concentration, droplet removal performance and dispersion were examined and compared among the three cases. The results revealed some discrepancies in the selection of an optimal ventilation strategy. Depending on the evaluated parameter, downward-ventilation fan or no ventilation strategy could be the most appropriate approach.

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Brüssow, H.
Pandemic preparedness: On the efficacy of non-pharmaceutical interventions in COVID-19 and about approaches to predict future pandemic viruses.
Microb Biotechnol, Vol. **17** n°(3), (2024)

Abstract With three major viral pandemics over the last 100?years, namely the Spanish flu, AIDS and COVID-19 each claiming many millions of lives, pandemic preparedness has become an important issue for public health. The economic, social and political consequences of the upheaval caused by such pandemics also represent a major challenge for governments with respect to sustainable development goals. The field of pandemic preparedness is vast and the current article can only address selected aspects. The article looks first backwards and addresses the question of the efficacy of non-pharmaceutical interventions (NPI) on the trajectory of the COVID-19 pandemic. The article looks then forward by asking to what extent viral candidates for future pandemics can be predicted by virome analyses from metagenome and transcriptome sequencing, by focusing on the virome from specific animal species and using ecological and epidemiological data about spillover viral infections in veterinary and human medicine. As a comprehensive overview on pandemic preparedness is beyond the capacity of a single reviewer, only selected topics will be discussed using recent key scientific publications. Since COVID-19 has not run its course, a computational program able to predict the future evolution of SARS-CoV-2 is mentioned that could assist proactive mRNA vaccine developments against possible future variants of concern. Ending the COVID-19 epidemic necessitates mucosal vaccines that can

suppress the transmission of SARS-CoV-2 and therefore this article closes by discussing a promising and versatile protein nanoparticle experimental vaccine approach for inhalation that does not depend on needles nor a cold chain for distribution.

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Raphe, P., Fellouah, H., Poncet, S., Ameur, M.
Parametric study on the age of air in a full-scale office room using perforated duct diffusers.
Heliyon, Vol. **10** n°(5), (2024)

Following the recent pandemic of COVID-19, scientists have made many efforts to devise a workable solution for it, worldwide. However, it was shown that the protective effect of a well-conditioning system is as high as five times in comparison to the face-covering and other proposed procedures. In this context, the age of air and the type of filtration systems in closed spaces became the critical criteria for comparing the capability of ventilation systems. In this paper, a validated numerical model for the perforated duct diffusers is used to study the behaviour of the local age of air at the full-scale office with 8 feet (2.44 [m]) height, under various initial conditions like initial velocity and air change per hour. Also, different geometries for the ducts have been investigated under the same initial condition, as well as the effect of direction, ventilation effectiveness, and flow pattern. Finally, the volume average of the age of air at different zones has been nominated to perform the sensitivity analysis of each variable based on the variation of the airflow. The results show that diffusers with vertical perforations would be more effective during the pandemic than the other types in airborne mitigation. Moreover, the highest available airflow shall be set until such time there is no windy area in the breathing zone. Within these modifications, the residence time of the infectious nuclei in the breathing zone may decrease by up to 30%.

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Pisharodi, M.
Portable and Air Conditioner-Based Bio-Protection Devices to Prevent Airborne Infections in Acute and Long-Term Healthcare Facilities, Public Gathering Places, Public Transportation, and Similar Entities.
Cureus, Vol. **16** n°(3), (2024)

The nature in which the coronavirus disease 2019 (COVID-19) pandemic started and spread all over the world has surprised and shocked experts and the general population alike. This has brought out a worldwide desire and serious efforts to prevent, or at least reduce, the severity of another airborne viral infection and protect individuals gathering for various reasons. Toward this main purpose, a novel method to disinfect the air, using graded, predictable, safe, and reliable dosage of ultraviolet C (UVC), with specially designed devices, is described here. Individuals exclusively breathing this disinfected air can prevent infection, thus destroying the airborne virus or any other pathogens outside the human body to prevent acute and chronic damage to the organs and provide a sense of security to congregate, use public transport, and be protected in acute and long-term healthcare facilities. The study involved designing and testing a unit with one UVC chamber and another unit with six UVC chambers both enclosed in UVC-opaque housings that could be used to destroy airborne pathogens. Wild-type severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was used as a representative pathogen. The virus was fed into these units and in both units, the virus was destroyed to undetectable levels. Such disinfected air can be made available for individuals to breathe at an individual and a community level. The two units that were studied were able to destroy the SARS-CoV-2 virus completely in UVC-opaque housings, making them safe for human use. By employing the air to bring the virus to the UVC, the problem of the virus getting protected behind structures was avoided. The individuals get to breathe totally disinfected air through a mask or a ventilator. To protect individuals who are unable or unwilling to use these units meant for individual use, the same principle can be expanded for use with air conditioners to provide community protection. It is envisaged that this method can prevent airborne infections from turning into pandemics and is a clear example of advocating prevention, rather than treatment. These units are

expandable and the UVC dosage to the pathogen can be adjusted and predictable, thereby making it a standard technique to study the dosage needed to inactivate different pathogens.

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Lee, H. Y., Park, Y.-J., Lee, S.-E., Yoo, H.-N., Kim, I.-H., No, J. S.*, et al.*
Risk factors for SARS-CoV-2 transmission during a movie theater outbreak in Incheon in the Republic of Korea, November 2021: a retrospective study.
Osong public health and research perspectives, Vol. **15** n°(1), (2024), 45-55 p.

