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.

Environmental Research 196 (2021) 110420

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Does greenery experienced indoors and outdoors provide an escape and support mental health during the COVID-19 quarantine?

Angel M. Dzhambov [a,*], Peter Lercher [b], Matthew H.E.M. Browning [c], Drozdstoy Stoyanov [d,e], Nadezhda Petrova [f,g], Stoyan Novakov [f], Donka D. Dimitrova [h]

[a] Department of Hygiene, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria
[b] Institute for Highway Engineering and Transport Planning, Graz University of Technology, Graz, Austria
[c] Department of Park, Recreation, and Tourism Management, Clemson University, Clemson, SC, USA
[d] Department of Psychiatry and Medical Psychology, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
[e] Research Institute at Medical University – Plovdiv, Plovdiv, Bulgaria
[f] Department of Human Anatomy, Histology and Embryology, Faculty of Medicine, Medical University of Plovdiv, Plovdiv, Bulgaria
[g] Department of Plant Physiology and Molecular Biology, Faculty of Biology, University of Plovdiv "Paisii Hilendarski", Plovdiv, Bulgaria
[h] Department of Health Management and Healthcare Economics, Faculty of Public Health, Medical University of Plovdiv, Plovdiv, Bulgaria

ARTICLE INFO

Keywords:
Anxiety
Depression
Gardening
Green space
Houseplants
Quarantine

ABSTRACT

Background: The COVID-19 pandemic has profoundly changed people's ability to recreate in public green spaces, which is likely to exacerbate the psychological impacts of the pandemic. In the current study, we seek to understand whether greenery can support mental health even with insufficient outdoor exposure in times of physical isolation from the outdoor environment.

Methods: Between 17 May and 10 June, 2020, we conducted an online survey among 323 students (21.99 ± 3.10 years; 31% male) in health-related programs from two universities in the city of Plovdiv, Bulgaria. Severities of depressive and anxiety symptoms over the past two weeks were measured with the Patient Health Questionnaire 9-item and the Generalized Anxiety Disorder 7-item scale. We employed two self-reported measures of greenery experienced indoors (number of houseplants in the home and proportion of exterior greenery visible from inside the home) and two measures of greenery experienced outdoors (presence/absence of a domestic garden and availability of neighborhood greenery). Restorative quality of the home (the "being away" dimension of the Perceived Restorativeness Scale; PRS) and the neighborhood (the "being away" and "fascination" dimensions of the PRS), engagement with outdoor greenery (frequency of different types of interaction) and perceived social support were treated as mediators. Associations between greenery and mental health were tested using generalized linear regression and logistic regression. Structural equation modelling (SEM) techniques were used to test the theoretically-indicated relations among the variables.

Results: Clinically-meaningful symptoms of moderate depression and anxiety were reported by approximately 33% and 20% of the students, respectively. The relative abundance of greenery visible from the home or in the neighborhood was associated with reduced depressive/anxiety symptoms and lower depression/anxiety rates. Having more houseplants or a garden was also associated with some of these markers of mental health. As hypothesized, the mental health-supportive effects of indoor greenery were largely explained by increased feelings of being away while at home. Neighborhood greenery contributed to neighborhood restorative quality, which in turn facilitated social support and more frequent engagement with greenery, and that led to better mental health.

Conclusions: Students who spent most of their time at home during the COVID-19 epidemic experienced better mental health when exposed to more greenery. Our findings support the idea that exposure to greenery may be a valuable resource during social isolation in the home. However, causal interpretation of these associations is not straightforward.

* Corresponding author.
E-mail addresses: angelleloti@gmail.com, angel.dzhambov@mu-plovdiv.bg (A.M. Dzhambov).

https://doi.org/10.1016/j.envres.2020.110420
Received 28 July 2020; Received in revised form 27 October 2020; Accepted 28 October 2020
Available online 4 November 2020
0013-9351/

1. Introduction

The COVID-19 pandemic has profoundly changed people's ability to recreate outdoors. Most national governments issued stay-at-home orders (Gostin and Wiley, 2020; Petersen et al., 2020) for unprecedented lengths of time (Brooks et al., 2020) prohibiting visiting parks, community gardens, playgrounds, and other outdoor activity spaces (Shoari et al., 2020). Simultaneously, the fear and uncertainty instilled by the perceived health risk and economic ramifications of the pandemic have increased insomnia, anxiety, depression, and suicide rates (Zhu et al., 2020; Rajkumar, 2020; Huang and Zhao, 2020; Wang et al., 2020). On the one hand, coronavirus anxiety has been found to decrease as social isolation measures intensify (Lee and Neimeyer, 2020). On the other, however, limitations to outdoor recreation are likely to exacerbate these concerning psychological impacts of the pandemic, since exposure to greenery in public outdoor spaces benefits mental health (Gascon et al., 2015; Triguero-Mas et al., 2015; WHO, 2016; Callaghan et al., 2020) in multiple ways: by mitigating harmful exposures (e.g., air pollution and noise), by restoring depleted adaptive capacities (e.g., cognitive resources), and by promoting new adaptive resources (e.g., outdoor physical activity and social interaction) (Markevych et al., 2017). Most of these pathways toward good mental health are unavailable when people spend almost all of their time at home, however (cf. Hartig et al., 2007).

When outdoor interaction with greenery is impeded, three alternative forms of engagement are important for psychological restoration. First, looking out windows onto greenery promotes psychological health benefits. Over the course of a few hours or days, green window views have been shown in experimental research to provide micro-restorative episodes that promote healing (Ulrich, 1984; Kaplan, 2001; Jo et al., 2019; Hartig et al., 2014), psychological restoration (Lee et al., 2015a), and recovery from stressful events (Li and Sullivan, 2016). Over the course of several months, green window views have been shown to increase a person's ability to complete difficult cognitive tasks, such as earning high grades/marks in a college writing course (Benfield et al., 2015). In cross-sectional analyses, window views of nature have also been associated with life satisfaction (Chang et al., 2020) and job satisfaction (Sop Shin, 2007). Such psychological benefits of green views are largely attributed to the extent to which they promote fascination and feelings of being away from everyday routines (Masoudinejad and Hartig, 2020). That is, the "being away" dimension reflects an absence of immediate threats to safety and a relative absence of perceived social and physical demands (e.g., crowding, noise or other obligations) in an environment. "Fascination" reflects how attention can also go effortlessly to interesting, pleasant aspects of the environment, thereby promoting faster and more complete decline in psychophysiological arousal (Kaplan and Kaplan, 1989; Kaplan, 1995).

A second opportunity to engage with greenery at home is through indoor vegetation. Potted plants can reduce stress, physical discomfort, anxiety, and depressive symptoms (Chang and Cheng 2005; Fjeld, 2000; Hall and Knuth, 2019; Han and Ruan, 2019) as well as increase attention (Raanaas et al., 2011; Hall and Knuth, 2019; Kim et al., 2018, 2020), mood (Han and Ruan, 2019), and cognitive performance (Adamson and Thatcher, 2019; Hall and Knuth, 2019). In one study, the mere presence of plants in the classroom also contributed to higher perceived restoration and positive affect of students (Han and Ruan, 2019). Another study found that students transplanting an indoor plant experienced reduced psychological and physiological stress and feelings of relaxation compared with working on a computer (Lee et al., 2015b). Jointly, these two forms of greenery experienced indoors (potted plants and window views) are important sensory facets of biophilic design (Xue et al., 2019) promoting occupants' recovery of stress and mental fatigue (Gillis and Gatersleben, 2015). Biophilic design describes modifications to the built environment (i.e., houses and apartments) for environmental sustainability and increases contact between people and elements from the natural world (Kellert et al., 2008).

The third way to engage with green elements while homebound is through gardens or balcony with plants. Having a domestic garden can reduce depression and anxiety when visits to public green spaces are not taken (Soga et al., 2016; Dennis and James, 2017; de Bell et al., 2020). Notably, adequate garden sizes may be an important means of reducing socioeconomic health inequalities (Brindley et al., 2018). Gardens have ranked higher than other private spaces in their perceived restorativeness (Cervinka et al., 2016). Specifically, gardening (i.e., engagement with a garden) has been shown to reduce anxiety and depressive symptoms and myriad other components of mental health (Soga et al., 2017; Howarth et al., 2020).

To the best of our knowledge, these three opportunities to engage with greenery have rarely been compared, much less directly (cf. Akpinar et al., 2016; Korpela et al., 2017; Dzhambov et al., 2018a). Evaluating the psychological benefits of each opportunity and their underlying pathways toward supporting mental health is a critical step toward buffering the burden of the COVID-19 pandemic. Thereafter, such an understanding could inform biophilic design in settings where outdoor mobility is necessarily limited (i.e., clinical settings, workplaces, schools, and military/space-missions) (Nadkarni et al., 2017; Yeo et al., 2020).

Most previous studies on indoor greenery were related to workplaces, especially office spaces or classrooms (Raanaas et al., 2011; Han and Ruan, 2019). In addition, studies conducted in experimental settings have yielded mixed findings (Bringslimark et al. 2007, 2009). It is not clear how these findings translate to a situation where the daily loops of an individual are confined to the home environment for a prolonged period. One recent international study investigated the impact of green-blue environments on mental health during the COVID-19 lockdown and found that people perceived that nature helped them to cope with lockdown measures (Pouso et al., 2020). We can also draw parallels to other nature-deprived environments like prisons, where nature videos reduced stress and irritability of inmates in solitary confinement (Nadkarni et al., 2017), and green views were associated with perceived restoration (Moran, 2019). Intervention studies in hospitals with horticulture arrangements showed not only shorter postoperative stays, lower intake of analgesics, lower pain intensity and improved vital signs (heart rate, blood pressure) but also more positive emotions and feelings and other health improvements (Annerstedt and Währborg, 2011; Kamioka et al., 2014; Khan et al., 2016; Siu et al., 2020)

In the current study, we seek to understand whether greenery can support mental health even with insufficient outdoor exposure in times of physical isolation from the outdoor environment. The study was conducted in Bulgaria around the time that country was under a state of emergency declaration caused by the COVID-19 pandemic. The stay-at-home order was issued on March 13, 2020. The emergency declaration and formal ban on visiting green spaces was lifted on 14 May (https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Bulgaria) but public perceptions of the coronavirus remained largely unchanged. Therefore, although unrestricted by law, engagement with urban greenery in this timeslot was expected to remain limited. It is in the few weeks after 14 May that we chose to survey a sample of students to investigate associations between different types of greenery at home and mental health. We hypothesized the following: (H1) greenery experienced indoors (houseplants and window view/s of greenery) would have protective effects on depression and anxiety principally by encouraging feelings of "being away," (H2) greenery experienced indoors would have stronger protective effects than outdoor greenery (a garden and other residential greenery), and (H3) any protective effects of outdoor greenery would be principally by encouraging feelings of "being away" and "fascination" leading to actual engagement (i.e., working the garden, or visiting the outdoor residential greenery) given the mood benefits and likely downstream consequences on mental health of actually going outdoors into natural settings relative to viewing them remotely (Browning et al., 2020) and facilitating social support. The intertwined nature of these hypothesizes is depicted in the study's conceptual framework (Fig. 1).

