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Qualité de l’air intérieur

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WoS, Google Scholar et Lens

Kolarik, J., Lyng, N. L., Bossi, R., Li, R., Witterseh, T., Smith, K. M.*, et al.*
Application of Cluster Analysis to Examine the Performance of Low-Cost Volatile Organic Compound Sensors.
Buildings, Vol. **13** n°(8), (2023)

Airtight energy-efficient buildings of today need efficient ventilation to secure high indoor air quality. There is a need for affordable and reliable sensors to make demand control available in a broad range of ventilation systems. Low-cost metal oxide semiconductor (MOS) volatile organic compound (VOC) sensors offer such a possibility, but they are usually non-selective and react to broad range of compounds. The objective of the present paper was to use cluster analysis to assess the ability of five commercially available MOS VOC sensors to detect pollutants in a residential setting. We studied three scenarios: emissions from people (human bioeffluents), furnishing materials (linoleum), and human activity (surface cleaning with spray detergent). We monitored each scenario with five MOS VOC sensors and a proton-transfer-reaction–time-of-flight mass spectrometer (PTR-ToF-MS). We applied an agglomerative hierarchical clustering algorithm to evaluate the dissimilarity between clusters. Four of the five tested sensors produced signals in agreement with the concentration patterns measured with the PTR-ToF-MS; one sensor underperformed in all cases. Three sensors showed a very similar performance under all emission scenarios. The results showed that the clustering could help in understanding whether a particular sensor matched the intended emission scenario.

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Bagaber, M., Kaafil, S. F.
Assessment of Indoor Air Quality in Different Spaces of Residential and Commercial Buildings in Jeddah, Saudi Arabia.
Asian Journal of Water Environment and Pollution, Vol. **20** n°(4), (2023), 79-86 p.

Indoor air pollution has a significant impact on human health, triggering and inducing a wide range of diseases that result in high morbidity and mortality. In this study, indoor air pollution in different spaces of residential and commercial buildings is assessed in terms of air quality index (AQI), particulate matter PM2.5, particulate matter PM10, carbon dioxide, formaldehyde (HCHO), the total volatile organic compound (TVOC), humidity, and temperature. Two residential apartment buildings are chosen for study, one is in a busy outdoor area and the other is situated in a calm outdoor area to see the effects of outdoor air quality on indoor spaces. It is found that the indoor air quality of bedrooms in residential spaces and cafes in commercial buildings is higher than the standards, and it is recommended to provide proper ventilation for better living of the occupants. Also, it is found that there is minimal effect of infiltration of outdoor air pollutants on indoor air quality and the reason is due to the provision of mechanical ventilation with air filters and effective building envelope.

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Darago, A., Klimczak, M., Jurewicz, J., Kucharska, M., Kilanowicz, A.
Assessment of lead exposure in indoor shooters in central Poland.
Scientific Reports, Vol. **13** n°(1), (2023)

A steady increase in shooting practices is observed worldwide. Potential lead exposure at shooting ranges poses a risk to their employees and users, which is not widely reported outside of the USA, especially in Poland. Exposure to lead results from the use of bullets containing lead and the main route of exposure to this metal at shooting ranges is inhalation, i.e., during shooting or cleaning. The aim of this study was to assess lead exposure of employees and users in selected indoor shooting ranges in central Poland. Airborne lead concentrations at all locations in the shooting ranges were above Polish occupational exposure limit (OEL, 0.05 mg m−3). Elevated blood and urine lead levels, and decreased 4-aminolevulinic acid dehydratase activity (ALA-D) were found in subjects participating in shooting even for only a few (< 10) hours per week. Lead exposure at shooting ranges in central Poland, as indicated by elevated blood lead levels and decreased ALA-D activity, could represent an elevated risk for adverse health effects. Thus, information on the possible health consequences of lead exposure should be provided at these sites, and biomonitoring appears to be reasonable for regular workers and shooters.

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Shen, X., Sun, Q., Mosey, G., Ma, J., Wang, L., Ge, M.

Benchmark of plant-based VOCs control effect for indoor air quality: Green wall case in smith campus at Harvard University.

Science of The Total Environment, (2023)

The emission of volatile organic compounds (VOCs) from interior materials can significantly impact people's health and daily activities, necessitating effective management. In the construction of the interior built environment, plants serve as a suitable means to enhance air quality. They not only function as ecological living materials for air purification and VOCs removal but are also valued for their aesthetic appeal. However, often the emphasis in designing green infrastructure is placed more on the aesthetics of planting design rather than considering plants' ecological properties. This research examines the ability of 12 plant species used in the interior green wall design at Harvard University's Smith Center as a case study to decompose and absorb VOCs through experimental studies. By integrating ecological properties and key factors such as spatial and budget constraints into the design process, this research explores the potential of using an algorithmic model to select plant species capable of reducing interior VOC pollution in green wall design. The significance of this study lies in its contribution to indoor environmental health and environmental management practices through providing a potential plant selection model and suggesting a relevant workflow for interior planting design with the goal of controlling VOC emissions. By leveraging the knowledge gained from experiments on the VOC removal abilities of selected plant species, this study offers a valuable resource for practitioners seeking to create innovative indoor air cleaning and decontamination technologies.

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Robin, Y., Amann, J., Goodarzi, P., Schneider, T., Schutze, A., Bur, C.*, et al.*

Comparison of Explainable Machine Learning Algorithms for Optimization of Virtual Gas Sensor Arrays.

In: IEEE International Instrumentation and Measurement Technology Conference (I2MTC) - Rising Above Covid-19. Kuala Lumpur, MALAYSIA2023.

Metal oxide semiconductor (MOS) gas sensors operated in temperature cycled operation (TCO) and calibrated with machine learning algorithms are increasingly promising for indoor air quality (IAQ) assessments. This can be attributed to the cost-efficient sensors, with a broad sensitivity spectrum and the possibility of continuous measurements. However, with the ever-increasing complexity of data-driven models used to calibrate the MOS gas sensors, understanding the connection between the raw input and the predicted gas concentration is especially important. In this work, two methods from the field of explainable AI are applied to our custom neural network (TCOCNN) and compared regarding their capability to identify essential parts of the raw input signal. For this purpose, a validation scheme is introduced to rate the explanation methods. Finally, it is shown that with only 7 % of the original raw input, root-mean-squared error (RMSE) values for formaldehyde that are only 22 % worse compared to the absolute best (15.8 ppb vs. 19.3 ppb) can be achieved. This more profound understanding of the sensor can then be used to show differences between sensors, allow more accessible models to be built, and optimize the temperature-cycled operation regarding the number of temperature steps.

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Robin, Y., Amann, J., Schneider, T., Schuetze, A., Bur, C.

Comparison of Transfer Learning and Established Calibration Transfer Methods for Metal Oxide Semiconductor Gas Sensors.

