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Home garden use during COVID-19: Associations with physical and mental wellbeing in older adults

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ABSTRACT

The COVID-19 pandemic has affected many aspects of people's lives. Lockdown measures to reduce the spread of COVID-19 have been more stringent for those aged over 70, at highest risk for the disease. Here, we examine whether home garden usage is associated with self-reported mental and physical wellbeing in older adults, during COVID-19 lockdown in Scotland. This study analysed data from 171 individuals (mean age 84 ± 0.5 years) from the Lothian Birth Cohort 1936 study who completed an online survey approximately two months after lockdown commenced (May/June, 2020), and reported having access to a home garden. The survey also included items on garden activities (gardening, relaxing), frequency of garden usage during lockdown, and measures of self-rated physical health, emotional and mental health, anxiety about COVID-19, and sleep quality. Ordinal regression models were adjusted for sex, living alone, education, occupational social class, anxiety and depressive symptoms, body mass index, and history of diabetes and cardiovascular disease. Neither gardening nor relaxing in the garden were associated with health outcomes. However, higher frequency of garden usage during lockdown was associated with better self-rated physical health ($P = 0.005$), emotional and mental health ($P = 0.04$), sleep quality ($P = 0.03$), and a composite health score ($P = 0.001$), after adjusting for covariates. None of the garden measures were associated with perceived change in physical health, mental and emotional health, or sleep quality, from pre-lockdown levels. The results of the current study provide support for positive health benefits of spending time in a garden—though associations may be bidirectional—and suggest that domestic gardens could be a potential health resource during the COVID-19 pandemic.

1. Introduction

Access to green space, such as gardens, parks, forests, and fields, is associated with a range of health benefits (Twohig-Bennett & Jones, 2018; Van den Berg et al., 2015). Numerous studies have identified links between exposure to green spaces and with nature, and reduced stress, improved mood, increased life satisfaction, mental stimulation, and a reduced risk of mental health problems (Cohen-Cline, Turkheimer, & Duncan, 2015; Houlden, Weich, Porto, de Albuquerque, Jarvis, & Rees, 2018; Milligan, Gatrell, & Bingley, 2004; Pope et al., 2018; Van den Berg et al., 2016). Additional benefits of spending time in natural environments include physical exercise and better physical health, improved sleep quality, and social interaction (Coombes, Jones, & Hillsdon, 2010; Maas, Van Dillen, Verheij, & Groenewegen, 2009; Mytton, Townshend, Rutter, & Foster, 2012).

The COVID-19 pandemic has led governments around the world to implement lockdowns to contain and reduce COVID-19 transmission. Key policy measures, including social distancing and self-isolation, have had unintended detrimental impacts on many aspects of people's lives including psychological and physical wellbeing, and levels of physical activity (Cellini, Canale, Mioni, & Costa, 2020; Cheval et al., 2020; Galea, Merchant, & Lurie, 2020; Pfefferbaum & North, 2020). Older

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adults, specifically those over the age of 70, carry the highest risk of morbidity and mortality from COVID-19 (WHO, 2019), and global government recommendations for this age group have been to home quarantine for prolonged periods and avoid contact with others. As such, older people are likely to be particularly affected by current circumstances and restrictions, potentially experiencing lockdown and its consequences on mental and physical health, to a greater extent than others (Brooke & Jackson, 2020; Webb, 2020). Given that the social distancing measures to reduce the spread of COVID-19 have impeded the access of older people to public green spaces, domestic gardens have arguably become more important than ever in providing contact with the natural environment, as well as opportunities for physical exercise.

Domestic gardens are an important component of green infrastructure (Cameron et al., 2012) yet their specific contribution to wellbeing is rarely assessed relative to urban green space (Dennis & James, 2017), with a couple of exceptions. Two recent population surveys in the UK indicate that having access to, and spending time in private gardens, is positively associated with enhanced wellbeing (Brindley, Jorgensen, & Maheswaran, 2018; de Bell et al., 2020). Furthermore, previous research suggests that neighbourhood green space (Van den Berg, Maas, Verheij, & Groenewegen, 2010; Weeland, Laceulle, Nederhof, Overbeek, & Reijneveld, 2019) and contact with nature (Marselle, Warber, & Irvine, 2019) may 'buffer' the psychological and physiological impact of stressful life events. Among the older generation who have been subject to extended periods of home confinement, being able to use a garden could potentially alleviate some of the mental and physical harms of the COVID-19 crisis.

Access to nature and urban green space is increasingly being recognised as playing an important role in COVID-19 recovery plans (Ahmadpoor & Shahab, 2020; Ferrini & Gori, 2020). Yet, to date, there have been no studies investigating the impact of domestic gardens on psychosocial factors and physical health during the mandatory lockdown period. A recent editorial highlighted the growing need to become better informed about ways to understand and promote health and wellbeing during this time, especially among more vulnerable groups such as the elderly (Balanzá-Martínez, Atienza-Carbonell, Kapczinski, & De Boni, 2020). Observational studies which examine lifestyle factors during self-isolation have the potential to inform public health strategies of protective behaviours for the prevention of a new pandemic of psychiatric disorders (Vindegaard & Benros, 2020), or indeed, future phases of the COVID-19 pandemic.

Here, we address the research gap by examining whether home green space contributes to physical and mental wellbeing in older adults during the COVID-19 nationwide lockdown period in Scotland, in which those aged >70 years were strongly advised to remain at home and avoid social contact. Specifically, we hypothesise that having access to, and spending time in a domestic garden during the pandemic, is associated with greater physical and psychological health. To test these hypotheses, we used data from the longitudinal Lothian Birth Cohort 1936 study of ageing, a richly-phenotyped sample with a wealth of existing data on demographic, health and other factors, in combination with responses to an online survey during the COVID-19 pandemic.

2. Materials and methods

2.1. Participants

Participants were from the Lothian Birth Cohort 1936 (LBC1936) study, a community-dwelling sample of 1091 individuals, being studied in later life principally to ascertain the determinants of cognitive and brain ageing. All were born in 1936 and most are surviving participants of the Scottish Mental Survey of 1947 (SCRE, 1949). At study entry (2004–2007), participants were aged ~ 70 years. They have been subsequently assessed every 3 years at ages 73 (n = 866), 76 (n = 697), 79 (n = 550), and most recently (2017–2019) at 82 (n = 431). The next planned follow-up has been postponed due to the COVID-19 pandemic. Participants have undergone repeated assessments for cognitive, medical, genetic, brain imaging (from age 73), and lifestyle and psychosocial assessment. Full details on the background, recruitment and data collection procedures are available (Taylor, Pattie, & Deary, 2018). Ethical approval was obtained from Multi-Centre Research Ethics Committee for Scotland (MREC/01/0/56; Wave 1), the Lothian Research Ethics Committee (LREC/2003/2/29; Wave 1), and the Scotland A Research Ethics Committee (07/MRE00/58; Waves 2–5). The study was performed in accordance with the ethical standards of the Declaration of Helsinki (World Medical Association, 2013).