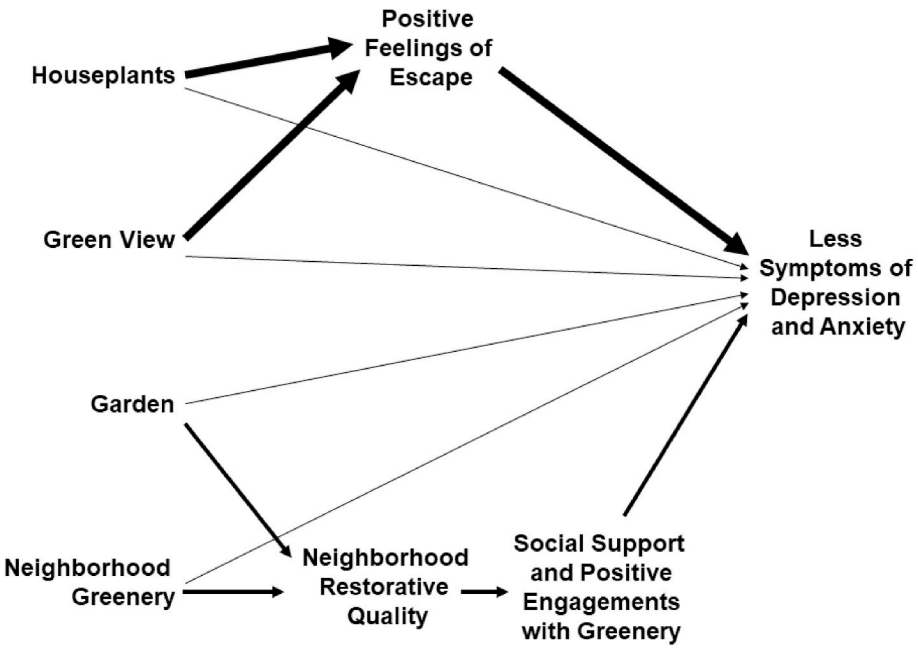

Fig. 1. Conceptual framework showing hypothesized pathways between greenery experienced in or around the home and depressive and anxiety symptoms during home confinement. Note: Line widths represent hypothesized pathway strength, with thicker lines denoting potentially stronger associations.

2. Material and methods

2.1. Study design and sampling

Between 17 May and 10 June, 2020, we conducted an online survey among students from two universities in the city of Plovdiv, Bulgaria. Plovdiv is situated on the banks of the Maritza River. It has a well-defined core with concentric surroundings and stronger integration towards the south and west. The predominant types of residences are multi-family units and apartment buildings. Public green spaces in Plovdiv cover 381.5 ha comprising 75.3% of all green spaces in the city. The central district of Plovdiv, where the two university campuses are located, has 14.3 m^2 of green space per capita. The backbone of this green infrastructure are several prominent green vegetated hills and the park "Tzar Simeon Garden", which offer recreational areas in walking distance to the university campuses. However, these green elements are mosaic and poorly integrated in the urban fabric owing to a lack of green corridors between them (Bulplan, 2015).

Students in medicine, dentistry and biology were approached by their lecturers with an invitation to participate in a survey on living conditions and mental health. Students could also forward the link to their peers. We targeted students in health-related programs because the psychological wear and tear of the student occupation more than likely took a heavy toll on their mental health (Huang et al., 2020). To be included, students had to be aged from 18 to 35 years and, to ensure that they were familiar with their neighborhood environment, had to have lived in their current home for at least six months.

The students received a link to an anonymized questionnaire in Microsoft Forms (https://forms.office.com/). The survey was administered in the Bulgarian language and included questions about socio-demographic factors, mental health, and the neighborhood and home environments. The average completion time was 13 min. Responses could be submitted only once from a unique IP address.

The design and conduct of the study followed the general principles outlined in the Declaration of Helsinki. After reading the information about the objectives of the study and instructions on filling-in the questionnaire, all respondents confirmed that they were at least 18 years old and provided informed consent in the survey form, thereby agreeing that their personal information would be processed and stored according to the General Data Protection Regulation in the European Union. The generic design of earlier studies in this series has been approved by the Ethics Committee at the institution of the principal investigator (Dzhambov et al., 2018a).

2.2. Mental health assessment

Severities of depressive and anxiety symptoms over the past two weeks were measured with two widely-used screening instruments. The Patient Health Questionnaire 9-item (PHQ-9) measures the frequency of symptoms of depression like anhedonia, hopelessness, sleep problems, fatigue, appetite changes, and thoughts of death (Kroenke et al., 2001). Its nine items are based on the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders – IV for major depressive disorder. Response options include 0 (not at all), 1 (several days), 2 (more than half of the days), or 3 (nearly every day). Scores (sum of the item responses) could range from 0 to 27. The items loaded onto one latent factor and the internal consistency in our sample was high (McDonald's $\omega = 0.87$). Here, an omega (ω) coefficient was employed to overcome the limitations (i.e., inflated values if strict assumptions are not met) associated with a Cronbach's alpha coefficient (Dunn et al., 2014).

The Generalized Anxiety Disorder 7-item (GAD-7) scale was designed to assess how often the person is bothered by common symptoms of anxiety, such as feeling nervous, worrying too much, having trouble relaxing, becoming easily annoyed, and feeling afraid that something bad might happen (Spitzer et al., 2006). Response options ranged from 0 (not at all) to 3 (nearly every day). Scores (sum of the item responses) could range from 0 to 21. The seven items loaded onto one latent factor and the internal consistency in our sample was high (McDonald's $\omega = 0.91$).

The PHQ-9 and GAD-7 scales were mainly modeled as linear outcomes, with higher summary scores indicating greater depression and anxiety, respectively. Still, we also present main effects for dichotomized the PHQ-9 and GAD-7 scores, where scores of 10 or above were consistent with moderate depression (Manea et al., 2012) and generalized anxiety disorder (Plummer et al., 2016), respectively.

2.3. Greenery assessment

We employed four measures of greenery experienced indoors and outdoors. All measures were self-reported and informed by literature precedent (Markevych et al., 2017; Korpela et al., 2017). The two indoor measures included the number of houseplants (pots/containers) in the home and the proportion of visible exterior from inside the home, through windows or from a terrace/balcony, that contained greenery (trees, green spaces, etc.). Responses for the latter measure were given on an 11-point scale with two verbal anchors (0 = 100% built-up view, 10 = 100% green view). The two outdoor measures included the presence or absence of a domestic garden and the availability of neighborhood greenery, the latter of which was measured in the same way as the visible greenery from inside the home question (0 = 100% built-up neighborhood, 10 = 100% green neighborhood).

2.4. Putative mediator assessment

We specified four a priori mediators. Restorative quality of the home was hypothesized to mediate the effect of greenery experienced indoors on mental health, whereas restorative quality of the neighborhood environment, engagement with greenery and social support were hypothesized to mediate the effect of outdoor greenery on mental health.

From the several aspects of restorative quality of the home, we measured only the concept of "being away" based on findings from previous research on green views from the home (Masoudinejad and Hartig, 2020). To reduce questionnaire length and response burden, we used a single item (Lindal and Hartig 2013, 2015) adapted from the Perceived Restorativeness Scale (PRS, Hartig et al., 1997a; 1997b). The questionnaire instructions were adapted to refer to the home environment (i.e., "At home, the time spent gives me a break from my day-to-day routine and I can get away from the things that usually demand my attention"). Responses were again given on an 11-point scale with two anchors (0 = not at all, 10 = completely).

Both the "being away" and "fascination" dimensions of the PRS operationalized neighborhood restorative quality. We again used single items: "My neighborhood has places where the time spent gives me a break from my day-to-day routine and where I can get away from the things that usually demand my attention." and "My neighborhood has places that are fascinating and where my attention is drawn to many interesting things." (0 = not at all, 10 = completely (Lindal and Hartig 2013; 2015)).

We measured engagement with outdoor greenery using four items regarding the frequency of different types of interaction. These types of interaction included passing by/through greenspace on the way to somewhere, taking a walk near or in greenspace, doing sport in nature/greenspace, and gathering/interacting with other people in greenspace/park. Response options included 0 (never), 1 (several days), 2 (more than half of the days), 3 (every day), or 4 (several times a day) during the past two weeks. The four items loaded onto one factor, which demonstrated high internal consistency (McDonald's $\omega = 0.83$).

Social support was measured with three items, which we reduced from the original Duke-UNC Functional Social Support Questionnaire (Broadhead et al., 1988). Social support was considered a potential mediator after earlier studies (Maas et al., 2009; Fan et al., 2011). Social support items were measured on a 7-point agree-disagree scale and included: "I have people who care what happens to me"; "I have people I can talk to if I have a problem or need an advice"; and "There are people who will help me if I need it". McDonald's ω for this unidimensional scale was 0.88.

2.5. Covariate assessment

We selected a parsimonious set of variables that could confound or modify the associations between greenery and mental health based on previous research findings (Markevych et al., 2017). These variables included socio-demographic characteristics, home characteristics, and other factors.

Socio-demographic characteristics included age, gender, ethnicity, and income. Ethnicity was measured as a binary variable: Bulgarian or not. Income was measured with a single perceived income adequacy item: "Having in mind the total monthly income you can make use of, how easy is it for you to meet your expenses without depriving yourself?" Response options ranged from 0 = very difficult to 5 = very easy.

House-related characteristics and behaviors included four measures. Data on dwelling type (i.e., apartment, house, or hostel), crowding in the household (people-to-rooms ratio), duration of residence, and time spent at home per day were collected.

Several other factors related to health, nature, and geography were measured. Presence of non-communicable chronic physical illness (es) was assessed to control for its potential effects on interaction with outdoor greenery (Labib et al., 2020). Participant's feeling that they are "connected" with nature (Tam, 2013) was measured with the Nature Connection Index (NCI, Richardson et al., 2019) to control for lower or higher levels of "connectedness" impacting the relationship between greenery and mental health (Bakir-Demir et al., 2019; Cleary et al., 2017). The NCI was translated to Bulgarian and included six items answered on a 7-point agree-disagree scale. The NCI was a unidimensional construct with McDonald's ω of 0.92 in our sample.

We did not have information on the exact home address but did collect the settlement where the respondent currently lived. We classified these settlements as cities (>100 000 residents), towns (10 000 to 100 000) or villages (<10 000). Finally, we retrieved data on at which university the respondent studied.

2.6. Analysis

Missing values (<10% on any given variable) were missing completely at random and imputed using the expectation-maximization algorithm (Dempster et al., 1977). All variables in multivariate analysis models were included in the imputation. Inspection of histograms and D'Agostino–Pearson K^2 test revealed that distributions of PHQ-9 and GAD-7 were right skewed. Therefore, these were square-root transformed for analyses.