Atmosphere, Vol. **14** n°(7), (2023)

Although metal oxide semiconductors are a promising candidate for accurate indoor air quality assessments, multiple drawbacks of the gas sensors prevent their widespread use. Examples include poor selectivity, instability over time, and sensor poisoning. Complex calibration methods and advanced operation modes can solve some of those drawbacks. However, this leads to long calibration times, which are unsuitable for mass production. In recent years, multiple attempts to solve calibration transfer have been made with the help of direct standardization, orthogonal signal correction, and many more methods. Besides those, a new promising approach is transfer learning from deep learning. This article will compare different calibration transfer methods, including direct standardization, piecewise direct standardization, transfer learning for deep learning models, and global model building. The machine learning methods to calibrate the initial models for calibration transfer are feature extraction, selection, and regression (established

methods) and a custom convolutional neural network TCOCNN. It is shown that transfer learning can outperform the other calibration transfer methods regarding the root mean squared error, especially if the initial model is built with multiple sensors. It was possible to reduce the number of calibration samples by up to 99.3% (from 10 days to approximately 2 h) and still achieve an RMSE for acetone of around 18 ppb (15 ppb with extended individual calibration) if six different sensors were used for building the initial model. Furthermore, it was shown that the other calibration transfer methods (direct standardization and piecewise direct standardization) also work reasonably well for both machine learning approaches, primarily when multiple sensors are used for the initial model.

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Mcgovern, F. R., Grogan, C., Amarandei, G., Mintova, S., Naydenova, I.
Developing Novel Holographic Optomechanical Sensing Platforms for Detection of Volatile Organic Compounds.
In: Conference on Holography - Advances and Modern Trends VIII. Prague, CZECH REPUBLIC2023.

Detecting volatile organic compounds (VOCs) is important, their presence in modern indoor environments being associated to health risks including respiratory diseases and cancers. State-of-the-art VOCs sensors as MEMS and semiconductor devices achieve high sensitivity but exhibit poor selectivity and high cross-sensitivity with other environmental analytes including temperature and humidity. Such sensors often require complex and costly fabrication/operation processes and/ or expensive readout equipment. Here, a novel optomechanical sensing platform, based on the combination of a holographic diffractive element and a static deflection bilayer cantilever, is presented. Its operation principle is based on the differential response of the cantilever layers to target analytes, and was verified using COMSOL Multiphysics. The cantilever deflection due to analyte presence was visually measured. As the sensitive layer is a photopolymer, a transmission volume holographic diffraction grating was recorded enabling a second, more sensitive, detection mode based on the variations in the diffracted beam intensity as the cantilever deflection angle changes. We compared the sensitivity of the optomechanical holographic sensor configuration to that of a holographic diffraction grating in a photopolymer layer coated on a glass slide. Selectivity and sensitivity of both configurations was increased by doping the photopolymer matrix with zeolite nanoparticles. The initial tests monitored the diffraction efficiency changes during the 5 minutes exposure time to 1000 ppm ethanol. The TOS presented changes of 1-4% in diffraction efficiency depending on the dopant concentration and photopolymer layer thickness, while the optomechanical sensor exhibited 7-14% change in diffraction efficiency.

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Unnithan, A., Bekele, D., Samarasinghe, C., Chadalavada, S., Naidu, R.
Evaluating the role of preferential pathways in exacerbating vapour intrusion risks.
Journal of Hazardous Materials Advances, Vol. **10**, (2023)

Vapour intrusion (VI) has been garnering more attention in the research field in the past few decades owing to its associated health risks. Many field studies have been conducted to understand the process of vapour migration from the source to indoor air and the factors affecting it. This research project primarily concentrated on the role of highly permeable backfill materials like sand and gravel used as bedding and embedment for utility lines. These can function as preferential pathways for vapour migration in the vadose zone. Extensive laboratory investigations were carried out over 13 days using two large two-dimensional (2-D) columns, one with preferential pathway and one without preferential pathway, to investigate the natural attenuation process and the role of preferential pathways in VI. The presence of preferential pathway has a role in determining soil gas vapour distribution in the vadose zone. A notable increase in vapour concentrations was observed in the top layer of the column with preferential pathway compared to the column with no preferential pathway. This was due to enhanced distribution of contaminant vapours along the column facilitated by the preferential pathway. An increase in concentration was observed in the column with preferential pathway throughout compared to the column with no preferential pathway, confirming that the presence of natural or man-made drainage features in the sun-surface can influence the distribution of contaminants throughout a site. This research project generates a better understanding of preferential pathways and recommends taking into account the role of highly permeable backfill materials when developing CSM and VI health risks assessments. In this way the strategic priorities for remediation projects will be successfully established.

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Poirier, B., Guyot, G., Woloszyn, M.
Evaluation of the overall performance of smart ventilation in low-energy housing.

Université Savoie-Mont Blanc. Thèse 2023

Energy consumption and carbon reduction in building sector is crucial to achieve sustainable development goals regarding the climate change. To support the energy transition in this sector, ambitious European objectives (EPBD Directive, 2003:2010.) aim to generalise nearly zero-energy buildings. However, ventilation systems for the renewal of indoor air are still a source of heat loss and of energy consumption. But the air renewal is essential, as indoor air quality (IAQ) in buildings could be worse than outdoor air environments. Given that the average European spends 60% to 90% of his or her time inside a building, ventilation systems play a key role in the evacuation and dilution of pollutants to meet corresponding public health challenges. In this context, smart ventilation systems, which are booming in practice present a great potential to meet the IAQ needs and improve energy performance of ventilation system. Such performance benefits need to be assessed, indeed the current regulations on ventilation propose a prescriptive approach advocating. For example in France (JOFR , 1982), exhausted airflow rates must be respected whatever their impacts on energy and IAQ. In this work, we focus on an “overall performance-based” approach, including indoor air quality and energy performance with the aim to avoid conflicts between them. We introduce the notion of “overall performance assessment” (named OPA) for ventilation systems. The mains objectives of this PhD work is to propose an improved method for overall performance assessment (named MOPA) of ventilation systems at design stage, with quantified uncertainty and to test the potential of this MOPA as a decision-making tool for ventilation systems at building design. We oriented this work to answer to the research questions on overall performance indicators, pollutants emission sources and scenarios, as well as uncertainty and robustness of the performance assessment method. This PhD work includes 4 published and 1 submitted articles, which are complemented by additional results and explanations. The developed MOPA is based on airflows simulations, performed with CONTAM. In addition, several energy simulations were performed based on DOMUS to question the use of constant temperatures in CONTAM and energy simulations. Moreover, a co-simulation exploratory work in collaboration with the the LST in the University PUCPR, Brasil has allowed to initiate the coupling between DOMUS and CONTAM. We defined in two literature review articles a relevant set of IAQ performance indicators, with their associated pollutants emission scenarios and occupancy schedules. The relative humidity, CO2, formaldehyde and PM2.5 were selected as the restrained key indoor air parameters to be studied. Resulting in five IAQ performance indicators: ICO2, IHCHO, IPM25, IRH70 ,IRH30_70 and one energy performance indicator IEwh based on heat loss calculation from ventilation airflows. Through two conference papers, we tested the applicability of the MOPA in different contexts (French and Danish within the framework of an international mobility at DTU Denmark) and for a diversity of ventilation systems (6 ventilation systems). We modelled, a low energy detached single-family house and an apartment in a multifamily building. These applications highlighted the importance of taking into account other IAQ parameters than the traditional CO2 and humidity, for a better consideration of IAQ in buildings. Lastly, we performed an uncertainty analysis by applying the RBD-FAST sensitivity analysis method and proposed a method for a robust design score calculation and a ranking of the systems. A synthesis of the developed MOPA regrouped all the learnings from these four chapters and a final application illustrated the method improvements; confirming the potential of smart ventilation for providing acceptable IAQ performance coupled with energy savings.