Data were collected on a total of 190 respondents to an online survey administered during the COVID-19 lockdown period in Scotland, UK (which commenced on 23 March 2020), when participants were aged 84 (±0.5) years. Of the total respondents, 171 provided usable data on garden use and self-reported health, and form the sample for the current study. According to Scottish Government guidelines, those over the age of 70, were strongly advised to stay at home during lockdown (Scottish Government, 2020). Restrictions were not eased for this age group until approximately 12 weeks later, on 18 June 2020.

2.2. COVID-19 online survey

Approximately two months after COVID-19 lockdown commenced in Scotland, all participants still registered with the LBC1936 study were invited to complete an online survey questionnaire. On May 27, 2020, letters were posted to all eligible participants (n = 454) inviting them to complete an online survey developed for the purpose of collecting data on knowledge and attitudes towards the COVID-19 pandemic, and impact on lifestyle, emotional and psychological health during lockdown. The letter contained a link to the online questionnaire created used using the Qualtrics XM platform. The survey comprised 145 questions (multiple choice, single choice, numeric, and open ended) on demographic data, knowledge and experience of COVID-19, and physical-, psychological-, and psychosocial health. The survey included a Participant Information Sheet (which explained that participation in the survey was voluntary, and provided information on the purpose, risks, and benefits of taking part) and a consent form. The questionnaire took approximately 30–45 min to complete. All questions were optional; thus, the number of respondents to each question varied. The questionnaire was live between May 27 and June 8, 2020.

2.2.1. Garden access, gardening, and garden usage

The COVID-19 survey contained items about garden access, garden activities, and garden usage frequency compared with before lockdown, as follows: (a) *Do you have a garden (including access to a shared garden) or allotment?* (no, yes-garden, yes-allotment); (b) *If yes, what do you do in the garden/allotment?* (gardening yes/no, relaxing yes/no); (c) *Compared with before COVID-19 measures were introduced, how often do you currently use your garden/allotment?* (much more often now, slightly more often now, about the same now, slightly less now, much less now).

2.2.2. Self-rated health measures

Four self-rated health outcome variables (physical health; emotional and mental health; anxiety about COVID-19; sleep quality) were derived from questions in the COVID-19 survey:

Physical health was measured by a single question "*In general, since the COVID-19 measures were introduced (March 23, 2020), would you say your physical health was …"* Responses were on a 5–point scale (excellent, very good, good, fair, poor).

Emotional and mental health was measured by a single question "*In general, since the COVID-19 measures were introduced (March 23, 2020), would you say your emotional and mental health was …"* Responses were on a 5–point scale (excellent, very good, good, fair, poor).

Anxiety about COVID-19 was measured by a single question "*In the last two weeks, how often have you felt nervous or stressed because of COVID-19?* Responses were on a 4–point scale (never, some of the time, most of

the time, all of the time).

Sleep quality was measured by a single question "*During the past month, how would you rate your sleep quality overall*?" taken from the Pittsburgh Sleep Quality Index (Buysse et al., 1989). Responses were on a 4–point scale (very bad, fairly bad, fairly good, very good).

A **composite health score** was calculated using responses from each of the four health outcomes and summing the category scores to provide a summary measure of overall wellbeing. As all self-rated health outcomes were negatively coded, a lower score represented better health.

2.2.3. Change in self-rated health measures

Participants were also asked to retrospectively rate three of the above health outcomes, according to how they felt before the COVID-19 measures were in place, in order to assess change in perceived health following the pandemic:

Physical health (pre-lockdown) was measured by a single question "*In general, before the COVID-19 measures were introduced (March 23, 2020), would you say your physical health was …"* Responses were on a 5–point scale (excellent, very good, good, fair, poor). A perceived change score was calculated by subtracting the "before" from the "since" measure whereby a positive change in response category (+1 or +2) represented a negative trend in health, 0 represented no change, and a negative change in response category (−1 or −2) represented a positive trend in health (given that lower values indicated better health).

Emotional and mental health (pre-lockdown) was measured by a single question "*In general, before the COVID-19 measures were introduced (March 23, 2020), would you say your emotional and mental health was …"* Responses were on a 5–point scale (excellent, very good, good, fair, poor). A perceived change score was calculated, as above.

Sleep quality change was measured using the single question "*Compared to before COVID-19 measures were introduced, is the quality of your sleep …*" Responses were on a 5–point scale (much better now, somewhat better now, about the same now, somewhat worse now, much worse now).

2.3. Covariates

We measured socio-demographic and health-related variables known to influence health outcomes. Living alone (yes/no) was measured at the time of the survey. Other socio-demographic variables were measured previously at study baseline (age 70), including education (years of formal full-time schooling), and occupational social class (coded as 1 (professional occupations) to 5 (manual occupations), using the highest obtained occupation) (Registrar General, 1980). Health and medical variables were taken from the most recent study assessment (2017–2019) at age 82. Body mass index (BMI) was calculated using nurse-measured height and weight during the most recent assessment phase. Anxiety and depressive symptoms were measured using the Hospital Anxiety and Depression Scale subscales: the HADS-A and HADS-D (Zigmond & Snaith, 1983); scores range from 0 to 21, and a higher score indicates more symptoms. Self-reported history of diabetes and cardiovascular disease (CVD) were collected during a medical history interview and binary coded (yes/no).

2.4. Statistical analyses

We used analysis of variance (ANOVA) and Chi-square tests to investigate the differences in socio-demographic and health-related variables according to three garden variables: gardening (yes/no); relaxing in the garden (yes/no); and garden usage since lockdown (more/same/less).