To probe for general patterns of associations within the data, we employed correlations (Pearson, point-biserial, and phi), Welch's ANOVAs, Fisher's exact tests, and Mood's median tests. Associations between greenery and mental health were tested using generalized linear regression and logistic regression for the continuous and dichotomized PHQ-9 and GAD-7 scores, respectively. Models were adjusted for age, gender, ethnicity, income, dwelling type, settlement type, university, and connectedness to nature. Tolerance values > 0.2 (Menard, 1995) and Variance Inflation Factor values < 5.0 (Rogerson, 2001) indicated no multicollinearity.

Then, we employed structural equation modelling (SEM) to test our hypotheses and the theoretically-indicated interplay between the variables (Fig. 1). Depression and anxiety were modeled as continuous summary scores, whereas neighborhood being away and fascination were assumed to load onto one latent factor (neighborhood restorative quality). We used a maximum likelihood estimator with bootstrap-generated (10 000 samples) confidence intervals and standard errors for all paths (Kelley, 2005; Haukoos and Lewis, 2005; Brown, 2006). Guided by theory and bivariate correlations in the dataset, we specified confounding paths between control variables and core variables in the model. Goodness of fit was evaluated using indices of acceptable model fit provided in Hu and Bentler (1999): a non-significant χ^2 ($p > 0.05$); a root mean square error of approximation (RMSEA) ≤ 0.06 with a 90% CI ≤ 0.06; a standardized root mean square residual (SRMSR) ≤ 0.08; and a comparative fit index (CFI) ≥ 0.95. We also used the parsimonious normed-fit index (PNFI), which compensates for the increase in fit in more complex models (Mulaik et al., 1989). Standardized residuals and modification indices were inspected to identify localized points of ill fit

Table 1
Participant characteristics (N = 323).

Characteristic	N (%)	Mean (SD)	Median (IQR)	Range
Socio-demographics				
Age (yrs)		21.99 (3.10)	21.00 (3.00)	18.00–35.00
Male	100 (31.0)			
Ethnicity (Bulgarian)	281 (87.0)			
Income		3.24 (1.11)	3.00 (1.00)	0.00–5.00
Mental health				
Depressive symptoms		9.01 (5.78)	8.00 (8.00)	0.00–25.00
Anxiety symptoms		5.00 (5.21)	5.00 (8.00)	0.00–21.00
Depression (PHQ-9 $\geq$ 10)	112 (34.7)			
Anxiety (GAD-7 $\geq$ 10)	70 (21.7)			
Greenery				
Houseplants (number)		10.91 (9.51)	10.00 (16.00)	0.00–42.00
Domestic garden	152 (47.1)			
Green view		6.34 (2.62)	7.00 (4.00)	1.00–10.00
Neighborhood greenery		6.64 (2.15)	7.00 (3.00)	1.00–10.00
Putative mediators				
Being away (home)		5.50 (3.28)	5.00 (5.00)	0.00–10.00
Being away (neighborhood)		5.70 (3.21)	5.00 (6.00)	0.00–10.00
Fascination (neighborhood)		4.31 (3.02)	4.00 (5.00)	0.00–10.00
Engagement w/ greenery		5.95 (3.51)	6.00 (6.00)	0.00–16.00
Social support		15.03 (3.78)	16.00 (4.00)	0.00–18.00
Home characteristics/behaviors				
Dwelling type				
Apartment	191 (59.1)			
House	120 (37.2)			
Hostel	12 (3.7)			
Duration of residence (yrs)		12.43 (8.38)	14.00 (16.00)	0.50–32.00
Time at home (hrs/day)		20.03 (3.09)	20.00 (4.50)	7.50–24.00
Crowding (people/rooms)		1.08 (0.52)	1.00 (0.58)	0.17–5.00
Other factors				
Chronic disease	29 (9.0)			
Connectedness to nature		36.17 (5.94)	37.00 (8.00)	7.00–42.00
Settlement type				
City	160 (49.5)			
Town	136 (42.1)			
Village	27 (8.4)			
University				
Med. Univ.-Plovdiv	241 (74.6)			
Plovdiv University	82 (25.4)			

Note: IQR = interquartile range; GAD-7 = General Anxiety Disorder-7; PHQ-9 = Patient Health Questionnaire-9; SD = standard deviation.

in the initial solution (M0), after which the model was re-specified. This was done when the suggested model re-specification was justified by theory. Confounding paths with at least marginal statistical significance ($p < 0.1$) were retained in the final solution. An indirect effect (i.e., a product of coefficients for the constituent links) that significantly exceeded zero was evidence of mediation (Zhao et al., 2010; Hayes, 2013). While we use terminology accepted in mediation modeling to denote the overall (total effect), direct (direct effect), and indirect (indirect effect) relationships in the SEM, the word "effect" should not be taken to indicate claims of causality.

Multiplicative interaction terms were constructed to investigate possible effect modification of the total effect of greenery on mental health by each covariate. Gender, income, dwelling type, crowding in the household, duration of residence, time spent at home per day, connectedness to nature, and social support were tested as modifiers. Criterion for statistical consideration was relaxed to $p < 0.1$ (i.e., Type I error rate of 10%) to report relevant effect modification that might otherwise remain undetected (Selvin, 1996; Greenland and Rothman, 1998; Marshall, 2007.).

Then we tested competing models nested in the full SEM model (M1). We wanted to see whether having greenery experienced indoors and/or outdoors improved model fit. Hence, we tested a reduced model that fixed the regression pathways from Houseplants and Green View to Being away and Depression/Anxiety to zero (M2). Next, we tested another reduced model with the paths from Garden and Neighborhood Greenery to Restorative quality and Depression/Anxiety fixed to zero (M3). Since there was overlap between Garden and Dwelling type—that is, 98% of houses had a garden whereas 14% of apartments and 67% of hostels had one—another nested model had the pathways from Dwelling type to other variables fixed to zero (M4). In another nested model (M5), we fixed to zero the paths to and from the mediators Being away and Social support to see whether the serial mediation components contributed to the model.

We were also concerned that participant's mental health status could have affected their willingness to take care for indoor plants (i.e., reverse causality) (cf. Korpela et al., 2017). Therefore, we fitted two separate non-recursive models with a bidirectional relationship between Houseplants and Depression (M6) and Anxiety (M7), respectively. We followed analytic considerations raised by Wong and Law (1999), specifying reciprocal paths between the variables and a covariance link between their error variances. The stronger predictor was determined based on statistical significance and strength of the two-way relationships. Performance of competing models against the main model was evaluated on the basis of a chi-square difference test, Akaike information criterion (AIC) and Bayesian information criterion (BIC); the model with the lower χ^2 (in case of significant difference), AIC and BIC values was considered better fitting (Kenny et al., 2006; Werner et al., 2010).

Data were processed with SPSS and Amos v. 23. A p-value of <0.05 was considered statistically significant except as noted above.

3. Results

3.1. Descriptive analyses

Out of the 328 respondents, we excluded five because they did not finish the questionnaire. This left us with an analysis sample of 323 unique respondents. Participant characteristics are shown in Table 1. The majority of participants were female, Bulgarian and in their late teens or early twenties. The majority were long-time dwellers in an apartment building or a detached house. Most resided in a city/town, with 137 spending the quarantine in Plovdiv. On average, they spent 20 h/day at home (See Supplemental Fig. S1 for the distribution of this variable). Approximately 33% of the participants reported symptom scores indicating moderate depression and 20% reported scores indicating moderate anxiety.

In terms of greenery, participants reported having 10 houseplants on average and half of participants reported having a garden. Participants rated both their view and their neighborhood as moderately green, on average. The restorative quality of the home and neighborhood was moderate. As expected during the COVID-19 pandemic, engagement with outdoor greenery was infrequent, especially in the form of sport or social interaction (See Supplemental Fig. S2).

Bivariate associations between the variables are given in Supplemental Table S1 and Table S2. Depressive and anxiety symptoms were more common in students who were older, female, an ethnic minority or lower-income as well as students who spent more time at home or experienced less social support. Greenery measures, except for the presence of a garden, as well as the feelings of being away and fascination and connectedness to nature were associated with better mental health. Greenery measures were also correlated with each other, the feelings of being away and fascination, settlement type, and dwelling type.

3.2. Total association between greenery, putative mediators and mental health

As a next step, we investigated the main associations between mental health and greenery, engagement with greenery, and the feeling of being away (Table 2). In linear models, greenery was generally associated with lower depressive and anxiety symptoms or clinically-meaningful levels of depression and anxiety. However, the estimates were marginally significant for Houseplants → Anxiety Symptoms and not significant for Houseplants → Anxiety. Neither were estimates significant for the presence of a garden predicting three of the four mental health outcomes. The feelings of being away and fascination, engagement with greenery and social support were inversely associated with both continuous and dichotomized depressive/anxiety symptoms.

3.3. Structural equation modeling

In the SEM, the initial model (M0) had a poor fit to the data: $\chi^2_{(99)} = 353.60$, $p < 0.001$; CFI = 0.87; RMSEA = 0.07 (90% CI: 0.06, 0.08); SRMR = 0.08; PNFI = 0.55. As explained in the Methods, we followed an iterative process of removing non-significant confounding path and adding paths or covariance links indicated by high modification indices. Comparison between the initial and final model structures is shown in Supplemental Fig. S3.

The final model, which we will call the Main model (M1), had an acceptable fit to the data: $\chi^2_{(135)} = 204.93$, $p < 0.001$; CFI = 0.96; RMSEA = 0.04 (90% CI: 0.03, 0.05); SRMR = 0.06; PNFI = 0.63. This model is shown in Fig. 2 (see Supplemental Table S3 for all direct effect estimates). Overall, M1 explained 30% of the variance in depressive symptoms and 24% in anxiety symptoms. As shown in Table 3, significant total effects were observed for Houseplants on Depressive symptoms and Neighborhood greenery on both Depressive and Anxiety symptoms. However, both greenery experienced indoors and outdoors were associated with depressive and anxiety symptoms indirectly. That is, having more houseplants and a greener view were associated with perceptions of being away, and in turn, with better mental health. At the same time, living in a greener neighborhood led to perceptions of higher restorative quality, which in turn led to greater social support, and in turn to better mental health. Another pathway from neighborhood greenery involved higher restorative quality, then more frequent engagement with outdoor greenery, and thus, less depressive symptoms. Having a garden was not associated with mental health either directly or indirectly.

3.4. Sensitivity analyses

Tests of potential effect modifiers revealed that these findings were mostly robust across levels of gender, income, crowding in the household, duration of residence, and social support (See Supplemental Tables S4 and S5). The few significant interactions suggested that the presence of a garden was associated with lower depressive symptoms for participants with higher levels of connectedness to nature. Also, houseplants were associated with lower anxiety symptoms only for respondents who spent more time at home. Green view was associated with lower anxiety in those living in an apartment and those with lower connectedness to nature.

Supplemental Table S6 shows comparisons of model fit indices for six alternative structural models (M2-M7) as well as the Main model (M1). Model M2-5 displayed worse fit than M1 according to a significant increase in the chi-square and higher AIC and BIC indices. There was no improvement in model fit for the non-recursive models (M6 and M7) with the addition of bidirectional paths between Houseplants and Depressive/Anxiety symptoms. None of the reciprocal paths in those

Table 2
Associations between greenery experienced indoors and outdoors and putative mediators and mental health.

