How important are home gardens and spending time outside for well-being during the COVID-19 pandemic? Comparing and combining data from 2020 to 2021

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ABSTRACT

Recent studies find that people's use of nature during the COVID-19 pandemic, including home gardens and public green spaces, correlates positively with measures of subjective well-being. To further investigate this relationship, we replicated a study conducted in 2020 in Germany, which focused on comparing garden owners and non-garden owners. Almost exactly one year after the original study in 2020, we collected matched data from n = 490 people living in Germany in 2021. We again found that garden owners had significantly greater life satisfaction and better mental well-being than non-garden owners. Indeed, the second study reproduced many of the 2020 findings. Garden owners and non-garden owners again differed on several sociodemographic factors. For instance, garden owners were more likely to have a higher income and less likely to live alone. Additionally, garden owners spent substantially more time in their garden than non-garden owners spent in public green spaces. We also replicated most findings regarding personality traits—namely, garden owners were more extroverted, more conscientious, less neurotic, and had more agency than non-garden owners. By pooling the data from 2020 to 2021, our hierarchical regression analyses supported the main conclusion from the original study, i.e., garden owners' greater life satisfaction and better mental well-being were attributable to the differences between the groups in sociodemographic factors (e.g., higher income), time spent outside (e.g., longer hours), and personality traits (e.g., less neuroticism). Overall, we found lower levels of life satisfaction in 2021 than in 2020.

1. Introduction

1.1. Brief summary of the main objectives

Increasingly, studies focus on the effect on well-being of having used nature during the COVID-19 pandemic. They typically find that peoples' use of nature, including home gardens and public green spaces, correlates positively with measures of subjective well-being (Poortinga et al., 2021; Theodorou et al., 2021). Evidence is novel in these unprecedented times, and data is just emerging, creating a pronounced need to further nuance these study findings. To situate the position of this research, our main aim was to replicate a 2020 study in Germany (Lehberger et al., 2021). The original study compared two distinct groups, garden owners and non-garden owners. Lehberger et al. (2021) found evidence that the two groups systematically differed regarding several socioeconomic variables, the time spent outside in green spaces, and personality traits.

The results suggested that all three aspects are valuable for understanding levels of mental well-being and life satisfaction. Controlling for these factors, differences between the groups' life satisfaction and mental well-being, i.e., garden owners having higher levels of both, disappeared. We aimed to replicate these central findings by collecting a matched sample one year after the original study. While we replicated the original study as closely as possible, this is a survey across two years within which the world changed rapidly. Thus, each difference in the results of the two samples might also be a function of factors we did not assess.

1.2. Well-being and nature

The literature has established the positive effect of nature and green spaces on different measures of well-being, not only in single studies but also in reviews and meta-analyses. For instance, one review study

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concluded that the effects of nature on mental and physical health have been thoroughly demonstrated, and the time spent in natural systems positively affected mental health (Russell et al., 2013). A meta-analysis examined the relationship between nature-connectedness and happiness (Capaldi, et al., 2014). It found that those individuals more connected to nature tended to have higher life-satisfaction scores than those less so. Another meta-analysis concluded that gardening in nature had a wide variety of positive effects on depression and anxiety symptoms and stress, enhancing the quality of life (Soga et al., 2017). Douglas et al. (2017) reviewed the evidence linking health, well-being, and green space, using a life-course approach. They found that as part of the wider environmental context, urban green spaces typically promote health and well-being across the life course.

More recently, several studies have reflected on people's use of nature and its effect on their well-being during the COVID-19 pandemic. Corley et al. (2021) focused on older adults in Scotland and the effect of spending time in the home garden during the COVID-19 lockdown. Those participants who reported having spent more lockdown time in home gardens than they had previously also reported significantly better emotional and mental well-being. In addition, during the lockdown in Italy, a relationship appeared between gardening and lower levels of psychopathological distress through decreased COVID-19-related distress (Theodorou et al., 2021). Robinson et al. (2021) found that people (mostly respondents from England) spent more time in nature, visited it more often, and felt that nature helped them cope during the pandemic. Similarly, in Oslo, Norway, the spring-2020 five-week comprehensive lockdown showed increased use of urban green infrastructure, increasing recreational activity by 240% (Venter et al., 2021). A survey of UK participants during and after the first peak of the COVID-19 outbreak found an association between perceived access to public green space (e.g., a park or woodland) or reported access to a private garden and better subjective well-being and self-reported health (Poortinga et al., 2021). In Nanjing City, China, access to high-quality green parks tended to improve residents' expressed happiness (Cheng et al., 2021). While these studies share the detection of a positive effect on well-being resulting from using or accessing green spaces, they all took place in different countries, with different segments of the population, and at different points in time during the pandemic. Moreover, they were likely just the beginning of the literature; which behaviors, associations, and effects will persist during the pandemic remains an open question.

1.3. The present study: research goals and hypotheses

Our *first goal* was to systematically compare garden owners and non-garden owners in two different samples: the original 2020 sample and a matched sample from 2021. For this goal, we looked at the samples from 2020 to 2021 individually and checked whether the 2021 sample replicated the 2020 results. Thus, we first systematically compared garden owners' and non-garden owners' socioeconomic factors, personalities, and time spent outside. Then, we tested the key hypotheses:

H1. Non-garden owners had lower levels of (H1a) mental well-being and (H1b) life satisfaction during the pandemic.

Our *second goal* was to determine whether differences in socioeconomic factors provided the key to understanding the differences in mental well-being and life satisfaction scores during the pandemic. Regression results from the original study suggested the second hypothesis:

H2. Non-garden owners had lower levels of (H2a) mental well-being and (H2b) life satisfaction during the pandemic, even when controlling for differences in socioeconomic factors.

We tested these hypotheses with the 2021 sample and with a pooled sample that combined the data from 2020 to 2021.

The *third goal* was to understand potential further associations with

mental well-being and life satisfaction during the pandemic, for which we combined the data from 2020 to 2021. The original study, as well as the research that we describe above (e.g., Russel et al., 2013; White et al., 2019), indicates that time spent outside in nature is valuable for understanding differences in levels of subjective well-being, leading to the following hypothesis:

H3. Spending time outside during the pandemic in green spaces is positively associated with levels of (H3a) mental well-being and (H3b) life satisfaction.

In addition to time spent outside in nature, personality traits have long been linked to subjective well-being. Neuroticism especially has a strong negative relation to measures of subjective well-being (e.g., Anglim et al., 2020), which Lehberger et al. (2021) also found. Thus, we test the following hypothesis:

H4. Neuroticism is negatively associated with (H4a) mental well-being and (H4b) life satisfaction during the pandemic.

