INADEQUATE EXPOSURE TO GREENSPACE AND ITS EFFECTS ON MENTAL HEALTH DURING THE PANDEMIC

Xiao Cai[1], Peter Aning Tedong[2], Rosilawati Zainol[3]

[1, 2, 3] *Department of Urban & Regional Planning, Centre for Sustainable Urban Planning and Real Estate (SUPRE), Faculty of Built Environment,*
[3] *Centre for Civilisational Dialogue,*
[3] *Centre for Transport Research (CTR),*
UNIVERSITI MALAYA

Abstract

Visiting greenspace plays an important role in maintaining public mental well-being. This study aims to explore what results from people's limited access to greenspace and the consequent effects on people's mental health. To achieve this goal, this study takes the district of Nanshan in Shenzhen, China as a case study to empirically examine whether residents are adequately exposed to greenspace. Findings revealed that there was an unbalanced spatial distribution of population and greenspace in Nanshan, which was one of the main factors deterring some residents from being served by greenspace. This study also found that the pandemic has caused a deterioration of mental health. Consequently, three nature-based approaches to reducing public psychological diseases under the condition of inadequate access to greenspace were proposed. These findings can provide policymakers with significant insights for local greenspace design and planning in Nanshan. It also offers some effective suggestions to handle public mental issues due to limited access to greenspace.

Keyword: COVID-19; Greenspace; Park accessibility, Mental health; Nanshan

[3] Associate Professor at Universiti Malaya. Email: rosilawatizai@um.edu.my

INTRODUCTION

In December 2019, the first case of infection by the coronavirus COVID-19 was reported in China. This virus quickly spread around the world, culminating in a pandemic. To limit the spread of this highly infectious coronavirus, various lockdown policies had been issued in countries across the world to restrict their citizens' movement, which in turn reduced people's access to greenspace. The uneven spatial distribution of greenspace in cities also limit residents from adequate access to the natural environment. These two aspects have adversely affected people's mental health.

In this regard, the goal of this study is to explore complex relationships among inadequate access to greenspace, mental health and the COVID-19 pandemic. To be specific, three research questions are expected to be addressed: (1) Are the residents of Nanshan able to easily visit *greenspace*? (2) How does the pandemic affect people's access to greenspace and further influence their mental health? (3) What potential nature-based solutions can improve psychological problems among the public during times of crisis?

LITERATURE REVIEW

Greenspace accessibility refers to the extent of difficulty to which people are able to visit greenspace. This indicator is often measured in previous studies for promoting urban parks visitation, which can be understood from emotional and physical aspects. First, emotional accessibility to greenspace is related to residents' perception of the greenspace, e.g., perceived safety. Improved park safety can bring about large improvements for accessibility and environmental justice (Williams et al., 2020). Second, physical accessibility to greenspace is related to the spatial availability of greenspace for people. It refers to either the distance between greenspace and places of residence, or the quantity of greenspace shared by its surrounding residents. The greenspace-residence distance is measured by real travel costs along the road network or the Euclidean distance in existing studies. For instance, Yu et al. (2020) suggested that a 15-minute walking time or 1000-meter distance (i.e., the real travel cost) is an appropriate threshold for residents to access a greenspace from their residence for daily recreational purposes. Natural England (2010) applied the Euclidean distance as requirements for park accessibility - everyone, wherever they live, should have an accessible natural greenspace of at least, (1) a two-hectare greenspace within 300 meters from home; (2) one 20-hectare greenspace within two kilometers from home; (3) one 100-hectare greenspace within five kilometers from home; and (4) one 500-hectare greenspace within ten kilometers from home. Greenspace accessibility measured in this study is physical accessibility.

Improving residents' accessibility to greenspace is significant because people with higher greenspace accessibility are more likely to visit greenspace (Hartabela et al., 2022). It is noted that exposure to natural environments can help

people at different age scopes deal with mental issues. For instance, Engemann et al. (2019) found that high levels of green space presence during childhood were associated with a lower risk of a wide spectrum of psychiatric disorders later in life. It is also found that long-term exposure to greenspace plays an important role in mental health (depression and anxiety) in adults (Gascon et al., 2018). A protective effect of greenness on depression was consistently observed for older adults (Sarkar et al., 2018), while having more greenspace near the residence supported mental health through several indirect pathways with serial components in young adults (Dzhambov et al., 2018). Street view green and blue spaces are protective against depression for the elderly (Helbich et al., 2019). Therefore, people at different ages can receive mental health benefits from exposure to greenspace. Given the importance of greenspace, a series of nature-based approaches are thus expected to be proposed to promote public health. This study defines the nature-based approach as the method of helping people increase their exposure to greenspace for promoting their mental health.