Greenery/mediators	Depressive symptoms[a]		Anxiety symptoms[a]		Depression (PHQ-9 ≥ 10)		Anxiety (GAD-7 ≥ 10)	
	B (95% CI)	p-value	B (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value
Houseplants	−0.02 (−0.04, −0.01)	<0.001	−0.04 (−0.03, 0.00)	0.054	0.97 (0.94, 0.99)	0.037	1.00 (0.96, 1.03)	0.852
Green view	−0.06 (−0.11, −0.02)	0.002	−0.05 (−0.10, −0.003)	0.038	0.88 (0.80, 0.98)	0.014	0.83 (0.74, 0.92)	0.001
Garden	−0.27 (−0.61, 0.08)	0.132	−0.47 (−0.89, −0.06)	0.025	0.44 (0.17,1.13)	0.088	0.51 (0.18, 1.46)	0.208
Neighborhood greenery	−0.10 (−0.14, −0.05)	<0.001	−0.11 (−0.16, −0.05)	<0.001	0.79 (0.70, 0.89)	<0.001	0.80 (0.70, 0.91)	0.001
Engagement	−0.07 (−0.10, −0.04)	<0.001	−0.07 (−0.11, −0.04)	<0.001	0.82 (0.76, 0.89)	<0.001	0.87 (0.79, 0.95)	0.002
Being away (home)	−0.09 (−0.12, −0.06)	<0.001	−0.10 (−0.14, −0.06)	<0.001	0.85 (0.79, 0.93)	<0.001	0.83 (0.76, 0.91)	<0.001
Being away (neigh.)	−0.09 (−0.12, −0.06)	<0.001	−0.09 (−0.13, −0.05)	<0.001	0.83 (0.77, 0.91)	<0.001	0.85 (0.77, 0.93)	<0.001
Fascination (neigh.)	−0.08 (−0.12, −0.05)	<0.001	−0.08 (−0.13, −0.04)	<0.001	0.80 (0.72, 0.88)	<0.001	0.84 (0.75, 0.93)	0.001
Social support	−0.08 (−0.11, −0.05)	<0.001	−0.11 (−0.14, −0.07)	<0.001	0.85 (0.79, 0.92)	<0.001	0.83 (0.76, 0.89)	<0.001

Note: GAD-7 = General Anxiety Disorder-7; PHQ-9 = Patient Health Questionnaire-9. Separate models are fitted for each of the greenery metrics/mediators. Models are adjusted for age, gender, ethnicity, income, dwelling type, settlement type, university, and connectedness to nature. Coefficients are unstandardized linear regression coefficients (B) or odds ratios (OR) with 95% confidence intervals (CI) and significance (p-values) reported and shown in bold text.

[a] Variable is square root-transformed.

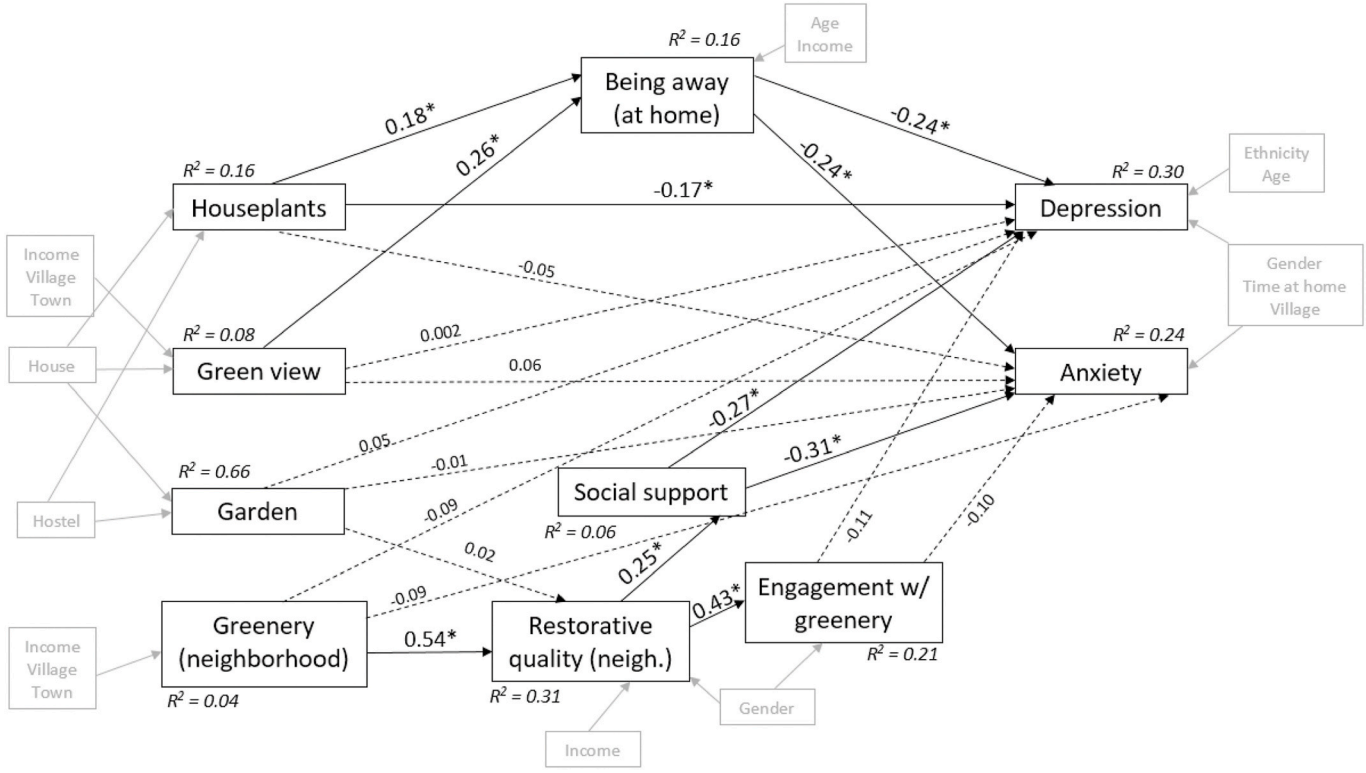

Fig. 2. Structural equation model showing the estimated paths linking greenery to mediators and depressive/anxiety symptoms. Note: Standardized regression weights with their significance level are given for each path. R^2 shows proportion of variance explained in endogenous variables. Coefficients marked with an asterisk (*) are statistically significant at $p < 0.05$. Control variables are shown in grey. Covariances and errors terms are not displayed to enhance readability.

models was significant (data not shown).

4. Discussion

4.1. General findings

In the present study, the mental health of homebound young adults during the COVID-19 pandemic was better if greenery was present. Specifically, the relative abundance of plants/greenery visible from windows/terraces/balconies or in the neighborhood was associated with reduced depressive/anxiety symptoms and lower rates of clinically-meaningful depression/anxiety levels. Having more houseplants or having a garden was also associated with some of these markers of mental health. As hypothesized, the mental health-supportive effects of greenery experienced indoors were largely explained by feelings of being away while at home, and the effects of outdoor greenery were largely explained by restorative quality and social support working together. However, despite the limited time spent outdoors, both indoor and outdoor experience of greenery seemed important.

Our findings are in line with literature precedent on the subject (Gascon et al., 2015; Jo et al., 2019; Han and Ruan, 2019; Hall and Knuth, 2019; Dzhambov et al., 2020; Callaghan et al., 2020; Pouso et al., 2020). Earlier studies in Plovdiv have shown that living in a greener neighborhood, closer to a green space, spending more time in greenery and having a green view were associated with better general mental health of students (Dzhambov et al., 2018a). We also corroborate mechanistic evidence that restorative quality, as measured here by feelings of being away and fascination, mediates the effect of greenery on mental well-being (e.g., Hipp et al., 2016; Dzhambov et al., 2018a; Dzhambov et al., 2019; Gulwadi et al., 2019). However, some studies found that while the presence of indoor plants led to greater restorative quality (perceived fascination), plants did not have superior restorative effects compared with inanimate objects (Evensen et al., 2015). It is assumed that natural environments enable restorative processes more readily than other environments owing to the relative absence of attentional demands and presence of engaging features which evoke "soft'' fascination (Kaplan and Kaplan, 1989; Hartig, 2004). In turn, that can promote social interaction and feelings of social support (Dzhambov et al., 2018a). Earlier studies have also found that lack of social support partially mediated the association between green space and mental health indicators (Maas et al., 2009; Fan et al., 2011). Previously, restorative quality of the neighborhood has been in the spotlight of greenery-health research (Dzhambov et al., 2020). In our case, the unusual circumstances of the COVID-19 pandemic led to activities at home (i.e., attending university entirely online) that may not have been direct sources of stress but still reduced the restoration potential of the home environment. Notwithstanding, our results suggest that greenery contributed to higher perceived capacity of the home and neighborhood to confer psychological distance from mental routines and demands. In addition to restoring depleted capacities, outdoor natural settings are conducive to building new adaptive social resources needed to resist stress (Markevych et al., 2017).

Comparing alternative nested models, we found that both greenery experienced indoors and outdoors were important. In fact, removing the effects of either of the two form of experience of greenery worsened the model fit. Against this background, we propose that having more houseplants and living in a greener neighborhood might partially offset the constrained restoration opportunities resulting from the restrictive measures imposed as part of the COVID-19 lockdown. It follows that keeping parks and green infrastructure accessible may confer mental health benefits in times of social isolation (Slater et al., 2020) despite few documented cases of epidemiologic risk in outdoor greens spaces (Weed and Foad, 2020). Therefore, populations without ready access to safe outdoor greenspaces – such as marginalized low-socioeconomic or ethno-racial minorities in many parts of the Global North (Astell-Burt et al., 2014; Gerrish and Watkins, 2018; Rigolon et al., 2018) and even

Table 3
Effects of greenery and mediators on mental health in the structural equation model.

