Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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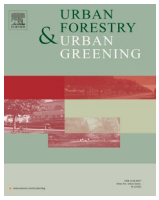

Home gardens can be more important than other urban green infrastructure for mental well-being during COVID-19 pandemics

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ABSTRACT

The current COVID-19 pandemics is a major threat to human populations. The disease has rapidly spread, causing mass hospitalization and the loss of millions of people mainly in urban areas which are hubs for contagion. At the same time, the social distancing practices required for containing the outbreak have caused an eruption of mental illnesses that include symptoms of depression, anxiety and stress. The severity of such mental distress is modulated by the context of media coverage and the information and guidelines from local health authorities. Different urban green infrastructures, such as gardens, parks, and green views can be important for mitigating mental distress during the pandemics. However, it is unclear whether some urban green infrastructures are more efficient than others in reducing mental distress or whether their effectiveness changes with the context. Here we assess the relative importance of different urban green infrastructures on the mental distress of residents of Rio de Janeiro, Brazil. We show that although urban parks and green views are important, home gardens are the most efficient in mitigating mental distress. This is likely related to the practice of self-isolation seen for the residents of Rio de Janeiro. Information on the efficiency of different urban green infrastructures in mitigating mental distress can be important to help guide programs to inform the public about the best practices for maintaining mental health during the current outbreak. This can also help planning cities that are more resilient to future pandemics.

1. Introduction

The current pandemic of the new coronavirus SARS-CoV-2 which causes the disease (COVID-19) is profoundly affecting human populations. Recent data shows that the coronavirus has infected more than 136 million people worldwide, causing the death of almost 3 million people and the cases are still increasing (World Health Organization, 2020a).

While the first vaccines are starting to be made available to the public, mass vaccination is still not possible and the only effective measure to control the COVID-19 transmission is through social distancing (Abouk and Heydari, 2021; Thunström et al., 2020). Countries around the world have restricted national and international travelling and promoted the temporary closure of businesses, schools, and universities (Courtemanche et al., 2020). In many cases this has restricted access to public green spaces, such as parks (Slater et al., 2020). Such containment measures are especially important in urban areas which are major hubs for the transmission of infectious diseases (Santiago-Alarcon and MacGregor-Fors, 2020). In many cities around the world, strong restrictive measures were necessary, including stay-at-home orders, lock-down, and quarantine which further social distancing (Lau et al., 2020).

COVID-19 related social distancing can have profound effects on mental health (Bao et al., 2020; Rossi et al., 2020). Social distancing affects people`s daily routine, causing isolation from beloved ones and deprivation of personal liberties which can lead to depression and anxiety (Venkatesh and Edirappuli, 2020). Depression can be related to increased frustration, boredom, and low mood (Lovibond and Lovibond, 1995). While anxiety can be related to panic attacks, fear, and trembling (Lovibond and Lovibond, 1995). Such symptoms can increase in response to fear of contagion and inaccurate information about the pandemic which can be determined by how media communicate the health crisis and the containment actions defined by local government (Brooks et al., 2020; Coelho et al., 2020; Shigemura et al., 2020).

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Mitigating mental distress during the COVID-19 pandemic has been of major concern. Governments and health professionals are being called upon to increase awareness of the public about the actions to alleviate mental distress derived from social distancing (Wang et al., 2020). The World Health Organization has publicized a series of advices to support mental health and psychosocial wellbeing such as practicing a healthy lifestyle (World Health Organization, 2020b). Healthy activities that include interaction with nature can be highly beneficial for mental health during the pandemic, especially in urban areas which are the epicenter of the outbreak (Gross et al., 2020).

Urban green infrastructures are known to be important for the mental health of the urban population and the COVID pandemic has strengthened such awareness (Grima et al., 2020; Soga et al., 2021). Urban green infrastructure includes parks, home gardens, street trees and any other form of greening that is embedded in the urban matrix which has an ecological function and provides ecosystem services (Childers et al., 2019). While many of such structures have important benefits for mental health, they can differ in the way such mental health benefits are delivered. For example, green areas such as urban parks provide an immersion experience in nature, free access to physical activity, and social interaction with local residents which can reduce stress and enhance emotional well-being (Chiesura, 2004; Liu et al., 2017). Home gardens provide direct contact with nature and gardening activities which reduce stress, anger, fatigue, depression and anxiety (de Bell et al., 2020; Soga et al., 2017). Gardens are also important for providing nature contemplation which can reduce anger, confusion, and anxiety (Lee, 2017). Neighborhood greenness allows for an indirect experience by viewing nature through the window which increases life satisfaction and attention, reducing depression and anxiety (Soga et al., 2020). Increasing evidence shows that urban green infrastructure, especially parks, gardens, and nearby greenness can reduce mental distress during the COVID-19 pandemic (Hanzl, 2020; Soga et al., 2020). However, we currently do not understand whether some green infrastructures are more efficient than others or whether their effectiveness in reducing mental distress changes as the COVID-19 pandemic progresses.