Recent evidence further suggests that life-satisfaction scores in Germany were lower in 2021 than in 2020 (Liebig & Kühne, 2021). Consequently, we add the following hypothesis:

H5. Levels of (H5a) mental well-being and (H5b) life satisfaction were lower in 2021 than they were in 2020.

To explore potential reasons why levels of subjective well-being differ between the years and whether they relate to time spent outside, we used the data collection year as a potential moderator.

Even when replicating studies as closely as possible and in controlled lab situations, many efforts to replicate past study findings fail (Camerer et al., 2018). In the case of the ongoing pandemic, the situation in 2021 in Germany was somewhat comparable to that of 2020. In May of both years, lockdowns were in place, but due to falling incidence rates, some regulations had started to loosen. Public green spaces were principally open in both years, and no nationwide curfews were in place. However, other external variables differed substantially in 2021, which may have affected key variables the original study used, such as life satisfaction, mental well-being, and time spent outside. First, vaccinations were principally available, albeit predominantly for older people and those at high risk for a severe course of the disease. Also, the rapid COVID-19 tests were sold in German supermarkets and pharmacies, opening the possibility for easier and more frequent testing for all citizens. Moreover, schools and kindergartens were open in most regions in Germany in 2021; in 2020 these institutions had mostly closed. All these factors may have led to changes in life satisfaction or well-being. Additionally, the weather in Germany during springtime 2021 included the coldest April in the last 40 years (DWD, 2021a) and the coldest May since 2010 (DWD, 2021b), colder on average than in the corresponding period in 2020. This may have negatively affected the time spent outside or mental well-being. Thus, overall, many uncontrollable external factors changed between 2020 and 2021. Arguably, a replication with a matched sample is still of particular importance to check whether, (i) the hypothesized differences between non-garden owners and garden owners and (ii) the identified associations between variables prevail, even if uncontrollable external factors changed.

2. Methods and material

2.1. Data collection and questionnaire

The data collection via an external panel provider took place online in Germany, from May 25 to 31, 2021, almost exactly one year after the collection in the original study. The median time to complete the survey was 10 min and 50 s. To incentivize participants, respondents received so-called "mingle points." Above a certain threshold, these could be exchanged for cash, converted into shopping vouchers, or donated to a nonprofit organization. We set quotas for age, gender, place of

residence, and household income, to make measurements comparable to those in the original study ("matched sample"; cf. Table 1). Participation was fully informed (informed consent), anonymous, voluntary, and in line with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Nonparticipation had no consequences beyond the nonreceipt of the full mingle points. Participants could have stopped the survey at any point and contacted the researchers with any inquiry or concern. In addition, we received a retroactive ethics approval from the legal department of the Hochschule Geisenheim University.

2.2. Data measurements

We recreated the measurements of the original study, so the only differences would be those related to participants and external variables (Brandt et al., 2014), such as time and weather. Thus, besides capturing independent variables in terms of sociodemographic factors, participants' personality traits, and time spent outside, we also captured two dependent variables, namely, "life satisfaction" and "mental well-being." A more detailed description of the measurements appears below. According to a power analysis for a two-tailed two-sample t-test regarding the difference between life satisfaction and mental well-being of garden and non-garden owners in 2020, with a power of 0.95 (alpha: 0.05), to detect 75% of the original effect sizes (Camerer et al., 2018) required at least 178 participants per group (Faul et al., 2007). Thus, our sample size in 2021 was large enough (cf. Table 1). We defined garden owners as those who owned a private home garden or were tenants of an allotment garden.

2.2.1. Dependent variables

We measured life satisfaction by using the same question as the 2020 research—"How satisfied are you at present, all in all, with your

Table 1
Systematic sociodemographic comparisons: 2020 vs. 2021; data from 2020 are published in Lehberger et al. (2021).

Characteristic	2020 n = 495 (%)	2021 n = 490 (%)	Comparison	
			Effect size	p-value
Age			0.031[a]	0.616[a]
18–29	22.2	21.6		
30–39	19.8	19.6		
40–49	20.8	20.0		
50–59	24.8	25.1		
60–65	12.3	13.7		
Gender			0.015[b]	0.633[b]
Women	49.1	50.6		
Men	50.9	49.4		
Size of residence			0.047[b]	0.141[b]
rural (<20,000 inhabitants)	45.1	40.4		
urban (>20,000 inhabitants)	54.9	59.6		
Net household income			0.107[a]	0.090[a]
€0-€1500	15.8	13.9		
€1501–€2499	22.4	20.0		
€2500–€4000	34.1	34.1		
>€4000	27.7	32.0		
Living alone			0.018[b]	0.570[b]
Yes	20.0	18.6		
No	80.0	81.4		
Full-time employed			0.045[b]	0.153[b]
Yes	60.8	56.3		
No	39.2	43.7		

[a] Two-Tailed Mann-Whitney U test, H0: both are identical, with effect size Cohen's d.
[b] Chi-squared test, (H0): there is no relationship with effect size Cramer's V.

life?"—presenting the participants with a response scale ranging from 0 (completely dissatisfied) to 10 (completely satisfied). To capture mental well-being, we again used the German version of the Warwick-Edinburgh Mental Well-being Scale (Lang & Bachinger, 2017). This scale includes 14 items that relate to the subjective experience of happiness and life satisfaction, as well as positive psychological functioning, good relationships with others, and self-realization (for the items, cf. Annex 1) (Stewart-Brown & Janmohamed, 2008). The final scale had a possible range from 14 to 70, the result of summing the responses to each of the 14 items using a 1-to-5-point scale.

2.2.2. Independent variables

Time spent outside: We reproduced the original questions by asking participants to indicate how many hours they spent outside on average per week in the spring of the current year, i.e., in March, April, and May, in different activities (leisure, sport, and—for garden owners—gardening), and added the hours together. We eliminated three data sets from our regression analyses, i.e., participants who reported having spent more than 168 h outside per week (i.e., obviously incorrect answers, as a week has 168 h). To conform with the measurement of the original study, we asked garden owners about their time spent in the garden and non-garden owners about their time spent in public green spaces. Additionally, participants were to rate the extent to which they spent "far less" (=1) to "far more" (=7) time in 2021 in the garden or in public green spaces doing sports and leisure activities, respectively, than in previous years.

Personality traits: We again used the MIDI Scale (Lachman & Weaver, 1997, pp. 1–9). The original study reported good reliability values. Thus, we captured the big five personality dimensions (openness, neuroticism, agreeableness, extraversion, and conscientiousness), as well as the trait "agency," via four-to-seven adjectives that participants had to judge on the extent to which the adjectives applied to them, using a response scale ranging from "a lot" (1) to "not at all" (4). For example, the four adjectives 'moody', 'worrying', 'nervous,' and 'calm' captured neuroticism. We recoded most statements so that higher numbers always indicated higher levels of the respective personality trait (Lachman & Weaver, 1997, pp. 1–9). Reliability tests indicated low reliability for neuroticism in 2021 (see Table 2).