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Ebrahimi, V., Yarahmadi, R., Salehi, M., Ashtarinezhad, A.
Exposure assessment to BTEX in the air of nail salons in Tehran city, Iran.
Heliyon, Vol. **9** n°(7), (2023)

The nail salon industry has grown considerably, but there are serious concerns about the health risks associated with working in this field. Therefore, the purpose of this study was to investigate the exposure of nail technicians to BTEX. A cross-sectional study was conducted on 49 salons, and NIOSH Method 1501 was used to measure the concentration of BTEX in the breathing zone of technicians. The EPA method was used to assess health risks. Statistical analysis was conducted using SPSS software. The mean concentrations of toluene were (82.65 & PLUSMN; 198.84 & mu;g/m3)& mu;g/m3, followed by benzene (10.58 & PLUSMN; 9.62 & mu;g/m3), p-xylenes (20.77 & PLUSMN; 37.79 & mu;g/m3), o-xylene (13.79 & PLUSMN; 25.70 & mu;g/m3), and ethylbenzene (29.35 & PLUSMN; 58.26 & mu;g/m3) , that lower than the permissible exposure limits suggested by NIOSH. Among the BTEX, toluene (82.65 & PLUSMN; 198.84 & mu;g/m3) has the most concentration in the nail salons. It was also discovered through multiple linear regression analysis that humidity had a significant effect on increasing the concentration of toluene (Beta = 0.50, P -value = 0.001) and ethylbenzene (Beta = 0.16, P = 0.049), while there was a considerable as-sociation between the number of services performed and benzene concentration (Beta = 0.34, P = 0.010). The average inhalation lifetime cancer risk for benzene

(4.9 x 10 -5 & PLUSMN;4.5 x 10-5) was higher than the recommended value set by the US EPA. Although the concentrations of BTEX were lower than the maximum permissible limits, the results of the cancer risk assessment for benzene showed that working in nail salons with poor ventilation is hazardous. Therefore, exposure can be minimized by ensuring appropriate ventilation in the workplace and using safe products.

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Marinello, S., Lolli, F., Coruzzolo, A. M., Gamberini, R.
Exposure to Air Pollution in Transport Microenvironments.
Sustainability, Vol. **15** n°(15), (2023)

People spend approximately 90% of their day in confined spaces (at home, work, school or in transit). During these periods, exposure to high concentrations of atmospheric pollutants can pose serious health risks, particularly to the respiratory system. The objective of this paper is to define a framework of the existing literature on the assessment of air quality in various transport microenvironments. A total of 297 papers, published from 2002 to 2021, were analyzed with respect to the type of transport microenvironments, the pollutants monitored, the concentrations measured and the sampling methods adopted. The analysis emphasizes the increasing interest in this topic, particularly regarding the evaluation of exposure in moving cars and buses. It specifically focuses on the exposure of occupants to atmospheric particulate matter (PM) and total volatile organic compounds (TVOCs). Concentrations of these pollutants can reach several hundreds of & mu;g/m(3) in some cases, significantly exceeding the recommended levels. The findings presented in this paper serve as a valuable resource for urban planners and decision-makers in formulating effective urban policies.

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Zhao, Y., Liu, Y. X., Han, B., Wang, M. Y., Wang, Q., Zhang, Y. N.
Fiber optic volatile organic compound gas sensors: A review.
Coordination Chemistry Reviews, Vol. **493**, (2023)

Most volatile organic compounds (VOCs) are toxic, carcinogenic, and mutagenic, and can have serious effects on human health and the ecological environment. Therefore, the detection and identification of VOCs have an urgent need in both indoor and outdoor environments. Fiber optic sensors, as intrinsically safe, miniature, portable, immune to electromagnetic interference, and easy to remote sensing and multiplexing sensing technology, are utilized in VOC gas sensing promising to provide new approaches to overcome the limitations of conventional gas sensing systems. This review assesses recent research advances in fiber optic VOC gas sensors, including various sensing principles, gas-responsive materials, new techniques for sensing material deposition, structures, and applications. Fiber optic VOC gas sensors are classified and discussed based on different principles. In addition, this paper extensively reviews the recent advances in fiber optic VOC gas sensors and discusses the strategies and approaches to further their development.

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Rogula-Kopiec, P., Mach, T., Rogula-Kozłowska, W.
Formaldehyde in the indoor air of beauty salon–first results.
4th Symposium “Air Quality and Health”2023, 03-07-2023 - 05-07-2023, Wrocław, Polska

Nowodays, there is a significant amount of data and publications available on indoor air quality in various types of buildings, including schools, theaters, classrooms, and libraries (Kociszewska K. et al. 2017, Chang C-J et al., 2018). Indoor air tests conducted in Poland have so far mainly covered the mass and number of concentrations of particulate matter (Rogula-Kopiec P. et al. 2019, Rogula-Kozłowska W. et al. 2020) Meanwhile, formaldehyde can have adverse health effects on humans. Short-term exposure to elevated formaldehyde levels causes irritation of the eyes, nose and throat, as well as respiratory symptoms such as coughing and wheezing (Tsigonia A. et al. 2010). Long-term or repeated exposure to formaldehyde is associated with respiratory problems, allergic reactions, and may even increase the risk of certain cancers (Decisioneering 2007). Formaldehyde levels in indoor air quality (IAQ) are often measured using air quality tests, which can include passive sampling devices. Professional air quality assessments let identify formaldehyde sources and determine indoor concentration. World Health Organization (WHO) recommends a maximum residential formaldehyde exposure limit of 0.08 parts per million (ppm) (WHO 2000). The work presents the first results from formaldehyde measurements in a selected beauty salon, located in Bytom city. The measurement was carried out with a compact microF formaldehyde analyzer from Chromatotec. It enabled continuous realtime qualification and

quantification of formaldehyde (HCHO) in real time. The obtained data series was presented as the course of six-hour averages over the period 8-23.03.2023. From the compiled results, a significant increase in concentrations of formaldehyde in the morning can be observed, lasting during the time when the salon is open and provides its services. It is clear that the highest concentrations occur during the opening and closing hours of the salon, which may indicate that its main source in the living room is most likely outdoor air 8-23.03.2023. From the compiled results, a significant increase in concentrations in the morning can be observed, lasting during the time when the salon is open and provides its services. It is clear that the highest concentrations occur during the opening and closing hours of the salon, which may indicate that its main source in the living room is most likely outside air.

