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Design healthy working environments during the COVID-19 period

Evangelia Chrysikou 1\*, Eleftheria Savvopoulou2, Eva Hernandez Garcia3, Simon Addyman4 and Alexi Marmot 5

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| **Names of the Topic editors:** Clarine van Oel**Names of the reviewers:****Milee Herweijer****Mina Shokrollahi Ardekani** **Journal:** The Evolving Scholar**DOI:** 10.24404/623c3d976d3e6122e0bb764c**Submitted:** 24 March 2022**Accepted: 29 July 2022****Published:** 22 March 2023**Citation:** Chrysikou, E., Savvopoulou, E., Garcia, E. H., Addyman, S., & Marmot, A. (2022, October). Design healthy working environments during the COVID-19 pe-riod. TU Delft OPEN. https://doi.org/10.24404/623c3d976d3e6122e0bb764This work is licensed under a Creative Commons Attribution BY license (CC BY).© 2022 Chrysikou, E., Savvopoulou, E., Garcia, E. H., Addyman, S., & Marmot, A published by TU Delft OPEN on behalf of the authors. |

1 the Bartlett School of Sustainable Construction UCL; e.chrysikou@ucl.ac.uk; https://orcid.org/

0000-0002-7894-6053

2 Independent researcher; syn-thesis@hotmail.com

3 the Bartlett School of Sustainable Construction UCL; eva.hernandez.20@ucl.ac.uk; https://orcid.org/

0000-0002-7263-2344

4 the Bartlett School of Sustainable Construction UCL; simon.addyman@ucl.ac.uk;

5 University College London UCL; a.marmot@ucl.ac.uk; <https://orcid.org/> 0000-0002-5136-5611

\* Use \* to indicate the corresponding author.

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| **Research highlights**1) This project explored measures for preventing or limiting the transmission of COVID-19 in indoor office workplaces, focusing on space and place by promoting healthy behaviours within those environments.2) The implications of COVID-19 for workspace are more timely than ever, so shedding light on the relationship between individuals and their working spaces and how this affects workers is of great importance.3) This review considered a number of questions that companies will need to take into account when planning and designing their workspaces, keeping in mind the people who use them and their needs. |

**Keywords:** design; healthy working environments; indoor office workplace; architecture; COVID-19;

1. Introduction

COVID-19 has affected most of our activities in multiple ways, changing our working environment being one of them. The pandemic led to unprecedented changes in people’s lives, affecting differently individuals across age groups and having implications for both their well-being and mental health (Hampshire et al., 2021). Healthcare (i.e., high burden of the medical system), social (i.e., social distancing, stress among people) and economic impact (i.e., losses in both national and international business), are some of the main domains affected by COVID-19 (Haleem et al., 2020). Several public health interventions were adopted so as to mitigate the spread of COVID-19, such as social distancing, which had an impact on reducing SARS-CoV-2 transmission globally (Zhang et al., 2020), restriction of mass gatherings, travel restrictions, city lockdown, mask wearing and community-wide policies, contact tracing and testing, etc. (Ayouni et al., 2021).

Indoor spaces, in particular, can pose a significant infection transmission risk (Qian et al., 2020) and therefore, it is imperative to rethink how we share these environments. The different routes of virus infection transmission — airborne, close contact, fomite surface (Tellier et al., 2019), and ocular surface (Zhang et al., 2020)—raised even more the risk indoor spaces can pose to the transmission of the virus. Especially in shared indoor environments like the workspace, further protective measures are needed beyond hygiene practices and use the of face masks. Surface hygiene measures, building parameters and systems, contact tracing methods and testing, modifications in the layout of offices, special considerations for elevators, proper staff training for protection, and a central management system are some of the measures that need to be integrated as part of a strategy to face the COVID-19 outbreak in the workplace (CDC, 2021). Additionally, behavioural advice measures should be taken into account, as the idea of working in a high-risk contagious environment or in an insufficiently precautionary workplace could lead to poor mental health outcomes or post-traumatic stress symptoms (Brooks et al., 2018). Understanding how office layout and the ways people use shared spaces affect disease transmission could help in developing effective measures for when people get back to work and make them feel safe in their working environment as well. This project explored strategies and control measures for preventing or limiting the transmission of the SARS-CoV-2 virus in indoor office workplaces. The study focused on three areas of advice: clinical, behavioural and built environment and building systems advice.