Greenery/mediators	Depressive symptoms[a]		Anxiety symptoms[a]	
	β (95% CI)	p-value	B (95% CI)	p-value
Total effects				
Houseplants	−0.02 (−0.03, −0.01)	<0.001	−0.01 (−0.03, 0.001)	0.071
Green view	−0.02 (−0.07, 0.02)	0.349	0.00 (−0.06, 0.06)	0.972
Garden	0.09 (−0.12, 0.30)	0.412	−0.04 (−0.29, 0.23)	0.795
Neighborhood greenery	−0.07 (−0.12, −0.01)	0.016	−0.09 (−0.15, −0.02)	0.012
Engagement w/ greenery	−0.03 (−0.07, 0.001)	0.057	−0.04 (−0.08, 0.01)	0.085
Being away (home)	−0.07 (−0.11, −0.04)	<0.001	−0.09 (−0.12, −0.05)	<0.001
Restorative quality (neighborhood)	−0.04 (−0.07, −0.02)	<0.001	−0.05 (−0.08, −0.02)	<0.001
Social support	−0.07 (−0.10, −0.04)	<0.001	−0.09 (−0.12, −0.07)	<0.001
Indirect effects				
Houseplants → Being away	−0.004 (−0.01, −0.002)	<0.001	−0.005 (−0.01, −0.002)	<0.001
Green view → Being away	−0.02 (−0.04, −0.01)	<0.001	−0.03 (−0.05, −0.01)	<0.001
Garden → Restorative quality → Engagement	−0.002 (−0.02, 0.01)	0.593	−0.002 (−0.02, 0.01)	0.572
Garden → Restorative quality → Social support	−0.002 (−0.02, 0.01)	0.709	−0.003 (−0.03, 0.02)	0.718
Neighborhood greenery → Restorative quality → Engagement w/ greenery	−0.01 (−0.03, 0.00)	0.047	−0.01 (−0.03, 0.001)	0.075
Neighborhood greenery → Restorative quality → Social support	−0.02 (−0.03, −0.01)	<0.001	−0.02 (−0.04, −0.01)	<0.001

Coefficients are unstandardized linear regression coefficients (β) with their 95% confidence intervals (CI).
[a] The variable is square root-transformed.

some cities in the Global South (Rigolon et al., 2018) – may benefit most from initiatives to increase greenery experienced indoors. Further, these populations are at high risk of COVID-19 infection and mortality, given lifestyle and employment characteristics (Selden and Berdahl, 2020); thus, such promising interventions to reduce psychological impacts without increasing physical health concerns may be extremely valuable.

We are not aware of other studies concerning this specific context of greenery impacts on mental health for housebound university students. Closest to this situation is probably research on hospitalized patients and other institutionalized residents. This research indicates that staying in a hospital room with plants or having a view of green landscapes engenders relaxation, reduced anxiety and fatigue, and ultimately faster recovery after surgical interventions (Ulrich, 1984; Park and Mattson, 2009; Aslam et al., 2016). The same goes for prisoners visually exposed to nature sceneries. They report improved affective state and restoration when shown videos of natural settings (Nadkarni et al., 2017; Moran, 2019).

Recent reports indicate increased interest in home gardening during the COVID-19 pandemic and positive effects on mood (Carvalho and Gois, 2020; Lades et al., 2020). Yet, in our study, the presence of a garden was only weakly associated with mental health (cf. Soga et al., 2016; Dennis and James, 2017; de Bell et al., 2020). For comparison, one study in older people living in residential care facilities, who spent a considerable part of their time indoors, found that garden greenery was associated with better self-rated health through an enhanced sense of being away. In turn, this afforded possibilities to experience the outdoor environment as an interest-provoking place, which encouraged visitation (Dahlkvist et al., 2016). Likewise, horticulture programs appear beneficial to inmate's mental health (Farrier et al., 2019). However, the majority of the students in our study were in their late teens and early twenties—a period in one's life when gardening is not a common leisure occupation especially in urban areas. Therefore, it could also be that the effect of having a domestic garden was reflected in the other greenery indicators or that the question students were asked was not specific enough to account for garden characteristics (e.g., green vs. paved area). Another explanation for this could be that the presence of a garden overlapped with other factors such as dwelling type, which alone explained 65% of the variance in garden. Sensitivity analyses did not support this conjecture though.

We found evidence of effect modification by rather few contextual factors. Houseplants were associated with lower anxiety only in students spending more time at home. Interestingly, green view related to lower depression and anxiety only in apartment dwellers. Since we did not have information on the apartment's floor, we could not determine whether this was due to the broader viewshed from taller apartment buildings. It is also plausible that because students living in houses had considerably higher exposure to greenery (see Supplemental Table S2), the impact of green view was diluted, whereas in apartment dwellers, its relative importance became more obvious. Regarding effect modification by connectedness to nature, results were inconclusive. While domestic garden was associated with lower depression in students reporting high connectedness, green view was associated with lower anxiety in students reporting low connectedness. We suspect that this inconsistency could either be a statistical artefact or due to a more complex interaction between connectedness to nature and other contextual or behavioral factors, which we could not model.

Overall, our findings support the idea that exposure to greenery and ensuing restorative experiences both at home and outdoors may be valuable resources during physical isolation. A restorative environment may support adaptation by compensating the lack of coping resources, such as social connections (Cartwright et al., 2018), or by contributing to personal or dyad coping resources (i.e., physiological, social, emotional and attention restoration) (Berto, 2014; Von Lindern et al., 2017; Hartig, n.d.).

4.2. Strengths and limitations

The present study has a number of strengths. We could take advantage of an unprecedented situation when people were largely confined to their homes and therefore primarily experiencing greenery indoors. This limited mobility considerably reduced exposure misclassification, which is a common issue when static exposure assessment is employed as was done here (Helbich, 2018, 2019). To partially overcome this bias, we considered multiple greenery indicators that reflected different aspects of exposure, including visual engagement in different settings and usage of green spaces for walks, sport and social interaction. Furthermore, we accounted for multiple contextual factors (i.e., income, housing type, and connectedness to nature), which could have confounded or modified the effects of greenery on mental health. We also investigated the role of both indoor and outdoor restorative experiences.

Regarding the generalizability of our sample's psychological state, respondents demonstrated heightened levels of anxiety and depression akin to other studies during the COVID-19 pandemic. A recent study of 7143 students in Hubei Province, China found 24.9% with anxiety (Cao et al., 2020). In our study, 21.7% of our respondents reported anxiety, whereas 10% or fewer respondents in surveys of general populations typically meet the thresholds for anxiety using the GAD screening battery (Plummer et al., 2016). Another recent study with 24 379 Chinese

young residents (age M = 19.9, SD = 1.6) found 14.8% with depression (Xin et al., 2020) whereas we observed 34.7% with depression, which also exceeds the prevalence of depression in many earlier studies using the PHQ (Manea et al., 2012). Collectively, these studies demonstrate a unifying force of the pandemic on the mental health of residents globally—one which some environmental exposures might protect against.

Several limitations should also be noted. For one, our sample size was modest; therefore, our models could have lacked sufficient power to detect other potentially important pathways. This was implied by several marginally significant path estimates. Next, findings for our convenience sample of students cannot be generalized to all youth experiencing mental health challenges during the COVID-19 epidemic. Moreover, an actual response rate could not be calculated given that students were also allowed to forward the survey link to their peers.

The cross-sectional design prevents us from making causal claims about the associations observed. While we statistically investigated possible reverse causation in the SEM by comparing alternative structural models, we only focused on a subset of potentially bidirectional pathways. Thus, it is conceivable that participant's mental health influenced perception of greenery because depressed individuals oftentimes pay little attention to their surroundings (Keller et al., 2019) and have deficits in memory for spatial context (Lamy et al., 2008). Likewise, affective state can determine engagement with greenery rather than be an outcome of it (Korpela et al., 2017). A more stringent approach would have been to use repeated measurements during and after the COVID-19 lockdown to see how the importance of different types of greenery would change over time. Further, more than half of students returned to their family home outside of Plovdiv which could have improved their mental health due to family support.

Because of privacy concerns and our desire to elicit honest answers to questions about behaviors inconsistent with the official stay-at-home orders (e.g., visiting green spaces), all data collected were anonymized. Because of that, residential addresses were unknown and we could not calculate georeferenced greenery indicators (i.e., normalized difference vegetation index, NDVI). While perceptual measures accurately capture first-person experiences of the individual's surround environment, we acknowledge that having self-reported data for both exposure and outcome variables may have engendered same-source bias (Chum et al., 2019). In an attempt to not alarm the students, we deliberately refrained from asking coronavirus-related questions. Therefore, we could not directly test the stress-buffering effect of greenery.

Relatedly, we collected no data on the specific green view features (e.g., coherence, complexity), which may be more important predictors of well-being than the overall amount of green in the view (van Esch et al., 2019; Lavdas and Schirpke, 2020). Likewise, we only considered the number of indoor plants rather than multisensory modalities, which regulate people's preferences (Qin et al., 2014), their potential to induce relaxation (Choi et al., 2016), and other myriad effects that may relate to their mental health benefits, such as climate control and indoor air pollutants (Armijos Moya et al., 2018). We did not have data on exposure to blue spaces, which may confer similar health benefits (e.g., Pasanen et al., 2019; Pouso et al., 2020).

Further, we acknowledge that for different students the extent of greenness of their garden/yard could vary. Moreover, students who lived in hostels or apartment buildings had access to a shared garden in front of the building, that is gathering places that were not entirely private or used by a single family. Taken together, the unknown degree of greenery and perceived safety of the garden might explain why it did not show strong associations with mental health on its own.

While we observed potentially protective effects of greenery, the clinical importance of this finding is difficult to judge. We had to rely on screening tools rather than psychiatric diagnoses. When we used dichotomized definitions of the outcomes, one-unit increase in neighborhood greenery, on a scale from 0 to 10, surprisingly led to 20% lower odds of moderate depression and anxiety. However, the greenery variables did not contribute much to the proportion of variance explained in continuously-measured depressive and anxiety symptoms and their effect sizes were rather small. Unfortunately, we did not have sufficient statistical power to model depressive and anxiety symptoms as dichotomized outcomes in the SEM, which could have revealed a different picture if the mean and right ends of their distribution were differentially associated with greenery.

Finally, we had no information on other variables that may have confounded or moderated associations between greenery and mental health. In particular, being married (Crouse et al., 2017) and higher cumulative life stressors (i.e., adverse childhood experiences) (Olvera Alvarez et al., 2020) may increase the protective effects of outdoor residential greenery on health. Students with pre-existing mental illness diagnoses or risk factors (i.e., social stressors) may also have shown stronger effects from greenery, since some evidence suggests restorative environments provides an equigenic effect whereby populations in greatest need benefit most (Mitchell et al., 2015).

5. Conclusions

Students who spent most of their time at home during the COVID-19 epidemic experienced better mental health when exposed to higher greenery. Experiencing greenery both indoors and outdoors was associated with lower depressive and anxiety symptoms. Houseplants and window view of exterior greenery led to higher perceived restorative quality of the home, and in turn to lower depressive/anxiety symptoms. Neighborhood greenery worked through perceptions of higher neighborhood restorative quality, which in turn facilitated social support and more frequent engagement with greenery. Our findings support the idea that exposure to greenery may be a valuable resource during social isolation in the home. However, causal interpretation of these associations is not straightforward.

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.

Acknowledgements

We are grateful to our colleagues from Medical University of Plovdiv and University of Plovdiv "Paisii Hilendarski" who facilitated data collection and to participating students for making this study possible.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.envres.2020.110420.

References

Adamson, K., Thatcher, A., 2019. Do indoor plants improve performance outcomes?: using the attention restoration theory. In: Bagnara, S., Tartaglia, R., Albolino, S., Alexander, T., Fujita, Y. (Eds.), Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018). IEA 2018. Advances in Intelligent Systems and Computing, vol. 825. Springer, Cham.

Akpinar, A., Barbosa-Leiker, C., Brooks, K.R., 2016. Does green space matter? Exploring relationships between green space type and health indicators. Urban For. Urban Green. 20, 407–418. https://doi.org/10.1016/j.ufug.2016.10.013.

