



Crisis mediated new discoveries, claims and encounters: Changing use and perception of residential greenery in multistory housing in Berlin, Germany

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ARTICLE INFO

Keywords:

Corona crisis
Cycling
Environmental justice
Health relevant ecosystem services
Public health
Public transport
Urban planning and housing

ABSTRACT

With the stay at home orders during the pandemic, the often semi-public green spaces of the residential environment, usually created during the building of the houses, became our literal spheres of experience. In our study, we explored use and perceptions of local greenery by residents after sixteen months of the COVID-19 crisis, using face to face questionnaires in eight socially disadvantaged neighborhoods of Berlin, all exposed to high loads of environmental stressors and belonging to four relevant building types of Central European cities. Residential greenery was highly appreciated by residents during COVID-19, and fostered a more active appropriation such as meeting neighbors to reduce the sense of loneliness, doing sports and co-creating refugia in challenging times (e.g. greened balconies). Having children or doing home office/schooling encouraged people to use the green in front of the door in more active ways, such as gardening or even during winter. A minor proportion of respondents reduced contacts mainly due to fear of infections, underlining the need to overcome those distances and to re-connect neighbors and living inside and outside the houses in a post-pandemic city. Our data prove the functionality of residential greenery as 'social tissue' or 'social hubs' of neighborhoods by fostering attachment to place and people and, at the same time, as healthy environment for practices such as enjoying nature and physical activity in fresh air.

1. Introduction

After the outbreak of the coronavirus SARS-CoV-2 in December 2019, governments around the world implemented measures to contain infections, including social distancing, stay at home orders ('lockdowns'), restrictions on mobility, closures of borders, 'non-essential' shops, kindergartens and schools, encouraging teleworking and e-learning. The stricter the lockdown rules, the higher the likelihood of impacts on health and wellbeing (Pouso et al. 2021). In Germany, these measures began in March 2020. Unlike some other countries (e.g. China, Spain, Italy), people were not generally forbidden to go out for walks or for exercise, although the number of people doing this together were often restricted to one or two different households. In this period during the crisis, the recognition of urban green spaces as a resource for health and well-being of urban dweller experienced an upsurge, even in those sections of society that had previously had a distanced relationship with urban nature (Slater et al. 2020; Venter et al. 2020; Grima et al. 2020). Since people miss many things only when they can no longer be taken for

granted due mobility and contact restrictions, spending time outside, meeting neighbors in the green was also missed by those who had previously rarely used the greenery close to home. In particular, small scale urban greens in close proximity to homes in gained importance for all, not just for less-mobile people (Ugolini et al. 2020).

In this study, we focus on residential greenery in Berlin, Germany. Most of these green spaces with direct connection to the residential buildings - on the door step as a 'green living room', and mostly semi-public access - were usually created during the construction of the houses. While depending on the era of the residential development, their design involves different concepts, they all remained accessible during the very first lockdowns in 2020 when communal administrations closed public play grounds and parks or prohibited sitting on benches.

In the growing body of literature on the role of urban green and blue during the pandemic, many of the studies still focus on large-scale urban green spaces such as parks or urban forests (Xie et al. 2020; Lopez et al. 2021; Larson et al., 2021; Noszczyk et al. 2022), perhaps due to the idea that larger parks or interconnected networks of parks provide greater

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<https://doi.org/10.1016/j.ufug.2022.127622>

Received 20 February 2022; Received in revised form 14 April 2022; Accepted 25 May 2022

Available online 31 May 2022

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Fig. 1. Residential greenery and building structures in the block-edge developments of the 1870–1920 s in Berlin: the Sprengelkiez, Wedding (A, B) is an example of a classic Wilhelminian quarter with a dense backyard development and 5–6 storeys, covering about 27 ha. Only one block was gutted and re-designed as the Sprengelpark. The Ideal-Passage, Neukölln (C, D) built in 1907/1908 was considered a model for social housing, with well-equipped flats with central heating, hot water, bath and square-like inner courtyards. SenStadtWo, Orthofotos August 2020; Geoportal Berlin. Source of photographs: *Healthy Living Project*.