Due to the low number of respondents in some of the self-rated health response categories, categories were combined where necessary. For the physical health and the emotional and mental health variables, the original 5–level response categories (excellent, very good, good, fair, poor) were changed to 3–level response categories (1–excellent or very good, 2–good, 3–fair or poor). The sleep quality variable was changed from a 4–level response category (very good, fairly good, fairly bad, very bad) to a 3–level response category (1–very good, 2–fairly good, 3–fairly bad or very bad). The anxiety about COVID-19 variable was changed from a 3–level response category (never, some, most) to a 2–level response category (1–never, 2–some or most of the time). The composite health score was calculated by summing the four individual health scores. For the self-reported perceived change measures, the physical health and the emotional and mental health questions were recoded, as above, to a 3–level response (1–excellent or very good, 2–good, 3–fair or poor). The sleep quality change measure was recoded from the original 5–level response category (much better now, somewhat better now, about the same now, somewhat worse now, much worse now) to a 3–level response category (1–better, 2–about the same, 3–worse). The original and recoded variable data can be found in Supplementary Table 1.

To examine associations between predictor variables—gardening (yes/no), relaxing in the garden (yes/no), and frequency of garden usage (more/same/less)—and self-rated health outcomes, we used ordinal regression models. For each predictor variable, we built a separate model for each of the five health outcomes (physical health, emotional and mental health, anxiety about COVID-19, sleep quality, and a composite health score). Each model was adjusted for the following sociodemographic and health factors; sex; education; occupational social class; lives alone; anxiety and depressive symptoms; BMI; history of diabetes; history of CVD. The models were repeated for each of the three perceived change in self-rated health scores (physical health, emotional and mental health, and sleep quality). Unstandardised estimates, 95% confidence intervals (CI), and P-values refer to models adjusted for sociodemographic and health variables. Alpha was set at 0.05.

3. Results

3.1. Sample description

A total of 190 online survey questionnaires were completed during lockdown. No participants reported having a medically confirmed diagnosis of COVID-19, and four reported a suspected case based on symptoms. Two participants had missing garden data ($n = 1$) or health data ($n = 1$) and were excluded. Of the 188 respondents with valid data, 171 (91%) had access to a garden (own or shared), and no participants reported having an allotment. Given the low number of participants with no garden access (8%) versus with garden access, we excluded those participants from the analyses. The current sample had a mean age of 84 ($sd = 0.5$) years and 53% were male.

We report the characteristics of the current study sample ($n = 171$) according to the three garden variables: gardening (yes/no); relaxing in the garden (yes/no); and garden usage (more/same/less) compared with pre-lockdown (Table 1). Of the 171 respondents with access to a garden, 70% ($n = 119$) reported they used the garden for gardening activities and 30% ($n = 52$) were non-gardeners. Those who reported being a gardener were less likely to have a history of depressive symptoms ($P = 0.015$) or of CVD ($P = 0.008$), but nominally more likely to have a higher BMI ($P = 0.03$), than non-gardeners. There were no significant differences between gardeners and non-gardeners regarding gender, education, occupational social class, anxiety symptoms, living alone, or history of diabetes. Of the whole sample, 67% ($n = 115$) reported using a garden for relaxation and 33% ($n = 56$) did not. There were no significant differences in characteristics between those who use a garden for relaxing and those who do not. Garden usage during lockdown was categorised into three groups (more, same, less): 50% ($n = 86$) reported using the garden more frequently compared with pre-lockdown, 42% ($n = 72$) the same, and 8% ($n = 13$) less often. Socio-demographic and health characteristics did not significantly differ across categories of garden usage.

Table 1
Characteristics of the LBC1936 study COVID-19 survey sample by garden usage measures.

Variables	Gardening, yes (n = 119)	Gardening, no (n = 52)		Relaxing, yes (n = 115)	Relaxing, no (n = 56)		Garden usage, more (n = 86)	Garden usage, same (n = 72)	Garden usage, less (n = 13)	
	M ± SD	M ± SD	P	M ± SD	M ± SD	P	M ± SD	M ± SD	M ± SD	P
Age	84.0 ± 0.5	84.0 ± 0.5	0.66	84.0 ± 0.5	84.0 ± 0.5	0.15	83.9 ± 0.5	84.0 ± 0.5	84.1 ± 0.4	0.24
Education	11.2 ± 1.2	11.3 ± 1.1	0.47	11.2 ± 1.1	11.2 ± 1.2	0.70	11.3 ± 1.2	11.2 ± 1.2	11.2 ± 1.1	0.90
Anxiety	3.9 ± 3.0	3.7 ± 3.0	0.66	3.9 ± 3.1	3.6 ± 2.9	0.57	4.0 ± 3.0	3.7 ± 3.1	3.5 ± 2.6	0.79
Depression	2.5 ± 1.9	3.5 ± 2.8	0.015	2.7 ± 2.3	3.0 ± 2.2	0.38	2.6 ± 2.1	3.1 ± 2.5	2.8 ± 2.0	0.42
BMI	27.2 ± 3.4	25.5 ± 6.7	0.03	26.9 ± 5.1	26.5 ± 3.6	0.62	27.0 ± 3.7	26.4 ± 5.7	26.5 ± 4.6	0.70
	N (%)	N (%)		N (%)	N (%)		N (%)	N (%)	N (%)	
Gender			0.91			0.09				0.10
Male	63 (52.9)	28 (53.8)		56 (48.7)	35 (62.5)		40 (46.5)	46 (63.0)	6 (46.2)	
Female	56 (47.1)	24 (46.2)		59 (51.3)	21 (37.5)		46 (53.5)	27 (37.0)	7 (53.8)	
Live alone			0.53			0.26				0.55
Yes	42 (35.3)	21 (40.3)		39 (33.9)	24 (42.9)		33 (38.4)	28 (38.4)	3 (23.1)	
No	77 (64.7)	31 (59.6)		76 (66.1)	32 (57.1)		53 (61.6)	45 (61.6)	10 (76.9)	
Occupational			0.93			0.99				0.43
Social class										
1.0 (prof)	39 (33.1)	17 (32.7)		39 (33.1)	17 (32.7)		31 (36.0)	20 (27.8)	5 (38.5)	
2.0	49 (41.5)	24 (46.2)		48 (41.7)	25 (44.6)		36 (41.9)	32 (44.4)	6 (46.2)	
3.0	17 (14.4)	5 (9.6)		15 (13.0)	7 (12.5)		10 (11.6)	12 (16.7)	0 (0)	
3.5	11 (9.3)	5 (9.6)		11 (9.3)	5 (9.6)		7 (8.1)	8 (11.1)	1 (7.7)	
4.0	2 (1.7)	1 (1.9)		2 (1.7)	1 (1.9)		2 (2.3)	0 (0)	1 (7.7)	
5.0	0 (0)	0 (0)		0 (0)	0 (0)		0 (0)	0 (0)	0 (0)	
CVD, yes	40 (33.6)	28 (53.8)	0.008	41 (35.7)	27 (48.2)	0.17	29 (33.7)	33 (45.2)	6 (46.2)	0.36
Diabetes, yes	12 (10.1)	5 (9.6)	0.95	10 (8.7)	7 (12.5)	0.39	6 (7.0)	9 (12.3)	2 (15.4)	0.33

BMI, body mass index; prof, professional; CVD, cardiovascular disease. *P*-values derived from ANOVA or Chi-square tests where appropriate.