In this study, we evaluate the role of different urban green infrastructures (ie. parks, home gardens and green view) in mitigating mental distress during the current COVID-19 pandemic. Untangling the relative importance of different urban green infrastructures in reducing mental distress can be crucial to help guide programs to inform the public about the best practices for maintaining mental health during the pandemic.

2. Methods

We surveyed the residents of the city of Rio de Janeiro, Brazil. Rio is a densely populated municipality with an estimated 6,747.815 habitants (IBGE, 2021). Like many other major urban areas in the world, Rio has been recording a high number of COVID-19 cases. At the time of this study (November 6th 2020) Rio de Janeiro had 314,809 people infected and 20,849 deaths related to COVID-19 (Brasil.IO, 2021). The need for social distancing was advised by health authorities but no stay-at-home orders were in place.

2.1. Data collection and spatialization

We used a questionnaire made available online for 80 days (November 6th 2020 to January 24th 2021) through GoogleDocs™. The questionnaire was publicized through email lists and social media. Participation was voluntary and participants were asked to fill the questionnaire and distribute it further, creating a snowball effect. A total of 173 participants answered the questionnaire. Data collection was approved by the committee on human research ethics of the Universidade do Estado do Rio de Janeiro (CEP-UERJ 4.380.516). Participants were required to indicate being of legal age (18+) and to provide their postal code.

We used the postal code to assess the distance of participants to parks. Distance from parks was estimated as the shortest Euclidean distance between the postal code and the nearest parks by using the "spatial analyst" extension of ArcGIS 10.6. ©. Also, we evaluated the spatial distribution of participants within the city of Rio de Janeiro using the Average Nearest Neighbor Analysis (ANNA) from ArcGIS©. ANNA was used to estimate the Euclidean distance between a participant and the nearest neighbor. The nearest neighbor distances of all participants are then averaged and divided by the expected average neighbor distance (a simulated hypothetical random distribution). This ratio indicates whether the distribution of participants clustered (ratio <1) or dispersed (ratio >1). A Z-test is applied to test if the observed average nearest neighbor distance is different from the simulated random distance.

The questionnaire included 6 questions divided in 3 sections that assessed mental health, lifestyle/socioeconomic aspects, and interaction with urban green infrastructure (Table 1).

2.2. Mental health indicators

We used the Depression, Anxiety and Stress scale 21-DASS 21 (Lovibond and Lovibond, 1995) to estimate the level of mental distress of each participant. We used the DASS 21 version previously translated and validated to be used in Brazil (Vignola and Tucci, 2014). The DASS-21 is a list of 21 negative emotional symptoms. The list is equally divided into symptoms related to depression, anxiety, and stress (7 items each). Participants were asked to indicate the severity of each symptom on the past week using a scale from 0 to 3. Where 0 indicates the symptom was not experienced in the last week and 3 suggest the symptom was experienced most of the time. We used the DASS-21 as a general mental distress score, as suggested by Zanon et al. (2020). We estimated mental distress by summing the scores from all symptom groups per participant multiplied by a factor of 2. The mental distress score ranges from 0 to 126 and values higher than 60 indicate severe mental distress (Lovibond and Lovibond, 1995).

Table 1
Questions related to lifestyle/socioeconomic aspects and exposure to green infrastructure. The questionnaire was made available online between November 6th 2020 and January 24th 2021. All respondents were of legal age (18+) living in the city of Rio de Janeiro.

Questions	Answer scale
Lifestyle and socioeconomic	
The summed income of all people that live in your home is equal to how many times the minimum stiped?	Participants were asked to indicate one of the following options: up to 2, between 2–3, between 3–5, between 5–6, between 6–8, between 8–10, between 10–15, between 15–20, between 20–30, more than 30.
During this pandemic, how many times on average did you leave home for non-essential activities (leisure, malls, events)?	Participants were asked to indicate one of the following options: 1–2 times a week, 3–4 times a week, 5–6 times a week, 6–7 times a week, at each 15 days, once a month or greater interval, never.
Exposure to green infrastructure	
During this pandemic, how frequently did you leave your home for visiting green areas such as parks or the beach?	Participants were asked to indicate one of the following options: 1–2 times a week, 3–4 times a week, 5–6 times a week, 6–7 times a week, at each 15 days, once a month or greater interval, never.
How many trees can you see through the windows of your house?	Participants were asked to indicate one of the following options: none, 1–2, 3–4, 5–6, 7–8, 9–10,11–12, 13–14, 15 or more.
Do you take care of any plants in your home? How many?	Participants were asked to indicate one of the following options: none, 1–3, 4–6, 7–9, 10–12, 13–15, 16–18, 19–21, 22 or more.
Is there a garden in your house?	Participants were asked to indicate one of the following options: yes, no.

