**The role of regular engagement with non-companion animals and proximity to green and blue space for mental health, wellbeing, and loneliness during Covid-19 social distancing measures: findings from a UK survey study**

Emily Shoesmith1\* & Elena Ratschen1

1Department of Health Sciences, University of York, York, YO10 5DD

\*Corresponding author: Emily.shoesmith@york.ac.uk

**Table of Contents short summary**

The Covid-19 pandemic and subsequent lockdown measures led to increased use of green and blue space. These changes impacted the direct interactions between humans and nature. This study aimed to investigate the links between mental health, proximity to and use of green/blue space, and interaction with non-companion animals (i.e., wildlife). The findings highlight the importance of green or blue space and the human-animal relationship, and how they might play a critical role in maintaining people’s mental health and wellbeing within a pandemic context.

**Abstract**

**Context:** The Covid-19 pandemic led to increased use of green/blue space as indoor spaces became frequently inaccessible. These changes impacted the direct interactions between humans and nature.

**Aims:** To investigate the links between mental health, loneliness, wellbeing, and interaction with non-companion animals, proximity to and use of green/blue space.

**Methods:** A cross-sectional online survey of adult UK residents was conducted between April and June 2020. The questionnaire included validated and bespoke items measuring demographics and exposures and outcomes related to mental health, wellbeing, loneliness, human-animal interactions with non-companion animals (wildlife/farm animals), and proximity to and use of green/blue space before and since the first UK Covid-19 lockdown.

**Key results:** Of 5,926 participants, 4,408 (74.4%) reported interacting with non-companion animals at least every other day. Frequent engagement with non-companion animals was significantly associated with smaller decreases in mental health scores (*b* = .131, 95% CI [.007 – .256], *p* = .038) and smaller increases in loneliness scores (*b* = -.135, 95% CI [-.241 – .030], *p* = .012). Just under half (48.4%, n=2,867) reported living directly next to a green/blue space, and over half (52.3%; n=3,097) reported using such space at least every day since lockdown. Regular use of green/blue space since lockdown was significantly associated with higher mental health (*b* = .154, 95% CI [.037 – .272], *p* = .010), lower loneliness (*b* = -.334, 95% CI [-.430 – -.238], *p* = .001), and higher wellbeing (*b* = .810, 95% CI [.572 – 1.047], *p* = .001). Closer proximity to such space was significantly associated with lower loneliness scores (*b* = -.224, 95% CI [-.319 - -.130], *p* = .001), and higher wellbeing scores (*b* = .632, 95% CI [.319 - .873], *p* = .001).

**Conclusion:** The multi-faceted human-nature relationship may promote key human health benefits in the context of the lockdown.

**Implications:** These findings highlight the importance of green/blue space and the human-animal relationship, and how they might play a critical role in maintaining people’s mental health within a pandemic context. Further targeted investigations relating to these areas and links with human health, are important within both pandemic and non-pandemic contexts.

**Introduction**

A growing number of studies have identified positive links between the availability of ‘natural’ spaces (e.g., green and blue space) and mental health outcomes (Hartig *et al.* 2014; Pritchard *et al.* 2020; Skibins *et al.* 2022). Evidence has suggested that exposure to nature has been associated with lower risk of stress, depression, and anxiety (de Keijzer *et al.* 2020; Gascon *et al.* 2016; Roberts *et al.* 2019). In particular, research has indicated that gardens (Sofo and Sofo 2020) and green and blue spaces (Dawwas and Dyson 2021) were an important refuge during Covid-19, and access to these spaces have improved participants mental health within the pandemic context (Grima *et al.* 2020; Xie *et al.* 2020). Despite this research, we know relatively little about the contribution of encounters with non-companion animals (e.g., wildlife) within these settings (Bell *et al.* 2014).

Human-animal interactions describe a wide spectrum of interactions and relationships between animals and humans (Serpell 1996). There has been increasing recognition of the potential impact of companion animals (e.g., pets) on mental health (Brooks *et al.* 2018), particularly within the context of the Covid-19 pandemic (Ratschen *et al.* 2020). However, the potential importance of human-animal interactions that involve non-companion animals for mental health has been highlighted (Fine 2015) but has frequently been overlooked in existing literature (Bell *et al.* 2018). It is commonly cited that companion animals are beneficial for human health through hypothesised mechanisms such as attachment to or companionship provided by the animal (Brooks *et al.* 2018). Therefore, the potential benefits derived from companion animals and non-companion animals may differ, and it is important to explore these interactions separately.

The desire to encounter wildlife in nature has been cited as an important motivation for visiting diverse ‘natural’ environments in the UK (Swanwick 2009). Participants visiting green spaces have reported greater wellbeing when they perceived higher levels of biodiversity based on species they could identify (Dallimer *et al.* 2012). Additionally, studies have reported positive associations between mental health and watching and hearing birds (Cox *et al.* 2017; Ratcliffe *et al.* 2013). However, there has been a dearth of literature investigating the role that non-companion animals may play in maintaining a sense of wellbeing during everyday life (Bell *et al.* 2018), particularly during the Covid-19 pandemic.