2. Theories and Methods

Since the beginning of the COVID-19 outbreak in China, contaminated surfaces have been identified as a route of transmission (CDC, 2020). Since then, a number of studies have been performed, investigating how long the virus remains viable or capable of infecting human cells on a number of different surfaces (Kampf et al., 2020; Fears et al., 2020). Even though SARS-CoV-2 on surfaces remains viable for some time, it is a relatively easy virus to inactivate. Research has shown different disinfectants and cleaning products, such as soap, alcohol in the form of ethanol or propanol, or household bleach, which used as instructed by the manufacturer, can inactivate the virus (Chin et al., 2020; Kampf et al., 2020). The surface material itself could play an important role, with the most easily cleanable surfaces being hard and smooth and the least cleanable being soft and porous (Detry et al., 2010).

During the outbreak of the COVID-19 pandemic, the daily routine disruptions and the fact that for long periods people were living under a number of restrictions had a strong psychological impact on the general population (Brooks et al., 2020). Although returning to work has been proposed as a relevant psychoneuroimmunity prevention strategy, the workplace could become a highly contagious setting for SARS-CoV-2 transmission (Kim & Su, 2020). Research has shown that organisational and managerial arrangements, including workplace hygiene practices and concerns for staff, are associated with less anxiety, depression, and psychological distress as well as less severe psychiatric symptoms for their workers (Tan et al., 2020). It is already known from healthcare architecture research what an important role the built environment can play in supporting people’s mental health (Chrysikou, 2014). Obviously, in healthcare settings, we can see the correlation between space and health more clearly because people have decreased coping abilities. In spaces where people tend to be more functional, including workplaces, they can employ more mental and physical ways to adjust their practice and cope (Forooraghi et al., 2021). Overall, these measures could contribute to making the experience of returning to work more tolerable while making one feel more secure.

In addition to contaminated surfaces and respiratory droplets, contamination can also happen through the air, especially in places with poor ventilation. Office workers should be provided with the maximum possible delivery of fresh, clean air in indoor areas. Ventilation mechanisms, airflow, temperature, and humidity levels could influence virus transmission (REHVA, 2020).

The research team applied two approaches to collecting material to respond to the three areas of interest presented above: First, a literature review was conducted using both systematic and narrative approaches. For the systematic search, four electronic databases were used: PubMed/Medline, Web of Science, Scopus, and Google Scholar. For the narrative literature, a search was conducted for the identification of eligible studies and guidelines from the government, health agencies, and industry. Key terms and free-words were introduced into web search engines, and their eligibility was based on ad hoc selection and research experience. For the narrative approach, at the end of each recommendation the phrase ‘top down’ (in case it was government guidance) or ‘bottom up’ (if it came from industry, academia, or regulatory bodies) was applied. Second, a series of workshops were held between the research team and the client/delegates, where the main findings were presented and the implications for office workplace design were discussed, creating knowledge by bridging the gap between academia and the industry.

3. Results

Findings were organized under the three main areas of this study: clinical, behavioural, and built environment advice.

3.1. Clinical advice

 Evidence has shown that SARS-CoV-2 tends to persist on surfaces (for different periods based on the surface material) and in the air for long periods of time (Kampf et al., 2020). As a result, contaminated droplets, especially on high-touch surfaces, such as office tables, kitchen areas, bathrooms, and lift buttons, could pose a great risk for office workers. The material of surfaces could also play an important role, as certain materials could be more porous, and as a result, more difficult to disinfect (Detry et al., 2010).

3.2. Behavior and the Built Environment Advice

 Behavioral aspects of returning to work during the COVID-19 period could be related to psychological distress and mental health outcomes. Research flagged the importance of social distancing in the workplace as well as the necessity of workers’ training to the new protocols and the company’s response plan in case of a COVID-19 emergency. New behavioral patterns such as hand hygiene practices, face mask wearing, and desk cleaning were also pointed (Perkins & Will, 2020). A number of key suggestions derived from literature and narrative review focusing on themes such as entering the building, guidelines for visitors, specific guidelines including layout for reception/lobby, common areas/lounges, work booths/workstations, coffee islands/kitchens, meeting rooms, shared spaces, circulation spines, furniture, and storage areas, technology use, and hygiene guidance. Psychological distress could derive from other factors as well, such as the building in which one is working, the journey to work, or indoor environment parameters such as artificial light or daylighting (Bedrosian & Nelson, 2017). Since this paper is about the UK, where there is less regulation in comparison to other countries related to daylight, examples of office spaces that could be dark (flickering, for instance) could be less annoying in the pre-Covid period when there were other positive developments (such as refreshments or a coffee machine) and more co-workers, as opposed to the post-Covid period with restrictions and stripped down offices. Research has shown that it is important to prepare buildings accordingly so as to welcome back workers. Measures such as thorough cleaning and disinfection, strategically placed touch-free sanitizer stations and signage, measures while entering such as a temperature check, and sitting reconfiguration in the working spaces were highlighted (HM Government, 2020; CBRE, 2020). Additionally, indoor environment parameters can play an important role, such as daylighting, air quality, green and blue spaces (for example, indoor plants or a fountain or any other water feature such as an aquarium), and indoor movement patterns could affect the physiological-psychological wellbeing in a positive way. Daylighting is preferred for visual comfort to artificial lighting, and exposure to optimised daylight in an office space can have a positive effect on the cognitive performance of occupants in these spaces, increase productivity, and positively affect sleep-activity patterns (Boubekri et al., 2014,,2020).