opportunities for maintaining social distance (Lopez et al. 2021). Some studies argue that while the basic need for urban green did not change, the variety of different types of urban green may have broadened, e.g. by traveling to rural sites, if allowed, or exploring small scale greens in the

neighborhood (Ugolini et al. 2020). Others reported an increased frequency of use of urban green, although in smaller groups compared to before the pandemic (Grima et al. 2020). Peoples’ motivation may also have changed, for instance they were now using green as a spaces to



Fig. 2. Residential greenery and building structures of block-edge developments in Berlin General Barby Strasse, Reinickendorf (A, B). This neighborhood built between 1927 and 1938, is a reform-oriented perimeter block development, in which the multi-storey apartment buildings include relatively large, landscaped inner courtyards. The row-buildings settlements of the so called ‘Reichsforschungssiedlung’ Haselhorst, Spandau (C, D) were built between 1930 and 1938, are 4–5-storey terraced buildings with almost 4,000 flats built on the basis of a competition announced in 1928. SenStadtWo, Orthofotos August 2020; Geoportal Berlin. Source of photographs: *Healthy Living Project*.



Fig. 3. Residential greenery and building structures of the 1950–1960 s in the row-buildings settlements in Berlin Alte-Jakobstrasse, Mitte (A, B) in an inner-city area of the East-Berliner Heinrich Heine Viertel (built in 1959/60) and the adjacent West-Berliner Otto Suhr Siedlung (built in 1956–1963). Both were divided by the Wall (1961–1989). The Paul-Hertz-Siedlung, Charlottenburg (C, D) was planned in the mid-1950 s and realized in 1961–65. Almost 2700 flats were built here in predominantly 4-story rows and nine eight-story point buildings. In the 1990 s, the neighborhood was re-densified, mainly by adding an additional story to the row buildings, which increased the number of flats in the area to almost 3,200. SenStadtWo, Orthofotos August 2020; Geoportal Berlin. Source of photographs: *Healthy Living Project*.

meet other people, to escape isolation, or to find personal refuge and solitude in a crowded city, or to escape from a multi-person household (Grima et al. 2020). In addition, different groups of residents have diverse preferences with regard to orderliness and safety, ‘well kept’ or ‘wild’ nature, to more active or passive uses (Weber et al., 2014; Säumel

et al., 2021).

The use and perception of urban green during the pandemic was frequently analyzed using online surveys that, besides other biases from representative samples of a neighborhood or city, were restricted to respondents with affinity to the internet (Grima et al. 2020, Ugolini et al.



Fig. 4. Residential greenery and building structures of the 1970–1980 s in the large housing estate as typical examples from the former West Berlin (Gropiusstadt, Neukölln; A, B). The Gropiusstadt was planned by Walter Gropius and built between 1962 and 1975. The Marzahn Promenade/ Marzahn (C, D) in the former East Berlin was built between 1977 and 1989. SenStadtWo, Orthofotos August 2020; Geoportal Berlin. Source of photographs: *Healthy Living Project*.

Table 1

Overview on socio-demographic characteristics of respondents in the study (N = 270). * For the question on most frequent modes of transport (up to 2 mentions possible), 28 female respondents indicated two modes of transport (total 56), 24 male respondents indicated two modes of transport (total 48); i.e. here n = 350. For most frequent modes of transportation, the number in the parenthesis indicates only the simple mentions in each category, and the number in the parenthesis in the ratio column indicates the percentage of those simple mentions.