RESEARCH METHODOLOGY
This study takes Nanshan (located in Shenzhen, China) as the study area to empirically examine whether residents can be adequately exposed to greenspace. This study collected census data in Nanshan from the local statistical bureau. The locations (i.e., the longitude and latitude of each community's geographic centroid) of communities were acquired from the Shenzhen Municipal Government Data Open Platform (https://opendata.sz.gov.cn). A total of 98 communities are applied for the following spatial analysis. Notably, to ensure the precision of spatial population distribution, this study examined the spatial distribution of population at the community level because the community is the least administrative zone in China.

A series of spatial analyses were conducted in ArcMap 10.2 to empirically examine residents' accessibility to greenspace in Nanshan. First, the spatial population distribution in Nanshan was achieved based on the method of Kriging interpolation. A buffer analysis was then applied for each piece of greenspace. According to the National Garden City Series Standards in China, 300-meter and 500-meter buffer radiuses are applied to greenspace with areas between 2000 and 5000 square meters and more than 5,000 square meters respectively. Third, whether people can access easily greenspace was examined by overlapping spatial distributions of population and greenspace service areas.

RESULTS AND DISCUSSION
**Limited access to greenspace in Nanshan**
Figure 1 presents the spatial population distribution in Nanshan using population density data at the community level. An evident spatial disparity in the population was discovered. Two high clusters were identified, located in the South and the

middle of Nanshan (see Zones A and B, Figure 1). A comparatively less dense cluster, Zone C, was identified (Figure 1). By contrast, the areas to the West and to the North are sparsely populated.
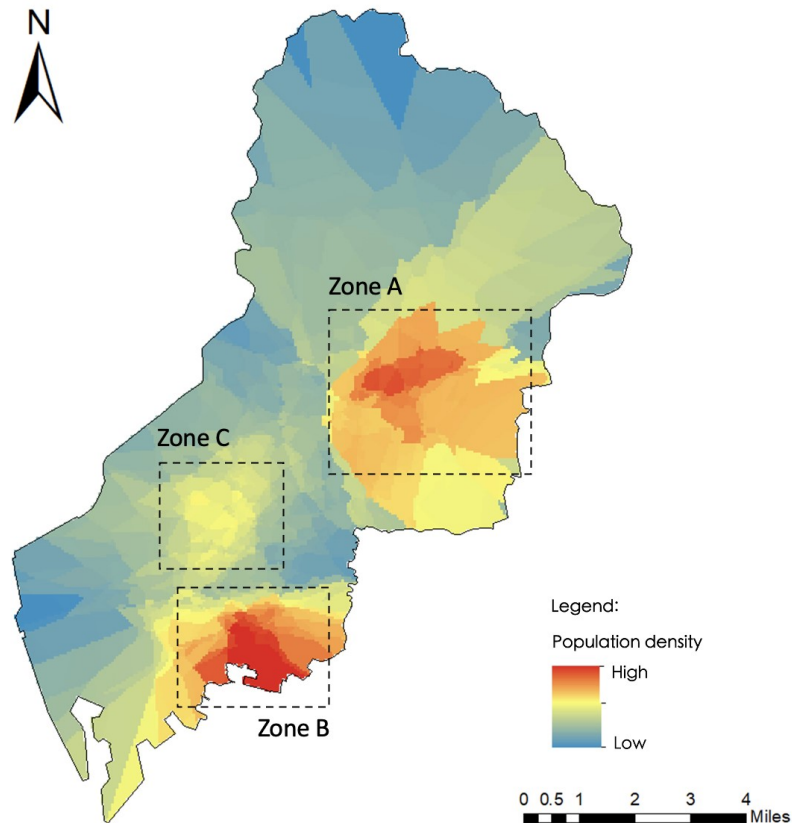
Figure 1: Spatial distribution of population in Nanshan
Source: Authors (2022)