Background
We examined factors contributing to the transmission of an acute respiratory virus within multi-use facilities, focusing on an outbreak of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in a movie theater in the Republic of Korea.
Methods
This retrospective cohort study involved a descriptive analysis of 48 confirmed cases. Logistic regression was applied to a cohort of 80 theater attendees to identify risk factors for infection. The infection source and transmission route were determined through gene sequencing data analysis.
Results
Of the 48 confirmed cases, 35 were theater attendees (72.9%), 10 were family members of attendees (20.8%), 2 were friends (4.2%), and 1 was an employee (2.1%). Among the 80 individuals who attended the 3rd to 5th screenings of the day, 35 became infected, representing a 43.8% attack rate. Specifically, 28 of the 33 third-screening attendees developed confirmed SARSCoV-2, constituting an 84.8% attack rate. Furthermore, 11 of the 12 cases epidemiologically linked to the theater outbreak were clustered monophyletically within the AY.69 lineage. At the time of the screening, 35 individuals (72.9%) had received 2 vaccine doses. However, vaccination status did not significantly influence infection risk. Multivariate analysis revealed that close contacts had a 15.9-fold higher risk of infection (95% confidence interval, 4.37-78.39) than casual contacts.
Conclusion
SARS-CoV-2 transmission occurred within the theater, and extended into the community, via a moviegoer who attended the 3rd screening during the viral incubation period after contracting the virus from a family member. This study emphasizes the importance of adequate ventilation in theaters.

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Lee, J. H., Shim, J. W., Lim, M. H., Baek, C., Jeon, B., Cho, M.*, et al.*
Towards optimal design of patient isolation units in emergency rooms to prevent airborne virus transmission: From computational fluid dynamics to data-driven modeling.
Comput Biol Med, Vol. **173**, (2024)

Background Patient isolation units (PIUs) can be an effective method for effective infection control. Computational fluid dynamics (CFD) is commonly used for PIU design; however, optimizing this design requires extensive computational resources. Our study aims to provide data-driven models to determine the PIU settings, thereby promoting a more rapid design process. Method Using CFD simulations, we evaluated various PIU parameters and room conditions to assess the impact of PIU installation on ventilation and isolation. We investigated particle dispersion from coughing subjects and airflow patterns. Machine-learning models were trained using CFD simulation data to estimate the performance and identify significant parameters. Results Physical isolation alone was insufficient to prevent the dispersion of smaller particles. However, a properly installed fan filter unit (FFU) generally enhanced the effectiveness of physical isolation. Ventilation and isolation performance under various conditions were predicted with a mean absolute percentage error of within 13%. The position of the FFU was found to be the most important factor affecting the PIU performance. Conclusion Data-driven modeling based on CFD simulations can expedite the PIU design

process by offering predictive capabilities and clarifying important performance factors. Reducing the time required to design a PIU is critical when a rapid response is required.

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Bian, Y., Fu, X., Gupta, R. K., Shi, Y.
Ventilation and Temperature Control for Energy-efficient and Healthy Buildings: A Differentiable PDE Approach.
arXiv preprint, (2024)

In this paper, we introduce a novel framework for building learning and control, focusing on ventilation and thermal management to enhance energy efficiency. We validate the performance of the proposed framework in system model learning via two case studies: a synthetic study focusing on the joint learning of temperature and CO2 fields, and an application to a real-world dataset for CO2 field learning. For building control, we demonstrate that the proposed framework can optimize the control actions and significantly reduce the energy cost while maintaining a comfort and healthy indoor environment. When compared to existing traditional methods, an optimization-based method with ODE models and reinforcement learning, our approach can significantly reduce the energy consumption while guarantees all the safety-critical air quality and control constraints. Promising future research directions involve validating and improving the proposed PDE models through accurate estimation of airflow fields within indoor environments. Additionally, incorporating uncertainty modeling into the PDE framework for HVAC control presents an opportunity to enhance the efficiency and reliability of building HVAC system management.

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Zhou, K., Ma, S., Shao, X., Li, S., Jin, Q.
Ventilation retrofit design for existing primary and secondary school classrooms under epidemic conditions.
Building Services Engineering Research and Technology, (2024)

In the context of regular epidemic prevention and control, most primary and secondary schools in developing countries are naturally ventilated. They are unable to use measures such as air filters equipped with centralized mechanical ventilation systems and demand-controlled ventilation. Therefore, the feasibility of using automatic control of negative pressure ventilation (NPV) in conjunction with CO2 concentration detectors to reduce the rate of infection in the classroom was investigated. Firstly, the CO2 concentration threshold calculation for epidemic prevention was carried out, and then the measured data of the classroom was fitted with the Computational Fluid Dynamics (CFD) simulation data to establish a simulation and analysis platform to comprehensively evaluate different NPV conditions. The results show that NPV can control the direction of airflow and CO2 concentration in the teaching room, which can significantly reduce the risk of infection, and that Upward Supply Upward Return NPV with automatic control of the CO2 concentration detector and the combination of windshields can protect the students from cross-infection. The study aims to optimize classroom ventilation strategies for epidemic proofing through low-cost building modifications, which could inform the retrofitting of hundreds of thousands of established primary and secondary schools in developing countries.Practical ApplicationVentilation systems controlled by environmental parameters have the advantages of low cost, high automation, and ease of operation. This system makes designing classrooms to combat airborne epidemics easier by implementing simple retrofitting measures for developing countries where natural ventilation is predominantly used and where most classrooms are not equipped with fresh air ducts. Tests of the top inlet and top return ventilation system proposed in this paper found that the classroom?s measured indoor carbon dioxide concentrations were reduced to below the theoretical limits.

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