2.3. Lifestyle and socioeconomic factors

We asked each participant to indicate gender. Only one participant indicated non-binary gender and was removed from all statistical analysis. Participants were also asked to indicate household income (the sum salary of all family members living in the same household). Household income was ranked from 1 to 10 (Table 1). Where 1 represents families with monthly earnings of up to two times the minimum wage in Brazil and 10 represents families with monthly earnings that are greater than 30 times the minimum wage.

Because social distancing was advised but no strict social isolation measures were in place (quarantine or lock-down), we asked participants to indicate the frequency they left their homes for non-essential activities during the pandemic (eg. visiting malls, social events). We ranked the answers from 0 to 6 to estimate the intensity of non-essential activities. Where 0 represents participants that did not leave home for non-essential activities and 6 represents participants that frequently left home for non-essential activities (Table 1).

2.4. Exposure to green infrastructure

Participants were asked to indicate the average frequency they visited parks, including beach, during the pandemics. We ranked the answers from 0 to 6 to estimate the use of parks (Table 1). Where 0 represents no visits and 6 represents high frequency of visits. Participants were also asked to indicate how many trees they could see through the window. We ranked the answers from 0 to 8 to estimate the amount of green view from inside the house (Table 1). Where 0 represents no trees and 8 represents a large number of trees (15 or more). Participants were asked to report how many plants they take care of. We ranked the answers from 0 to 8, to estimate the intensity of gardening activities. Where 0 represents not taking care of any plants (no gardening) and 8 represents taking care of 22 or more plants (intense gardening). Lastly, participants indicated whether they live in a house with a garden.

2.5. Statistical analyses

We built a linear mixed model (LMM) to assess the relative importance of different green infrastructures on improving mental distress. We used mental distress as a response variable. While the visit to parks, green view, home garden, gender, distance from parks, non-essential activities, and plants taken care of were fixed factors. Household income was included as a random factor. We included income, gender, and distance from parks in our models because evidence shows that these are important factors related to mental health during the COVID-19 pandemic (Sturm and Cohen, 2014; Vindegaard and Benros, 2020). We include the number of plants taken care of as a proxy for the direct interaction of respondents with green infrastructure trough gardening. We included the frequency of non-essential activities because self-imposed strict social distancing can be used as a proxy of fear of contagion.

We fitted the LMM model with the *lme4* package for R (Bates et al., 2015). Variables were scaled as needed. Model fit was evaluated visually using Q-Q plots. We assessed the predictors for multicollinearity with the VIF function of the *car* package for R (Fox and Weisberg, 2011). The variances explained by both fixed plus random factor (conditional R square, R^2_c), and the variance explained only by the fixed factors (marginal R square, R^2_m) were estimated using the "r.squaredGLMM" function of the R package *MuMIn*.

We plotted the estimated coefficient for each fixed factor on a forestplot using the function "plot_model" of the package sjPlot (Lüdecke, 2021). All deviations are shown as standard error of the mean.

3. Results

Our spatial analysis show that participants live relatively close to natural parks (2 ± 0.13 km) (Fig. 1) being distributed in small clusters across the city of Rio de Janeiro, similarly dispersed around parks (Z-score= -9,99, p-value<0.001) (Supplementary material, Fig. S1). At the time of the survey, participants had moderate levels of mental distress (42.2 ± 2 DASS score) (Supplementary material, Fig. S2). Most are Females (77 %) with a household income between 3−5 times the minimum wage (21 %) (Supplementary material, Figs. S3 and S4). At the time of the survey, most participants rarely or never left home for non-essential activities (34 % and 25 % of participants, respectively) (Supplementary material, Fig. S5)

The interaction with urban green infrastructure show that participants never or rarely visited parks (41 % and 28 % or participants) (Supplementary material, Fig. S6). The number of trees seen through the window ranges from 15 or more (22 % of participants) to none or a few (20 % and 17 % of participants, respectively) (Supplementary material, Fig. S7). The number of participants with and without home garden was similar (45 % and 55 %, respectively) and most were not actively involved in taking care of plants (a proxy for gardening) (34 % of participants) (Supplementary material, Figs. S8 and S9).