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Fang, B., Yang, N., Wang, C., Zhao, W., Zhou, H., Zhang, W.
Highly sensitive portable laser absorption spectroscopy formaldehyde sensor using compact spherical mirror multi-pass cell.
Sensors and Actuators B: Chemical, Vol. **394**, (2023)

A portable sensor with an optical case dimension of 46 × 28 × 16 cm3 based on laser absorption spectroscopy for highly sensitive measurement of formaldehyde was reported. A compact improved spherical mirror multi-pass cell consisting of two 5-cm diameter spherical mirrors separated by 17.7 cm was developed. The cell offered a sample volume of 350 mL and an optical absorption path length of 50.6 m, giving a high path length-to-volume ratio of 14.6 cm−2. The sampling response time was less than 1 s, allowing the application of rapid spectral background subtraction technique to effectively suppress optical fringes. The achieved detection limit was 650 pptv (1σ, 1 s), corresponding to a minimum detection absorption coefficient of 2.3 × 10−9 cm−1. The capability of the HCHO sensor was demonstrated by two days of continuous indoor air monitoring. The developed portable sensor is suitable for mobile and fast indoor air quality measurements.

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Haroon, M. U., Ozarisoy, B., Altan, H.
Improvement in Indoor Air Quality in Urban Pakistani Regions by Reducing Particulate Matter Size Concentration.
Preprints, Vol., (2023), p.

This paper describes the indoor air pollution in urban (Lahore, Faisalabad, Gujranwala, Rawalpindi and Karachi) Pakistani regions while considering the outdoor air and the health and wellbeing of the occupants present indoors. It also aims to assess previous methodological approaches Such as Air Conditioning Systems, used by developed countries to improve air quality to demonstrate the improvements that can be made in air quality in Pakistani urban areas. This research also investigates the causes, concentration and effects of poor air quality in Pakistani urban areas such as particulate matter (PM2.5), carbon oxides (COx), nitrogen oxides (NOx), sulphur oxides (SOx) and volatile organic compounds (VOC's). The average concentration of these pollutants in Pakistan's indoor air is, particulate matter (PM): [100 – 250 µg/m3 for PM2.5, 200 – 600 µg/m3 for PM10] 1 – 20 ppm for carbon monoxide (CO), nitrogen oxides (NOx): [50 – 100 µg/m3 for NO2, 20 – 40 µg/m3 for NO], 20 – 50 µg/m3 for sulfur dioxide (SO2), volatile organic compounds (VOCs): 0.1 – 0.5 ppm for formaldehyde, 5 – 10 µg/m3 for benzene and 20 – 30 µg/m3 for toluene. It should be noted that these concentrations can differ depending on the origin of pollution, location, and time of day. The literature review is made up of a combination of descriptive research methods that are used to inform the research background of ambient and indoor air quality, thus the literature review provides a theoretical and methodological background about the air pollution and its improvement in different parts of the world. According to the World Air Quality Index, Pakistan is the third most polluted country in terms of average PM2.5 concentration which is 14.2 times the WHO annual air quality guideline value. As a result, it is suggested that a PM2.5 concentration reduction program be implemented in urban Pakistani regions' indoor air.

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Moura, P. C., Santos, F., Fujão, C., Vassilenko, V.
In Situ Indoor Air Volatile Organic Compounds Assessment in a Car Factory Painting Line.
Processes, Vol. **11** n°(8), (2023)

Proper working conditions must be one of the employers' main concerns in any type of company but particularly in work locations where the employees are chronically exposed to hazardous compounds, like factories and production

lines. Regarding this challenge, the present research addresses the mapping of a car factory painting line to possibly toxic volatile organic compounds emitted by all the coatings and chemicals used during the work shifts for the future evaluation of employees' exposure. For the first time, a Gas Chromatography–Ion Mobility Spectrometry device was employed for the in situ detection of volatile organic compounds in an automotive factory. A total of 26 analytes were detected at nine different locations, of which 15 VOCs were accurately identified. Pure chemical-grade substances were used for the development of the VOC database. Although quantitative analysis was not the goal of this study, a calibration model was presented to one analyte for exemplificative purposes. Relative intensity profiles were plotted for all locations, revealing that some indoor VOCs can reach intensity levels up to 60 times higher than in outdoor air samples. The achieved results proved that the painting line has an abundant number of VOCs emitted from different sources and may lead to serious health risks for the employees. Additional studies shall be developed in the painting line for quantitative evaluation of the existing VOCs and their influence on the employees' health conditions.

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Dimitroulopoulou, S., Dudzińska, M. R., Gunnarsen, L., Hägerhed, L., Maula, H., Singh, R.*, et al.*
Indoor air quality guidelines from across the world: An appraisal considering energy saving, health, productivity, and comfort.
Environment International, Vol. **178**, (2023)

Buildings are constructed and operated to satisfy human needs and improve quality of life. Good indoor air quality (IAQ) and thermal comfort are prerequisites for human health and well-being. For their provision, buildings often rely on heating, ventilation, and air conditioning (HVAC) systems, which may lead to higher energy consumption. This directly impacts energy efficiency goals and the linked climate change considerations. The balance between energy use, optimum IAQ and thermal comfort calls for scientifically solid and well-established limit values for exposures experienced by building occupants in indoor spaces, including homes, schools, and offices. The present paper aims to appraise limit values for selected indoor pollutants reported in the scientific literature, and to present how they are handled in international and national guidelines and standards. The pollutants include carbon dioxide (CO2), formaldehyde (CH2O), particulate matter (PM), nitrogen dioxide (NO2), carbon monoxide (CO), and radon (Rn). Furthermore, acknowledging the particularly strong impact on energy use from HVAC, ventilation, indoor temperature (T), and relative humidity (RH) are also included, as they relate to both thermal comfort and the possibilities to avoid moisture related problems, such as mould growth and proliferation of house dust mites. Examples of national regulations for these parameters are presented, both in relation to human requirements in buildings and considering aspects related to energy saving. The work is based on the Indoor Environmental Quality (IEQ) guidelines database, which spans across countries and institutions, and aids in taking steps in the direction towards a more uniform guidance for values of indoor parameters. The database is coordinated by the Scientific and Technical Committee (STC) 34, as part of ISIAQ, the International Society of Indoor Air Quality and Climate.