	N			%			N	%
	Female	Male	n/a	Female	Male	n/a		
Age								
10–20a	13	10	0	5	4	0	23	9
21–30a	29	18	0	11	7	0	47	17
31–40a	34	40	0	13	15	0	74	27
41–50a	16	9	0	6	3	0	25	9
51–60a	16	16	0	6	6	0	32	12
> 60a	42	27	0	16	10	0	69	26
n/a	0	0	0	0	0	0	0	0
Household								
Single	48	35	0	18	13	0	83	31
2-Persons	37	41	0	14	15	0	78	29
> 2-Persons	25	13	0	9	5	0	38	14
> 3-Persons	44	27	0	16	10	0	71	26
Having Children (<14 years)								
0	65	58	0	24	21	0	123	46
1	18	9	0	7	3	0	27	10
2	20	8	0	7	3	0	28	10
3	5	6	0	2	2	0	11	4
n/a	0	0	0	0	0	0	0	0
Having Dog(s)								
Yes	22	17	0	8	6	0	39	14
No	132	99	0	49	37	0	231	86
n/a	0	0	0	0	0	0	0	0
Having an Allotment Garden								
Yes	15	7	0	6	3	0	22	8
No	139	109	0	51	40	0	248	92
n/a	0	0	0	0	0	0	0	0
Having Balcony								
Yes	129	94	0	48	35	0	223	83
No	25	22	0	9	8	0	47	17
n/a	0	0	0	0	0	0	0	0
Having Green Balcony								
Yes	112	69	0	41	26	0	181	67
No	17	25	0	6	9	0	42	16
n/a	0	0	0	0	0	0	0	0
Weekly Park Visits								
0	31	25	0	11	9	0	56	21
0.5–1	28	23	0	10	9	0	51	19
2–3x	48	30	0	18	11	0	78	29
≥ 4	47	38	0	17	14	0	85	31
Most used Mode of Transport*								
Public Transportation	83 (47)	55 (40)	0	40 (22)	39 (29)	0	138 (87)	39 (46)
Car	43 (20)	31 (24)	0	20 (10)	22 (17)	0	74 (44)	21 (23)
Bicycle	41 (17)	32 (19)	0	20 (8)	23 (14)	0	73 (36)	21 (19)
Total	43 (14)	22 (9)	0	20 (7)	16 (6)	0	65 (23)	19 (12)
Residential Time								
1–1.5 Years	17	11	0	6	4	0	28	10
1.5–10 Years	51	53	0	19	20	0	104	39
11–20 Years	42	26	0	16	10	0	68	25
21–40 Years	25	13	0	9	5	0	38	14
> 40 Years	19	13	0	7	5	0	32	12
How many persons doing Homeoffice/Homeschooling during lockdowns?								
0	47	41	0	17	15	0	88	33
1	43	37	0	16	14	0	80	30
2	35	24	0	13	9	0	59	22
> 2	29	14	0	11	5	0	43	16

2020, Lopez et al. 2021, Dushkova et al. 2021; Pérez-Urrestarazu et al., 2021; Noszczyk et al. 2022). As respondents were mostly asked to self-rate a change before and during pandemic, those reflections on the use or perception of urban green before the crisis also depended on experienced distortions during the crisis. In contrast, we were able to take advantage of being able to build on our previous research on amenity and health-related ecosystem services (Battisti et al. 2019), and on the use and perceptions of residential greenery in multistory houses in Berlin, Germany (Säumel et al. 2021, Schmid & Säumel 2021).

We conducted face-to-face questionnaires with residents between the

lockdowns with a small team at eight study sites that represent the four main building types in Berlin. The aim was to analyze local residents' changing use and perception of residential greenery after 16 months of pandemic and compare these results with the previous study (Säumel et al. 2021) in these areas, as this is fundamental to critically revising our knowledge on use and perception of urban green in times of crisis, to identify changes and to explore how to optimize the provision of ecosystem services and human welfare benefits.

We explored the following aspects in detail: (1) the role residential greenery plays in the lives of the neighbors during the pandemic; (2)

Table 2

Survey results of respondents use and perception of residential greenery RG in the four most relevant building types in Berlin: Sprengelkiez/Wedding, Ideal-Passage/Neukölln and General Barby Siedlung/Reinickendorf from the 1870–1920 s; Paul-Hertz-Siedlung/Charlottenburg; Haselhorst/Spandau; Alte-Jakobstrasse/Mitte from the 1920–1970 s and Marzahner Promenade/ Marzahn and Gropiusstadt/Neukölln from the 1960–1980 s * We calculated the overall positive perception of RG per study area as the average of the percentage of “yes” statements or respective positive scores (pretty much true and completely true) with regard to the perception of RG. Some questions haven’t been responded, therefore the sum of some Y and N answers do not reach 100 %. The difference to 100 % are n/a answers.