3.3. Building systems advice

 Research has shown that in order to minimise the risk of airborne transmission, it is imperative to increase the flow of fresh air ventilation, either by manually operable windows or by mechanically ventilated mechanisms. It is necessary to review the operation of heat and air-circulation systems in the office space so as to minimise the re-circulation of air and air leakage as much as possible (ASHRAE, 2020, REHVA, 2020). Recommendations coming up from research suggest, among other things, an increase in the rate and duration of ventilation, a review of the heat recovery systems, and room-based fan coil and split systems to avoid the risk of cross contamination and advanced filtration through HEPA and UVGI filters (CIBSE, 2020).

4. Discussion

 Results shown how COVID-19 for many people has taken away the pleasure derived from their work environment and flagged areas of concern but also practical measures that could help in reshaping more effectively the working space. Environments that until recently would have been considered safe now be perceived as vulnerable and need to be adjusted. Under the current circumstances, special attention should be paid to the working space configuration, disinfection and cleaning measures, as well as employee mental health, which may have been negatively affected. It is imperative to support the health, safety, and wellbeing of employees, especially the re-evaluation of their particular needs while returning to work, so as to make the journey to work worthwhile.

5. Conclusions

This project sheds light on the interrelationship between individuals and their office space, how the latter influences workers, and the knowledge transfer from the area of health humanities that aims to understand and provide for the perception and physiological changing needs that occur as a result of illness or disease; in that case, to the office design for COVID-19, a time that was challenging for intervention, casting prevention as a critical path for the control of the disease and the morbidities related to it. The research team identified the need to have a systemic approach to how one deals with the return to the office during or after COVID-19 and takes into account all seven topics: vulnerability assessment and the workplace, employee mental wellbeing, interactions with surfaces, building service systems, behaviour change and trust, and offices worth the journey. Some of these themes have been prioritized, such as infection control and hygiene, while others were neglected so as to mitigate the risk, such as employee mental wellbeing as well as social interaction in the workspace. This project identified the importance of all themes and how these could be addressed in the office space through built environment interventions. It is imperative that occupants and facilities managers are well informed and work together not only to keep spaces clean so as to reduce the risk of transmission but also to reconfigure the vulnerable spaces so as to provide offices that are worth the travel. This cross-disciplinary review raised questions that need to be considered in future studies, including other topic areas apart from the ones discussed here, so as to generate interdisciplinary knowledge on other equally important fields of study that will impact companies that plan and design workspaces and the people who use them, promoting both healthy working environments and behaviours.

**Contributor statement**

Author 1: Conceptualisation, supervision, writing - review and editing, validation, methodology, project administration, funding acquisition. Author 2: Writing - original draft, visualization, project administration, resources. Author 3: Writing - original draft, visualization, resources. Author 4:Conceptualisation, writing - review and editing, project administration, funding acquisition. Author 5: Conceptualisation, writing - review and editing, funding acquisition, resources