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Felgueiras, F., Mourao, Z., Moreira, A., Gabriel, M. F.
Indoor environmental quality in offices and risk of health and productivity complaints at work: A literature review.
Journal of Hazardous Materials Advances, Vol. **10**, (2023)

Many service jobs are carried out in modern offices, with individual offices being increasingly replaced by open-plan settings. The high number of adult people working in office buildings, in most situations sharing the work-place with many others during a considerable part of their daily time, highlights the importance of providing adequate guidance to ensure the quality of office environments. This paper aims to summarize existing data on modern offices' indoor environmental quality (IEQ) conditions in terms of air pollution (volatile organic compounds (VOC), particulate matter and inorganic pollutants), thermal comfort, lighting and acoustics and the respective associations with health and productivity-related outcomes in workers. Evidence shows that al-though many offices present acceptable IEQ, some office settings can have levels of air pollutants, hygrothermal conditions/thermal comfort and illuminance that do not comply with the existing international standards and recommendations. In addition, findings suggest the existence of significant associations between the assessed IEQ indicators and the risk of detrimental effects on health and productivity of office workers. In particular, airborne particles, CO2, O 3 and thermal comfort were linked with the prevalence of sick building syndrome symptoms. Poor lighting and acoustical quality have also been associated with malaise and physiological stress among office workers. Similarly, better productivity levels have been registered for good indoor air quality conditions, in terms of VOC, airborne particles and CO2. Overall, the evidence revised in this

work suggests that for promoting health and productivity recommendations for office building managers include actions to ensure that: i) all relevant IEQ indicators are periodically controlled to ensure that levels comply with recommended limit values; ii) declared in-door pollution sources are avoided; iii) adequate ventilation and acclimatization strategies are implemented; and iv) there is the possibility of conduct personalized adjustments to environmental conditions (following workers' preferences).

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Dong, S., Luo, Y., Hu, X., Zhu, W.
Investigation of indoor air quality in coal-heating rural residential buildings in Northern China based on longtime monitoring.
Indoor and Built Environment, (2023)

Indoor air quality (IAQ) is closely related to resident health and has been drawing extensive consideration from academics as well as government regulators. However, few studies have quantitatively investigated IAQ in rural buildings during the heating period, in which the resident time indoors is relatively longer. This study has monitored and quantitatively analyzed the indoor air parameters (temperature, CO2, formaldehyde and PM2.5) of 20 rural houses in Northern China during the heating season (15 days out of 120). After quantitatively analyzing the IAQ parameters, the Pearson correlation model was also adopted to evaluate the relationships between them. Results showed that only 4 households could keep the indoor temperature above 18°C for more than 50% of the heating period. Additionally, there were 7, 2 and 18 households, of which the over-standard time of CO2, formaldehyde and PM2.5 took up more than 40%. The concentration of indoor PM2.5 was higher than outdoors most of the time. Therefore, indoor PM2.5 was mainly caused by indoor activities rather than transported from outside. Correlation analysis showed that CO2 was positively correlated with formaldehyde and PM2.5 in 16 and 12 households.

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Ismail, Z.-A.
Machine learning applications for a better demand controlled ventilation system experience in buildings: a review.
Open House International, (2023)

Purpose
At the beginning of the Corona Virus Disease 2019 (COVID-19) pandemic, a digitalized construction environments surfaced in the heating, ventilation and air conditioning (HVAC) systems in the form of a modern delivery system called demand controlled ventilation (DCV). Demand controlled ventilation has the potential to solve the building ventilation's biggest problem of managing indoor air quality (IAQ) for controlling COVID-19 transmission in indoor environments. However, the improper evaluation and information management of infection prevention on dense crowd activities such as measurement errors and volatile organic compound (VOC) generation failure rates, is fragmented so the aim of this research is to integrate this and explore potentials with machine learning algorithms (MLAs).

Design/methodology/approach
The method used is a thorough systematic literature review (SLR) approach. The results of this research consist of a detailed description of the DCV system and digitalized construction process of its IAQ elements.

Findings
The discussion revealed that DCV has a potential for being further integrated by perceiving it as a MLAs and hereby enabling the management of IAQ level from the perspective of health risk function mechanism (i.e. VOC and CO2) for maintaining a comfortable thermal environment and save energy of public and private buildings (PPBs). The appropriate MLA can also be selected in different occupancy patterns for seasonal variations, ventilation behavior, building type and locations, as well as current indoor air pollution control strategies. Furthermore, the conceptual framework showed that MLA application such as algorithm design/Model Predictive Control (MPC) integration can alleviate the high spread limitation of COVID-19 in the indoor environment.

Originality/value
Finally, the research concludes that a large unexploited potential within integration and innovation is recognized in the DCV system and MLAs which can be improved to optimize level of IAQ from the perspective of health throughout the building sector DCV process systems. The requirements of CO2 based DCV along with VOC concentrations monitoring

practice should be taken into consideration through further research and experience with adaption and implementation from the ventilation control initial stage of the DCV process.

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Davies, H. L., O'leary, C., Dillon, T., Shaw, D. R., Shaw, M., Mehra, A.*, et al.*
A measurement and modelling investigation of the indoor air chemistry following cooking activities.
Environmental Science: Processes & Impacts, (2023)

Domestic cooking is a source of indoor air pollutants, including volatile organic compounds (VOCs), which can impact on indoor air quality. However, the real-time VOC emissions from cooking are not well characterised, and similarly, the resulting secondary chemistry is poorly understood. Here, selected-ion flow-tube mass spectrometry (SIFT-MS) was used to monitor the real-time VOC emissions during the cooking of a scripted chicken and vegetable stir-fry meal, in a room scale, semi-realistic environment. The VOC emissions were dominated by alcohols (70% of total emission), but also contained a range of aldehydes (14%) and terpenes (5%), largely attributable to the heating of oil and the preparation and heating of spices, respectively. The direct cooking-related VOC emissions were then simulated using the Indoor Chemical Model in Python (INCHEM-Py), to investigate the resulting secondary chemistry. Modelling revealed that VOC concentrations were dominated by direct emissions, with only a small contribution from secondary products, though the secondary species were longer lived than the directly emitted species. Following cooking, hydroxyl radical concentrations reduced by 86%, while organic peroxy radical levels increased by over 700%, later forming secondary organic nitrates, peroxyacylnitrates (PANs) and formaldehyde. Monoterpene emissions were shown to drive the formation of secondary formaldehyde, albeit to produce relatively modest concentrations (average of 60 ppt). Sensitivity analysis of the simulation conditions revealed that increasing the outdoor concentrations of ozone and NOx species (2.9× and 9×, respectively) resulted in the greatest increase in secondary product formation indoors (≈400%, 200% and 600% increase in organic nitrates, PANs and formaldehyde production, respectively). Given the fact that climate change is likely to result in increased ozone concentrations in the future, and that increased window-opening in response to rising temperatures is also likely, higher concentrations of indoor oxidants are likely in homes in the future. This work, therefore, suggests that cooking could be a more important source of secondary pollutants indoors in the future.