The Covid-19 pandemic raised previously unexplored questions about the role that wildlife and exposure to natural spaces played in the context of widely applied social distancing and isolation measures. Indoor spaces were frequently inaccessible and outdoor spaces became increasingly popular (Yan *et al.* 2021), subsequently impacting human-nature interactions. For example, time spent outdoors increased (Hansen *et al.* 2022) and the choice of outdoor activities shifted, as interactions with wildlife increased (Hockenhull *et al.* 2021; Morse *et al.* 2020). This is possibly due to changes in opportunity, for example, increased availability of time and the closure of indoor facilities (Soga *et al.* 2021). However, to the best of our knowledge, no studies have investigated the impact of both engagement with non-companion animals and proximity to ‘natural’ spaces (e.g., green and blue space) for mental health, wellbeing, and loneliness during the Covid-19 pandemic. Therefore, we investigated the following questions:

1. Are changes in mental health and loneliness scores since lockdown associated with regular engagement, and type of engagement activity with non-companion animals?
2. What is the association between mental health, loneliness and wellbeing, proximity to local green and blue space, and regular use of green and blue space before and since the first UK lockdown phase?

**Methods**

*Study design*

Cross-sectional, retrospective survey

*Settings and participants*

The survey was conducted in the UK general population. All UK residents over 18 years of age were eligible to take part, irrespective of companion animal ownership.

*Recruitment and procedures*

Participants were recruited using convenience sampling and snowball sampling methods. The survey was released in Qualtrics survey software and promoted using academic and third sector networks (including animal charities), social media (e.g., Facebook, Twitter), and other media outlets (e.g., Reddit). The advert outlined that the survey aimed to investigate how relationships with animals affect human health and wellbeing during the first Covid-19 lockdown phase in the UK, and highlighted any UK resident over 18 could participate, irrespective of whether they owned a companion animal or not. The survey was distributed to various groups and accounts on social media and other media outlets, not exclusively to those interested in or related to companion animals or wildlife.

The study commenced on 16th April 2020, four weeks after the first UK lockdown phase came into force, and ended on 14th June, when the lockdown measures were officially eased. Prospective participants followed a link to the survey where a Participant Information Sheet and consent form was presented. Consent to participate in the anonymous survey was indicated by checking an online tick box. A screening question requiring participants to indicate their country of residence denied access to those living outside of the UK. All data were stored on the secure Qualtrics server at the University of York.

Ethical approval for the survey was granted by the Health Sciences Research Ethics Committee at the University of York, UK on 16th April 2020.

*Measures*

As described in detail elsewhere (Ratschen *et al.* 2020), a bespoke questionnaire was developed by a multi-disciplinary team of academics with input from third sector animal welfare and training organisations. The questionnaire included validated items and new bespoke items based on expert consensus relating to emerging Covid-19-related aspects with reference to both companion and non-companion animals (e.g., wildlife and farm animals). We provide a brief overview of the measures included in the current paper:

Demographics: Demographic information was collected about participants’ age (in bands, including 70 and above), gender (male/female/non-binary), living with partner/spouse (yes/no), home ownership (owned/rented/belonging to housing association) and access to private garden area (yes/no), used as covariates in the analyses.

Companion animal ownership: Participants were asked: ‘Do you have any animals that live with you or near you, and that you or anyone in your household are the main caretaker of? Please do not include animals kept as livestock (e.g., farm sheep, cattle).’

Interactions with non-companion animals: Participants were asked whether they engaged regularly in feeding/watching garden birds or other wildlife in their homes or in nature, volunteered or worked for animal rescue organisations or sanctuaries, rode horses that they did not own, visited/watched farm animals near their home, or followed wildlife webcams or YouTube channels and social media groups that shared animal videos. These options were categorised into three groups: engaging with non-companion animals at home or in the garden/engaging with non-companion animals in nature or wildlife/engaging with non-companion animals online, for analyses for RQ1. For those who indicated they engaged with non-companion animals, participants were asked how often they spent engaging in these activities since the first lockdown phase, with responses ‘every day’, ‘every other day’, ‘twice a week’, ‘once a week’, or ‘less than once a week’.

Mental health, wellbeing and loneliness: The Short Warwick Edinburgh Mental Wellbeing Scale (SWEMWBS) (Taggart *et al.* 2013), the mental health subscale of the SF-36 (MHI-5) (McCabe *et al.* 1996), and the 3-item short version of the UCLA loneliness scale (Hughes *et al.* 2004) were included. Higher scores on these scales represent better wellbeing, mental health, and greater loneliness, respectively. The MHI-5 scale, and the 3-item loneliness scale were used to collect current and retrospective data, asking participants to indicate their perceptions for the time ‘before lockdown’ and the present time at questionnaire completion (during the first UK lockdown), respectively.

Proximity to and use of green/blue space: Participants were asked to indicate approximately how far they lived from the nearest public or open green or blue space (e.g., parks, woods, beaches), with responses ‘I live right next to such a space’, ‘I live less than a mile away’, ‘I live more than a mile away’, or ‘I live many miles away’. Participants were also asked how often they spent in public green or blue spaces before and since the first UK lockdown period, with responses ‘every day’, ‘every other day’, ‘twice a week’, ‘once a week’, or ‘less than once a week’.

**Data analysis**

Descriptive summary statistics are presented for demographic variables and data relating to engagement with non-companion animals, proximity to and use of local green or blue space.

To understand whether changes in mental health and loneliness scores since lockdown were associated with regular engagement and type of engagement with non-companion animals (RQ1), linear regression analyses were conducted to assess the association between regular engagement with non-companion animals: every day/less than every day, and the change scores for mental health and loneliness scores since lockdown (outcome variables), adjusting for relevant covariates (gender, age, living with partner/spouse, access to private garden, companion animal ownership, home ownership). Separate linear regression analyses were also conducted to assess the association between type of engagement activity with non-companion animals: engaging with non-companion animals in their homes or gardens (yes/no), engaging with non-companion animals in nature/wild (yes/no), engaging with non-companion animals online (yes/no), and the change score for mental health and loneliness scores since lockdown (outcome variables), adjusting for the same covariates.