Socioeconomic variables: Consistent with the original study, we used several standard socioeconomic controls. Accordingly, for "age," we compared four age groups to the reference group of 18–29-year-olds (30–39-year-olds; 40–49-year-olds; 50–59-year-olds; 60–65-year-olds). For "household income," we compared three groups to the reference group of those with ≤€1500 household income (€1501–€2499; €2500–€4000; >€4000). We used "gender," "living alone" and "employment" status as dummy variables, whereas "fear of job loss" was measured on a scale ranging from "no fear at all" = 1 to "a lot of fear" = 7.

2.3. Data analysis

Regarding the data-analysis process for identifying group differences between garden owners and non-garden owners (first research goal), we followed the original study and used the same group-comparison tests. Depending on the scale of the variable, these are either Two-Tailed Mann-Whitney U tests, Chi-squared tests, or two-tailed t-tests (c.f. Tables 3 and 4). To draw conclusions from the results, we primarily focused on the "statistical significance criterion" that Camerer et al. (2018) coined, i.e., the detection of a significant association ($p < 0.05$) in the same direction as the original study, using the same statistical tests. We also discussed differences in effect sizes between the years.

To test whether mental well-being and life satisfaction differed between the two groups, even if socioeconomic factors are kept constant (second research goal), we ran linear regressions on the dependent variables "mental well-being" and "life satisfaction." The variance inflation factors were <4 in all regression models, indicating that

Table 2
Systematic comparisons of further descriptive variables: 2020 vs. 2021, data from 2020 are published in Lehberger et al. (2021).

Variable/Scale (Mc Donald's Omega in 2020 and 2021)	2020			2021			Size effect	Comparison
	n	Mean	SD	n	Mean	SD	Cohen's d [95% CI] [a]	p-value[a]
Fear of job loss	495	2.60	1.78	490	2.13	1.16	0.28 [0.15, 0.40]	<0.00
Personality traits								
Extraversion (0.817; 0.817)	495	2.92	0.61	490	2.86	0.60	0.10 [-0.03, 0.22]	0.13
Agreeableness (0.843, 0.857)	495	3.14	0.59	490	3.15	0.59	−0.03 [-0.15, 0.10]	0.68
Agency (0.814, 0.801)	495	2.66	0.67	490	2.66	0.63	−0.00 [-0.13, 0.12]	0.96
Openness (0.792, 0.773)	495	2.85	0.56	490	2.85	0.52	0.00 [-0.12, 0.13]	0.97
Conscientiousness (0.714, 0.664)	495	3.24	0.59	490	3.23	0.53	0.03 [-0.10, 0.15]	0.65
Neuroticism (0.623, 0.489)*	495	2.34	0.68	490	2.25	0.57	0.13 [0.01, 0.26]	0.04
Hours spent per week in green spaces	490	14.35	17.49	487	14.76	18.35	−0.03 [-0.15, 0.10]	0.72
Change in time spent in green spaces								
Sport	495	4.26	1.37	490	3.71	1.32	0.41 [0.29, 0.54]	<0.00
Leisure time	495	4.03	1.21	490	4.07	1.49	−0.03 [-0.15, 0.10]	0.65
Life satisfaction	495	6.88	2.10	490	6.41	2.24	0.22 [0.10, 0.35]	<0.01
Mental well-being (0.912, 0.942)	495	48.75	9.08	490	49.26	10.21	−0.05 [-0.18, 0.07]	0.41

[a] Two-tailed *t*-test, H0: both are identical. *Cronbach's Alpha.

Table 3
Sociodemographic comparison within the samples (garden owners vs. non-garden owners), data from 2020 published in Lehberger et al. (2021).

Characteristic	2020					2021					Germans (18–65 years) in 2019
	Total sample (%)	Garden owners (%)	Non-garden owners (%)	Comparison		Total sample (%)	Garden owners (%)	Non-garden owners (%)	Comparison		
				Effect size	p-value				Effect size	p-value	
n	495	262	233			490	296	194			
Age				0.306[c]	<0.001[c]				0.284[c]	0.001[c]	
18–2	22.2	17.9	27.0			21.6	16.2	29.9			21.6[a]
30–39	19.8	17.6	22.3			19.6	19.3	20.1			20.6[a]
40–49	20.8	19.8	21.9			20.0	21.6	17.5			19.4[a]
50–59	24.8	31.3	17.6			25.1	28.7	19.6			25.7[a]
60–65	12.3	13.4	11.2			13.7	14.2	12.9			12.7[a]
Gender				0.141[d]	0.002[d]				0.023[d]	0.603[d]	
Women	49.1	55.7	41.6			50.6	49.7	52.1			49.0[b]
Men	50.9	44.3	58.4			49.4	50.3	47.9			51.0[b]
Size of residence				0.284[d]	<0.001[d]				0.284[d]	<0.001[d]	
rural (<20,000 inhabitants)	45.1	58.4	30.0			40.4	51.7	23.2			
urban (>20,000 inhabitants)	54.9	41.6	70.0			59.6	48.3	76.8			
Net household income				0.699[c]	<0.001[c]				0.586[c]	<0.001[c]	
€0-€1500	15.8	8.4	24.0			13.9	6.1	25.8			16.3[b]
€1501-€2499	22.4	15.3	30.5			20.0	17.9	23.2			18.6[b]
€2500-€4000	34.1	37.4	30.5			34.1	36.1	30.9			32.7[b]
>€4000	27.7	38.9	15.0			32.0	39.9	20.1			32.5[b]
Living alone				0.227[d]	<0.001[d]				0.289[d]	<0.001[d]	
Yes	20.0	11.5	29.6			18.6	9.5	32.5			21.2
No	80.0	88.5	70.4			81.4	90.5	67.5			78.8
Fulltime employed				0.031[d]	0.497[d]				0.103[d]	0.022[d]	
Yes	60.8	62.2	59.2			56.3	60.5	50.0			
No	39.2	37.8	40.8			43.7	39.5	50.0			

[a] Statistisches Bundesamt (2019).
[b] GESIS-Leibniz-Institut für Sozialwissenschaften (2019).
[c] Two-Tailed Mann-Whitney *U* test, H0: both are identical, with effect size Cohen's d.
[d] Chi-squared test, (H0): there is no relationship with effect size Cramer's V; Note: grey indicates that the statistical significance criterion is fulfilled (p < 0.05).

multicollinearity should not be an issue. The Breusch-Pagan test indicated that we could assume heteroscedasticity in both models. Consequently, robust standard errors were estimated, and we set the alpha value at p < 0.05.