Annerstedt, M., Währborg, P., 2011. Nature-assisted therapy: systematic review of controlled and observational studies. Scand. J. Publ. Health 39 (4), 371–388. https://doi.org/10.1177/1403494810396400.

Armijos Moya, T., van den Dobbelsteen, A., Ottelé, M., Bluyssen, P.M., 2018. A review of green systems within the indoor environment. Indoor Built Environ. https://doi.org/10.1177/1420326X18783042.

Aslam, A., Shaheen, I., Afzal, N., Ain, Q-ul, Qasim, M., Zaman, F., Hussain, S., Hussain, S., 2016. Effect of hospital landscaping on the health and recovery of patients. Advance in Agriculture and Biology 5 (4), 86–88.

Astell-Burt, T., Feng, X., Mavoa, S., Badland, H.M., Giles-Corti, B., 2014. Do low-income neighbourhoods have the least green space? A cross-sectional study of Australia's

most populous cities. BMC Publ. Health 14, 292. https://doi.org/10.1186/1471-2458-14-292.
Bakir-Demir, T., Berument, S.K., Sahin-Acar, B., 2019. The relationship between greenery and self-regulation of children: the mediation role of nature connectedness. J. Environ. Psychol. 65, 101327. https://doi.org/10.1016/j.jenvp.2019.101327.
Benfield, J.A., Rainbolt, G.N., Bell, P.A., Donovan, G.H., 2015. Classrooms with nature views: evidence of differing student perceptions and behaviors. Environ. Behav. 47, 140–157. https://doi.org/10.1177/0013916513499583.
Berto, R., 2014. The role of nature in coping with psycho-physiological stress: a literature review on restorativeness. Behav. Sci. 4 (4), 394–409. https://doi.org/10.3390/bs4040394.
Brindley, P., Jorgensen, A., Maheswaran, R., 2018. Domestic gardens and self-reported health: a national population study. Int. J. Health Geogr. 17 (1), 31. https://doi.org/10.1186/s12942-018-0148-6.
Bringslimark, T., Hartig, T., Patil, G.G., 2007. Psychological benefits of indoor plants in workplaces: putting experimental results into context. Hortscience 42 (3), 581–587. https://doi.org/10.21273/HORTSCI.42.3.581.
Bringslimark, T., Hartig, T., Patil, G.G., 2009. The psychological benefits of indoor plants: a critical review of the experimental literature. J. Environ. Psychol. 29 (4), 422–433. https://doi.org/10.1016/j.jenvp.2009.05.001.
Broadhead, W.E., Gehlbach, S.H., de Gruy, F.V., Kaplan, B.H., 1988. The Duke-UNC Functional Social Support Questionnaire. Measurement of social support in family medicine patients. Med. Care 26 (7), 709–723. https://doi.org/10.1097/00005650-198807000-00006.
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 (10227), 912–920. https://doi.org/10.1016/S0140-6736(20)30460-8. Epub 2020 Feb 26. PMID: 32112714; PMCID: PMC7158942.
Brown, T., 2006. Confirmatory Factor Analysis for Applied Research. Guilford Press, New York, NY.
Browning, M., Shipley, N.J., Becker, D.A., Hartig, T., Yu, C.-P., McAnirlin, O., et al., 2020. An actual natural setting improves mood better than its virtual counterpart: a meta-analysis of experimental data. Front. Psychol. https://doi.org/10.3389/fpsyg.2020.02200. ….
Bulplan, O.O.D., 2015. Concept of Spatial Development of Plovdiv Municipality 2015-2025: A Brief Report. Sofia-Plvdiv. Available at: http://plovdiv.bulplan.eu/_docs/KPRO_PLOVDIV_RESUME.pdf. (Accessed 27 October 2020).
Callaghan, A., McCombe, G., Harrold, A., McMeel, C., Mills, G., Moore-Cherry, N., Cullen, W., 2020. The impact of green spaces on mental health in urban settings: a scoping review. J. Ment. Health 1–15. https://doi.org/10.1080/09638237.2020.1755027. Epub ahead of print. PMID: 32310728.
Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., Zheng, J., 2020 May. The psychological impact of the COVID-19 epidemic on college students in China. Psychiatr. Res. 287, 112934. https://doi.org/10.1016/j.psychres.2020.112934. Epub 2020 Mar 20. PMID: 32229390; PMCID: PMC7102633.
Cartwright, B.D.S., White, M.P., Clitherow, T.J., 2018. Nearby nature 'buffers' the effect of low social connectedness on adult subjective wellbeing over the last 7 days. Int. J. Environ. Res. Publ. Health 15 (6), 238. https://doi.org/10.3390/ijerph15061238.
Carvalho, V.O., Gois, C.O., 2020. COVID-19 pandemic and home-based physical activity. J Allergy Clin Immunol Pract S2213–2198 (20), 30510-9. https://doi.org/10.1016/j.jaip.2020.05.018. Epub ahead of print. PMID: 32470443; PMCID: PMC7250754.
Cervinka R, Schwab M, Schönbauer R, Hämmerle I, Pirgie L, Sudkamp J. My Garden – My Mate? Perceived Restorativeness of Private Gardens and Its Predictors. Urban For. Urban Green. 16: 182–187. https://doi.org/10.1016/j.ufug.2016.01.013.
Chang, C.-Y., Chen, P.-K., 2005. Human response to window views and indoor plants in the workplace. Hortscience 40 (5), 1354–1359.
Chang, C.-C., Oh, R.R.Y., Nghiem, T.P.L., Zhang, Y., Tan, C.L.Y., Lin, B.B., et al., 2020. Life satisfaction linked to the diversity of nature experiences and nature views from the window. Landsc. Urban Plann. 202, 103874–103878. https://doi.org/10.1016/j.landurbplan.2020.103874.
Choi, J.Y., Park, S.A., Jung, S.J., Lee, J.Y., Son, K.C., An, Y.J., Lee, S.W., 2016 Oct. Physiological and psychological responses of humans to the index of greenness of an interior space. Compl. Ther. Med. 28, 37–43. https://doi.org/10.1016/j.ctim.2016.08.002. Epub 2016 Aug 5. PMID: 27670868.
Chum, A., O'Campo, P., Lachaud, J., Fink, N., Kirst, M., Nisenbaum, R., 2019 Oct. Evaluating same-source bias in the association between neighbourhood characteristics and depression in a community sample from Toronto, Canada. Soc. Psychiatr. Psychiatr. Epidemiol. 54 (10), 1177–1187. https://doi.org/10.1007/s00127-019-01718-6. Epub 2019 May 3. PMID: 31054019.
Cleary, A., Fielding, K.S., Bell, S.L., Murray, Z., Roiko, A., 2017. Exploring potential mechanisms involved in the relationship between eudaimonic wellbeing and nature connection. Landsc. Urban Plann. 158, 119–128. https://doi.org/10.1016/j.landurbplan.2016.10.003.
Crouse, D., Pinault, L., Balram, A., Hystad, P., Peters, P.A., Chen, H., et al., 2017. Urban greenness and mortality in Canada's largest cities: a national cohort study. Lancet Planetary Health 1, e289–e297. https://doi.org/10.1016/S2542-5196(17)30118-3.
Dahlkvist, E., Hartig, T., Nilsson, A., Högberg, H., Skovdahl, K., Engström, M., 2016. Garden greenery and the health of older people in residential care facilities: a multi-level cross-sectional study. J. Adv. Nurs. 72, 2065–2076.
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 Plann. 200, 103836. https://doi.org/10.1016/j.landurbplan.2020.103836.
Dempster, A.P., Laird, N.M., Rubin, D.B., 1977. Maximum likelihood estimation from incomplete data via the EM algorithm (with discussion). J Royal Stat Assoc B39, 1–38.
Dennis, M., James, P., 2017. Evaluating the relative influence on population health of domestic gardens and green space along a rural-urban gradient. Landsc. Urban Plann. 157, 343–351. https://doi.org/10.1016/j.landurbplan.2016.08.009.
Dunn, T.J., Baguley, T., Brunsden, V., 2014. From alpha to omega: a practical solution to the pervasive problem of internal consistency estimation. Br. J. Psychol. 105, 399–412. https://doi.org/10.1111/bjop.12046.
Dzhambov, A., Hartig, T., Markevych, I., Tilov, B., Dimitrova, D., 2018a. Urban residential greenspace and mental health in youth: different approaches to testing multiple pathways yield different conclusions. Environ. Res. 160, 47–59.
Dzhambov, A.M., Hartig, T., Tilov, B., Atanasova, V., Makakova, D.R., Dimitrova, D.D., 2019 Nov. Residential greenspace is associated with mental health via intertwined capacity-building and capacity-restoring pathways. Environ. Res. 178, 108708. https://doi.org/10.1016/j.envres.2019.108708. Epub 2019 Aug 28. PMID: 31526908.
Dzhambov, A.M., Browning, M.H.E.M., Markevych, I., Hartig, T., Lercher, P., 2020. Analytical approaches to testing pathways linking greenspace to health: a scoping review of the empirical literature. Environ. Res. 186, 109613. https://doi.org/10.1016/j.envres.2020.109613.
Evensen, K.H., Raanaas, R.K., Hagerhall, C.M., Johansson, M., Patil Grete, G., 2015. Restorative elements at the computer workstation: a comparison of live plants and inanimate objects with and without window view. Environ. Behav. 47 (3), 288–303. https://doi.org/10.1177/0013916513499584.
Fan, Y, Das, KV, Chen, Q, 2011. Neighborhood green, social support, physical activity, and stress: assessing the cumulative impact. Health Place 17 (6), 1202–1211. https://doi.org/10.1016/j.healthplace.2011.08.008.
Farrier, A., Baybutt, M., Dooris, M., 2019. Mental health and wellbeing benefits from a prisons horticultural programme. Int. J. Prison. Health 15 (1), 91–104. https://doi.org/10.1108/IJPH-11-2017-0055.
Fjeld, T., 2000. The effect of interior planting on health and discomfort among workers and school children. HortTechnology 10, 46–52.
Gascon, M., Triguero-Mas, M., Martínez, D., Dadvand, P., Forns, J., Plasència, A., Nieuwenhuijsen, M.J., 2015. Mental health benefits of long-term exposure to residential green and blue spaces: a systematic review. Int. J. Environ. Res. Publ. Health 12 (4), 4354–4379. https://doi.org/10.3390/ijerph120404354. PMID: 25913182; PMCID: PMC4410252.
Gerrish, E., Watkins, S.L., 2018. The relationship between urban forests and income: a meta-analysis. Landsc. Urban Plann. 170, 293–308. https://doi.org/10.1016/j.landurbplan.2017.09.005.
Gillis, K., Gatersleben, B., 2015. A review of psychological literature on the health and wellbeing benefits of biophilic design. Buildings 5, 948–963. https://doi.org/10.3390/buildings5030948.
Gostin, L.O., Wiley, L.F., 2020. Governmental public health powers during the COVID-19 pandemic: stay-at-home orders, business closures, and travel restrictions [published online ahead of print, 2020 apr 2]. J. Am. Med. Assoc. https://doi.org/10.1001/jama.2020.5460, 10.1001/jama.2020.5460.
Greenland, S., Rothman, K.J., 1998. Chapter 18: concepts of interaction. In: Rothman, K. J., Greenland, S. (Eds.), Modern Epidemiology, second ed. Lippincott-Raven, New York, pp. 329–342.
Gulwadi, G.B., Mishchenko, E.D., Hallowell, G., Alves, S., Kennedy, M., 2019. The restorative potential of a university campus: objective greenness and student perceptions in Turkey and the United States. Landsc. Urban Plann. 187, 36–46.
Hall, C., Knuth, M., 2019. An update of the literature supporting the well-being benefits of plants: a review of the emotional and mental health benefits of plants. J. Environ. Hortic. 37 (1), 30–38. https://doi.org/10.24266/0738-2898-37.1.30.
Han, K.-T., Ruan, L.-W., 2019. Effects of indoor plants on self-reported perceptions: a systemic review. Sustainability 11 (16), 4506.
Hartig, T., 2004. Restorative environments. In: Spielberger, C. (Ed.), Encyclopedia of Applied Psychology. Academic, San Diego, pp. 273–279.
Hartig, T, in press. Restoration in Nature: Beyond the Conventional Narrative. In: Schutte, AR, Torquati, J, Stevens, JR (Eds.), Exploring the Relationship Between Natural Environments and Cognition - Health, Human Behavior and Well being. Springer Nature, Cham, Switzerland. In press.
Hartig, T., Kaiser, F.G., Bowler, P.A., 1997a. Further Development of a Measure of Perceived Environmental Restorativeness. Working Paper No. 5. Institute for Housing and Urban Research, Uppsala University, Gävle, Sweden.
Hartig, T., Korpela, K., Evans, G.W., Garling, T., 1997b. A measure of restorative quality in environments. Scand. Hous. Plann. Res. 14, 175–194.
Hartig, T., Kylin, C., Johansson, G., 2007. The telework tradeoff: stress mitigation vs. Constrained restoration. Appl. Psychol. 56 (2), 231–253. https://doi.org/10.1111/j.1464-0597.2006.00252.x.
Hartig, T., Mitchell, R., de Vries, S., Frumkin, H., 2014. Nature and health. Annu. Rev. Publ. Health 35, 207–228. https://doi.org/10.1146/annurev-publhealth-032013-182443.
Haukoos, J.S., Lewis, R.J., 2005. Advanced statistics: bootstrapping confidence intervals for statistics with "difficult" distributions. Acad. Emerg. Med. 12 (4), 360–365.
Hayes, A., 2013. Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach. Guilford Press, New York.
Helbich, M., 2018. Toward dynamic urban environmental exposure assessments in mental health research. Environ. Res. 161, 129–135. https://doi.org/10.1016/j.envres.2017.11.006.
Helbich, M., 2019. Dynamic Urban Environmental Exposures on Depression and Suicide (NEEDS) in The Netherlands: a protocol for a cross-sectional smartphone tracking