To investigate whether mental health, loneliness and wellbeing scores since lockdown were associated with proximity to and use of local green/blue space (RQ2), we conducted separate linear regression analyses. These assessed the association between each predictor (proximity to space: right next to such a space/less than a mile away or more; regular use of space before the first UK lockdown phase: every day/less than every day; regular use of space since the first UK lockdown phase: every day/less than every day), and the mental health, loneliness, and wellbeing scores since lockdown (outcome variables), adjusting for relevant covariates (gender, age, living with partner/spouse, access to private garden, companion animal ownership, home ownership).

Throughout all analyses, missing values on covariates were imputed using an imputation model with all other variables as predictors: ten imputed datasets were created, each analysed separately, and the results were combined to produce pooled estimates of effects; allowing the analyses to account for uncertainty caused by estimating missing data. Data were analysed using SPSS version 28.0 (IBM®). Standard alpha-levels were applied in two-tailed tests of significance (*p* < .05 considered significant), with family-wise error rate corrected using the false discovery rate (Benjamini and Hochberg 1995).

All analyses were pre-specified and uploaded Eon the Open Science Framework [https://osf.io/d2mjz].

**Results**

A total of 5,926 participants consented and were eligible to take part in the study (see Table 1 for participant characteristics). The majority of the sample owned an animal (89.8%; n = 5,323) and consisted predominantly of female participants (78.6%; n = 4,657). Full characteristics for the whole survey sample are detailed elsewhere (Ratschen *et al.* 2020).

[Insert Table 1 here]

A large majority of the sample (74.4%; n = 4,408) indicated they interacted with non-companion animals at least every other day. The most common activity was feeding/watching the birds (54.5%; n = 3,228), followed by watching other wildlife in nature (39.5%; n = 2,346), and feeding/watching other wildlife in the garden (28.4%, n = 1,685). Other activities included visiting/watching farm animals close to home (13.9%, n = 822), following wildlife webcams online (11.8%, n = 698), volunteering/working for animal rescue organisations or sanctuaries (5.6%, n = 330), and other enjoyable activities involving animals that the participant was not the main caretaker of (8.1%, n = 479). A small number of participants reported they rode horses that they were not the main caretaker of (1.6%, n = 97).

**Are changes in mental health and loneliness scores since lockdown associated with regular engagement, and type of engagement with non-companion animals?**

Adjusting for relevant covariates, regular engagement with non-companion animals was significantly associated with smaller decreases in mental health scores and smaller increases in loneliness scores, as indicated by the MHI-5 and UCLA change scores (Table 2). The type of engagement activity with non-companion animals was not significantly associated with mental health or loneliness change scores (Table 2). Similar findings were observed when repeating the regression models without adjusting for relevant covariates (Supplementary Table 1).

[Insert Table 2 here]

**What is the association between mental health, loneliness and wellbeing, proximity to local green and blue space; and regular use of green and blue space before and since the first UK lockdown phase?**

Adjusting for relevant covariates, regular use of green/blue space since lockdown was significantly associated with higher mental health and wellbeing scores and lower loneliness scores (Table 3). Closer proximity to green/blue space was significantly associated with lower loneliness scores and higher wellbeing scores. Regular use of green/blue space before lockdown was significantly associated with lower loneliness scores since lockdown, but not mental health or wellbeing scores (Table 3). Similar findings were observed when repeating the regression models without adjusting for relevant covariates (Supplementary Table 2).

[Insert Table 3 here]

**Discussion**

To the best of our knowledge, this is the first study to investigate aspects relating to interaction with non-companion animals, the use of and proximity to green/blue space and mental health in a sample of this size. Results from this survey indicate that regular engagement, but not type of engagement, was associated with less deterioration in mental health and smaller increases in loneliness since lockdown. Additionally, the findings suggest the use of and proximity to green or blue space during the first UK Covid-19 lockdown might play an important role in mental health, wellbeing, and loneliness. These findings suggest that the holistic and multi-faceted human-nature relationship may influence psychological wellbeing in the context of the lockdown, more so than a specific focus on type of engagement with non-companion animals. Specifically, exposure to nature is likely to influence mental health through a range of pathways (Shanahan *et al.* 2016) dependent on the individual and their preferences. For example, characteristics of the space (e.g., visual complexity), appeal of the space, (e.g., providing a pleasant location for social or physical activities), and variation in duration and frequency of nature exposure (Shanahan *et al.* 2015). These various mechanisms may contribute towards the human-nature relationship that influences psychological wellbeing.

*Interactions with non-companion animals and its links with changes in mental health and loneliness since lockdown*

Global Covid-19 lockdowns have demonstrated how mental health has been positively influenced by companion animals (e.g., pets) (Ratschen *et al.* 2020; Young *et al.* 2020), witnessing the return of wildlife (Garlick 2020), and interactions with non-companion animals (Shoesmith *et al.* 2021). This aligns with our current findings as regular engagement with non-companion animals was significantly associated with less deterioration in mental health and smaller increases in loneliness since lockdown. Moreover, qualitative data from our survey reported in detail elsewhere (Shoesmith *et al.* 2021) highlights the positive impact of interaction with non-companion animals during the first lockdown phase. Many participants reported that these interactions ameliorated feelings of loneliness, and provided a sense of distraction to see animals in their natural environment (Shoesmith *et al.* 2021). Due to these perceived benefits, it is unsurprising that interaction with wildlife in outdoor spaces has increased since the pandemic (Morse *et al.* 2020). However, the type of engagement was not significantly associated with changes in mental health and loneliness scores since lockdown. Therefore, the human-animal interaction and proximity to, and time spent using green or blue space may be more important than the type of activities, including those focused on non-companion animals, that are conducted within this space. However, future research is required to unravel the elements contributing to the potential benefits of the complex human-animal relationship, especially to facilitate our understanding of non-companion animal interactions due to the dearth of research in this area.