3.2. Correlations between self-reported health outcomes

The health outcomes were correlated with one another (data not presented) with the exception of physical health and sleep quality. Physical health and emotional/mental health were correlated $r = 0.45$ ($P < 0.001$), emotional/mental health and sleep quality were correlated $r = 0.21$ ($P = 0.02$), and emotional/mental health and anxiety about COVID-19 were correlated $r = 0.33$ ($P < 0.001$). The measures of change in physical and emotional/mental health were correlated $r = 0.34$ ($P < 0.001$), as were emotional/mental health change and sleep quality change $r = 0.27$ ($P = 0.003$). Change in physical health and change in sleep quality were not correlated.

Table 2
Ordinal regression models[a] predicting self-rated health outcomes, using measures of home garden usage.

	Est	95% CI	P
Physical health			
Gardening, yes/no	−0.07	−0.78, 0.64	0.84
Relaxing in garden, yes/no	0.27	−0.41, 0.95	0.43
Garden usage in lockdown, more/same/less	0.74	0.23, 1.25	**0.005**
Emotional & mental health			
Gardening, yes/no	0.58	−0.24, 1.40	0.16
Relaxing in garden, yes/no	0.04	−0.72, 0.79	0.93
Garden usage in lockdown, more/same/less	0.58	0.02, 1.13	**0.04**
Sleep quality			
Gardening, yes/no	−0.34	−1.01, 0.36	0.34
Relaxing in garden, yes/no	−0.22	−0.89, 0.46	0.53
Garden usage in lockdown, more/same/less	0.58	0.07, 1.09	**0.03**
Anxiety about COVID-19			
Gardening, yes/no	0.64	−0.19, 1.45	0.13
Relaxing in garden, yes/no	−0.58	−1.34, 0.18	0.14
Garden usage in lockdown, more/same/less	0.19	−0.37, 0.75	0.51
Composite health score			
Gardening, yes/no	0.21	−0.43, 0.85	0.52
Relaxing in garden, yes/no	−0.21	−0.82, 0.41	0.50
Garden usage in lockdown, more/same/less	0.79	0.32, 1.25	**0.001**

[a]Adjusted for age, sex, lives alone, education, occupational social class, body mass index, HADS-Anxiety score, HADS-Depression score, CVD, diabetes. Boldtype represents significant associations, $P < 0.05$.

3.3. Garden measures and self-rated health

Table 2 shows the results of regression models to test the associations between garden measures and self-reported health outcomes, adjusted for sex, education, occupational social class, lives alone, anxiety symptoms, depressive symptoms, BMI, history of diabetes, and history of CVD. Firstly, gardening vs non-gardening groups did not differ significantly in any of the health outcomes. Secondly, using the garden for relaxation vs not using a garden for relaxation was not associated with differences in health outcomes. However, participants reporting higher garden usage, compared with pre-lockdown, experienced more positive health outcomes: adjusted models show that increased garden usage was associated with better self-reported physical health (0.74 [95% CI: 0.23–1.25] P = 0.005), emotional and mental health (0.58 [95% CI: 0.02–1.13] P = 0.04), and sleep quality (0.58 [95% CI: 0.07–1.09] P = 0.03). Frequency of garden usage was not associated with levels of anxiety (being nervous or stressed) about COVID-19 over the previous two weeks (P = 0.51). A composite health score built using all four health outcomes was strongly associated with increased garden usage (0.79 [95% CI: 0.32–1.25] P = 0.001) where a lower score indicates better health. Supplementary Tables 2–4 present the distribution of responses across each health measure according to category of garden predictor variable.

3.4. Garden measures and change in self-rated health

Table 3 presents the results of regression models to test the associations between garden measures and perceived change in self-reported health outcomes, from pre-to during lockdown. Models were adjusted for sex, education, occupational social class, lives alone, anxiety symptoms, depressive symptoms, BMI, history of diabetes, and history of CVD, as before. None of the gardens variables were associated with perceived change in physical health, emotional and mental health, or sleep quality, from pre-lockdown levels. Supplementary Tables 2–4 present the distribution of responses across each measure of change according to category of garden predictor variable.

Table 3
Ordinal regression models[a] predicting change in self-rated health outcomes, using measures of home garden usage.

	Est	95% CI	P
Change in physical health[b]			
Gardening, yes/no	0.20	−0.88, 1.09	0.83
Relaxing in garden, yes/no	0.05	−0.87, 0.98	0.91
Garden usage in lockdown, more/same/less	−0.23	−0.93, 0.48	0.53
Change in emotional & mental health[b]			
Gardening, yes/no	0.45	−0.42, 1.32	0.31
Relaxing in garden, yes/no	0.15	−0.76, 0.97	0.71
Garden usage in lockdown, more/same/less	0.07	−0.53, 0.66	0.83
Perceived change in sleep quality[c]			
Gardening, yes/no	0.08	−1.07, 1.16	0.94
Relaxing in garden, yes/no	−0.13	−1.16, 0.90	0.80
Garden usage in lockdown, more/same/less	−0.03	−0.83, 0.76	0.94

[a]Adjusted for age, sex, lives alone, education, occupational social class, body mass index, HADS-Anxiety score, HADS-Depression score, CVD, diabetes. [b]Change scores for physical health and emotional health were calculated as the difference between before and after COVID-19 responses. [c]Change in sleep quality was derived from responses to the item about perceived change in sleep quality since lockdown started. Boldtype represents significant associations, $P < 0.05$.