References

1. ASHRAE, 2020. ASHRAE Position Document on Airborne Infectious Diseases, American Society of Heating, Refrigerating and Air Conditioning Engineers.
2. Ayouni, E., Maatoug, J., Dhouib, W., Zammit, N., Fredj B S., Ghammam, R., Ghannem H. (2021). Effective public health measures to mitigate the spread of COVID-19: a systematic review. *BMC Public Health*, 21, 1015
3. Bedrosian, T. A. and Nelson, R. J. (2017) ‘Timing of light exposure affects mood and brain circuits’, Translational Psychiatry. Nature Publishing Group, 7(1), p. e1017. doi: 10.1038/tp.2016.262
4. Brooks, S. K., Dunn, R., Amlot, R., Rubni, J. G., Greenberg, N. (2018). A Systematic, Thematic Review of Social and Occupational Factors Associated With Psychological Outcomes in Healthcare Employees During an Infectious Disease Outbreak. *Journal of Occupational and Environmental Medicine*, 60(3), 248–257
5. Boubekri, M., Cheung, N I., Reid, J K., Wang, C., Zee, C P. (2014). Impact of Windows and Daylight Exposure on Overall Health and Sleep Quality of Office Workers: A Case-Control Pilot Study’. *Journal of Clinical Sleep Medicine*, 10(6), 603–611
6. Boubekri, M., Lee, J., MacNaughton, P., Woo, M., Schuyler, L., Tinianov, B., Satish, U. (2020). The Impact of Optimized Daylight and Views on the Sleep Duration and Cognitive Performance of Office Workers. *International Journal of Environmental Research and Public Health,* 17(9), 3219
7. CBRE (2020) ‘Reopening the world’s workplaces’. https://www.cbre.com/-/media/files/back-to-work/reopening-the-worlds-workplaces\_cond\_041620.pdf?la=en
8. CIBSE, 2020. Emerging from Lockdown, Chartered Institution of Building Services Engineers.
9. CDC. (2021). *COVID-19 Employer Information for Office Buildings.* Retrieved from: <https://www.cdc.gov/coronavirus/2019-ncov/community/office-buildings.html>
10. Chin, A., Chu, J., Perera, RA M., Hui, P Y K., Yen, H., Chan, C W M., et al. (2020). Stability of SARS-CoV-2 in different environmental conditions. *The Lancet*, 1(1): E10
11. Chryikou, E. (2014). *Architecture for psychiatric environments and therapeutic spaces*. Amsterdam, the Netherlands: IOS Press
12. Detry, JG., Sindic, M., Deroanne, C. (2010). Hygiene and cleanability: a focus on surfaces. *Critical reviews in food science and nutrition,* (50)7, 583-604
13. Fears, A., Klimstra, W., Duprex, P., Hartman, A., Weaver, S., & Plante, K. et al. (2020). Comparative dynamic aerosol efficiencies of three emergent coronaviruses and the unusual persistence of SARS-CoV-2 in aerosol suspensions. Emerging Infectious Diseases, 26(9),2168–71
14. Forooraghi, M., Miedema, E., Ryd, N., Wallbaum, H. (2021). How Does Office Design Support Employees’ Health? A Case

Study on the Relationships among Employees’ Perceptions of the Office Environment, Their Sense of Coherence and Office Design. *International Journal of Environmental Research and Public Health*, 18, 12779

1. Haleem, A., Javaid, M., Vaishya, R. (2020). Effects of COVID-19 pandemic in daily life. *Current Medicine Research and Practice,* 10(2): 78–79
2. Hampshire A, Hellyer PJ, Trender W, Chamberlain SR. (2021). Insights into the impact on daily life of the COVID-19 pandemic and effective coping strategies from free-text analysis of people’s collective experiences. *Interface Focus,* 11: 20210051
3. HM Government (2020) ‘Working safely during COVID-19 in offices and contact centres. Guidance for employers, employees and the self-employed’. UK: Crown. https://assets.publishing.service.gov.uk/media/5eb97e7686650c278d4496ea/working-safely-during-covid-19-offices-contact-centres-110520.pdf
4. Kampf, G., Todt, D., Pfaender, S., Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *The Journal of Hospital Infection*, 104 (3), 246-251
5. Kim, S. W. and Su, K. P. (2020). Using psychoneuroimmunity against COVID-19. *Brain, Behavior, and Immunity,* 87:4-5
6. Perkins & Will (2020) ‘Road map for return. Guidance for a return to the office during COVID-19’: https://perkinswill.com/road-map-for-return/
7. REHVA. (2020). *COVID-19 guidance document*. Federation of European Heating, Ventilation and Air Conditioning Associations.
8. Tan, W., Hao, F., McIntyre, R, S., Jiang, L., Jiang, X., Zhang, L., Zhao, X., Zou, Y., Hu, Y., Luo, X., Zhang, Z., Lai, A., Ho, R., Tran, B., Ho, C., Tam, W. (2020). Is returning to work during the COVID-19 pandemic stressful? A study on immediate mental health status and psychoneuroimmunity prevention measures of Chinese workforce. *Brain, Behavior, and Immunity,* 87, 84-92
9. Tellier, R., Li, Y., Cowling, B, J., Tang, J, W. (2019). Recognition of aerosol transmission of infectious agents: a commentary. BMC Infectious Diseases. *BMC Infectious Diseases,* 19(101), 101
10. Zhang, X., Chen, X., Chen, L., Deng, C., Zou, X., Liu, W., Yu, H., Chen, B., Sun, X. (2020). The evidence of SARS-CoV-2 infection on ocular surface. *The Ocular Surface*, 18(3), 360–362