Figure 2 presents the spatial distribution of greenspace and its buffer zones in Nanshan. It was found that there are quite a number of areas underserved by greenspace. This indicates that it requires people residing in these areas to travel a longer distance to access a greenspace. On the other hand, there were also apparent differences in buffer zones. The saturation level of buffer zones depends on the number of overlaps, thus representing how well an area is served by greenspace. As shown in Figure 2, a greater number of buffer zones overlap in the southern and central regions of Nanshan. This suggests that people living in these areas can be well served by greenspace compared to other areas.
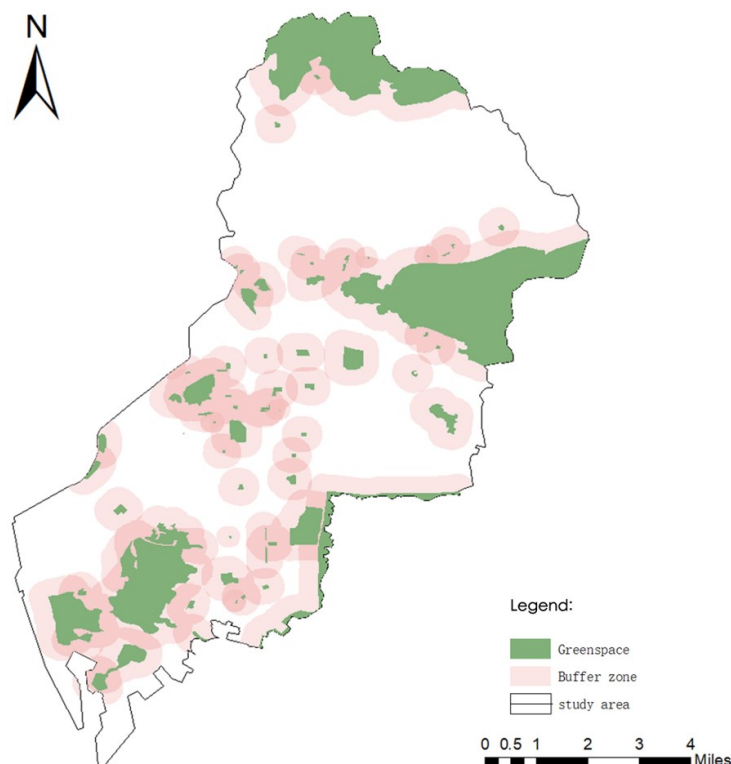
Figure 2: Spatial distribution of greenspace and its buffer zones in Nanshan
Source: Authors (2022)

Figure 3 presents overlap relationships between population and greenspace-served areas. It was found that two high population clusters in Zone A and Zone B were not entirely served by greenspace. Worse, the comparatively high population cluster in Zone C was almost completely underserved by greenspace. These two findings indicate that it is difficult for people to access greenspace in Nanshan, even though the greenspace coverage has met local greenspace proportion standards. People are required to travel long distances to visit a park.

Based on the above analysis, this study concludes that people living in Nanshan have unequal access to greenspace, which is the same as the previous study conducted by Lv et al. (2017). Actually, a significant disparity in greenspace distribution exists among Chinese cities (Huang et al., 2020), and the level of disparities vary according to population scales and geographic locations (Xu et al., 2019). It was reported that only 57.62 percent of residents in Shenzhen can access the nearest community park within a 500-meter walking distance Li et al. (2017). In fact, Nanshan possesses exceptional advantages in greenspace

resources because four mountains with a series of urban parks provide the public with adequate greenspace amount. The main problem, this study holds, is that the spatial distribution of greenspace in Nanshan is not reasonable. As supported in Figure 3, three population clusters cannot be served entirely by greenspace, which leads to less adequate accessibility to greenspace in a whole.
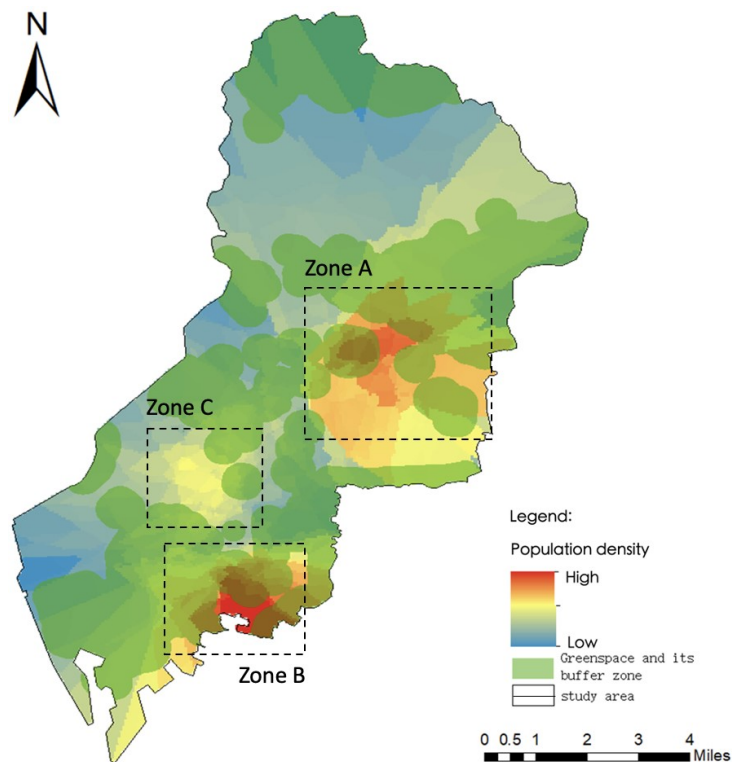
Figure 3: Residents' accessibility to greenspace in Nanshan
Source: Authors (2022)