The survey did not collect data in relation to how frequently participants engaged with non-companion animals before the Covid-19 lockdown phase. This would be interesting to explore further, as interactions may not have changed in regularity due to the pandemic context. Research has suggested that the first UK lockdown may not have caused a substantial increase in human-animal interaction during time spend outdoors (Hockenhull *et al.* 2021). The significant association found between regular engagement with non-companion animals and changes in mental health and loneliness scores since lockdown may be attributable to the fact those who appreciate encounters with non-companion animals may always have sought these interactions, while those who do not, did not alter their human-animal interaction behaviour following lockdown. This is plausible to suggest as nearly 90% of the sample were also companion animal owners, suggesting this was a ‘survey of animal lovers’ (Ratschen *et al.* 2020), and animal ownership was found to be a significant covariate in our regression models investigating the association between loneliness change scores and engagement with non-companion animals. Importantly, data from our survey reported in detail elsewhere (Ratschen *et al.* 2020) suggest there were no significant associations between regular interactions with non-companion animals and mental health and loneliness outcomes in non-animal owners only. Therefore, it is more likely that the potential benefits of interactions with non-companion animals may result in a human-animal relationship that could translate into benefits during the lockdown phase for animal owners, compared to non-animal owners.

Lastly, the welfare of non-companion animals is also essential to consider alongside the potential benefits to human health. A recent study reported that interacting with animals was a common activity undertaken while walking during the first UK Covid-19 lockdown (Hockenhull *et al.* 2021), with 85% of participants indicating they observed wildlife. The authors reported only a small percentage of participants reported feeding wildlife. The welfare implications of feeding wildlife can be significant (e.g., if the food offered is inappropriate) (Hockenhull *et al.* 2021). However, this depends on the species, as feeding birds is often actively encouraged and has been associated with improved health and survival rates (Pierret and Jiguet 2018; Robb *et al.* 2008). Overall, the impact of green and blue space on mental health and physical health has been well-established (Britton *et al.* 2018), and is becoming increasingly recognised (Hockenhull *et al.* 2021). The regular use of this outdoor space is only likely to increase as we move out of the pandemic context. Therefore, it is important to consider the welfare of the animals that occupy this space alongside the benefits offered to both physical and mental human health.

*The influence of green and blue space on psychological wellbeing*

As social isolation has a negative impact on mental health (Brooks *et al.* 2020; Smith and Victor 2019), it is unsurprising that depression and anxiety increased during the first Covid-19 lockdown in the UK (Dettmann *et al.* 2022). However, contact with nature can buffer or mitigate against the negative effects of social isolation on mental health (Cartwright *et al.* 2018; Yang *et al.* 2021), an effect that appears to have been particularly important during lockdown (Samuelsson *et al.* 2020; Venter *et al.* 2020). This aligns with our current findings, as closer proximity to green or blue space was significantly associated with higher wellbeing scores and lower loneliness scores, and regular use of green or blue space since lockdown was significantly associated with higher mental health and wellbeing and lower loneliness. This highlights the important role of contact with nature for maintaining wellbeing, even when restrictions are in place for time spent outdoors. During the first lockdown in the UK, people were only allowed outside of their home once a day, with guidelines recommending up to one hour only (Hockenhull *et al.* 2021). The limited time allowed outdoors appeared to have an important influence on mental health during the first UK lockdown.

Companion animal ownership was included in our regression models investigating the association between mental health, loneliness, wellbeing, and proximity to and use of green/blue space. Ownership was included as it is plausible to assume that animal owners, particularly those owning dogs, would frequently use outdoor space compared to non-animal owners. It has been reported that dog owners were four times more likely to meet the weekly minimum physical activity guidance than their non-dog owning counterparts (Westgarth *et al.* 2019). Additionally, studies conducted during the Covid-19 pandemic have demonstrated that dog ownership encouraged owners to leave the house and promoted physical activity (Holland *et al.* 2021; Shoesmith *et al.* 2021). However, animal ownership was only a significant covariate for the regression models investigating the association between loneliness scores and proximity to and use of green/blue space before and since lockdown. This aligns with research that suggests animal owners reported feeling less lonely during lockdown than those without an animal (Oliva and Johnston 2021), and having an excuse to leave the house to walk the dog was important and resulted in increased social interactions (Holland *et al.* 2021; Oliva and Johnston 2021). Interestingly, animal ownership was not a significant covariate for the regression models investigating the association of green/blue space with mental health and wellbeing. In relation to green/blue space, it may be the exposure to nature that provides psychological benefits. Contact with nature may act as a protection against the negative consequences of lockdown measures in mental health and wellbeing.