Building type	Block-edge development				Row-building settlements				Large housing estates									
			1870–1920 s		1920–1940 s		1920–1970 s		1970–1980 s									
	Overall		Sprengel- kiez/ Wedding	Ideal- Passage/ Neukölln	General Barby Siedlung/ Reinicken- dorf	Paul-Herz- Siedlung/ Charlotten- burg	Haselhorst/ Spandau	Alte- Jakobstr/ Mitte	Marzahner Promenade/ Marzahn	Gropius- stadt/ Neukölln								
	% (N = 270)		% (N = 30)		% (N = 30)		% (N = 30)		% (N = 30)									
	Y	N	Y	N	Y	N	Y	N	Y	N								
I use our RG...	86	14	77	23	77	23	83	17	80	20	88	12	95	5	90	10	90	10
to get fresh air	53	47	67	33	60	40	50	50	47	53	44	56	65	35	40	60	70	30
to walk/sit	39	61	20	80	57	43	40	60	27	73	26	74	68	33	30	70	40	60
to enjoy sun	59	41	47	53	63	37	57	43	57	43	50	50	70	30	57	43	70	30
to escape heat	45	54	33	67	33	67	67	33	60	40	38	62	58	43	37	63	47	53
in winter	65	15	57	43	57	43	53	47	60	40	62	38	88	13	57	43	80	20
to meet people	72	28	53	47	60	40	50	50	47	53	44	56	90	10	40	60	70	30
to exercise	15	85	20	80	33	67	7	93	13	87	2	98	30	70	13	87	7	93
for gardening	81	19	83	17	50	50	90	10	83	17	78	22	95	5	90	10	73	27
Children use our RG	78	22	23	77	60	40	30	70	67	33	84	16	18	83	90	10	13	87
It feels healthy to spend time in our RG*	64	12	77	10	73	10	63	13	47	33	66	4	65	10	70	13	50	7
I feel safe in our RG*	24		13		17		23		20		30		25		17		43	
I feel safe in our RG just at daytime	59	41	37	63	50	50	70	30	53	47	68	32	58	43	60	40	67	33
Our RG is clean, orderly and well-kept*	77	23	70	30	77	23	70	30	83	17	72	28	90	10	80	20	70	30
I like to watch nature in our RG*	91	9	90	10	77	23	87	13	90	10	94	6	95	5	97	3	100	0
I like the natural sounds of our RG*	74 ± 13		59 ± 28		67 ± 12		64 ± 21		68 ± 19		77 ± 12		65 ± 31		76 ± 19		60 ± 32	
Overall perception of RG* (% ± SD)																		

how perception and usage preferences differed compared to pre-crisis; (3) whether perception and usage preferences differ among different groups of residents or between the neighborhoods; (4) residents’ suggestions to optimize health benefits and wellbeing and how these can be integrated into RG management.

2. Material and methods

2.1. Study area

Environmentally and socio-economically disadvantaged neighborhoods are particularly vulnerable to crises and have limited resources to cope with them (e.g. Coughlin, 1996; Bonaccorsi et al. 2020; Barboza et al. 2021; Gür 2021). The pandemic exacerbated existing inequalities and negative impacts in neighborhoods with pre-existing multiple stressors leading to contrasting ‘tales of two pandemics’ (Collinson, 2021; Rios et al. 2021; Carreras et al. 2021). Here we assessed neighborhoods of the most disadvantaged areas of Berlin with high noise pollution, high air pollution, high bioclimatic stress, low social status indexes and low access to green spaces identified on the basis of the Environmental Justice Map of Berlin (Fig. 1; SenStadtUm, 2015). The neighborhoods consist of modernist housing complexes from different epochs that are home to three quarters of the Berlin population: in the dense and closed block-edge developments (1870–1920s; Fig. 1), in the block-edge development with large green backyards (1920–1940 s; Fig. 2A-B), in parallel and free row development within landscaped residential greeneries (1920–1970s; Fig. 2C-D, Fig. 3), and in large housing estates with towers and high-rise buildings (1960–1980s; Fig. 4).

Both design and facilities of the residential greenery in the neighborhoods were studied by Battisti et al. (2019). As the budget allocated allows only standard maintenance, and those were also reduced to a minimum during the lockdowns, there were no marked changes. For each of the eight areas, 4 sample plots were randomly chosen for face-to-face interviews to fill in questionnaires. This methodology has been used successfully in previous studies of perception in urban environments (e.

g. Weber et al., 2014; Riechers et al., 2019; Säumel et al. 2021).