Our model ($R^2_c = 0.23$ and $R^2_m = 0.21$) shows that gender and home garden are the most important predictors related to the reduction of mental distress during the COVID-19 pandemic (LMM model coefficients: -6.9 and -5.2, respectively) (Fig. 2) (Supplementary material, Table S1). While visit to parks, a green view and taking care of plants have a smaller relative importance in reducing mental distress (LMM model coefficients: -1.9, -0.7 and -0.5, respectively) (Supplementary material, Table S1) (Fig. 2). The increased distance from parks and leaving home for non-essential activities had a minor relative importance in enhancing mental distress (LMM model coefficients: 1.1 and 0.4, respectively) (Supplementary material, Table S1) (Fig. 2).

4. Discussion

The current COVID-19 pandemics has impaired mental health of human populations (Rajkumar, 2020; Rossi et al., 2020). Indicators of mental distress including symptoms of stress, anxiety and depression have increased mainly in urban areas which are hubs for COVID-19 pandemic (Gross et al., 2020; Santiago-Alarcon and MacGregor-Fors, 2020). Here we show that gender and urban green infrastructures are important factors determining mental distress during the pandemic, irrespective of household income. Specifically, our data expose that the different urban green infrastructures have varying importance for mitigating mental distress.

The effect of gender on mental health during the COVID-19 pandemics has been largely documented. Women`s mental health is severely affected by the pandemic mainly because of gender-based violence (Sediri et al., 2020). Also, women experience additional stressors related to reproductive functioning such as pregnancy, postpartum, and miscarrying which further the risk of developing mental health problems during the pandemics (Almeida et al., 2020). Although gender is the most important predictor of mental distress in our data (Fig. 2), an in-depth discussion on gender-related mental health during COVID-19 pandemics is beyond the scope of this paper. Further information on that topic can be found in recent reviews (Connor et al., 2020; Thibaut and van Wijngaarden-Cremers, 2020).

Multiple evidence shows that urban green infrastructures can be important for mitigating mental distress during the COVID-19 pandemic (Hanzl, 2020; Pouso et al., 2021; Soga et al., 2020). The use of parks, a green view from the window, and home gardens are all related to increased life satisfaction and reduced levels of loneliness, depression, anxiety, and stress related to COVID-19 pandemic (Corley et al., 2021; Pouso et al., 2021; Soga et al., 2017). The use of parks has been specially recommended as an important factor in mitigating mental distress during the outbreak (Slater et al., 2020). However, our data show that while all urban green infrastructures have the potential for reducing mental distress during the pandemic, home gardens can be more

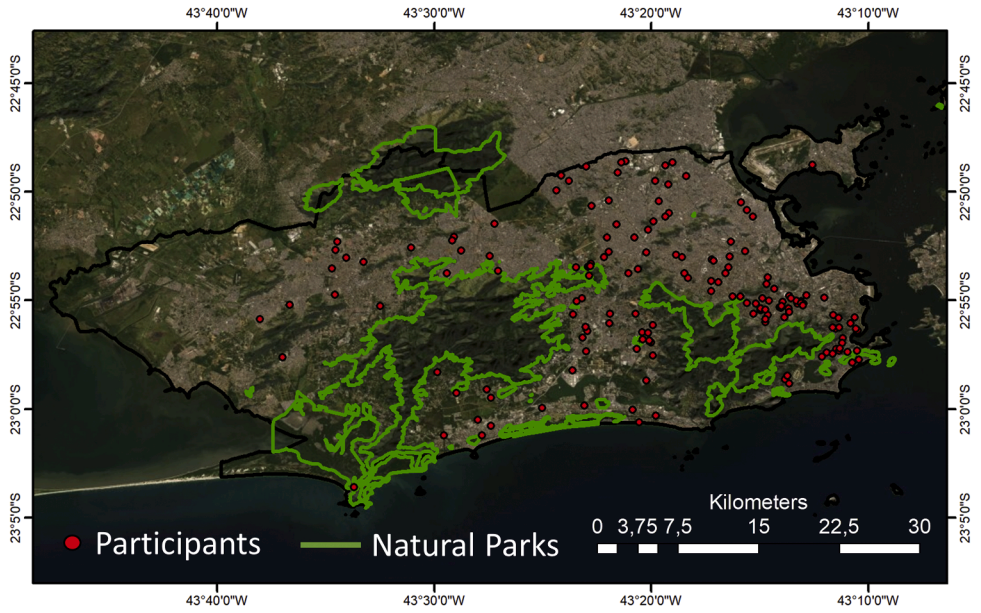

Fig. 1. Distribution of participants in the survey. The city of Rio de Janeiro`s limits are marked in black. Symbols (red dots) represent the location (postal code) of each participant. Map was built using ArcGIS 10.6. © (for interpretation of the references to colour in the Figure Legend, the reader is referred to the web version of this article).