To determine which further variables provided insights into why levels of mental well-being and life satisfaction differ (third research goal), we pooled the data from both years. As in the original study, we ran hierarchical linear regressions on our dependent variables, "mental well-being" and "life satisfaction" but also included a dummy variable for the year of the data collection (base year = 2020). We added three blocks of independent variables stepwise into the model, to evaluate their impact on the model fit and dependent variables:

- Block I: Sociodemographic control variables, including owning a garden and year of data collection;
- Block II: Time spent in the garden and in public greens;

Table 4

Comparison within the samples (garden owners vs. non-garden owners): further variables included in the regressions, data from 2020 are published in Lehberger et al. (2021).

Variable/Scale	2020								2021							
	Non-garden owners			Garden owners			Comparison		Non-garden owners			Garden owners			Comparison	
	n	Mean	SD	n	Mean	SD	Cohen's d [95% CI]	p-value[a]	n	Mean	SD	n	Mean	SD	Cohen's d [95% CI]	p-value[a]
Fear of job loss	233	2.84	1.91	262	2.39	1.64	0.26 [0.08, 0.43]	0.01	194	2.25	1.67	296	2.05	1.50	0.13 [-0.06, 0.31]]	0.17
Personality traits																
Extraversion	233	2.82	0.63	262	3.01	0.58	−0.32 [-0.50, −0.14]	<0.01	194	2.78	0.60	296	2.91	0.60	−0.21 [-0.40, −0.03]	0.02
Agreeableness	233	3.04	0.63	262	3.22	0.53	−0.31 [-0.49, −0.14]	<0.01	194	3.16	0.59	296	3.15	0.58	0.01 [-0.18, 0.19]	0.95
Agency	233	2.55	0.69	262	2.76	0.63	−0.32 [-0.50, −0.14]	<0.01	194	2.58	0.58	296	2.71	0.66	−0.22 [-0.40, −0.04]	0.02
Openness	233	2.75	0.59	262	2.94	0.53	−0.34 [-0.51, −0.16]	<0.01	194	2.81	0.52	296	2.87	0.52	−0.12 [-0.30, 0.06]	0.19
Conscientiousness	233	3.13	0.61	262	3.34	0.55	−0.37 [-0.55, −0.19]	<0.01	194	3.12	0.54	296	3.29	0.51	−0.32 [-0.50, −0.13]	<0.01
Neuroticism	233	2.42	0.69	262	2.26	0.66	0.24 [0.06, 0.41]	0.01	194	2.34	0.52	296	2.20	0.59	0.25 [0.07, 0.43]	<0.01
Hours spent per week in green spaces in March/April/May of the respective year (2020 or 2021)	229	9.91	16.69	261	18.24	17.27	−0.49 [-0.67, −0.31]	<0.01	194	9.79	16.19	293	18.05	18.97	−0.46 [-0.65, −0.28]	<0.01
Change in time spent in green spaces																
Leisure time	233	4.10	1.28	262	3.97	1.14	0.11 [-0.07, 0.28]	0.24	194	3.84	1.55	296	4.23	1.42	−0.26 [-0.44, −0.08]	0.01
Sports	233	3.73	1.40	262	4.74	1.16	−0.79 [-0.98, −0.61]	<0.01	194	3.52	1.52	296	3.83	1.15	−0.24 [-0.43, −0.06]	0.01
Life satisfaction	233	6.31	2.26	262	7.40	1.80	−0.54 [-0.72, −0.36]	<0.01	194	5.88	2.37	296	6.75	2.09	−0.40 [-0.58, −0.22]	<0.01
Mental well-being	233	46.55	9.01	262	50.71	8.69	−0.47 [-0.65, −0.29]	<0.01	194	47.50	10.87	296	50.41	9.61	−0.29 [-0.47, −0.11]	<0.01

Note: p-values for the two-tailed *t*-test and Cohen's d from the original study were newly calculated; grey indicates that the statistical significance criterion is fulfilled (p < 0.05).

[a] Two-tailed *t*-test, H0: both are identical. Note: Light blue highlight denotes significant differences.

- Block III: Personality traits.

Notably, adding more variables into a regression typically increases the R^2, even if only by chance. We used SPSS software version 28. The variance inflation factors were <4 in all regression models, indicating again that multicollinearity should not be an issue. The Breusch-Pagan test indicated that we could assume heteroscedasticity in all models. Consequently, we estimated robust standard errors and, again, set the alpha value at p < 0.05.

3. Results and discussion

3.1. Descriptive statistics of the two samples

Tables 1 and 2 depict a comparison between the samples from 2020 to 2021. The tables show that only a few captured variables differ significantly between the two years. Due to our matched sampling procedure, where we used the same quotas for gender, age, income, and region in 2021 as in 2020, there are no statistically significant differences in these variables. But also, further sociodemographic factors, such as "living alone," follow a similar distribution in both studies. Overall, our comparisons suggest that our intention to avoid differences in mental well-being and life satisfaction results, purely due to differences in sample structure, worked rather well.

Still, we see a few significant differences between the years. First, the fear of job loss is significantly lower in May 2021 than in the original study from May 2020. The German government financially supported employers during the pandemic, to buffer the potential effects of the COVID-19 crisis on the labor market. Thus, the decrease in fear of losing a job may be due to the pandemic not having as great a negative effect on the job market as people may have feared at its beginning. Second, results suggest that neuroticism was slightly less pronounced in the data from 2021. However, this may be due to the low reliability of this scale in 2021. Last, we found evidence that the time spent outside for sport was significantly lower in 2021. However, the time spent outside (calculated in hours) did not significantly differ between the years, somewhat surprising since the springtime in Germany was, on average, substantially colder in 2021 than in 2020 (DWD, 2021a; 2021b).

Overall, a clear trend toward an increase in time spent outside—for instance, as evidence from Robinson et al. (2021) and Venter et al. (2021) suggests—is not visible in our data.

Mental well-being scores did not significantly differ between the two years, but levels of life satisfaction were significantly lower in 2021 than in 2020. The latter finding supports the results of Liebig and Kühne (2021), who found that the average life-satisfaction score in Germany was lower in 2021 than in 2020.

3.2. Comparing garden owners and non-garden owners: research goal 1

Tables 3 and 4 show a comparison of the descriptive statistics for garden owners and non-garden owners in both years. Many significant differences between garden owners and non-garden owners manifested in the same direction in our current study. Accordingly, our results suggest:

- Non-garden owners again had statistically significantly lower scores for mental well-being (Cohen's d = −0.29) and life satisfaction (Cohen's d = −0.40) than garden owners. This is also comparable to evidence from Poortinga et al. (2021), who reported that access to a private garden was associated with better subjective well-being.
- Garden owners and non-garden owners again differed statistically significantly on many socioeconomic factors. Specifically, our results support the previous findings that garden owners were (i) older (Cohen's d = 0.284), (ii) had a higher income (Cohen's d = 0.586), and lived more often (iii) with people (Cramer's V = 0.289) and (iv) in rural areas (Cramer's V = 0.284).
- Non-garden owners spent statistically significantly less time in public green spaces than garden owners in their gardens (Cohen's d = −0.46).
- Garden owners and non-garden owners again differed statistically significantly in many personality traits. Specifically, non-garden owners were (i) less extroverted (Cohen's d = −0.21), (ii) less conscientious (Cohen's d = −0.32), (iii) more neurotic (Cohen's d = 0.25), and had (iv) lower levels of agency (Cohen's d = −0.22).