2.2. Questionnaires on perception and use of residential greenery

We adopted the previously used questionnaire on resident’s perception and use of residential greenery (Säumel et al. 2021). The questionnaire, developed in German and English, consists of 15 mainly closed or semi-open questions (Appendix A), and an open question asking for suggestions to improve residential greenery. We also asked for some sociodemographic context data, including gender, age, used method of transportation and length of residence. The duration of an interview was about 10 min. The survey was performed from June to September 2021. In total, 270 interviews were performed: 30 in Sprengelkiez/Wedding (Fig. 1A,B), 30 in Ideal Passage/Neukölln (Fig. 1C,D), and 30 in General Barby Siedlung/Reinickendorf (Fig. 2A, B); 50 in Haselhorst/Spandau (Fig. 2C,D); 30 in Paul-Hertz-Siedlung/Charlottenburg (Fig. 3A,B); 40 in Alte-Jakobstrasse/Mitte (Fig. 3C,D); and 30 in Gropiusstadt/Neukölln (Fig. 4A,B) and 30 in Marzahner Promenade/Marzahn (Fig. 4C,D).

The most used method of transportation consisted of three categories: public transportation, car and bicycle, participants could choose up to two transportation modes. Participants length of residence consisted of five categories: 0–1.5, 1.5–10, 11–20, 21–40, and more than 40 years. The first category consisted of those who had arrived new to the neighborhood during the crisis. The weekly park visits consisted of three categories: 0.5–1, 2–3 and ≥ 4 times per week. The open-ended question was analyzed using content analysis (Mayring, 2010). A system of categories was developed, based on the respondents’ statements, meaning that statements with similar content and keywords were mapped to a category (Appendix C). Each individual keyword was assigned to one or more of the categories and so transformed into a variable. We classified respondents as ‘Active Users’, ‘Passive Users’, ‘Order Lovers’, and ‘Others’. We developed categories, based on the respondents’ statements on the open question on suggestions with similar content regarding ‘active or passive use’ and regarding ‘orderliness’ were mapped to a category. Respondents using the following keywords were mapped to

Table 3

Correlation between use and perception of Residential Greenery and resident characteristics by chi-squared test. P- value of Chi-square test is given as significant at 0.05 level are bold. χ^2 , df and p-values are given in the Appendix D.

	Age	Gender	Household	Residential time	Homeoffice	Having Kid (s)
Use RG to exercise	0.001	0.874	0.208	0.278	0.572	0.583
Use RG to walk and sit/rest	0.751	0.239	0.533	0.065	0.193	0.265
Use RG in winter	0.028	0.865	0.807	0.001	0.037	0.801
Use RG to meet neighbours/people	0.190	0.277	0.063	0.001	0.287	0.045^a
It feels healthy to spend time in RG	0.230	0.052	0.438	0.062	0.059	0.124
Feeling save in RG	0.828	0.001	0.104	0.461	0.811	0.563
Do Children use the RG	0.419	0.108	0.327	0.148	0.205	0.007^a
RG is well kept. clean and orderly	0.415	0.513	0.390	0.415	0.416	0.420
Connected to nature in RG	0.036	0.031	0.277	0.082	0.310	0.762
Come to RG to get fresh air	0.177	0.137	0.420	0.019	0.454	0.895
Enjoy the natural sounds in RG	0.232	1	0.076	0.034	0.726	0.388
Use RG to escape the heat in summer	0.800	0.877	0.289	0.191	0.602	0.069
Come to RG to enjoy the sunshine	0.373	0.476	0.572	0.344	0.841	0.249
Use RG for gardening activities	0.670	0.969	0.362	0.859	0.106	0.027
Would you like to change something of your RG	0.770	0.548	0.710	0.278	0.284	0.011

^a Fisher test when $n < 5$

the category 'Order Lover': 'dirty; thrash; dog excrements; not so beautiful; more maintenance needed; looks unkempt; animals, rats; messy'. Active users asked for more facilities that enable active use and/or used key words such as 'meet neighbors; walk the dog; doing BBQ; doing sports; play with the children; doing gardening'.