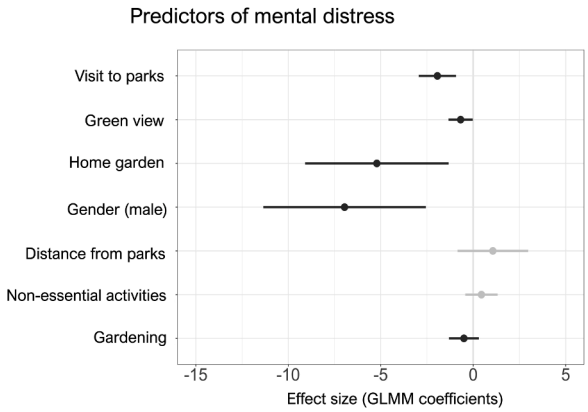

Fig. 2. Linear mixed model coefficients. The model assessed the effect of different green infrastructures on mental distress. Where mental distress was the response variable and visits to parks, green view from the window, having a home garden, gender, distance from parks, practicing non-essential activities outdoors and gardening (number of plants taken care of) fixed factors. Household income was used as a random factor and it is not included in the figure. Bars represent 95 % confidence intervals and symbols show model coefficient for each factor.

important in reducing mental distress of residents of Rio de Janeiro.

The process of taking care of plants, working on a garden and keeping the garden attractive (ie. gardening) has long been considered to help promoting mental health (Parr, 2007). Gardening reduces depression, anxiety, and stress symptoms (Soga et al., 2017). This is especially the case for urban population, for which gardening may be one of the few activities allowing direct interaction with nature in cities (Lin et al., 2018). However, our model show that gardening has a much lower importance than having a home garden. This suggests that gardens can have an important added contemplative value. Visual interaction with gardens can reduce anger, confusion and anxiety (Lee, 2017). Indirect interactions can also include non-visual experiences, such as listening to bird songs, which also improve mental health (Ratcliffe et al., 2013).

In the context of the pandemic, where people fear being infected and are encouraged to stay home, gardens can play a disproportionate role. The severity of the outbreak, inaccurate information from local government or media can increase fear of contagion or fear of the unknown (Coelho et al., 2020). Fear of contagion will likely reduce mental health benefits obtained from outdoor activities and can help explain why in some regions there was a reduction in park visitation during the pandemics (Ugolini et al., 2020). Our data suggest that at the time of the interview, people feared contagion and self-isolated, despite no stay-at-home orders being in place. The effect of fear can also help explain why distance from parks, an often important predictor of mental health (Sturm and Cohen, 2014), has a small relative importance during the covid outbreak. Alternatively, the weak relationship between distance from parks and mental health can be related to the high number of parks in the city of Rio de Janeiro which allow most of the residents to live relatively close to parks (2 km away, on average).

Taking into account the context-dependency of the interaction between mental health and urban green infrastructure can be fundamental for better informed actions for mitigating mental distress during the COVID-19 pandemics. Early in the outbreak, some governments issued orders to restrict the access to parks (Slater et al., 2020). This caused debate and recommendations for keeping parks open, under the argument that exposure to nature in green spaces is important for mental and physical health (Slater et al., 2020). However, our study suggests that, in some cases, park visitation may not be the most effective way to mitigate mental distress during the pandemic. We suggest future governmental action to first assess the mental health benefits of parks compared to other urban green infrastructures before taking action. This can be performed relatively fast thought on-line questionnaires. As the pandemic progresses, the perceived fear of contamination will likely change, and this can affect the mental health benefits obtained from different urban green infrastructures. This exposes that recommendations of use and type of urban green infrastructure with the best mental health benefits need to be re-accessed over time.

Despite providing important information about the context dependency of the mental health benefits provided by urban green infrastructure, this study has limitations. We were not able to determine a cause-and-effect relationship between home garden and reduction of mental distress because of the cross-sectional nature of our study. It is possible that respondents with better mental health tend to have home

gardens. Also, most participants in our study were females (77 %) and because females are more mentally affected by the COVID-19 pandemics (Pieh et al., 2020) our mental distress estimates can be inflated. Participants in our survey were spatially well distributed, suggesting a good representation of the different social contexts within the city. However, a relatively low number of participants answered our questionnaire. This can impair broad generalizations and predictions based on our data. Despite that, our study raises important hypotheses about the context dependency of the relationship between mental health and urban green infrastructure during the COVID-19 pandemics. Further studies with a larger number of respondents, which consider how the mental health-urban green infrastructure relationship changes through time as the pandemic develops, will be fundamental to better understand how urban green infrastructures can help mitigate mental distress.