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Li, L., Dai, W., Shen, M., Niu, X., Hu, T., Duan, J.*, et al.*
Molecular Characteristics, Sources, and Health Risk Assessment of Gaseous Carbonyl Compounds in Residential Indoor and Outdoor Environments in a Megacity of Northwest China.
Indoor Air, Vol. **2023**, (2023)

Carbonyl compounds (CCs) in indoor air pose a significant threat to residents’ health and have garnered considerable attention in recent years. However, most studies have focused on low-molecular-weight carbonyl compounds (LMW-CCs) and have underestimated the impact of high-molecular-weight ones (HMW-CCs), causing a failure to comprehensively understand their effects on health. In this study, we analyzed twenty carbonyls in the indoor and outdoor air at typical residential communities in a megacity in Northwest China by using high-performance liquid chromatography (HPLC) coupled with a photodiode array detector (DAD). The total concentration of indoor carbonyls was 1.4-3.4 times that of outdoor carbonyls. In addition, the concentration of indoor carbonyls was much higher during the heating season than that during the nonheating season. Conversely, the concentration of outdoor carbonyls was higher during the nonheating season than that during the heating season. The principal component analysis (PCA) revealed that indoor carbonyl pollution was primarily influenced by building materials, cooking fume, and wooden furniture. Formaldehyde exposure in indoor environments posed a greater health risk to children than acetaldehyde exposure. HMW-CCs were the primary contributors to indoor odor pollution, which was considered a significant cause of sick building syndrome (SBS). Our findings underscore the crucial role of HMW-CCs in indoor environments in exerting adverse impacts on health.

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Karanfil, B. Y., Tavukcuoglu, A.
A new approach changing expectations from solid parts of building envelopes: testing the carbon dioxide diffusion and retaining performances of building materials.
Metu Journal of the Faculty of Architecture, Vol. **40** n°(1), (2023), 125-150 p.

The COVID-19 pandemic has made the world realize how vital indoor air quality is. For healthy and sustainable indoor environments, the "breathable building skin" approach deserves the attention of the building science community. In contrast to the common approach of airtight buildings, the "breathable skin" approach changes what is expected from the solid parts of a building envelope. Here, a new approach, new measurable parameters, and a new practical testing method are presented. Benefitting from the pollutant reduction and self-ventilation potentials of building materials is a new approach introduced here for enhancing indoor air quality. The effectiveness assessment of that approach requires developing testing methods for measuring the pollutant reduction (diffusion and retaining) performance of building materials. Among the occupant-related indoor air pollutants, CO2 is well-known and one of the widely-used indicators for assessing indoor air quality. The testing method proposed in this study assesses CO2 reduction performance of building materials in terms of "CO2 concentration decay rate," "effective CO2 diffusion coefficient," and "CO2 retaining ratio" as the related measurable parameters. Sample use of the testing method conducted on adobe and autoclaved aerated concrete was presented to explain the proposed testing procedure. This procedure involved the combined use of single-chamber and double-chamber diffusion tests. The single-chamber setup is a system that permits CO2 transmission through a porous material and measures the CO2 concentration decay rate. The double-chamber setup is a closed system that prevents CO2 from escaping thereupon measures the impact of CO2 retaining behavior on CO2 concentration decay rate. Joint interpretation of the data allows discussing the potentials and limitations of materials in reducing indoor CO2 concentrations. For further evaluations, this practical testing method is useful in producing reference data on CO2 reduction performances of building materials.

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Halder, S.
Novel microdevices to analyze toxic volatile organic compounds.
University of Louisville. Thèse 2023

There has been a growing interest to measure volatile organic compounds (VOCs) in a range of environmental applications. The presence of toxic VOCs in the air has been associated with serious health problems including asthma, central nervous system dysfunction, cardiovascular disease and cancer, etc. Different analytical instruments such as gas chromatography-mass spectrometry (GC-MS) and sensor systems, such as metal oxide sensors are used to analyze VOCs. However, challenges still exist in the detection of airborne VOCs because of their trace concentration and interference with complex gas mixtures. In this dissertation, two microfabricated devices, a sensor array and a micropreconcentrator were investigated for both detection and quantitative analysis of toxic VOCs in environmental air. First, the microfabricated sensor-array has been developed for the simultaneous testing of multiple sensors. Alkali metal carboxylate-linked gold monolayer protected clusters (Au MPCs) have been investigated to selectively sense aromatic and chlorinated VOCs. Cation–π interaction towards the electron-rich aromatic region and electron-deficient cations such as Li+, Na+ and K+was explored to develop a sensor for aromatic compounds. Furthermore, Cs+-linked Au MPCs were utilized to develop a sensor for trichloroethylene because of Cs+ and Cl^- coordination. The nature of the interaction of these sensors with humidity led us to design and use a preconcentrator to trap the analyte of interest and to thermally desorb the captured compounds for producing moisture-free concentrated target VOC samples. Next, a microfabricated micropreconcentrator (µPC) was developed to enable the detection of trace target VOCs by the sensor array and eliminate moisture interference. Carboxen 1000 adsorbent was loaded inside the µPC to capture benzene, toluene, ethylbenzene and xylene (BTEX) and trichloroethylene. The performance of the µPC has been characterized and integrated with solid-phase micro-extraction (SPME) to improve signals for GC-MS analysis. Furthermore, a novel dual-compartment µPC has been developed to capture a wide range of VOCs. This microdevice contains two different sorbents – Carbopack X for trapping aromatic VOCs and silica gel coated with O-2,3,4,5,6-pentaflurobenzyl hydroxylamine (PFBHA) for capturing carbonyls via oximation. The captured compounds were eluted with dichloromethane and analyzed by GC-MS. About 90% of recoveries have been achieved for BTEX, formaldehyde, acetaldehyde and acetone. Finally, this microdevice was used for detecting BTEX and carbonyls at different locations in Louisville, KY. The combination of this dual-compartment µPC with our developed sensor-array could satisfy the demand for a portable system in the application of air quality monitoring and disease diagnostics from exhaled breath.

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Al Assaad, D., Sengupta, A., Breesch, H.
A novel quantitative assessment framework of the IAQ resilience performance of buildings: The resilience score metric.