4. Discussion

In the present study, we have shown that older adults in Scotland spending more time in the garden during COVID-19 lockdown, compared with pre-lockdown, reported significantly better physical health, emotional and mental wellbeing, and sleep quality, after adjusting for a range of socio-demographic and health-related variables. The strongest associations were observed for self-rated physical health and a composite measure of health. The results suggest that the 'nature' of garden activity (i.e. whether gardening or relaxing) may not be as important to wellbeing during the pandemic as the amount of time spent in the garden. To our knowledge, we provide the first empirical evidence of a link between home garden use and greater wellbeing during the COVID-19 pandemic. In these unprecedented times of uncertainty and stress, domestic gardens may provide an outlet for mental activity as well as boosting physical health, especially for older people under extended home quarantine.

The current study provides further support for the notion that access to private outdoor green space has benefits for health and wellbeing (Brindley et al., 2018; de Bell et al., 2020) and extends the previous literature by identifying associations in an exclusively elderly cohort. Our results are consistent with those of de Bell et al., who reported higher evaluative wellbeing in those with access to private outdoor space in a population-representative sample of 7814 English adults, aged 16–65+, from the Monitor of Engagement with the Natural Environment (MENE) survey (de Bell et al., 2020). Subjective wellbeing is an important outcome in its own right; importantly, it has also been consistently shown to be an independent predictor of health and longevity (Diener & Chan, 2011), particularly for older adults (Wiest, Schüz, Webster, & Wurm, 2011). A further study, using UK census data, identified a link between garden size and population health; people with larger gardens had better self-reported general health (Brindley et al., 2018). Though the present study did not assess garden size, there were no sociodemographic differences between garden usage groups. As such, spending time in the garden may contribute to reducing health inequality within populations through the provision of equal opportunities to interact with green space and nature (Dennis & James, 2017). Below we discuss several potential pathways through which home gardens could improve respondents' health.

First, spending time in a garden involves some degree of physical activity, which promotes physical strength, fitness and flexibility, as well as offering additional psychological health benefits (Wang & MacMillan, 2013). Regular physical exercise contributes to healthy ageing (McPhee et al., 2016) and reduces the risk of a range of chronic diseases (Leskinen et al., 2018). Here, we observed an association of better self-reported physical health with more garden use. Despite this, we did not find any significant differences in rates of CVD, diabetes or BMI, according to time spent in the garden. One reason could be that we measured current garden usage compared with before the COVID-19 pandemic hit, rather than total time spent in the garden. Therefore, we were unable to account for level of habitual garden usage, which is likely to be associated with general health. As a result of COVID-19 lockdown measures, opportunities for older adults to exercise have been greatly impacted (Cellini et al., 2020). Gentle exercise is essential for older people to maintain adequate physiological function and health status during quarantine (Jiménez-Pavón, Carbonell-Baeza, & Lavie, 2020). A domestic garden represents a potentially important resource for maintaining basic physical activity at home.

Second, domestic gardens, along with other types of publicly accessible urban greenspace, provide people with an opportunity to interact directly with nature. Exposure to nature benefits psychological health, wellbeing, and quality of life (Cox & Gaston, 2016; Dean et al., 2018; Maller, Townsend, Pryor, Brown, & St Leger, 2006; White et al., 2019) through mechanistic pathways established by classic early research, namely attention restoration theory (Kaplan, 2001) and stress reduction (via emotion regulation) theory (Ulrich et al, 1991). One recent study reported that 73% of individuals have experienced low mood during the pandemic, and the incidence of anxiety and insomnia is high (Brooks et al., 2020). We observed a positive link between an increase in time spent in the garden during lockdown and sleep quality in our sample, a finding supported by studies which have concluded that the natural environment is a critical factor for sleep quality and quantity in adults (Grigsby-Toussaint et al., 2015; Shin, Parab, An, & Grigsby-Touissant, 2020) and older people specifically (>60 years) (Sia et al., 2020). In contrast, we found no association between garden use and reduced anxiety about COVID-19. However, only 2% of participants reported feeling anxious about COVID-19 most of the time, and 35%, some of the time. That the majority of our sample (64%) reported 'never' feeling anxious about COVID-19 across the preceding two-week period, could be considered a positive finding here, and suggests that older people may be more resilient to worrying about the effects of the pandemic. Whether a similar association is found in the general population, remains unclear at present.

Third, domestic gardens provide regular access to sunshine and fresh air which bring indirect benefits on health, including aiding sleeping and eating patterns (Düzgün & Durmaz Akyol, 2017; Park, Shoemaker, & Haub, 2009). Exposure to sunlight is associated with increased vitamin D, a deficiency of which is highly prevalent among older Scottish adults (Zgaga et al., 2011), and with improved mood (Okereke & Singh, 2016; Stewart & Hirani, 2010). The lockdown period coincided with the sunniest UK spring on record (Met Office, 2020) and may partly explain why those spending more time in the garden over this period reported better overall physical health and sleep quality.

Finally, spending time in the garden may provide people with opportunities to interact with neighbours, whilst obeying social distancing, thus promoting a sense of community and social ties (De Vries, Van Dillen, Groenewegen, & Spreeuwenberg, 2013). Increased social cohesion has been identified as an underlying mechanism behind the relationship between green space and health (Groenewegen, van den Berg, Maas, Verheij, & de Vries, 2012; Maas et al., 2009) and it is known to be a key determinant of psychological wellbeing in older adults (Choi & Matz-Costa, 2018; Cramm, Van Dijk, & Nieboer, 2013). Here, we were unable to test the association between garden use and social benefits directly. However, the current study was conducted in the city of Edinburgh where over half the residents live in tenements with shared back greens (Scotland's Census, 2011). Such communal green spaces increase social engagement and social support among neighbours, and have been found to reduce feelings of isolation among older people (Tyvimaa, 2011).

Gardening was not associated with more beneficial health outcomes; gardeners and non-gardeners reported a similar level of health. These results are in contrast with those of other studies (Moeller, King, Burr, Gibbs, & Gomersall, 2018; Scott, Masser, & Pachana, 2020; Soga, Cox, et al., 2017), and a meta-analysis (Soga, Gaston, & Yamaura, 2017) which found that gardening activity is associated with enhanced physical health and wellbeing in older people. At age 84, many of our sample may have reduced physical capacity or strength required for kneeling, operating gardening tools, and manipulating the ground, but our survey did not allow us to characterise variance in how strenuously people garden. Furthermore, our single measure of gardening did not take into account frequency or duration of gardening, i.e. on how many occasions and for how long participants perform gardening activities per week. However, regardless of garden activities, some previous reports suggest that merely having access to a garden, or even being able to look out at a garden, i.e. having a green view, has therapeutic benefits (Burton, Mitchell, & Stride, 2015), which may include lowered blood pressure, stress reduction, better immune functioning, and increased subjective vitality (Ulrich, 1984).