5. Conclusion

The current COVID-19 pandemic exposed the urgency of planning cities for future global health crisis (Allam and Jones, 2020). In such planning, nourishing and protecting urban green spaces seems fundamental (Rodgers, 2020). Our study suggests that while multiple urban green infrastructures have a role in mitigating mental distress during the COVID-19 pandemic, their effectiveness can vary with context, being affected by how urban residents perceive and behave when facing the risk of contagion. We suggest that planning for a diverse range of urban green infrastructures such as parks, gardens, and street greening is important for maintaining a dynamic provisioning of mental health benefits under health crisis. This can be fundamental for social resiliency of cities in future pandemics (Pamukcu-Albers et al., 2021).

Author statement on the contribution to the paper

Piatã Marques: conceptualization, methodology, formal analysis, project administration, writing - original draft, visualization

Andrey Santos Silva: conceptualization, methodology

Yane Quaresma: conceptualization, methodology

Luisa Resende Manna: conceptualization, methodology, writing – review and editing

Newton de Magalhães Neto: formal analysis, visualization, writing – review and editing

Rosana Mazonni: supervision, writing – review and editing, funding acquisition

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ufug.2021.127268.

References

Abouk, R., Heydari, B., 2021. The immediate effect of COVID-19 policies on social-distancing behavior in the United States. Public Health Rep. 136, 245–252. https://doi.org/10.1177/0033354920976575.

Allam, Z., Jones, D.S., 2020. Pandemic stricken cities on lockdown. Where are our planning and design professionals [now, then and into the future]? Land Use Policy 97, 104805. https://doi.org/10.1016/j.landusepol.2020.104805.

Almeida, M., Shrestha, A.D., Stojanac, D., Miller, L.J., 2020. The impact of the COVID-19 pandemic on women's mental health. Arch. Womens Ment. Health 23, 741–748. https://doi.org/10.1007/s00737-020-01092-2.

Bao, Y., Sun, Y., Meng, S., Shi, J., Lu, L., 2020. 2019-nCoV epidemic: address mental health care to empower society. Lancet 395, e37–e38. https://doi.org/10.1016/S0140-6736(20)30309-3.

Bates, D.M., Machler, M., Bolker, B.M., Walker, S.C., 2015. Fitting linear mixed-effects models using lme4. J. Stat. Softw. 67 https://doi.org/10.18637/jss.v067.i01.

Brasil.IO, 2021. Brasil.io [WWW Document]. URL. https://brasil.io/covid19/RJ/.

Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., Rubin, G.J., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. Lancet 395, 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8.

Chiesura, A., 2004. The role of urban parks for the sustainable city. Landsc. Urban Plan. 68, 129–138. https://doi.org/10.1016/j.landurbplan.2003.08.003.

Childers, D.L., Bois, P., Hartnett, H.E., McPhearson, T., Metson, G.S., Sanchez, C.A., 2019. Urban ecological infrastructure: an inclusive concept for the non-built urban environment. Elem Sci Anth 7, 46. https://doi.org/10.1525/elementa.385.

Coelho, C.M., Suttiwan, P., Arato, N., Zsido, A.N., 2020. On the nature of fear and anxiety triggered by COVID-19. Front. Psychol. 11 https://doi.org/10.3389/fpsyg.2020.581314.

Connor, J., Madhavan, S., Mokashi, M., Amanuel, H., Johnson, N.R., Pace, L.E., Bartz, D., 2020. Health risks and outcomes that disproportionately affect women during the Covid-19 pandemic: a review. Soc. Sci. Med. 266, 113364 https://doi.org/10.1016/j.socscimed.2020.113364.

Corley, J., Okely, J.A., Taylor, A.M., Page, D., Welstead, M., Skarabela, B., Redmond, P., Cox, S.R., Russ, T.C., 2021. Home garden use during COVID-19: associations with physical and mental wellbeing in older adults. J. Environ. Psychol. 73, 101545 https://doi.org/10.1016/j.jenvp.2020.101545.

Courtemanche, C., Garuccio, J., Le, A., Pinkston, J., Yelowitz, A., 2020. Strong social distancing measures in the united states reduced the COVID-19 growth rate. Health Aff. (Millwood) 39, 1237–1246. https://doi.org/10.1377/hlthaff.2020.00608.

de Bell, S., White, M., Griffiths, A., Darlow, A., Taylor, T., Wheeler, B., Lovell, R., 2020. Spending time in the garden is positively associated with health and wellbeing: results from a national survey in England. Landsc. Urban Plan. 200, 103836 https://doi.org/10.1016/j.landurbplan.2020.103836.