Building and Environment, Vol. **243**, (2023)

Resilience performance in building design has emerged as a critical consideration in the face of increasing uncertainties or 'shocks' posed by natural disasters, climate change & excessive pollution. To evaluate and optimize building design decisions, holistic performance metrics are needed. This work defines a novel quantitative assessment framework of indoor air quality (IAQ) resilience which output is the resilience score (RS) metric that integrates all resilience aspects and building-relevant pollutants. The framework was demonstrated via simulations on a validated model of a case study educational building in Belgium for 3 ventilations systems: constant air volume (CAV), demand-controlled ventilation (DCV), DCV without filters, and 3 shock types (mechanical MS, internal IS, outdoor shocks OS). Results showed that OS was the least critical shock type, followed by IS and MS. With increasing degree of shock, RSMS decreased for all 3 systems linearly by 64% until 2.8 h of power outage, beyond which the rate of decrease slowed down considerably. CAV & DCV had the same RSMS and that of DCV w/o filters was 13% lower. The RSIS for CAV & DCV deteriorated by 38.8% & 46% before plateauing at values of 0.45 & 0.36 respectively. CAV had better resilience against IS. The effect of filters did not reflect in the RSIS. The RSOS for CAV & DCV deteriorated by 51% & 26% before plateauing at values of 0.49 & 0.73 respectively. DCV had the best resilience against OS, followed by DCV w/o filters & CAV.

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Qi, X., Sun, W., Huang, H., Deng, T., Huang, H., Hu, S.
Numerical Simulation and Optimisation of a New Air Purification System Based on CFD.
Water, Air, & Soil Pollution, Vol. **234** n°(9), (2023), 585 p.

Indoor air pollution directly threatens human health, with prolonged exposure to pollutants leading to respiratory problems, immune system issues, and even cancer. Thus, implementing advanced air purification technologies is crucial to effectively mitigate indoor pollutants. The current common air purifiers have low removal efficiency for pollutants, a high cost of replacing adsorption materials, and a single function. Therefore, a novel air purification system that provides high-efficiency and rapid air purification and enhances the reusability of adsorption materials is in demand. This study evaluated the purification effect of the New Air Purification System under the internal circulation mode using computational fluid dynamics. The results showed that (1) the air exchange rates of the New Air Purification System were adjusted to 42.6, 85.2, and 127.8 h−1, respectively, when the release rates of 222Rn were 2.268, 4.536, 6.804, and 9.072 Bqm−2h−1. The indoor 222Rn concentration was reduced to < 21% of the background 222Rn concentration. (2) The initial concentration of indoor formaldehyde was 0.1 mg/m3 and increased to 0.0204, 0.0181, and 0.0174 mg/m3, respectively. These values were less than the World Health Organization’s recommended limits. This study provides a solid foundation for designing and optimising the New Air Purification System, provides technical guidance for the next step in its design, and would substantially help in improving indoor air quality and living conditions.

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Weschler, C. J., Nazaroff, W. W.
Ozone Loss: A Surrogate for the Indoor Concentration of Ozone-Derived Products.
Environmental Science & Technology, (2023)

Ozone concentrations tend to be substantially lower indoors than outdoors, largely because of ozone reactions with indoor surfaces. When there are no indoor sources of ozone, a common condition, the net concentration of gaseous products derived from indoor ozone chemistry scales linearly with the difference between outdoor and indoor ozone concentrations, termed “ozone loss.” As such, ozone loss is a metric that might be used by epidemiologists to disentangle the adverse health effects of ozone’s oxidation products from those of exposure to ozone itself. The present paper examines the characteristics, potential utility, and limitations of the ozone loss concept. We show that for commonly occurring indoor conditions, the ozone loss concentration is directly proportional to the total rate constant for ozone removal on surfaces (ksum) and inversely proportional to the net removal of ozone by air exchange (λ) plus surface reactions (ksum). It follows that the ratio of indoor ozone to ozone loss is equal to the ratio of λ to ksum. Ozone loss is a promising metric for probing potential adverse health effects resulting from exposures to products of indoor ozone chemistry. Notwithstanding its virtues, practitioners using it should be mindful of the limitations discussed in this paper.

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Banot, K., Drzeniecka-Osiadacz, A.

Particulate matter in the indoor air in a residential house–a case study from Goczałkowice-Zdrój.
4th Symposium “Air Quality and Health”2023, 03-07-2023 - 05-07-2023, Wrocław, Polska

Indoor air pollution is increasingly being researched by scientists. It is estimated that about 90% of the time people spend indoors. For this reason, interest in indoor air quality (IAQ) has increased. The problem of air pollution in buildings concerns highly and poorly developed countries. However, the reasons for the worse state of the microenvironment inside are different. In addition to atmospheric air, IAQ is influenced by the activity of residents, ventilation and indoor microclimate. Pollutants include chemical compounds such as carbon monoxide, nitrogen oxides and formaldehyde as well as volatile organic compounds. In addition, they are also solid particles in the form of particulate matter. These substances can be hazardous to health and life. Exposure to pollution is mainly manifested by irritation of the upper and lower respiratory tract. It increases the risk of cardiovascular diseases and increases the likelihood of allergies. Frequent complaints from exposure to indoor pollutants can lead to Sick Building Syndrome (SBS). In this work, a measurement module was used to study the concentration of particulate matter PM1, PM2.5 and PM10 in rooms containing potential pollution emitters. Based on the results, it was noted that the actions taken by users have a significant impact on air quality. A negative impact of tobacco smoke on the concentration of particulate matter in the air was also found.

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Fromme, H., Sysoltseva, M., Achten, C., Buhl, T., Rohl, C., Leubner, S.*, et al.*
Polycyclic aromatic hydrocarbons including dibenzopyrenes in indoor air samples from schools and residences in Germany.
Atmospheric Environment, Vol. **309**, (2023)

Polycyclic aromatic hydrocarbons (PAH) are several hundred organic substances that are formed in the course of incomplete combustion of organic material. Of particular importance are the carcinogenic effects of PAH. Various dibenzopyrenes as well as benzo[c]fluorene (BcFl) seems to have a particular toxicological potency, which have hardly been investigated in indoor air so far.Therefore, the indoor air samples of 27 classrooms and 35 central living spaces of residences in Germany were collected to analyze 56 particle-bound PAH as well as naphthalene (Nap).The PM10 values in schools and residences ranged between 9.1 and 210 & mu;g/m3 (mean: 93.4 & mu;g/m3) and from 3.6 to 52.0 & mu;g/m3 (mean: 12.0 & mu;g/m3), respectively. For the sum of the 16 priority US EPA PAH (except acenaphthylene and naphthalene) means (95th percentiles) in classrooms and residences were 1.20 ng/m3 (2.77 ng/m3) and 0.84 ng/m3 (2.64 ng/m3), respectively. Higher values were observed for naphthalene with mean concentrations of 596 ng/m3 (2,800 ng/m3) in classrooms and 243 ng/m3 (530 ng/m3) in residences.For classrooms and residences mean concentrations of 8.3 pg/m3 and 7.4 pg/m3 for dibenzo[a,l]pyrene (DBalPyr), 16.4 pg/m3 and 11.9 pg/m3 for dibenzo[a,e] pyrene (DBaePyr), 9.2 and 5.7 pg/m3 for dibenzo[a,h]pyrene (DBahPyr), and 6.4 and 4.2 pg/m3 for BcFl were observed, respectively, while DBaiPyr was found in only one sample above LOD.The BaPeq (benzo[a]pyrene equivalents) for the sum of 20 PAH is on average 482 pgTEQ/m3 (schools) and 393 pgTEQ/m3 (residences), which corresponds to an incremental lifetime cancer risk to 42 x 10-6 and 34 x 10-6.Although dibenzopyrenes and BcFl are found only in very low concentrations in indoor air, they have a significant impact on the risk if the assumptions about the toxicological potency of this group turn out to be valid.