study and a longitudinal population register study. BMJ Open 9 (8), e030075. https://doi.org/10.1136/bmjopen-2019-030075. Published 2019 Aug 10.
Hipp, J.A., Gulwadi, G.B., Alves, S., Sequeira, S., 2016. The relationship between perceived greenness and perceived restorativeness of university campuses and student-reported quality of life. Environ. Behav. 48 (10), 1292–1308. https://doi.org/10.1177/0013916515598200.
Howarth, M., Brettle, A., Hardman, M., Maden, M., 2020. What is the evidence for the impact of gardens and gardening on health and well-being: a scoping review and evidence-based logic model to guide healthcare strategy decision making on the use of gardening approaches as a social prescription. BMJ Open 10, e036923–16. https://doi.org/10.1136/bmjopen-2020-036923.
Hu, L.T., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model. 6, 1–55.
Huang, Y., Zhao, N., 2020 Jun. Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. Psychiatr. Res. 288, 112954. https://doi.org/10.1016/j.psychres.2020.112954. Epub 2020 Apr 12. PMID: 32325383; PMCID: PMC7152913.
Huang, L., Xu, F., Liu, H., 2020. Emotional responses and coping strategies of nurses and nursing college students during COVID-19 outbreak. medRxiv 1–17. https://doi.org/10.1101/2020.03.05.20031898.
Jo, H., Song, C., Miyazaki, Y., 2019. Physiological benefits of viewing nature: a systematic review of indoor experiments. Int. J. Environ. Res. Publ. Health 16 (23), 4739. https://doi.org/10.3390/ijerph16234739.
Kamioka, H., Tsutani, K., Yamada, M., Park, H., Okuizumi, H., Honda, T., Okada, S., Park, S.J., Kitayuguchi, J., Abe, T., Handa, S., Mutoh, Y., 2014 Oct. Effectiveness of horticultural therapy: a systematic review of randomized controlled trials. Compl. Ther. Med. 22 (5), 930–943. https://doi.org/10.1016/j.ctim.2014.08.009. Epub 2014 Sep 1. PMID: 25440385.
Kaplan, S., 1995. The restorative benefits of nature: towards an integrative framework. J. Environ. Psychol. 15, 169–182.
Kaplan, R., 2001. The nature of the view from home. Environ. Behav. 33 (4), 507–542.
Kaplan, R., Kaplan, S., 1989. The Experience of Nature: Y Psychological Perspective. Cambridge University Press, New York.
Keller, A.S., Leikauf, J.E., Holt-Gosselin, B., Staveland, B.R., Williams, L.M., 2019. Paying attention to attention in depression. Transl. Psychiatry 9 (1), 279. https://doi.org/10.1038/s41398-019-0616-1. Erratum in: Transl Psychiatry. 2020 Feb 12;10(1):64. PMID: 31699968; PMCID: PMC6838308.
Kellert, S.R., Heerwagen, J., Mador, M.L. (Eds.), 2008. Biophilic Design: the Theory, Science & Practice of Bringing Buildings to Life. John Wiley & Sons, Hoboken, NJ.
Kelley, K., 2005. The effects of nonnormal distributions on confidence intervals around the standardized mean difference: bootstrap and parametric confidence intervals. Educ. Psychol. Meas. 65 (1), 51–69.
Kenny, D.A., Kashy, D.A., Cook, W.L., 2006. Dyadic Data Analysis. Guilford Press, New York.
Khan, M., Amin, N., Khan, A., Imtiaz, M., Khan, F., Ahmad, I., Ali, A., Islam, B., 2016. Plant therapy: a nonpharmacological and noninvasive treatment approach medically beneficial to the wellbeing of hospital patients. Gesunde Pflanz. 68, 191–200. https://doi.org/10.1007/s10343-016-0377-1.
Kim, J., Cha, S.H., Koo, C., Tang, S.K., 2018. The effects of indoor plants and artificial windows in an underground environment. Build. Environ. 138, 53–62. https://doi.org/10.1016/j.buildenv.2018.04.029.
Kim, H.-H., Yeo, I.-Y., Lee, J.-Y., 2020. Higher attention capacity after improving indoor air quality by indoor plant placement in elementary school classrooms. The Horticulture Journal 89 (3), 319–327. https://doi.org/10.2503/hortj.UTD-110.
Korpela, K., De Bloom, J., Sianoja, M., Pasanen, T., Kinnunen, U., 2017. Nature at home and at work: naturally good? Links between window views, indoor plants, outdoor activities and employee well-being over one year. Landsc. Urban Plann. 160, 38–47. https://doi.org/10.1016/j.landurbplan.2016.12.005.
Kroenke, K., Spitzer, R.L., Williams, J.B., 2001. The PHQ-9: validity of a brief depression severity measure. J. Gen. Intern. Med. 16 (9), 606–613.
Labib, S.M., Shuvo, F.K., Browning, M.H.E.M., Rigolon, A., 2020. Noncommunicable diseases, park prescriptions, and urban green space use patterns in a Global South context: the case of dhaka, Bangladesh. Int. J. Environ. Res. Publ. Health 17 (11), 3900. https://doi.org/10.3390/ijerph17113900. PMID: 32486391; PMCID: PMC7313456.
Lades, L.K., Laffan, K., Daly, M., Delaney, L., 2020. Daily emotional well-being during the COVID-19 pandemic. Br. J. Health Psychol. https://doi.org/10.1111/bjhp.12450, 10.1111/bjhp.12450. Epub ahead of print. PMID: 32573074; PMCID: PMC7361840.
Lamy, D., Goshen-Kosover, A., Aviani, N., Harari, H., Levkovitz, H., 2008. Implicit memory for spatial context in depression and schizophrenia. J. Abnorm. Psychol. 117 (4), 954–961. https://doi.org/10.1037/a0013867.
Lavdas, A.A., Schirpke, U., 2020. Aesthetic preference is related to organized complexity. PloS One 15 (6), e0235257.
Lee, SA, Neimeyer, RA, 2020. Social isolation as a means of reducing dysfunctional coronavirus anxiety and increasing psychoneuroimmunity. Brain, Behav. Immun. 87, 138–139. https://doi.org/10.1016/j.bbi.2020.05.007.
Lee, K.E., Williams, K.J.H., Sargent, L.D., Williams, N.S.G., Johnson, K.A., 2015a. 40-second green roof views sustain attention: the role of micro-breaks in attention restoration. J. Environ. Psychol. 42, 182–189. https://doi.org/10.1016/j.jenvp.2015.04.003.
Lee, M.-S., Lee, J., Park, B.-J., Miyazaki, Y., 2015b. Interaction with indoor plants may reduce psychological and physiological stress by suppressing autonomic nervous system activity in young adults: a randomized crossover study. J. Physiol. Anthropol. 34, 21. https://doi.org/10.1186/s40101-015-0060-8.
Li, D., Sullivan, W.C., 2016. Impact of views to school landscapes on recovery from stress and mental fatigue. Landsc. Urban Plann. 148, 149–158.
Lindal, P.J., Hartig, T., 2013. Architectural variation, building height, and the restorative quality of urban residential streetscapes. J. Environ. Psychol. 33, 26–36.
Lindal, P.J., Hartig, T., 2015. Effects of urban street vegetation on judgments of restoration likelihood. Urban For Urban Gree 14 (2), 200–209.
Maas, J., van Dillen, S.M.E., Verheij, R.A., Groenewegen, P.P., 2009. Social contacts as a possible mechanism behind the relation between green space and health. Health Place 15, 586–595. https://doi.org/10.1016/j.healthplace.2008.09.006.
Manea, L., Gilbody, S., McMillan, D., 2012. Optimal cut-off score for diagnosing depression with the Patient Health Questionnaire (PHQ-9): a meta-analysis. CMAJ (Can. Med. Assoc. J.) 184, E191–E196.
Markevych, I., Schoierer, J., Hartig, T., Chudnovsky, A., Hystad, P., Dzhambov, A.M., de Vries, S., Triguero-Mas, M., Brauer, M., Nieuwenhuijsen, M.J., Lupp, G., Richardson, E.A., Astell-Burt, T., Dimitrova, D., Feng, X., Sadeh, M., Standl, M., Heinrich, J., Fuertes, E., 2017 Oct. Exploring pathways linking greenspace to health: theoretical and methodological guidance. Environ. Res. 158, 301–317. https://doi.org/10.1016/j.envres.2017.06.028. Epub 2017 Jun 30. PMID: 28672128.
Marshall, S.W., 2007. Power for Tests of Interaction: Effect of Raising the Type I Error Rate. Epidemiologic Perspectives and Innovations.
Masoudinejad, S., Hartig, T., 2020. Window view to the sky as a restorative resource for residents in densely populated cities. Environ. Behav. 52 (4), 401–436. https://doi.org/10.1177/0013916518807274.
Menard, S., 1995. Applied Logistic Regression Analysis: Sage University Series on Quantitative Applications in the Social Sciences. Sage, Thousand Oaks, CA.
Mitchell, RJ, Richardson, EA, Shortt, NK, Pearce, JR, 2015. Neighborhood environments and socioeconomic inequalities in mental well-being. Am. J. Prevent. Med. 49 (1), 80–84. https://doi.org/10.1016/j.amepre.2015.01.017.
Moran, D., 2019. Back to nature? Attention restoration theory and the restorative effects of nature contact in prison. Health Place 57, 35–43. https://doi.org/10.1016/j.healthplace.2019.03.005.
Mulaik, S.A., James, L.R., Van Alstine, J., Bennett, N., Lind, S., Stilwell, C.D., 1989. Evaluation of goodness-of-fit indices for structural equation models. Psychol. Bull. 105 (3), 430–445.
Nadkarni, N., Hasbach, P., Thys, T., Gaines, E., Schnacker, L., 2017. Impacts of nature imagery on people in severely nature-deprived environments. Front. Ecol. Environ. 15 (7), 395–403. https://doi.org/10.1002/fee.1518.
Olvera Alvarez, H.A., Yin, J., Bratman, G.N., Spengler, J.D., 2020. Adverse childhood experiences modify the effect of nature on stress recovery among males: a between-subject experiment in virtual reality. In: Proceedings from International Society of Environmental Epidemology Conference, Washington, DC.
Park, S., Mattson, R.H., 2009. Therapeutic influences of plants in hospital rooms on surgical recovery. Hortscience 44 (1), 102–105.
Pasanen, T.P., White, M.P., Wheeler, B.W., Garrett, J.K., Elliott, L.R., 2019. Neighbourhood blue space, health and wellbeing: the mediating role of different types of physical activity. Environ. Int. 131, 105016. https://doi.org/10.1016/j.envint.2019.105016.
Petersen, E., McCloskey, B., Hui, D.S., Kock, R., Ntoumi, F., Memish, Z.A., Kapata, N., Azhar, E.I., Pollack, M., Madoff, L.C., Hamer, D.H., Nachega, J.B., Pshenichnaya, N., Zumla, A., 2020 May. COVID-19 travel restrictions and the International Health Regulations - call for an open debate on easing of travel restrictions. Int. J. Infect. Dis. 94, 88–90. https://doi.org/10.1016/j.ijid.2020.04.029. Epub 2020 Apr 17. PMID: 32305518; PMCID: PMC7162781.
Plummer, F., Manea, L., Trepe, D., McMillan, D., 2016. Screening for anxiety disorders with the GAD-7 and GAD-2: a systematic review and diagnostic metaanalysis. Gen. Hosp. Psychiatr. 39, 24–31. https://doi.org/10.1016/j.genhosppsych.2015.11.005.
Pouso, S, Borja, A, Fleming, LE, Gómez-Baggethun, E, White, M, Uyarra, MC, 2020. Maintaining contact with blue-green spaces during the COVID-19 pandemic associated with positive mental health. SocArXiv. https://doi.org/10.31235/osf.io/gpt3r. Submitted for publication.
Qin, J., Sun, C., Zhou, X., Leng, H., Lian, Z., 2014. The effect of indoor plants on human comfort. Indoor Built Environ. 23 (5), 709–723. https://doi.org/10.1177/1420326X13481372.
Raanaas, R.K., Evensen, K.H., Rich, D., Sjøstrøm, G., Patil, G., 2011. Benefits of indoor plants on attention capacity in an office setting. J. Environ. Psychol. 31 (1), 99–105. https://doi.org/10.1016/j.jenvp.2010.11.005.
Rajkumar, R.P., 2020. COVID-19 and mental health: a review of the existing literature. Asian J Psychiatr 52, 102066. https://doi.org/10.1016/j.ajp.2020.102066. Epub ahead of print. PMID: 32302935; PMCID: PMC7151415.
Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., Barbett, L., Clitherow, T., White, M., 2019. A measure of nature connectedness for children and adults: validation, performance, and insights. Sustainability 11 (12), 3250.
Rigolon, A., Browning, M., Jennings, V.L., 2018. Inequities in the quality of urban park systems: an environmental justice investigation of cities in the United States. Landsc. Urban Plann. 178, 156–169. https://doi.org/10.1016/j.landurbplan.2018.05.026.
Rogerson, P.A., 2001. Statistical Methods for Geography. Sage, London.
Selden, T.M., Berdahl, T.A., 2020. COVID-19 and racial/ethnic disparities in health risk, employment, and household composition. Health Aff. 94 https://doi.org/10.1377/hlthaff.2020.00897, 10.1377/hlthaff–8.
Selvin, S., 1996. Statistical Analysis of Epidemiologic Data. Oxford University Press, New York: NY, pp. 213–214.
Shoari, N., Ezzati, M., Baumgartner, J., Malacarne, D., Fecht, D., 2020. Accessibility and Allocation of Public Parks and Gardens during COVID-19 Social Distancing in England and Wales. medRxiv, p. 20098269. https://doi.org/10.1101/2020.05.11.20098269, 05.11.
Siu, A.M.H., Kam, M., Mok, I., 2020. Horticultural therapy program for people with mental illness: a mixed-method evaluation. Int. J. Environ. Res. Publ. Health 17 (3), 711. https://doi.org/10.3390/ijerph17030711. Published 2020 Jan 22.