Additionally, accessibility to a private garden was found to be a significant covariate in our regression models investigating the association between mental health, loneliness, wellbeing, and proximity to and use of local green and blue space. The measures adopted during the first UK lockdown included employment constraints (e.g., home office working or being furloughed), and private outdoor spaces appear to have played a role in coping with the lockdown measures. Research has highlighted the importance of private gardens for wellbeing and promoting physical activity (de Bell *et al.* 2020), and offering a space to escape from every day stresses (Kingsley 2009). The benefits of gardens may also be linked to the privacy of the space, for example, maintenance of the recommended social distancing in shared gardens (e.g., in apartments or flats) may be stressful and challenging, compared to private and quiet gardens (Pouso *et al.* 2021). Additionally, research reports differences in mental health between people with and without accessible outdoor spaces existed before lockdown measures, suggesting the positive impact of these spaces exists under normal non-pandemic circumstances (Bratman *et al.* 2019). Further research is required to ascertain if there are significant differences between types of private outdoor spaces and nature views available (e.g., if views to blue spaces have higher buffering effects than views to green spaces) (Nutsford *et al.* 2016).

**Limitations**

We acknowledge limitations to the current study. Firstly, the population consisted predominantly of female participants, so the sample is not representative of the UK general population. Although gender differences have been identified for some elements relating to animal ownership (Amiot and Bastian 2015), this does not appear to be the case for interactions with non-companion animals. Therefore, our predominantly female sample may not have affected our results substantially. Additionally, nearly 90% of our sample owned a companion animal. Hence, this survey was evidently a ‘survey of animal lovers’, as common in this area of research. The findings need to be interpreted with this in mind, as it is possible that the self-selected sample frequently engaged with non-companion animals prior to the Covid-19 restrictions. It would be important for future research to explore the association between mental health and engagement with non-companion animals in a larger sample of participants who did not own a companion animal. We did not collect data relating to participant income which is known to have an impact on the relationship between people, nature, and wellbeing (Richardson *et al.* 2022; Scopelliti *et al.* 2016). However, we did collect information about home ownership as a proxy, as this was deemed less intrusive than asking about household income, and has been used as a variable in previous research to measure socioeconomic status (Niedzwiedz *et al.* 2020).

Lastly, although we collected data on proximity to and use of green/blue space, this is self-reported and therefore may vary in accuracy. We also did not collect further details relating to the type of outdoor spaces (private and/or public) that the participants had access to. Types of outdoor space and the associated views from the space may differentially affect the impact of the space on psychological wellbeing and would be important to explore in future research.

**Conclusion**

Our study demonstrated the role of non-companion animals as potential buffers for psychological distress and loneliness, regardless of the type of engagement. Future research could explore the potential role of human-animal interactions and relationships that form as a result of engagement with non-companion animals further. Additionally, exposure to and use of green/blue space provides society with various benefits that can also act as a buffer against the negative consequences of lockdown measures in psychological wellbeing. Overall, the current study provides an overview of the important role that the multi-faceted human-nature relationship played during the first UK lockdown phase. Further targeted investigations relating to these important areas and links with human health, are important within both pandemic and non-pandemic contexts.

**Data Availability Statement:** All relevant data are uploaded to the OSF repository and publicly accessible via the following URL:<https://osf.io/a5uy9>

**Conflicts of Interest:** The authors declare no conflict of interest.

**Declaration of Funding:** This research did not receive any specific funding, but this study is supported by the Yorkshire and Humberside Applied Research Collaboration (YHARC). Any views expressed here are those of the authors and do not necessarily represent the views of the YHARC.

**References**

Amiot CE and Bastian B (2015) Toward a psychology of human-animal relations. *Psychol Bull* **141**, 6-47. doi: 10.1037/a0038147.

Bell SL, Phoenix C, Lovell R, and Wheeler BW (2014) Green space, health and wellbeing: Making space for individual agency. *Health & Place* **30**, 287-292. doi: <https://doi.org/10.1016/j.healthplace.2014.10.005>.

Bell SL, Westley M, Lovell R, and Wheeler BW (2018) Everyday green space and experienced well-being: The significance of wildlife encounters. *Landscape Research* **43**, 8-19. doi: 10.1080/01426397.2016.1267721.

Benjamini Y and Hochberg Y (1995) Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (Methodological)* **57**, 289-300. doi: <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>.

Bratman GN, Anderson CB, Berman MG, Cochran B, De Vries S, Flanders J, Folke C, Frumkin H, Gross JJ, and Hartig T (2019) Nature and mental health: An ecosystem service perspective. *Science advances* **5**, eaax0903.

Britton E, Kindermann G, Domegan C, and Carlin C (2018) Blue care: A systematic review of blue space interventions for health and wellbeing. *Health Promotion International* **35**, 50-69. doi: 10.1093/heapro/day103.

Brooks HL, Rushton K, Lovell K, Bee P, Walker L, Grant L, and Rogers A (2018) The power of support from companion animals for people living with mental health problems: A systematic review and narrative synthesis of the evidence. *BMC psychiatry* **18**, 1-12.

Brooks SK, Webster RK, Smith LE, Woodland L, Wessely S, Greenberg N, and Rubin GJ (2020) The psychological impact of quarantine and how to reduce it: Rapid review of the evidence. *The lancet* **395**, 912-920.

Cartwright BD, White MP, and Clitherow TJ (2018) Nearby nature ‘buffers’ the effect of low social connectedness on adult subjective wellbeing over the last 7 days. *International journal of environmental research and public health* **15**, 1238.

Cox DTC, Shanahan DF, Hudson HL, Plummer KE, Siriwardena GM, Fuller RA, Anderson K, Hancock S, and Gaston KJ (2017) Doses of neighborhood nature: The benefits for mental health of living with nature. *BioScience* **67**, 147-155. doi: 10.1093/biosci/biw173.