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Ricklund, N., Bryngelsson, I. L., Hagberg, J.
Self-reported symptoms in Swedish hairdressers and association with exposure to volatile organic compounds (VOCs), including aldehydes.
Bmc Public Health, Vol. **23** n°(1), (2023)

BackgroundWorking as a hairdresser involves combined exposure to multiple chemicals in hair treatment products that may induce symptoms in airways and skin.MethodsIn this cross-sectional study, perceived symptoms among Swedish hairdressers at 10 hair salons were surveyed through a questionnaire. Associations with personal exposure to volatile organic compounds (VOCs), including aldehydes, and their corresponding hazard index (HI), based on the estimated risk for non-cancer health effects, were examined. The prevalence of four out of 11 symptoms was compared to available reference datasets from two other studies of office workers and school staff.ResultsAll 11 surveyed symptoms were reported among the hairdressers (n = 38). For the whole study group, the most prevalent symptoms were dripping nose (n = 7) and headache (n = 7), followed by eczema (n = 6), stuffed nose (n = 5), cough (n = 5) and discomfort with strong odors (n = 5). Significant relationships between exposure and symptoms were scarce. The exception was total VOC

(TVOC) exposure adjusted to worked years in the profession; a difference was observed for any symptom between hairdressers in the group with 20 + years compared to 0-5 years in the profession (logistic regression, OR 0.03, 95% CI 0.001-0.70). Out of the four symptoms available for comparison, the prevalence of headache and cough was significantly higher in hairdressers than in controls (OR 5.18, 95% CI 1.86-13.43 and OR 4.68, 95% CI 1.17-16.07, respectively).ConclusionsAdverse health effects related to occupation was common among the hairdressers, implying a need for exposure control measures in hair salons. Symptoms of headache and cough were more frequently reported by hairdressers than staff in offices and schools. A healthy worker effect among the hairdressers was indicated in the group with 20 + years compared to 0-5 years in the profession. Significant relationships between measured exposure and symptoms were scarce but gave information about advantages and disadvantages of the different exposure measures. The study design could be improved by increasing the size of the study population, using a better match of reference data and increasing the applicability and representability over time of the measured exposure.

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Li, X. R., Yan, Y. H., Fang, X., He, F. J., Tu, J. Y.
Towards understanding of inhalation exposure of pilots in the control cabin environment.
Building and Environment, Vol. **242**, (2023)

Transport characteristics of TVOC in cockpits of commercial airliners have not been carefully studied relative to passenger cabins, and VOC emissions are currently not well regulated by the standards (e.g. ASHRAE, FAA, etc.). This study numerically performed a comprehensive assessment of cockpit environment using the developed all-in-one model, for the first time, integrating a full-scale A320 cockpit model and detailed manikins with 3D-rebuilt nasal cavity models. A generalised total volatile organic compound (TVOC) was selected as one representative gaseous contaminant and two representative emission scenarios in the cabin environment (aged and new aircraft) were analysed. Potential risky regions of the nasal system after inhaling the given contaminants were further evaluated. The outcomes demonstrated that windshield inlets were the key determinant of yielding the strong local vortex in the pilot's near field, which could potentially promote the contaminant lock-up. For aged aircraft, the average contaminant concentration in the pilots' breathing zone was nearly half of that in a brand-new aircraft, while TVOC concentrations were significantly higher in the human upper respiratory system than those detected in the breathing zones for both cases, particularly for vestibule, olfactory, sinus and nasopharynx regions. Olfactory regions were the most affected region in two cases, with an approximately 20% increase in the case of brand-new aircraft compared to an aged one. This study enlightened a novel pathway to assess indoor environment, from tracing the pollutants from the release source to ultimately quantifying the contaminant distribution characteristics in human upper respiratory system.

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Zhang, Y. Z., Guo, Z. R., Zhuo, L. T., An, N. R., Han, Y. F.
Ventilation Strategies for Highly Occupied Public Environments: A Review.
Buildings, Vol. **13** n°(7), (2023)

In urban public transportation and highly diversified air environments, air pollutant exposure is becoming an increasing concern in terms of public health and personal safety. Herein, the scientific literature on air quality and virus transmission in densely crowded environments is reviewed to determine effective control methods. The research results are classified on the basis of different crowded environments. Much research has been conducted on pollutants in subways and buses. High particulate matter concentrations in public transportation are still a serious problem, but few studies on the spread of viruses exist. With existing types of ventilation systems, increasing local exhaust may be an efficient way to remove pollutants. Air quality sensors should be distributed in densely crowded spaces to achieve real-time display of pollutant concentration data. When pollution levels exceed the safe values, scientifically designed ventilation and filtration schemes should be implemented to reduce the pollution levels. Occupant activities are among the important factors that make pollutant transmission more complex. The analysis results herein contribute to the assessment of indoor pollutant concentrations and the protection of occupants from cross-infection.

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Şahin, Ü. A., Oğur, N. E., Ayvaz, C., Dumanoğlu, Y., Onat, B., Uzun, B.*, et al.*
Volatile organic compound concentrations under two different ventilation structures and their health risks in the adhesive tape manufacturing workplace.
Air Quality, Atmosphere & Health, (2023)

Exposure to the high volatile organic compounds (VOCs) concentration in the workplaces where solvents are used is an essential point for worker's health. However, the VOCs in the indoor air of an adhesive tape production facilities that use large amounts of solvents and the health risk of the toxic compounds have not been sufficiently investigated to this date. VOC samples were collected in the morning and afternoon times of day in the indoor air of workplaces of an adhesive tape production facility at 9 different points under two different central ventilation conditions. Carbon dioxide, humidity, temperature, flow rate, and pressure values were measured continuously throughout the work time with an average recording period of 1 min. The total VOC value had a wide range from 0.1 to 138 mg/m3. BTEX (benzene, toluene, ethylbenzene, xylenes) contribution to total VOC accounted for between 40 and 60% and the toluene, methylepentane, and trichloroethane concentrations among the sampling points and campaigns dominated the total VOCs. The total hazard quotient (HQ) values for each measurement campaigns were higher than the acceptable limit of 1.0, while the lifetime cancer risk (LCR) values for benzene and carbon tetrachloride were lower than the acceptable limit of 1.0×10−6. This observational study suggests that the effective and efficient operation of the workplace ventilation systems and the feasibility of the designed ventilation systems are essential on the accumulation of toxic compounds in the air and must be well evaluated.

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