Mental well-being, exposure to greenspace, and the COVID-19 pandemic
Exposure to greenspace on a frequent basis is significant for improving people's mental well-being (Salleh et al., 2022). However, lockdown deprives people of visiting greenspace freely, causing potentially an eruption of mental distress (Heo et al., 2021). Pouso et al. (2020) reported that people were experiencing worse mental conditions under lockdown conditions. This consequence is partially attributed to reduced physical activities and increased screen time (Olszewska-Guizzo et al., 2021). People who are habitual users of greenspace suffer more adversely due to the dramatic change in greenspace visitation frequency,

compared to those who visited greenspace less frequently before the pandemic (Ugolini et al., 2021).

On the other hand, a recent study also stated that most people self-reported no differences in mental health before and during the COVID-19 pandemic (Xie et al., 2020). This contrary finding can be explained by different quarantine conditions among countries, which can lead to differential mental health outcomes (Ribeiro et al., 2021). Some countries did not impose strict restrictions, especially during the early time of the pandemic. For instance, a study conducted by Robinson et al. (2021) found that people's greenspace use and duration of visiting nature were more frequent and longer during the pandemic. As a result, people's mental health is only slightly affected because there is not an evident decrease in people's exposure to greenspace after the breakout of the pandemic.

The pandemic is also affecting people's greenspace visitation patterns. For instance, it was found that people had a preference to visit urban parks with a higher greenery coverage rate during the pandemic (Cheng et al., 2021). It might be because that these urban parks have adequately spacious spaces for social distancing. It was also reported that people's visits to various capacious greenspace (e.g., woodlands and natural parks) were more frequent than before the pandemic (Grima et al., 2020; Logan et al., 2021). Two reasons can account for this phenomenon. First, a shift of working and life patterns enables people to spend time in exposure to nature when the quarantine policy is less strict (Fagerholm et al., 2021). Second, people start to realize the importance of greenspace for public well-being and attempt to find opportunities to be exposed to nature. These public greenspaces enable residents to contact directly with nature and provide them with safe spaces for necessary social interaction.

Ways of exposure to greenspace during the COVID-19 pandemic
As mentioned above, Nanshan has poor greenspace accessibility. However, solving these problems is quite challenging because Nanshan is located in the center of Shenzhen's built-up areas with limited land for building greenspace. Meanwhile, the pandemic has decreased people's exposure to greenspace. In this regard, the following ways can help alleviate the adverse effect on people's mental health.

First, visiting private gardens can make great contributions towards reducing psychological diseases when access to public greenspace is not available (Marques et al., 2021). As reported by Lehberger et al. (2021), the residents with private gardens expressed greater life satisfaction and self-reported a higher sense of mental well-being substantially than those without gardens. Second, indirect exposure to greenspace (i.e., having green views from windows at home and watching nature-based videos) can help people have a more positive mood. It was surprisingly found that green views had a greater effect on people's psychological

health than the effect brought by physical use of greenspace (Soga et al., 2021). A recent controlled experiment conducted by Olszewska-Guizzo et al. (2021) reported that greenspace scenes (in comparison with busy urban center scenes) could not induce a stress and anxiety related hemodynamic pattern, so as to offset negative neuropsychological effects during the pandemic. Third, having some plants in the house can also be an easily achievable alternative for mitigating people's psychological issues (Spano et al., 2021).

CONCLUSION

The goal of this study is to explore the effect of limited access to greenspace on people's mental health. According to the above analyses, limited exposure to greenspace does exist, which could cause some mental issues for the public. To solve this problem, this study summarizes three approaches to enhance public mental well-being.