Dallimer M, Irvine KN, Skinner AM, Davies ZG, Rouquette JR, Maltby LL, Warren PH, Armsworth PR, and Gaston KJ (2012) Biodiversity and the feel-good factor: Understanding associations between self-reported human well-being and species richness. *BioScience* **62**, 47-55.

Dawwas EB and Dyson K (2021) Covid-19 changed human-nature interactions across green space types: Evidence of change in multiple types of activities from the west bank, palestine. *Sustainability* **13**, 13831.

de Bell S, White M, Griffiths A, Darlow A, Taylor T, Wheeler B, and Lovell R (2020) Spending time in the garden is positively associated with health and wellbeing: Results from a national survey in england. *Landscape and urban planning* **200**, 103836.

de Keijzer C, Bauwelinck M, and Dadvand P (2020) Long-term exposure to residential greenspace and healthy ageing: A systematic review. *Current environmental health reports* **7**, 65-88.

Dettmann LM, Adams S, and Taylor G (2022) Investigating the prevalence of anxiety and depression during the first covid-19 lockdown in the united kingdom: Systematic review and meta-analyses. *British Journal of Clinical Psychology* **n/a**. doi: <https://doi.org/10.1111/bjc.12360>.

Fine A (2015) 'Handbook on animal-assisted therapy. Foundations and guidelines for animal-assisted interventions.' (Academic Press: San Diego, California)

Garlick B (2020) Lockdown isn't good news for all wildlife - many animals rely on humans for survival. . (The Conversation)

Gascon M, Triguero-Mas M, Martínez D, Dadvand P, Rojas-Rueda D, Plasència A, and Nieuwenhuijsen MJ (2016) Residential green spaces and mortality: A systematic review. *Environment international* **86**, 60-67.

Grima N, Corcoran W, Hill-James C, Langton B, Sommer H, and Fisher B (2020) The importance of urban natural areas and urban ecosystem services during the covid-19 pandemic. *Plos one* **15**, e0243344.

Hansen AS, Beery T, Fredman P, and Wolf-Watz D (2022) Outdoor recreation in sweden during and after the covid-19 pandemic – management and policy implications. *Journal of Environmental Planning and Management*, 1-22. doi: 10.1080/09640568.2022.2029736.

Hartig T, Mitchell R, De Vries S, and Frumkin H (2014) Nature and health. *Annual review of public health* **35**, 207-228.

Hockenhull J, Squibb K, and Cameron A (2021) How has the covid-19 pandemic affected the way we access and interact with the countryside and the animals within it? *Animals* **11**, 2281.

Holland KE, Owczarczak-Garstecka SC, Anderson KL, Casey RA, Christley RM, Harris L, McMillan KM, Mead R, Murray JK, and Samet L (2021) “More attention than usual”: A thematic analysis of dog ownership experiences in the uk during the first covid-19 lockdown. *Animals* **11**, 240.

Hughes ME, Waite LJ, Hawkley LC, and Cacioppo JT (2004) A short scale for measuring loneliness in large surveys: Results from two population-based studies. *Research on Aging* **26**, 655-672. doi: 10.1177/0164027504268574.

Kingsley J (2009) Yotti. *Townsend, M., Henderson‐Wilson, C*, 207-219.

McCabe CJ, Thomas KJ, Brazier JE, and Coleman P (1996) Measuring the mental health status of a population: A comparison of the ghq–12 and the sf–36 (mhi–5). *British Journal of Psychiatry* **169**, 517-521. doi: 10.1192/bjp.169.4.516.

Morse JW, Gladkikh TM, Hackenburg DM, and Gould RK (2020) Covid-19 and human-nature relationships: Vermonters’ activities in nature and associated nonmaterial values during the pandemic. *PLOS ONE* **15**, e0243697. doi: 10.1371/journal.pone.0243697.

Niedzwiedz CL, O’Donnell CA, Jani BD, Demou E, Ho FK, Celis-Morales C, Nicholl BI, Mair FS, Welsh P, Sattar N, Pell JP, and Katikireddi SV (2020) Ethnic and socioeconomic differences in sars-cov-2 infection: Prospective cohort study using uk biobank. *BMC Medicine* **18**, 160. doi: 10.1186/s12916-020-01640-8.

Nutsford D, Pearson AL, Kingham S, and Reitsma F (2016) Residential exposure to visible blue space (but not green space) associated with lower psychological distress in a capital city. *Health & Place* **39**, 70-78.

Oliva JL and Johnston KL (2021) Puppy love in the time of corona: Dog ownership protects against loneliness for those living alone during the covid-19 lockdown. *International Journal of Social Psychiatry* **67**, 232-242. doi: 10.1177/0020764020944195.

Pierret P and Jiguet F (2018) The potential virtue of garden bird feeders: More birds in citizen backyards close to intensive agricultural landscapes. *Biological Conservation* **222**, 14-20.

Pouso S, Borja Á, Fleming LE, Gómez-Baggethun E, White MP, and Uyarra MC (2021) Contact with blue-green spaces during the covid-19 pandemic lockdown beneficial for mental health. *The Science of the total environment* **756**, 143984-143984. doi: 10.1016/j.scitotenv.2020.143984.

Pritchard A, Richardson M, Sheffield D, and McEwan K (2020) The relationship between nature connectedness and eudaimonic well-being: A meta-analysis. *Journal of Happiness Studies* **21**, 1145-1167. doi: 10.1007/s10902-019-00118-6.