The main limitation of our study is the cross-sectional design, where exposures and outcomes were measured in participants at the same single time-point, and therefore we are unable to establish cause and effect relationships. We cannot discount the possibility that the results are bidirectional, i.e. existing physical and emotional health problems impact participants' ability to use a garden rather than vice versa. Though, as reported, garden usage during lockdown was not associated with a history of disease or depressive or anxiety symptoms, measured at a previous study assessment and prior to the pandemic, suggesting the results may not due to reverse causation. Second, the distribution of responses was uneven across categories including garden usage frequency, for which a low number reported using the garden less over lockdown. Third, although we considered a range of socio-demographic and health-related variables in our analyses, there may be other factors affecting health outcomes. Fourth, we were only able to collect responses from participants with internet access and a certain level of technology proficiency, and as such, our sample may be skewed toward those from higher socio-economic status backgrounds. Finally, we did not correct for multiple comparisons, which may have increased the potential for Type I error, i.e. the erroneous rejection of the null hypothesis.

Despite these limitations, our results suggest that domestic gardens may help to maintain the health of older people during the COVID-19 pandemic. This was an exploratory study with, for the most part, relatively modest effect sizes. As an ongoing longitudinal study, we will be able to investigate these associations further, with follow-up surveys planned as lockdown is eased. This is advantageous given the potential for further lockdown re-instatement at a local or national level, and that the wider effects of the pandemic and associated restrictions on public health, and the economy, may not become apparent until a later point. The results of the current study may also provide insights into the relationship between domestic green space and health more generally, i.e. beyond pandemics, and point to the increased acknowledgement of gardens in health promotion. Future studies are warranted which investigate the effects of a home garden on promoting resilience, by moderating the relationship between life stressors and important health outcomes.

5. Conclusions

Global efforts to reduce the transmission of COVID-19 have had unintended adverse consequences on health and wellbeing. There is a growing need to become better informed about lifestyle measures to mitigate these impacts especially among more vulnerable groups, now, and in future phases of the pandemic. Our results suggest that spending time in the garden may be an important health resource during the COVID-19 crisis, especially for older people who may be experiencing the consequences of prolonged and strict social distancing guidelines on psychological and physical health, more severely than other sectors of the population.

Declarations of interest

None.

CRediT authorship contribution statement

Janie Corley: Conceptualization, Methodology, Formal analysis, Investigation, Visualization, Writing - original draft. **Judith A. Okely:** Investigation, Writing - review & editing. **Adele M. Taylor:** Project administration, Investigation, Writing - review & editing. **Danielle Page:** Investigation, Writing - review & editing. **Miles Welstead:** Investigation, Writing - review & editing. **Barbora Skarabela:** Writing - review & editing. **Paul Redmond:** Data curation, Writing - review & editing. **Simon R. Cox:** Project administration, Funding acquisition, Supervision, Writing - review & editing. **Tom C. Russ:** Supervision, Funding acquisition, Writing - review & editing.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jenvp.2020.101545.

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Data availability

Data from this study will be made available upon reasonable request.

References

Ahmadpoor, N., & Shahab, S. (2020). Realising the value of greenspace: A planners' perspective on the COVID-19 pandemic. Article 10.3828/tpr *Town Planning Review*, 37 (in press).

Balanzá–Martínez, V., Atienza–Carbonell, B., Kapczinski, F., & De Boni, R. B. (2020). Lifestyle behaviours during the COVID-19–time to connect. *Acta Psychiatrica Scandinavica, 141*, 399–400. https://doi.org/10.1111/acps.13177

de Bell, S., White, M., Griffiths, A., Darlow, A., Taylor, T., Wheeler, B., et al. (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*. https://doi.org/10.1016/j.landurbplan.2020.103836. Article 103836.

Brindley, P., Jorgensen, A., & Maheswaran, R. (2018). Domestic gardens and self-reported health: A national population study. *International Journal of Health Geographics, 17*. https://doi.org/10.1186/s12942-018-0148-6. Article 31.

Brooke, J., & Jackson, D. (2020). Older people and COVID-19: Isolation, risk and ageism. *Journal of Clinical Nursing, 29*, 2044–2046. https://doi.org/10.1111/jocn.15274

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

Burton, E., Mitchell, L., & Stride, C. (2015). Bed of roses? The role of garden space in older people's well-being. *Proceedings of the Institution of Civil Engineers-Urban Design and Planning, 168*, 164–173. https://doi.org/10.1680/udap.14.00030

Buysse, D. J., Reynolds, C. F., III, Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*, 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Cellini, N., Canale, N., Mioni, G., & Costa, S. (2020). Changes in sleep pattern, sense of time and digital media use during COVID-19 lockdown in Italy. *Journal of Sleep Research.* , Article e13074. https://doi.org/10.1111/jsr.13074

Cheval, B., Sivaramakrishnan, H., Maltagliati, S., Fessler, L., Forestier, C., Sarrazin, P., & Boisgontier, M. P. (2020). Relationships between changes in self-reported physical activity and sedentary behaviours and health during the coronavirus (COVID-19) pandemic in France and Switzerland. *Journal of Sports Sciences*, 1–6. https://doi.org/10.1080/02640414.2020.1841396

Choi, Y. J., & Matz-Costa, C. (2018). Perceived neighborhood safety, social cohesion, and psychological health of older adults. *The Gerontologist, 58*, 196–206. https://doi.org/10.1093/geront/gnw187

Cohen-Cline, H., Turkheimer, E., & Duncan, G. E. (2015). Access to green space, physical activity and mental health: A twin study. *Journal of Epidemiology & Community Health, 69*, 523–529. https://doi.org/10.1136/jech-2014-204667

Coombes, E., Jones, A. P., & Hillsdon, M. (2010). The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Social Science & Medicine, 70*, 816–822. https://doi.org/10.1016/j.socscimed.2009.11.020

Cox, D. T., & Gaston, K. J. (2016). Urban bird feeding: Connecting people with nature. *PloS One, 11*, Article e0158717. https://doi.org/10.1371/journal.pone.0158717. Article.