There are a few limitations preventing this study from receiving more convincing results, but the authors believe this can only produce insignificant detrimental effects. First, buffer analysis was employed to examine residents' access to greenspace. This method is easy to use but does not take real travel difficulties into consideration, which could result in less realistic measurement results. Future studies can employ more effective methods to measure accessibility to greenspace, such as the 2-step floating catchment area method. Second, fine-grained population data (i.e., at the community level) make measurement results more precise, which is an advantage for this study. However, there are missing population data for five communities of a total of 107 communities, which might somewhat affect the accuracy of results. Besides, the population data in Nanshan were censused in 2019, and there might be some slight changes in population distribution from then until 2021. It is highly suggested to measure spatial population distribution using big data rather than census data in future studies, such as mobile phone data. This kind of data allows researchers to acquire real-time spatial population distribution.

This study can provide relevant policymakers some insights into greenspace design and planning in Nanshan. Besides, the findings also offer some effective suggestions to handle limited access to greenspace. This is of significance for the public to mitigate mental distress due to limited access to greenspace given the pandemic.

REFERENCES

Cheng, Y., Zhang, J., Wei, W., & Zhao, B. (2021). Effects of urban parks on residents' expressed happiness before and during the COVID-19 pandemic. *Landscape and Urban Planning, 212*. doi:10.1016/j.landurbplan.2021.104118
Dzhambov, A. M., Markevych, I., Hartig, T., Tilov, B., Arabadzhiev, Z., Stoyanov, D., . . . Dimitrova, D. D. (2018). Multiple pathways link urban green- and bluespace to

mental health in young adults. *Environmental Research, 166*, 223-233. doi:10.1016/j.envres.2018.06.004

Engemann, K., Pedersen, C. B., Arge, L., Tsirogiannis, C., Mortensen, P. B., & Svenning, J. C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America, 116*(11), 5188-5193. doi:10.1073/pnas.1807504116

Fagerholm, N., Eilola, S., & Arki, V. (2021). Outdoor recreation and nature's contribution to well-being in a pandemic situation - Case Turku, Finland. *Urban Forestry and Urban Greening, 64*. doi: 10.1016/j.ufug.2021.127257

Gascon, M., Sanchez-Benavides, G., Dadvand, P., Martinez, D., Gramunt, N., Gotsens, X., . . . Nieuwenhuijsen, M. (2018). Long-term exposure to residential green and blue spaces and anxiety and depression in adults: A cross-sectional study. *Environmental Research, 162*, 231-239. doi: 10.1016/j.envres.2018.01.012

Grima, N., Corcoran, W., Hill-James, C., Langton, B., Sommer, H., & Fisher, B. (2020). The importance of urban natural areas and urban ecosystem services during the COVID- 19 pandemic. *PLoS ONE, 15*(12 December). doi: 10.1371/journal.pone.0243344

Hartabela, D., Dewancker, B., Vidyana, C., & Mori, Y. (2022). Tourist preferences and expectations of urban park: A case study in Kitakyushu, Japan. *Planning Malaysia, 20*, 89-100. doi:10.21837/PM. V20I20.1081

Helbich, M., Yao, Y., Liu, Y., Zhang, J., Liu, P., & Wang, R. (2019). Using deep learning to examine street view green and blue spaces and their associations with geriatric depression in Beijing, China. *Environment International, 126*, 107-117. doi:10.1016/j.envint.2019.02.013

Heo, S., Desai, M. U., Lowe, S. R., & Bell, M. L. (2021). Impact of changed use of greenspace during covid-19 pandemic on depression and anxiety. *International Journal of Environmental Research and Public Health, 18*(11). doi:10.3390/ijerph18115842

Huang, B. X., Chiou, S. C., & Li, W. Y. (2020). Accessibility and street network characteristics of urban public facility spaces: Equity research on parks in Fuzhou city based on GIS and space syntax model. *Sustainability, 12*(9), 19. doi:10.3390/su12093618

Lehberger, M., Kleih, A. K., & Sparke, K. (2021). Self-reported well-being and the importance of green spaces – A comparison of garden owners and non-garden owners in times of COVID-19. *Landscape and Urban Planning, 212*. doi:10.1016/j.landurbplan.2021.104108

Li, L., Liu, J., & Ren, F. (2017). Using house level data to evaluating accessibility for public parks in Shenzhen. *Geomatics & Spatial Information Technology, 40*(9), 38-43.

Logan, M. J., Metzger, M. J., & Hollingdale, J. (2021). Contributions of Scottish community woodlands to local wellbeing before and during the COVID-19 pandemic. *Scottish Geographical Journal*. doi:10.1080/14702541.2021.1945670

Lv, Q., Gao, W., & Fan, X. (2017). Study on spatial distribution equilibrium of community parks based on valid service areas: A case study of Nanshan district in Shenzhen. *Architecture & Culture*(06), 185-187.