Ratcliffe E, Gatersleben B, and Sowden PT (2013) Bird sounds and their contributions to perceived attention restoration and stress recovery. *Journal of environmental psychology* **36**, 221-228.

Ratschen E, Shoesmith E, Shahab L, Silva K, Kale D, Toner P, Reeve C, and Mills DS (2020) Human-animal relationships and interactions during the covid-19 lockdown phase in the uk: Investigating links with mental health and loneliness. *PLOS ONE* **15**, e0239397. doi: 10.1371/journal.pone.0239397.

Richardson M, Hamlin I, Elliott LR, and White MP (2022) Country-level factors in a failing relationship with nature: Nature connectedness as a key metric for a sustainable future. *Ambio* **51**, 2201-2213. doi: 10.1007/s13280-022-01744-w.

Robb GN, McDonald RA, Chamberlain DE, and Bearhop S (2008) Food for thought: Supplementary feeding as a driver of ecological change in avian populations. *Frontiers in Ecology and the Environment* **6**, 476-484.

Roberts H, van Lissa C, Hagedoorn P, Kellar I, and Helbich M (2019) The effect of short-term exposure to the natural environment on depressive mood: A systematic review and meta-analysis. *Environmental research* **177**, 108606.

Samuelsson K, Barthel S, Colding J, Macassa G, and Giusti M (2020) Urban nature as a source of resilience during social distancing amidst the coronavirus pandemic.

Scopelliti M, Carrus G, Adinolfi C, Suarez G, Colangelo G, Lafortezza R, Panno A, and Sanesi G (2016) Staying in touch with nature and well-being in different income groups: The experience of urban parks in bogotá. *Landscape and Urban Planning* **148**, 139-148. doi: <https://doi.org/10.1016/j.landurbplan.2015.11.002>.

Serpell J (1996) 'In the company of animals: A study of human-animal relationships.' (Cambridge University Press: Cambridge, UK)

Shanahan DF, Bush R, Gaston KJ, Lin BB, Dean J, Barber E, and Fuller RA (2016) Health benefits from nature experiences depend on dose. *Scientific Reports* **6**, 28551. doi: 10.1038/srep28551.

Shanahan DF, Lin BB, Bush R, Gaston KJ, Dean JH, Barber E, and Fuller RA (2015) Toward improved public health outcomes from urban nature. *American journal of public health* **105**, 470-477.

Shoesmith E, Shahab L, Kale D, Mills DS, Reeve C, Toner P, Santos de Assis L, and Ratschen E (2021) The influence of human-animal interactions on mental and physical health during the first covid-19 lockdown phase in the u.K.: A qualitative exploration. *Int J Environ Res Public Health* **18**. doi: 10.3390/ijerph18030976.

Skibins JC, Das BM, and Schuler G (2022) Digital modalities, nature, and quality of life: Mental health and conservation benefits of watching bear cams. *Human Dimensions of Wildlife*, 1-15. doi: 10.1080/10871209.2021.2024629.

Smith KJ and Victor C (2019) Typologies of loneliness, living alone and social isolation, and their associations with physical and mental health. *Ageing & Society* **39**, 1709-1730.

Sofo A and Sofo A (2020) Correction to: Converting home spaces into food gardens at the time of covid-19 quarantine: All the benefits of plants in this difficult and unprecedented period (human ecology,(2020), 48, 2,(131-139), 10.1007/s10745-020-00147-3). *Human Ecology* **48**.

Soga M, Evans MJ, Cox DTC, and Gaston KJ (2021) Impacts of the covid-19 pandemic on human–nature interactions: Pathways, evidence and implications. *People and Nature* **3**, 518-527. doi: <https://doi.org/10.1002/pan3.10201>.

Swanwick C (2009) Society's attitudes to and preferences for land and landscape. *Land use policy* **26**, S62-S75.

Taggart F, Friede T, Weich S, Clarke A, Johnson M, and Stewart-Brown S (2013) Cross cultural evaluation of the warwick-edinburgh mental well-being scale (wemwbs) -a mixed methods study. *Health and Quality of Life Outcomes* **11**, 27. doi: 10.1186/1477-7525-11-27.

Venter ZS, Barton DN, Gundersen V, Figari H, and Nowell M (2020) Urban nature in a time of crisis: Recreational use of green space increases during the covid-19 outbreak in oslo, norway. *Environmental research letters* **15**, 104075.

Westgarth C, Christley RM, Jewell C, German AJ, Boddy LM, and Christian HE (2019) Dog owners are more likely to meet physical activity guidelines than people without a dog: An investigation of the association between dog ownership and physical activity levels in a uk community. *Scientific reports* **9**, 1-10.

Xie J, Luo S, Furuya K, and Sun D (2020) Urban parks as green buffers during the covid-19 pandemic. *Sustainability* **12**, 6751.

Yan Y, Bayham J, Richter A, and Fenichel EP (2021) Risk compensation and face mask mandates during the covid-19 pandemic. *Scientific reports* **11**, 1-11.

Yang Y, Wang L, Passmore H-A, Zhang J, Zhu L, and Cai H (2021) Viewing nature scenes reduces the pain of social ostracism. *The Journal of Social Psychology* **161**, 197-215.