Cramm, J. M., Van Dijk, H. M., & Nieboer, A. P. (2013). The importance of neighborhood social cohesion and social capital for the well being of older adults in the community. *The Gerontologist, 53*, 142–152. https://doi.org/10.1093/geront/gns052

De Vries, S., Van Dillen, S. M., Groenewegen, P. P., & Spreeuwenberg, P. (2013). Streetscape greenery and health: Stress, social cohesion and physical activity as mediators. *Social Science & Medicine, 94*, 26–33. https://doi.org/10.1016/j.socscimed.2013.06.030

Dean, J. H., Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Barber, E., & Fuller, R. A. (2018). Is nature relatedness associated with better mental and physical health? *International Journal of Environmental Research and Public Health, 15*. https://doi.org/10.3390/ijerph15071371. Article 1371.

Dennis, M., & James, P. (2017). Evaluating the relative influence on population health of domestic gardens and green space along a rural-urban gradient. *Landscape and Urban Planning, 157*, 343–351. https://doi.org/10.1016/j.landurbplan.2016.08.009

Diener, E., & Chan, M. Y. (2011). Happy people live longer: Subjective well-being contributes to health and longevity. *Applied Psychology: Health and Well-Being, 3*, 1–43. https://doi.org/10.1111/j.1758-0854.2010.01045.x

Düzgün, G., & Durmaz Akyol, A. (2017). Effect of natural sunlight on sleep problems and sleep quality of the elderly staying in the nursing home. *Holistic Nursing Practice, 31*, 295–302. https://doi.org/10.1097/HNP.0000000000000206

Ferrini, F., & Gori, A. (2020). Cities after COVID-19: How trees and green infrastructures can help shaping a sustainable future. *Ri-Vista*. https://doi.org/10.13128/rv-8553 (in press) www.fupress.net/index.php/ri-vista/.

Galea, S., Merchant, R. M., & Lurie, N. (2020). The mental health consequences of COVID-19 and physical distancing: The need for prevention and early intervention. *JAMA Internal Medicine, 180*, 817–818. https://doi.org/10.1001/jamainternmed.2020.1562

Grigsby-Toussaint, D. S., Turi, K. N., Krupa, M., Williams, N. J., Pandi-Perumal, S. R., & Jean-Louis, G. (2015). Sleep insufficiency and the natural environment: Results from the US behavioral risk factor surveillance system survey. *Preventive Medicine, 78*, 78–84. https://doi.org/10.1016/j.ypmed.2015.07.011

Groenewegen, P. P., van den Berg, A. E., Maas, J., Verheij, R. A., & de Vries, S. (2012). Is a green residential environment better for health? If so, why? *Annals of the Association of American Geographers, 102*, 996f–1003. https://doi.org/10.1080/00045608.2012.674899

Houlden, V., Weich, S., de Albuquerque, J. P., Jarvis, S., & Rees, K. (2018). The relationship between greenspace and the mental wellbeing of adults: A systematic review. *PloS One, 13*, Article e0203000. https://doi.org/10.1371/journal.pone.0203000. Article.

Jiménez-Pavón, D., Carbonell-Baeza, A., & Lavie, C. J. (2020). Physical exercise as therapy to fight against the mental and physical consequences of COVID-19 quarantine: Special focus in older people. *Progress in Cardiovascular Diseases, 63*, 386–388. https://doi.org/10.1016/j.pcad.2020.03.009

Kaplan, S. (2001). Meditation, restoration, and the management of mental fatigue. *Environment and Behavior, 33*, 480–506. https://doi.org/10.1177/00139160121973106

Leskinen, T., Stenholm, S., Aalto, V., Head, J., Kivimäki, M., & Vahtera, J. (2018). Physical activity level as a predictor of healthy and chronic disease-free life expectancy between ages 50 and 75. *Age and Ageing, 47*, 423–429. https://doi.org/10.1093/ageing/afy016

Maas, J., Van Dillen, S. M., 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

Maller, C., Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2006). Healthy nature healthy people:'contact with nature'as an upstream health promotion intervention for populations. *Health Promotion International, 21*, 45–54. https://doi.org/10.1093/heapro/dai032

Marselle, M. R., Warber, S. L., & Irvine, K. N. (2019). Growing resilience through interaction with nature: Can group walks in nature buffer the effects of stressful life events on mental health? *International Journal of Environmental Research and Public Health, 16*. https://doi.org/10.3390/ijerph16060986. Article 986.

McPhee, J. S., French, D. P., Jackson, D., Nazroo, J., Pendleton, N., & Degens, H. (2016). Physical activity in older age: Perspectives for healthy ageing and frailty. *Biogerontology, 17*, 567–580. https://doi.org/10.1007/s10522-016-9641-0

Met Office. (2020). Spring 2020: The sunniest on record in the UK. Retrieved from https://blog.metoffice.gov.uk/2020/05/29/spring-2020-the-sunniest-on-record-in-the-uk/. (Accessed 13 July 2020) Accessed.

Milligan, C., Gatrell, A., & Bingley, A. (2004). 'Cultivating health': Therapeutic landscapes and older people in northern england. *Social Science & Medicine, 58*, 1781–1793. https://doi.org/10.1016/S0277-9536(03)00397-6

Moeller, C., King, N., Burr, V., Gibbs, G. R., & Gomersall, T. (2018). Nature-based interventions in institutional and organisational settings: A scoping review. *International Journal of Environmental Health Research, 28*, 293–305. https://doi.org/10.1080/09603123.2018.1468425

Mytton, O. T., Townsend, N., Rutter, H., & Foster, C. (2012). Green space and physical activity: An observational study using health survey for england data. *Health & Place, 18*, 1034–1041. https://doi.org/10.1016/j.healthplace.2012.06.003

Okereke, O. I., & Singh, A. (2016). The role of vitamin D in the prevention of late-life depression. *Journal of Affective Disorders, 198*, 1–14. https://doi.org/10.1016/j.jad.2016.03.022

Park, S. A., Shoemaker, C. A., & Haub, M. D. (2009). Physical and psychological health conditions of older adults classified as gardeners or nongardeners. *HortScience, 44*, 206–210. https://doi.org/10.21273/HORTSCI.44.1.206

Pfefferbaum, B., & North, C. S. (2020). Mental health and the Covid-19 pandemic. *New England Journal of Medicine, 383*, 510–512. https://doi.org/10.1056/NEJMp2008017

Pope, D., Tisdall, R., Middleton, J., Verma, A., Van Ameijden, E., Birt, C., & Bruce, N. G. (2018). Quality of and access to green space in relation to psychological distress: Results from a population-based cross-sectional study as part of the EURO-URHIS 2 project. *The European Journal of Public Health, 28*, 35–38. https://doi.org/10.1093/eurpub/ckv094

Registrar General. (1980). *Classification of occupations*. London: HM Stationary Office.