Marques, P., Silva, A. S., Quaresma, Y., Manna, L. R., de Magalhães Neto, N., & Mazzoni, R. (2021). Home gardens can be more important than other urban green infrastructure for mental well-being during COVID-19 pandemics. *Urban Forestry and Urban Greening, 64*. doi:10.1016/j.ufug.2021.127268

Natural England. (2010). *Nature nearby: accessible natural greenspace guidance.* Peterborough: Natural England Retrieved from http://www.naturalengland.org.uk/

Olszewska-Guizzo, A., Mukoyama, A., Naganawa, S., Dan, I., Husain, S. F., Ho, C. S., & Ho, R. (2021). Hemodynamic response to three types of urban spaces before and after lockdown during the covid-19 pandemic. *International Journal of Environmental Research and Public Health, 18*(11). doi:10.3390/ijerph18116118

Pouso, S., Borja, Á., Fleming, L. E., Gómez-Baggethun, E., White, M. P., & Uyarra, M. C. (2020). Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Science of the Total Environment.* doi:10.1016/j.scitotenv.2020.143984

Ribeiro, A. I., Triguero-Mas, M., Jardim Santos, C., Gómez-Nieto, A., Cole, H., Anguelovski, I., . . . Baró, F. (2021). Exposure to nature and mental health outcomes during COVID-19 lockdown. A comparison between Portugal and Spain. *Environment International, 154*. doi:10.1016/j.envint.2021.106664

Robinson, J. M., Brindley, P., Cameron, R., Maccarthy, D., & Jorgensen, A. (2021). Nature's role in supporting health during the covid-19 pandemic: A geospatial and socioecological study. *International Journal of Environmental Research and Public Health, 18*(5), 1-21. doi:10.3390/ijerph18052227

Salleh, M. Z. M., Othman, N., Malek, N. A., & Suddin, L. S. (2022). A paradoxical proposition of connectedness to nature, recycling behaviour and psychological restoration relationship in urban park context: A path analysis evidence. *Planning Malaysia, 20*, 101-111. doi:10.21837/PM.V20I20.1082

Sarkar, C., Webster, C., & Gallacher, J. (2018). Residential greenness and prevalence of major depressive disorders: a cross-sectional, observational, associational study of 94 879 adult UK Biobank participants. *The Lancet Planetary Health, 2*(4), e162-e173. doi:10.1016/S2542-5196(18)30051-2

Soga, M., Evans, M. J., Tsuchiya, K., & Fukano, Y. (2021). A room with a green view: the importance of nearby nature for mental health during the COVID-19 pandemic. *Ecological Applications, 31*(2). doi:10.1002/eap.2248

Spano, G., D'Este, M., Giannico, V., Elia, M., Cassibba, R., Lafortezza, R., & Sanesi, G. (2021). Association between indoor-outdoor green features and psychological health during the COVID-19 lockdown in Italy: A cross-sectional nationwide study. *Urban Forestry and Urban Greening, 62*. doi:10.1016/j.ufug.2021.127156

Ugolini, F., Massetti, L., Pearlmutter, D., & Sanesi, G. (2021). Usage of urban green space and related feelings of deprivation during the COVID-19 lockdown: Lessons learned from an Italian case study. *Land Use Policy, 105*. doi:10.1016/j.landusepol.2021.105437

Williams, T. G., Logan, T. M., Zuo, C. T., Liberman, K. D., & Guikema, S. D. (2020). Parks and safety: a comparative study of green space access and inequity in five US cities. *Landscape and Urban Planning, 201*. doi:10.1016/j.landurbplan.2020.103841

Xie, J., Luo, S., Furuya, K., & Sun, D. (2020). Urban parks as green buffers during the COVID-19 pandemic. *Sustainability (Switzerland), 12*(17). doi:10.3390/SU12176751

Xu, Z. N., Gao, X. L., Wang, Z. Q., & Fan, J. (2019). Big data-based evaluation of urban parks: A Chinese case study. *Sustainability, 11*(7), 16. doi:10.3390/su11072125

Yu, S. Q., Zhu, X. G., & He, Q. (2020). An assessment of urban park access using house-level data in urban China: Through the lens of social equity. *International Journal of Environmental Research and Public Health, 17*(7), 19. doi:10.3390/ijerph17072349