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, 200204–200208. https://doi.org/10.5888/pcd17.200204.

Soga, M., Gaston, K.J., Yamaura, Y., 2016. Gardening is beneficial for health: a meta-analysis. Prev Med Rep 5, 92–99.

Soga, M., Gaston, K.J., Yamaura, Y., 2017. Gardening is beneficial for health: a meta-analysis. Preventive Medicine Reports 5, 92–99. https://doi.org/10.1016/j.pmedr.2016.11.007.

Sop Shin, W., 2007. The influence of forest view through a window on job satisfaction and job stress. Scand. J. For. Res. 22, 248–253. https://doi.org/10.1080/02827580701262733.

Spitzer, R.L., Kroenke, K., Williams, J.B., Löwe, B., 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch. Intern. Med. 166 (10), 1092–1097.

Tam, K.-P., 2013. Concepts and measures related to connection to nature: similarities and differences. J. Environ. Psychol. 34, 64–78. https://doi.org/10.1016/j.jenvp.2013.01.004.

Triguero-Mas, M., Dadvand, P., Cirach, M., Martínez, D., Medina, A., Mompart, A., Basagaña, X., Gražulevičienė, R., Nieuwenhuijsen, M.J., 2015. Natural outdoor environments and mental and physical health: relationships and mechanisms. Environ. Int. 77, 35–41. https://doi.org/10.1016/j.envint.2015.01.012.

Ulrich, R.S., 1984. View through a window may influence recovery from surgery. Science 224 (4647), 420–421.

van Esch, E., Minjock, R., Colarelli, S.M., Hirsch, S., 2019. Office window views: view features trump nature in predicting employee well-being. J. Environ. Psychol. 64, 1–40. https://doi.org/10.1016/j.jenvp.2019.05.006.

Von Lindern, E., Lymeus, F., Hartig, T., 2017. The restorative environment: a complementary concept for salutogenesis studies. In: Mittelmark, M.B., Sagy, S., Eriksson, M., Bauer, G.F., Pellikan, J., Lindström, B., Espnes, G.A. (Eds.), The Handbook of Salutogenesis (Chapter 19). Springer. https://doi.org/10.1007/978-3-319-04600-6.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R.S., Choo, F.N., Tran, B., Ho, R., Sharma, V.K., Ho, C., 2020 Jul. A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. Brain Behav. Immun. 87, 40–48. https://doi.org/10.1016/j.bbi.2020.04.028. Epub 2020 Apr 13. PMID: 32298802; PMCID: PMC7153528.

Weed, M., Foad, A., 2020. Rapid Scoping Review of Evidence of Outdoor Transmission of COVID-19. medRxiv, pp. 1–16. https://doi.org/10.1101/2020.09.04.20188417.

Werner, C., Schermelleh-Engel, K., 2010. Deciding between Competing Models: Chi-Square Difference Tests, vol. 5. Goethe University, Frankfurt, p. 2011.

WHO, 2016. Urban Green Spaces and Health. WHO Regional Office for Europe, Copenhagen.

Wong, C.-S., Law, K.S., 1999. Testing reciprocal relations by nonrecursive structural equation models using cross-sectional data. Organ. Res. Methods 2 (1), 69–87.

Xin, M., Luo, S., She, R., Yu, Y., Li, L., Wang, S., Ma, L., Tao, F., Zhang, J., Zhao, J., Li, L., Hu, D., Zhang, G., Gu, J., Lin, D., Wang, H., Cai, Y., Wang, Z., You, H., Hu, G., Lau, J. T., 2020. Negative cognitive and psychological correlates of mandatory quarantine during the initial COVID-19 outbreak in China. Am. Psychol. 75 (5), 607–617. https://doi.org/10.1037/amp0000692. PMID: 32673008.

Xue, F., Lau, S.S., Gou, Z., Song, Y., Jiang, B., 2019. Incorporating biophilia into green building rating tools for promoting health and wellbeing. Environ. Impact Assess. Rev. 76, 98–112. https://doi.org/10.1016/j.eiar.2019.02.004.

Yeo, N.L., Elliott, L.R., Bethel, A., White, M.P., Dean, S.G., Garside, R., 2020. Indoor nature interventions for health and wellbeing of older adults in residential settings: a systematic review. Gerontol. 60 (3), e184–e199. https://doi.org/10.1093/geront/gnz019. PMID: 30884495.

Zhao, X., Lynch, J.G., Chen, Q., 2010. Reconsidering Baron and Kenny: myths and truths about mediation analysis. J. Consum. Res. 37 (2), 197–206.

Zhu, S., Wu, Y., Zhu, C.Y., Hong, W.C., Yu, Z.X., Chen, Z.K., Chen, Z.L., Jiang, D.G., Wang, Y.G., 2020 Jul. The immediate mental health impacts of the COVID-19 pandemic among people with or without quarantine managements. Brain Behav. Immun. 87, 56–58. https://doi.org/10.1016/j.bbi.2020.04.045. Epub 2020 Apr 18. PMID: 32315758; PMCID: PMC7165285.