Scotland's Census. (2011). Retrieved from https://www.scotlandscensus.gov.uk/news/census-2011-key-results-households-and-families-and-method-travel-work-or-study-scotland. (Accessed 11 November 2020) Accessed.

Scottish Council for Research in Education Mental Survey Committee. (1949). *The trend of scottish intelligence: A comparison of the 1947 and 1932 surveys of the intelligence of eleven-year-old pupils* (Vol. 30). University of London Press.

Scottish Government. (2020). *People advised to limit social contact*. Retrieved from https://www.gov.scot/news/people-advised-to-limit-social-contact/. (Accessed 13 July 2020) Accessed.

Scott, T. L., Masser, B. M., & Pachana, N. A. (2020). Positive aging benefits of home and community gardening activities: Older adults report enhanced self-esteem, productive endeavours, social engagement and exercise. *SAGE Open Medicine, 8*, 1–13. https://doi.org/10.1177/2050312120901732

Shin, J. C., Parab, K. V., An, R., & Grigsby-Toussaint, D. S. (2020). Greenspace exposure and sleep: A systematic review. *Environmental Research, 182*. https://doi.org/10.1016/j.envres.2019.109081. Article 109081.

Sia, A., Tam, W. W., Fogel, A., Kua, E. H., Khoo, K., & Ho, R. C. (2020). Nature-based activities improve the well-being of older adults. *Scientific Reports, 10*. https://doi.org/10.1038/s41598-020-74828-w. Article 18178.

Soga, M., Cox, D. T., Yamaura, Y., Gaston, K. J., Kurisu, K., & Hanaki, K. (2017). Health benefits of urban allotment gardening: Improved physical and psychological well-being and social integration. *International Journal of Environmental Research and Public Health, 14*. https://doi.org/10.3390/ijerph14010071. Article 71.

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

Stewart, R., & Hirani, V. (2010). Relationship between vitamin D levels and depressive symptoms in older residents from a national survey population. *Psychosomatic Medicine, 72*, 608–612. https://doi.org/10.1097/PSY.0b013e3181e9bf15 [reference anonymised for review].

Taylor, A. M., Pattie, A., & Deary, I. J. (2018). Cohort profile update: the Lothian Birth Cohorts of 1921 and 1936. *International Journal of Epidemiology, 47*. https://doi.org/10.1093/ije/dyy022, 1042–1042r.

Twohig-Bennett, C., & Jones, A. (2018). The health benefits of the great outdoors: A systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research, 166*, 628–637. https://doi.org/10.1016/j.envres.2018.06.030

Tyvimaa, T. (2011). Social and physical environments in senior communities: The Finnish experience. *International Journal of Housing Markets and Analysis, 4*, 197–209. https://doi.org/10.1108/17538271111152997

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science, 224*, 420–421. https://doi.org/10.1126/science.6143402

Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., & Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*, 201–230. https://doi.org/10.1016/S0272-4944(05)80184-7

Van den Berg, A. E., Maas, J., Verheij, R. A., & Groenewegen, P. P. (2010). Green space as a buffer between stressful life events and health. *Social Science & Medicine, 70*, 1203–1210. https://doi.org/10.1016/S0272-4944(05)80184-7

Van den Berg, M., van Poppel, M., van Kamp, I., Andrusaityte, S., Balseviciene, B., Cirach, M., & Smith, G. (2016). Visiting green space is associated with mental health and vitality: A cross-sectional study in four european cities. *Health & Place, 38*, 8–15. https://doi.org/10.1016/j.healthplace.2016.01.003

Van den Berg, M., Wendel-Vos, W., van Poppel, M., Kemper, H., van Mechelen, W., & Maas, J. (2015). Health benefits of green spaces in the living environment: A

systematic review of epidemiological studies. *Urban Forestry and Urban Greening, 14*, 806–816. https://doi.org/10.1016/j.ufug.2015.07.008

Vindegaard, N., & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity, 89*, 539–542. https://doi.org/10.1016/j.bbi.2020.05.048

Wang, D., & MacMillan, T. (2013). The benefits of gardening for older adults: A systematic review of the literature. *Activities, Adaptation & Aging, 37*, 153–181. https://doi.org/10.1080/01924788.2013.784942

Webb, L. (2020). Covid-19 lockdown: A perfect storm for older people's mental health. *Journal of Psychiatric and Mental Health Nursing*. https://doi.org/10.1111/jpm.12644 (Published online April 30, 2020).

Weeland, J., Laceulle, O. M., Nederhof, E., Overbeek, G., & Reijneveld, S. A. (2019). The greener the better? Does neighborhood greenness buffer the effects of stressful life events on externalizing behavior in late adolescence? *Health & Place, 58*. https://doi.org/10.1016/j.healthplace.2019.102163. Article 102163.

White, M. P., Alcock, I., Grellier, J., Wheeler, B. W., Hartig, T., Warber, S. L., & Fleming, L. E. (2019). Spending at least 120 minutes a week in nature is associated with good health and wellbeing. *Scientific Reports, 9*. https://doi.org/10.1038/s41598-019-44097-3. Article 7730.

WHO. (2019). Coronavirus disease 2019 (COVID-19): Situation report - 89 (18 april 2020). Retrieved from https://reliefweb.int/report/world/coronavirus-disease-2019-covid-19-situation-report-89-18-april-2020. (Accessed 13 July 2020) Accessed.

Wiest, M., Schüz, B., Webster, N., & Wurm, S. (2011). Subjective well-being and mortality revisited: differential effects of cognitive and emotional facets of well-being on mortality. *Health Psychology, 30*, 728–735. https://doi.org/10.1037/a0023839

World Medical Association. (2013). Declaration of Helsinki: Ethical principles for medical research involving human subjects. *Journal of the American Medical Association, 310*, 2191–2194. https://doi.org/10.1001/jama.2013.281053

Zgaga, L., Theodoratou, E., Farrington, S. M., Agakov, F., Tenesa, A., Walker, M., & Kyle, J. (2011). Diet, environmental factors, and lifestyle underlie the high prevalence of vitamin D deficiency in healthy adults in Scotland, and supplementation reduces the proportion that are severely deficient. *Journal of Nutrition, 141*, 1535–1542. https://doi.org/10.3945/jn.111.140012

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*, 361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x