However, Tables 3 and 4 indicate that effect sizes were often smaller in the current study, apparently a common phenomenon in replication studies, even in much more controlled situations (e.g., control lab experiments) than the one studied here (Camerer et al., 2018). Nonetheless, effect sizes were mostly within the range of the original confidence intervals.

We could not replicate all significant differences between the two groups on a 5% level, including the one regarding garden owners being more open and agreeable. In addition, we found new statistically significant differences between the two groups in 2021. Garden owners spent more time outside with leisure activities than in previous years and were more likely to have full-time employment. Few official data and analyses are available that relate to the effects of the pandemic on the job market and differentiate between specific subpopulations. Thus, explaining the more pronounced difference in 2021 in full-time employment between the two groups is difficult. One may speculate that more full-time jobs in Germany were lost in urban areas, where more non-garden owners live, or that the loss of full-time jobs affects younger people more often, as they are more likely to be temporary employees and typically have less job protection.

3.3. Controlling for socioeconomic factors: research goal 2

To check whether non-garden owners have lower levels of mental well-being and life satisfaction, even when controlling for differences in socioeconomic factors, Tables 5 and 6 depict results from the respective linear regressions.

Looking first at the results regarding mental well-being, our data suggest that in 2021, garden owners and non-garden owners did not statistically significantly differ in their levels of mental well-being when controlling for differences in socioeconomic factors. Thus, differences in mental well-being in 2021 appear to relate to garden owners and non-garden owners differing in their socioeconomic factors (e.g., household income, full-time employment; cf. Table 3). However, pooling the data shows that the dummy variable "garden ownership" becomes significant. We note that, by definition and ceteris paribus, p-value shrinks with sample size.

Regarding life satisfaction, non-garden owners were significantly less satisfied with their life, both when we looked at 2021 individually and when we pooled the data from both years, even when controlling for differences in socioeconomic factors.

3.4. Exploring further associations with mental well-being: research goal 3

To identify other variables that are valuable for understanding levels of mental well-being during the pandemic, Table 7 shows the results of the hierarchical linear regressions.

Garden ownership, time spent outside, and personality: The variable "garden ownership" has a positive and significant beta value in Model 1,

Table 5
Regression exploring mental well-being during the pandemic (robust standard errors estimated).

	Mental well-being 2021				Mental well-being pooled data			
	Beta	p-value	95% CI		Beta	p-value	95% CI	
Gender	*0.010*	*0.991*	*−1.842*	*1.862*	*−0.295*	*0.621*	*−1.466*	*0.876*
Age (reference = 18 – 29) years)								
30–39	*−0.622*	*0.638*	*−3.221*	*1.976*	*0.058*	*0.948*	*−1.665*	*1.780*
40–49	*0.315*	*0.823*	*−2.448*	*3.079*	*−0.298*	*0.740*	*−2.056*	*1.460*
50–59	*−1.063*	*0.448*	*−3.815*	*1.688*	*−0.571*	*0.506*	*−2.254*	*1.112*
60–65	*2.342*	*0.175*	*−1.046*	*5.730*	*2.530*	*0.025*	*0.312*	*4.749*
Household income (reference = ≤€1500)								
€1501 - €2499	*1.646*	*0.382*	*−2.048*	*5.341*	*0.814*	*0.490*	*−1.500*	*3.127*
€2500 - €4000	*3.135*	*0.095*	*−0.547*	*6.817*	*2.444*	*0.041*	*0.096*	*4.791*
>€4000	*5.557*	*0.004*	*1.747*	*9.368*	*3.823*	*0.002*	*1.360*	*6.286*
Fully employed (1= yes)	*3.418*	*0.001*	*1.440*	*5.396*	*2.841*	*0.000*	*1.538*	*4.145*
Region (1= urban)	*0.964*	*0.300*	*−0.860*	*2.788*	*0.765*	*0.221*	*−0.460*	*1.989*
Living alone (1 = yes)	*−1.408*	*0.369*	*−4.488*	*1.672*	*−1.427*	*0.135*	*−3.299*	*0.446*
Fear of job loss	*−1.090*	*0.007*	*−1.887*	*−0.294*	*−1.203*	*0.000*	*−1.626*	*−0.780*
Garden owners (1 = yes)	*1.145*	*0.252*	*−0.816*	*3.106*	*1.946*	*0.004*	*0.634*	*3.259*
F-statistics	*F(13,473) = 6.311*				*F(13, 963)= 12.600*			
Prob > F	*0.000*				*0.000*			
Adjusted R2	*0.124*				*0.134*			
R2	*0.148*				*0.145*			

Table 6
Regression exploring life satisfaction during the pandemic (robust standard errors estimated).

	Life satisfaction 2021				Life satisfaction 2020 and 2021			
	Beta	p-value	95% CI		Beta	p-value	95% CI	
Gender	*0.024*	*0.901*	*−0.353*	*0.401*	*0.099*	*0.454*	*−0.160*	*0.359*
Age (reference = 18 – 29) years)								
30–39	*−0.554*	*0.050*	*−1.109*	*0.001*	*−0.326*	*0.083*	*−0.696*	*0.043*
40–49	*−0.204*	*0.505*	*−0.805*	*0.397*	*−0.468*	*0.017*	*−0.852*	*−0.084*
50–59	*−0.758*	*0.015*	*−1.370*	*−0.145*	*−0.743*	*0.000*	*−1.118*	*−0.367*
60–65	*0.181*	*0.597*	*−0.493*	*0.855*	*−0.210*	*0.388*	*−0.686*	*0.267*
Household income (reference = ≤€1500)								
€1501 - €2499	*0.506*	*0.214*	*−0.293*	*1.305*	*0.476*	*0.083*	*−0.063*	*1.014*
€2500 - €4000	*1.160*	*0.004*	*0.366*	*1.955*	*1.144*	*0.000*	*0.614*	*1.673*
>€4000	*1.728*	*0.000*	*0.905*	*2.550*	*1.589*	*0.000*	*1.030*	*2.148*
Fully employed (1= yes)	*0.489*	*0.023*	*0.068*	*0.910*	*0.401*	*0.007*	*0.108*	*0.695*
Region (1= urban)	*0.149*	*0.460*	*−0.248*	*0.547*	*−0.046*	*0.736*	*−0.314*	*0.222*
Living alone (1 = yes)	*−0.102*	*0.752*	*−0.739*	*0.534*	*−0.239*	*0.239*	*−0.638*	*0.159*
Fear of job loss	*−0.350*	*0.000*	*−0.502*	*−0.198*	*−0.305*	*0.000*	*−0.399*	*−0.210*
Garden owners (1 = yes)	*0.473*	*0.033*	*0.038*	*0.909*	*0.461*	*0.002*	*0.165*	*0.757*
F-statistics	*F(13, 473)= 10.184*				*F(13, 963)= 18.458*			
Prob > F	*0.000*				*0.000*			
Adjusted R2	*0.197*				*0.189*			
R2	*0.219*				*0.199*			