Fox, J., Weisberg, S., 2011. A R Companion to Applied Regression, second edi. Sage, Thousand Oaks CA.

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, e0243344. https://doi.org/10.1371/journal.pone.0243344.

Gross, S.A., Robbins, D.H., Greenwald, D.A., Schnoll-Sussman, F.H., Pochapin, M.B., 2020. Preparation in the Big Apple: new York City, a new epicenter of the COVID-19 pandemic. Am. J. Gastroenterol. https://doi.org/10.14309/ajg.0000000000000636.

Hanzl, M., 2020. Urban forms and green infrastructure – the implications for public health during the COVID-19 pandemic. Cities Health 0, 1–5. https://doi.org/10.1080/23748834.2020.1791441.

IBGE, Instituto Brasileiro de Geografia e Estatística, 2021. Ibge [WWW Document]. IBGE. URL https://cidades.ibge.gov.br/brasil/rj/rio-de-janeiro/panorama (accessed 4.16.21).

Lau, H., Khosrawipour, V., Kocbach, P., Mikolajczyk, A., Schubert, J., Bania, J., Khosrawipour, T., 2020. The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. J. Travel Med. 27 https://doi.org/10.1093/jtm/taaa037.

Lee, J., 2017. Experimental study on the health benefits of garden landscape. Int. J. Environ. Res. Public Health 14, 829. https://doi.org/10.3390/ijerph14070829.

Lin, B.B., Egerer, M.H., Ossola, A., 2018. Urban gardens as a space to engender biophilia: evidence and ways forward. Front. Built Environ. 4 https://doi.org/10.3389/fbuil.2018.00079.

Liu, H., Li, F., Li, J., Zhang, Y., 2017. The relationships between urban parks, residents' physical activity, and mental health benefits: a case study from Beijing. China. J. Environ. Manage. 190, 223–230. https://doi.org/10.1016/j.jenvman.2016.12.058.

Lovibond, S.H., Lovibond, P.F., 1995. Manual for the Depression Anxiety Stress Scales. Psychology Foundation of Australia.

Lüdecke, D., 2021. sjPlot: Data Visualization for Statistics in Social Science.

Pamukcu-Albers, P., Ugolini, F., La Rosa, D., Grădinaru, S.R., Azevedo, J.C., Wu, J., 2021. Building green infrastructure to enhance urban resilience to climate change and pandemics. Landsc. Ecol. 36, 665–673. https://doi.org/10.1007/s10980-021-01212-y.

Parr, H., 2007. Mental health, nature work, and social inclusion. Environ. Plan. Soc. Space 25, 537–561. https://doi.org/10.1068/d67j.

Pieh, C., Budimir, S., Probst, T., 2020. The effect of age, gender, income, work, and physical activity on mental health during coronavirus disease (COVID-19) lockdown in Austria. J. Psychosom. Res. 136, 110186 https://doi.org/10.1016/j.jpsychores.2020.110186.

Pouso, S., Borja, Á., Fleming, L.E., Gómez-Baggethun, E., White, M.P., Uyarra, M.C., 2021. Contact with blue-green spaces during the COVID-19 pandemic lockdown