Young J, Pritchard R, Nottle C, and Banwell H (2020) Pets, touch, and covid-19: Health benefits from non-human touch through times of stress. **4**, 25-33.

|  |
| --- |
| Table 1. Participant characteristics  |
|  |  | **% (N)** |
| Gender | Female | 78.6 (4,657) |
| Male | 20.6 (1,222) |
| In another way | 0.6 (36) |
| Prefer not to say | 0.2 (11) |
| Age (years) | 18 – 24 | 7.1 (420) |
| 25 – 34 | 17.5 (1,040) |
| 35 – 44 | 16.8 (994) |
| 45 – 54 | 23.8 (1,409) |
| 55 – 64 | 22.2 (1,313) |
| 65 – 70 | 7.1 (418) |
| Over 70 | 5.6 (332) |
| Living with spouse | Yes | 61.3 (3,630) |
| Companion animal ownership | Yes | 89.8 (5,323) |
| Access to private garden | Yes | 96.0 (5,687) |
| Home ownership | Owned outright or with mortgage | 70.8 (4,194) |
| Rented  | 20.8 (1,230) |
| Accommodation belongs to a housing association | 8.4 (502) |
| Frequency of engagement with non-companion animals since lockdown phase | Every day | 54.5 (3,231) |
| Every other day | 19.9 (1,177) |
| Twice a week | 11.3 (667) |
| Once a week | 8.0 (477) |
| Less than once a week | 6.3 (374) |
| Proximity to local green/blue space | Right next to space | 48.4 (2,867) |
| Less than a mile way | 43.0 (2,549) |
| More than a mile | 7.0 (415) |
| Many miles away | 1.6 (95) |
| Use of green/blue space before lockdown phase | Every day | 52.0 (3,080) |
| Every other day | 14.1 (833) |
| Twice a week | 12.5 (739) |
| Once a week | 9.4 (558) |
| Less than once a week | 12.0 (716) |
| Use of green/blue space since lockdown phase | Every day | 52.3 (3,097) |
| Every other day | 14.0 (830) |
| Twice a week | 7.1 (419) |
| Once a week | 4.7 (278) |
| Less than once a week | 21.9 (1,302) |

|  |
| --- |
| Table 2. Linear regression models of association of regular engagement and type of engagement activity with non-companion animals and the change scores for mental health and loneliness, adjusting for relevant covariates |
| Predictor | **Mental health change score** |
| ***b*adj** | **95% CI** | ***p*-value** | **R2** |
| Regular engagement with non-companion animals1 | .131 | .007 - .256 | .038\* | .009 |
| Engagement activity in home/garden1 | .023 | -.094 - .140 | .701 | .009 |
| Engagement activity in wildlife/nature1 | -.031 | -.140 - .077 | .574 | .009 |
| Engagement activity online1 | .200 | .035 - .365 | .059 | .010 |
|  | **Loneliness change score** |
| ***b*adj** | **95% CI** | ***p*-value** | **R2** |
| Regular engagement with non-companion animals2 | -.135 | -.241 - .030 | .012\* | .027 |
| Engagement activity in home/garden3 | .046 | -.053 - .145 | .361 | .024 |
| Engagement activity in wildlife/nature3 | .079 | -.013 - .170 | .091 | .024 |
| Engagement activity online3 | -.063 | -.202 - .076 | .374 | .024 |

1 Age\*, gender\*, living with partner/spouse, access to private garden, animal ownership\*, home ownership; \* indicates significance (*p* < 0.05).

2 Age\*, gender, living with partner/spouse\*, access to private garden, animal ownership\*, home ownership; \* indicates significance (*p* < 0.05).

3 Age\*, gender\*, living with partner/spouse\*, access to private garden, animal ownership\*, home ownership; \* indicates significance (*p* < 0.05).

|  |
| --- |
| Table 3. Linear regression models of association of predictors and mental health, loneliness, and wellbeing scores, adjusting for relevant covariates  |
| Predictor | **Mental health score since lockdown** |
| ***b*adj** | **95% CI** | ***p*-value** | **R2** |
| Proximity to green/blue space1 | .057 | -.057 - .172 | .328 | .127 |
| Regular use of green/blue space before lockdown1 | -.059 | -.176 - .058 | .326 | .127 |
| Regular use of green/blue space since lockdown1 | .154 | .037 - .272 | .010\* | .128 |
|  | **Loneliness score since lockdown** |
|  | ***b*adj** | **95% CI** | ***p*-value** | **R2** |
| Proximity to green/blue space2 | -.224 | -.319 - -.130 | .001\* | .110 |
| Regular use of green/blue space before lockdown2 | -.126 | -.224 - -.028 | .011\* | .107 |
| Regular use of green/blue space since lockdown3 | -.334 | -.430 - -.238 | .001\* | .114 |
|  | **Wellbeing score since lockdown** |
| ***b*adj** | **95% CI** | ***p*-value** | **R2** |
| Proximity to green/blue space2 | .632 | .391 - .873 | .001\* | .067 |
| Regular use of green/blue space before lockdown2 | .190 | .052 - .431 | .123 | .064 |
| Regular use of green/blue space since lockdown2 | .810 | .572 - 1.047 | .001\* | .071 |

1 Age\*, gender\*, living with partner/spouse\*, access to private garden\*, animal ownership, home ownership\*; \* indicates significance (*p* < 0.05).

2 Age\*, gender\*, living with partner/spouse\*, access to private garden\*, animal ownership\*, home ownership\*; \* indicates significance (*p* < 0.05).

3 Age, gender\*, living with partner/spouse\*, access to private garden\*, animal ownership\*, home ownership\*; \* indicates significance (*p* < 0.05).