Table 7
Hierarchical regression exploring the mental well-being of German residents during the COVID-19 pandemic (unstandardized beta weights), pooled data (2020 and 2021; robust standard errors estimated).

	Model 1				Model 2				Model 3			
	Beta	p-value	95% CI		Beta	p-value	95% CI		Beta	p-value	95% CI	
Block I: Socioeconomic factors												
Gender (base = women)	−0.294	0.623	−1.466	0.878	0.072	0.901	−1.059	1.203	−0.103	0.855	−1.217	1.010
Age (base = 18–29 years)												
30–39	0.060	0.946	−1.664	1.783	0.257	0.764	−1.426	1.941	0.274	0.731	−1.285	1.832
40–49	−0.301	0.738	−2.063	1.461	0.334	0.704	−1.395	2.064	−0.276	0.742	−1.923	1.371
50–59	−0.578	0.501	−2.263	1.106	0.163	0.851	−1.532	1.857	−0.607	0.446	−2.168	0.954
60–65	2.520	0.026	0.300	4.740	3.227	0.004	1.057	5.396	1.648	0.097	−0.296	3.592
Household income (base = ≤€1500)												
€1501 - €2499	0.817	0.489	−1.499	3.133	0.855	0.430	−1.269	2.979	0.022	0.982	−1.921	1.966
€2500 - €4000	2.456	0.041	0.104	4.808	2.145	0.055	−0.044	4.335	1.402	0.170	−0.600	3.403
>€4000	3.843	0.002	1.372	6.314	3.665	0.002	1.372	5.957	2.612	0.017	0.464	4.759
Fully employed (base = no)	2.821	<0.001	1.516	4.127	2.419	<0.001	1.192	3.646	1.044	0.083	−0.138	2.227
Region (base = rural)	0.789	0.207	−0.436	2.014	0.681	0.249	−0.479	1.841	0.254	0.639	−0.809	1.317
Living alone (base = no)	−1.420	0.137	−3.293	0.454	−1.425	0.105	−3.147	0.297	−1.205	0.137	−2.793	0.383
Fear of job loss	−1.215	<0.001	−1.647	−0.783	−1.207	<0.001	−1.598	−0.816	−1.091	<0.001	−1.468	−0.715
Garden owners (base = no)	1.970	0.003	0.654	3.287	0.374	0.592	−0.996	1.745	−0.366	0.567	−1.621	0.888
Block II: Being outside (base = ≤4 h)												
>4 to ≤10 h (2nd quartile)					2.511	0.002	0.923	4.098	1.858	0.011	0.434	3.282
>10 to ≤18 h (3rd quartile)					2.605	0.004	0.837	4.373	1.735	0.038	0.096	3.373
>18 h (4th quartile)					3.314	<0.001	1.615	5.014	1.817	0.022	0.264	3.370
Change in time spent outside for sport					0.826	0.001	0.349	1.303	0.764	0.001	0.299	1.228
Change in time spent outside for leisure					1.132	<0.001	0.634	1.630	0.861	<0.001	0.394	1.329
Block III: Personality traits												
Extroversion									2.672	<0.001	1.267	4.077
Agreeableness									0.665	0.294	−0.578	1.909
Agency									1.283	0.023	0.178	2.389
Openness									1.107	0.121	−0.292	2.506
Conscientiousness									1.139	0.054	−0.021	2.299
Neuroticism									−3.528	<0.001	−4.460	−2.597
Year Dummy (base= 2020)	−0.325	0.589	−1.504	0.854	0.307	0.609	−0.869	1.482	0.248	0.654	−0.839	1.335
F Statistic	F(14, 962) = 11.714				F(19, 957) = 14.626				F(25, 951) = 22.052			
Prob > F	<0.001				<0.001				<0.001			
Adjusted R²	0.133				0.210				0.367			
R²	0.146				0.225				0.350			
Delta R²					0.079				0.125			

suggesting that garden owners had significantly better mental well-being than non-garden owners when controlling for standard socioeconomic variables and the year of data collection. By including variables regarding the time spent outside (Model 2), R^2 increased around 7.9%,[1] and we see that garden ownership is no longer statistically significant and that the beta value substantially drops from 1.970 to 0.374. All variables capturing the time spent outside are statistically significant. From the beta values of these variables, we can conclude that the longer participants were outside, the better (i.e., >18 h has the highest beta value). A change in time spent outside for leisure has a slightly higher positive association with mental well-being than doing sports. All these findings reflect evidence indicating that time spent in nature is important for understanding well-being in general (Russel et al., 2013; White et al., 2019) but also specifically during the pandemic (Corley et al., 2021). Overall, results from Model 2 suggest that owning a garden appeared to be less important for mental well-being than the time spent outside. However, Table 4 suggests that garden owners spent far more time outside; thus, the access to one's own garden appeared to motivate going outside, which, in turn, increased mental well-being.

Adding personality traits into the model (Model 3), we find that the R^2 increased further, by 12.5%. The beta value of garden ownership is still not statistically significant, and all variables related to spending time outside remain so. Additionally, being more extroverted and having more agency had a statistically significant positive association with mental well-being, while being more neurotic had a negative association. Table 2 indicates that garden owners were significantly more extroverted, had more agency, and were less neurotic than non-garden owners. Thus, we may conclude that these differences in personality between the two groups are also helpful for understanding their differences in mental well-being.

Sociodemographic variables: Focusing on those sociodemographic variables that are significant in all three models, we find that only the fear of job loss has a robust and negative significant association with mental well-being, and income >4000€ has a positive one. Table 3 shows that non-garden owners were less likely to have higher incomes, indicating that this difference is also relevant for understanding the difference in mental well-being.