beneficial for mental health. Sci. Total Environ. 756, 143984 https://doi.org/10.1016/j.scitotenv.2020.143984.
Rajkumar, R.P., 2020. COVID-19 and mental health: a review of the existing literature. Asian J. Psychiatry 52, 102066. https://doi.org/10.1016/j.ajp.2020.102066.
Ratcliffe, E., Gatersleben, B., Sowden, P.T., 2013. Bird sounds and their contributions to perceived attention restoration and stress recovery. J. Environ. Psychol. 36, 221–228. https://doi.org/10.1016/j.jenvp.2013.08.004.
Rodgers, C., 2020. Nourishing and protecting our urban 'green' space in a post-pandemic world. Environ. Law Rev. 22, 165–169. https://doi.org/10.1177/1461452920934667.
Rossi, R., Socci, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., Di Marco, A., Rossi, A., Siracusano, A., Di Lorenzo, G., 2020. COVID-19 Pandemic and lockdown measures impact on mental health among the general population in Italy. Front. Psychiatry 11. https://doi.org/10.3389/fpsyt.2020.00790.
Santiago-Alarcon, D., MacGregor-Fors, I., 2020. Cities and pandemics: urban areas are ground zero for the transmission of emerging human infectious diseases. J. Urban Ecol. 6 https://doi.org/10.1093/jue/juaa012.
Sediri, S., Zgueb, Y., Ouanes, S., Ouali, U., Bourgou, S., Jomli, R., Nacef, F., 2020. Women's mental health: acute impact of COVID-19 pandemic on domestic violence. Arch. Womens Ment. Health 23, 749–756. https://doi.org/10.1007/s00737-020-01082-4.
Shigemura, J., Ursano, R.J., Morganstein, J.C., Kurosawa, M., Benedek, D.M., 2020. Public responses to the novel 2019 coronavirus (2019-nCoV) in Japan: mental health consequences and target populations. Psychiatry Clin. Neurosci. 74, 281–282. https://doi.org/10.1111/pcn.12988.
Slater, S.J., Christiana, R.W., Gustat, J., 2020. Recommendations for keeping parks and green space accessible for mental and physical health during COVID-19 and other pandemics. Prev. Chronic Dis. 17 https://doi.org/10.5888/pcd17.200204.
Soga, M., Gaston, K.J., Yamaura, Y., 2017. Gardening is beneficial for health: a meta-analysis. Prev. Med. Rep. 5, 92–99. https://doi.org/10.1016/j.pmedr.2016.11.007.
Soga, M., Evans, M.J., Tsuchiya, K., Fukano, Y., 2020. A room with a green view: the importance of nearby nature for mental health during the COVID-19 pandemic. Ecol. Appl. n/a, e2248. https://doi.org/10.1002/eap.2248.
Soga, M., Evans, M.J., Cox, D.T.C., Gaston, K.J., 2021. Impacts of the COVID-19 pandemic on human–nature interactions: pathways, evidence and implications. People Nat. 3, 518–527. https://doi.org/10.1002/pan3.10201.
Sturm, R., Cohen, D., 2014. Proximity to urban parks and mental health. J. Ment. Health Policy Econ. 17, 19–24.
Thibaut, F., van Wijngaarden-Cremers, P.J.M., 2020. Women's mental health in the time of COVID-19 pandemic. Front. Glob. Womens Health 1, 588372. https://doi.org/10.3389/fgwh.2020.588372.
Thunström, L., Newbold, S.C., Finnoff, D., Ashworth, M., Shogren, J.F., 2020. The benefits and costs of using social distancing to flatten the curve for COVID-19. J. Benefit-Cost Anal. 11, 179–195. https://doi.org/10.1017/bca.2020.12.
Ugolini, F., Massetti, L., Calaza-Martínez, P., Cariñanos, P., Dobbs, C., Ostoić, S.K., Marin, A.M., Pearlmutter, D., Saaroni, H., Šaulienė, I., Simoneti, M., Verlič, A., Vuletić, D., Sanesi, G., 2020. Effects of the COVID-19 pandemic on the use and perceptions of urban green space: an international exploratory study. Urban For. Urban Green. 56, 126888 https://doi.org/10.1016/j.ufug.2020.126888.
Venkatesh, A., Edirappuli, S., 2020. Social distancing in COVID-19: what are the mental health implications? BMJ m1379. https://doi.org/10.1136/bmj.m1379.
Vignola, R.C.B., Tucci, A.M., 2014. Adaptation and validation of the depression, anxiety and stress scale (DASS) to Brazilian Portuguese. J. Affect. Disord. 155, 104–109. https://doi.org/10.1016/j.jad.2013.10.031.
Vindegaard, N., Benros, M.E., 2020. COVID-19 pandemic and mental health consequences: systematic review of the current evidence. Brain Behav. Immun. 89, 531–542. https://doi.org/10.1016/j.bbi.2020.05.048.
Wang, G., Zhang, Y., Zhao, J., Zhang, J., Jiang, F., 2020. Mitigate the effects of home confinement on children during the COVID-19 outbreak. Lancet 395, 945–947. https://doi.org/10.1016/S0140-6736(20)30547-X.
World Health Organization, 2020a. WHO COVID-19 Dashboard.
World Health Organization, 2020b. Mental Health and Psychosocial Considerations During the COVID-19 Outbreak.
Zanon, C., Brenner, R.E., Baptista, M.N., Vogel, D.L., Rubin, M., Al-Darmaki, F.R., Gonçalves, M., Heath, P.J., Liao, H.-Y., Mackenzie, C.S., Topkaya, N., Wade, N.G., Zlati, A., 2020. Examining the dimensionality, reliability, and invariance of the Depression, Anxiety, and Stress Scale–21 (DASS-21) across eight countries. Assessment. https://doi.org/10.1177/1073191119887449.