Year of data collection: We see that the year-of-data-collection dummy is not statistically significant in any of the three models, and the beta value is rather low, indicating that differences in mental well-being between the years were marginal when controlling for the variables captured here. Beyond the depicted models, we ran exploratory models where we included moderation effects between the year of data collection and variables related to garden ownership and time spent outside (i. e., garden ownership, percentiles of time spent outside, change in time spent in green spaces for sport and leisure). However, none of these moderation effects were significant in the respective models, nor did they change the R^2 meaningfully.

Comparison to original study results: Overall, regression results are very similar to the original results by Lehberger et al. (2021), with all significant associations taking the same direction as in the original study, and all significant robust results by Lehberger et al. (2021) being significant in the present Model 3. The biggest differences from the original results are that more variables are significant in the present study using pooled data, predictable because, by definition and ceteris paribus, p-value shrinks with sample size.

3.5. Exploring further associations with life satisfaction: research goal 3

To identify which further variables are valuable for understanding levels of life satisfaction during the pandemic, Table 8 shows the results

of the hierarchical linear regressions.

Garden ownership, time spent outside, and personality: Regarding the association of "garden ownership" with life satisfaction, when controlling for standard socioeconomic variables as well as the year of data collection, garden owners had significantly greater life satisfaction than non-garden owners during the pandemic. However, as soon as we control for time spent outside (Model 2), the effect size is much smaller and no longer statistically significant. Adding variables related to time spent outside increases the R^2 by 3.2%,[2] where almost all variables had a statistically significant positive association with life satisfaction—only the change in time spent outside for sport was not significant. Indeed, other research indicates that not only the absolute time spent in nature but also the different activities pursued outside are important for understanding life satisfaction (e.g., de Bell et al., 2020).

Adding personality traits further increases the R^2 by 5.7%; only neuroticism has a statistically significant and negative association with life satisfaction. The latter is in line with research linking neuroticism to a negative impact on life satisfaction (e.g., Anglim et al., 2020) and also supports Kroencke et al. (2020), who argued that people measuring high levels of neuroticism are especially at risk during the ongoing pandemic. Also, Table 4 shows that garden owners in both years were less neurotic, suggesting that differences in neuroticism were partly responsible for garden owners' greater satisfaction with their life than non-garden owners during the pandemic. When controlling for personality, all beta values regarding time spent outside drop. Only being outside for >18 h, as well as the change in time spent outside for leisure, are still statistically significant.

Sociodemographic variables: Focusing again only on the robust findings, we see that being between 40 and 59 years old and fearing job loss had a statistically significant negative association with life satisfaction, whereas having an income >2499€ had a positive one. The finding regarding age contrasts with evidence from Canada (Helliwell et al., 2020) and England (Carson, Prescott, Allen, & McHugh, 2020), suggesting that on average, younger people had lower life-satisfaction scores during the pandemic. This may indicate that the age effect is region-specific.

Year of data collection: The year dummy is negative and statistically significant in all models, indicating that controlling for differences in all independent variables here cannot fully mitigate the difference in life satisfaction between the years. Beyond the models depicted here, we again ran exploratory models, including moderation effects between the year of data collection and variables related to garden ownership and time spent outside (i.e., garden ownership, percentiles of time spent outside, change in time spent in green spaces for sport and leisure). One moderation effect was significant: the "change in time spent outside for leisure" * "year dummy" ($\Delta R^2 = 0.29\%$, $F(1, 950) = 4.08$, p: 0.44, 95% CI [−0.357, - 0.005]). While the change in R^2 was small, the year dummy was no longer significant when including this moderation effect. Results further suggest that the positive association between "life satisfaction" and the "change in time spent outside for leisure" was less pronounced in 2021, leading, ceteris paribus, to lower life-satisfaction levels in 2021.

Comparison to original study results: Only a few differences in the final Model 3 were detectable: "> 18 h outside" is significant now, and the negative association of age 60–65 years, compared to 18–29 years, was no longer statistically significant on a 5% level.

3.6. Summary regarding the research goals and hypotheses

Regarding our first research goal, we reproduced the finding that garden owners and non-garden owners significantly differ in many

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[1] When adding the personality traits first into the model and then variables related to "time spent outside," the R^2 increases, due to variables related to "time spent outside," by 4.5%.

[2] When adding the personality traits first into the model and then variables related to "time spent outside," the R^2 increases, due to variables related to "time spent outside," by 1.8%.

Table 8

Hierarchical regression exploring life satisfaction of German residents during the COVID-19 pandemic (unstandardized beta weights), pooled data (2020 and 2021; robust standard errors estimated).

	Model 1				Model 2				Model 3			
	Beta	p-value	95% CI		Beta	p-value	95% CI		Beta	p-value	95% CI	
Block I: Socioeconomic factors												
Gender (base = women)	0.102	0.434	−0.153	0.357	0.154	0.237	−0.101	0.409	0.104	0.427	−0.153	0.361
Age (base = 18–29 years)												
30–39	−0.322	0.076	−0.678	0.034	−0.304	0.095	−0.662	0.053	−0.302	0.088	−0.648	0.045
40–49	−0.475	0.015	−0.857	−0.092	−0.394	0.041	−0.772	−0.017	−0.470	0.013	−0.840	−0.100
50–59	−0.759	<0.001	−1.126	−0.391	−0.672	<0.001	−1.031	−0.313	−0.769	<0.001	−1.119	−0.418
60–65	−0.232	0.339	−0.709	0.245	−0.158	0.515	−0.634	0.318	−0.385	0.103	−0.849	0.078
Household income (base = ≤€1500)												
€1501 - €2499	0.483	0.075	−0.050	1.016	0.482	0.069	−0.038	1.002	0.380	0.148	−0.135	0.896
€2500 - €4000	1.170	<0.001	0.649	1.691	1.119	<0.001	0.602	1.637	1.026	<0.001	0.513	1.540
>€4000	1.634	<0.001	1.083	2.185	1.600	<0.001	1.056	2.143	1.459	<0.001	0.914	2.003
Fully employed (base = no)	0.357	0.015	0.071	0.644	0.300	0.038	0.017	0.584	0.107	0.450	−0.171	0.386
Region (base = rural)	0.007	0.956	−0.257	0.272	−0.009	0.949	−0.270	0.253	−0.068	0.605	−0.324	0.189
Living alone (base = no)	−0.223	0.267	−0.617	0.171	−0.220	0.264	−0.608	0.167	−0.197	0.317	−0.582	0.189
Fear of job loss	−0.332	<0.001	−0.426	−0.237	−0.332	<0.001	−0.424	−0.241	−0.316	<0.001	−0.408	−0.225
Garden owners (base = no)	0.515	0.001	0.221	0.808	0.273	0.086	−0.039	0.584	0.170	0.274	−0.135	0.474
Block II: Being outside (base = ≤4 h)												
>4 to ≤10 h (2nd quartile)					0.409	0.022	0.059	0.759	0.318	0.064	−0.018	0.654
>10 to ≤18 h (3rd quartile)					0.494	0.014	0.102	0.887	0.382	0.051	−0.002	0.766
>18 h (4th quartile)					0.585	0.003	0.201	0.969	0.388	0.046	0.007	0.769
Change in time spent outside for sport					0.093	0.085	−0.013	0.198	0.084	0.115	−0.021	0.189
Change in time spent outside for leisure					0.160	0.006	0.046	0.273	0.123	0.032	0.011	0.236
Block III: Personality traits												
Extroversion									0.320	0.063	−0.018	0.657
Agreeableness									0.112	0.486	−0.202	0.426
Agency									0.223	0.126	−0.063	0.509
Openness									0.217	0.178	−0.099	0.532
Conscientiousness									0.033	0.817	−0.247	0.313
Neuroticism									−0.534	<0.001	−0.743	−0.326
Year Dummy (base= 2020)	−0.722	<0.001	−0.969	−0.474	−0.641	<0.001	−0.896	−0.385	−0.658	<0.001	−0.908	−0.408
F Statistic	F(14, 962) = 20.043				F(19, 957) = 17.532				F(25, 951) = 17.289			
Prob > F	<0.001				<0.001				<0.001			
Adjusted R^2	0.215				0.243				0.294			
R^2	0.226				0.258				0.312			
Delta R^2					0.032				0.057			

socioeconomic traits, as well as time spent outside and personality. More precisely, garden owners were older, had more income, and lived alone less often and in rural areas more often. Non-garden owners spent less time outside in public green spaces than garden owners in their garden. Non-garden owners were less extroverted, less conscientious, and more neurotic and had lower levels of agency. Interestingly, we also found new significant differences between the two groups in 2021. Garden owners spent more time than in previous years outside with leisure activities than non-garden owners and were more likely to have full-time employment. Concerning our first hypothesis, we replicated the finding that non-garden owners have lower levels of mental well-being (H1a) and life satisfaction (H1b) during the pandemic.

Concerning our second research goal, we find robust evidence that garden owners had significantly higher life-satisfaction scores during the pandemic than non-garden owners, even when controlling for differences in socioeconomic factors (H2b). When controlling for differences in socioeconomic factors, mental well-being, however, did not significantly differ in 2021 (H2a).

Regarding our third goal, we find that by pooling the data from 2020 to 2021, our analyses support the hypothesis that spending time outside in green space was positively associated with levels of mental well-being (H3a) and life satisfaction (H3b) during the pandemic. Additionally, we find that garden owners spent more time outside in their garden than non-garden owners outside in public green spaces. This indicates that variables related to spending time outside are valuable for understanding differences in mental well-being and life satisfaction between garden owners and non-garden owners. Also, our analyses support the hypotheses that neuroticism was negatively associated with mental well-being (H4a) and life satisfaction (H4b) during the pandemic. As

garden owners have significantly lower levels of neuroticism in both years, our data also suggest that neuroticism is valuable for understanding differences in mental well-being and life satisfaction between the two groups during the pandemic. Overall, we find that levels of life satisfaction were significantly lower in 2021 than they were in 2020 (H5b). Here, our exploratory investigation of potential moderation effects indicated that the positive association between "life satisfaction" and the "change in time spent outside for leisure" was less pronounced in 2021, leading, ceteris paribus, to lower life-satisfaction levels in 2021. However, mental well-being did not significantly differ between 2020 and 2021 (H5a).

4. Limitations and recommendations for research and policy

Our study faced several limitations. First, although we recreated the measurements of the original study as closely as possible, this is a survey across two years, within which the world changed fast. Thus, each difference in the results of the two samples might also depend on factors that we have not assessed here. Second, our analyses are limited to statements about correlations. For instance, our repeated finding that garden owners and non-garden owners differ in personality does not allow for deducing a causal relationship between owning a garden and personality traits. Future (quasi-)experimental evidence may help to disentangle correlations from causation. Third, our measurements relied on participants' willingness and ability to report their behavior accurately, which may be especially difficult when judging the average time spent outside in the past. While the similarities in results regarding the time spent outside in 2020 and 2021 indicate that there is no structural break in the two data sets, we cannot exclude inaccuracies. We also did

not include any measures related to connectedness to nature. Here, future research may investigate potential differences between garden owners and non-garden owners and their consequences, as connectedness to nature has been shown to be associated with time spent outside—e.g., in parks (Lin et al., 2014)—and happiness (Capaldi et al., 2014). Last, despite using a commonly applied instrument to capture personality traits, we observed low internal consistency in the neuroticism scale.

Our study has value for policymakers as well as city planners. Overall, and alongside other scholars who focus on the association between nature and well-being during the pandemic (e.g., Poortinga et al., 2021), we conclude that both public and private green spaces are an important resource in times of contact and access restrictions. Our findings suggest that spending time outside is valuable for fostering life satisfaction and mental well-being. Our analysis showed that the time spent outside did not significantly differ between 2020 and 2021, indicating that either awareness of the benefits of going outside remained unchanged or their possibility of and/or willingness to go outside did not. However, in both years, garden owners spent more time in their garden than non-garden owners spent in public green spaces. Thus, we suggest that policymakers must further facilitate access to green spaces and advocate for the benefits more effectively, especially for those who do not have access to their own private garden. These people are also more likely to have lower incomes and be living in urban areas, making this an equality issue.

5. Conclusion

Our main aim was to repeat a study on mental well-being and life satisfaction of garden and non-garden owners during the pandemic. While we could not replicate all findings, our results are often similar to the original ones, where garden owners and non-garden owners differed in many sociodemographic aspects, as well as in time spent outside, personality, life satisfaction, and mental well-being. Additionally, socioeconomic factors, time spent outside in green space and personality traits are associated with levels of mental well-being and life satisfaction. Thus, overall, our results here support the original finding regarding differences in self-reported well-being of garden and non-garden owners during the pandemic. Not the ownership of the garden itself but, rather, variables related to garden ownership provide the key to understanding the higher life-satisfaction and mental well-being scores of garden owners.

Author contributions

Mira Lehberger: conceptualization, methodology, formal analysis, writing - original draft, review & editing. Kai Sparke: conceptualization, review & editing.

Declaration of competing interests

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

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Annex 1. Mental well-being items of the Warwick-Edinburgh Mental Well-being Scale

1. I've been feeling optimistic about the future
2. I've been feeling useful
3. I've been feeling relaxed
4. I've been feeling interested in other people
5. I've had energy to spare
6. I've been dealing with problems well
7. I've been thinking clearly
8. I've been feeling good about myself
9. I've been feeling close to other people
10. I've been feeling confident
11. I've been able to make up my own mind about things
12. I've been feeling loved
13. I've been interested in new things
14. I've been feeling cheerful

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