The survey data were analyzed using R (R Development Core Team, 2019) to test cross-tabulated ordinal data for independence with the chi-squared test.

3. Results

3.1. Characteristics of respondents

Of the respondents, 43 % were male and 57 % female. As the gender proportions in Berlin are nearly equal between male and female, men are slightly underrepresented in this survey (Table 1). Half of the respondents were between 31 and 60 years old. Residents had lived on average 17 years in the neighborhood; and 10 % of the residents were new to the neighborhood during the crisis. Of the respondents, 30 % lived alone, 30 % in a two person household, and 40 % with more than two persons. A quarter of the respondents had children younger than 14 years at home, with 43 % of the women and 23 % of the men indicating having children. One-third reported that no person in their household worked in home office or schooling; one-third had one person working in home office or schooling; and one-third had two or more people doing home office or schooling in their household. Dogs were owned by 14 % of the respondents, 8 % had an allotment garden; 80 % had a balcony; 20 % did not visit public parks, another 20 % did this no more than once a week, and a third visited public parks more than four times a week. Three quarters of the respondents mainly used the public transport (Table 1). Additionally, the respondents of Marzahn Promenade/Marzahn most often, and, less often, those of the Paul Hertz Siedlung/Charlottenburg, indicated having children. Compared to the other neighborhoods, more respondents of the inner-city neighborhoods (Sprengekiew/Wedding; Alte Jakobstr./Mitte and Ideal Passage/Neukölln) used cycling as main transport mode (Appendix B). In Marzahn Promenade/Marzahn, the Paul Hertz Siedlung/Charlottenburg and the General Barby Siedlung/Reinickendorf, respondents most often indicated having dogs. The ratio of allotment gardens is highest in Marzahn Promenade/Marzahn, followed by Gropiusstadt/Neukölln. Cycling was the main mode of transportation for distances less than 5 km (AfS, 2019).

3.2. Use and perception of residential greenery by local residents

In general, 86 % of the respondents used the residential greenery (RG) to 'get some fresh air', to enjoy the sunshine (39 %), or to escape heat in summer (59 %; Table 2); 53 % of the residents walked and sat in the RG, did exercises within their RG (72 %), and even more (77 %) to come into contact with nature (i.e. plants and animals), or to enjoy natural sounds of bird or leaves rustling (91 %). Half of the residents used the RG also during wintertime, 65 % of the respondents indicated meeting neighbors or other people in the residential greenery. A clear majority stated that children used the residential greenery; 15 % gardened; and 79 % felt spend time there to be healthy. For 59 %, the residential greenery was well kept, clean and orderly. For most respondents (64 %), the residential greenery was a safe place, a quarter felt safe during the day, 12 % of the respondents do not feel safe (Table 2, Appendix D).

A larger majority (90 %) of the female respondents than of men (64 %) felt more connected to nature in the RG. The percentage of female respondents not feeling safe at night in the RG (15 %) was double that of male respondents (Table 3). When more or less than one person was at home office or schooling during lockdowns, the respondents indicated using the RG significantly more often, including during winter. Surprisingly, young people below the age of 30 years used RG less often than older residents (above 30 years old) to do exercises and in winter, but younger people also stated feeling more connected to nature (Table 3). Respondents with children were more often involved in gardening, more often indicated that children use the RG, and less often wanted to change something in their RG. There is no correlation between number of persons per household and use and perception (Table 3). The respondents who had lived long in their neighborhood more often indicated using the RG also in winter, to meet neighbors, to get fresh air, and to enjoy natural sounds.

3.3. Differences across neighborhoods

Three quarters of the respondents had an overall positive perception of the RG across all neighborhoods. In all neighborhoods, the majority of the respondents felt good in their residential greeneries. Haselhorst/Spandau and for Marzahn Promenade/Marzahn had the highest scores, Sprengekiew/Wedding and Gropiusstadt/Neukölln had less high but also positive scores on average (Table 2). Across all neighborhoods, the vast majority of the respondents associated residential green with the opportunity to get fresh air and to get in touch with nature and natural sounds. The majority felt safe in the RG, partially only at daytime.

Table 4
Use and perception of Residential Greenery by different User groups. For grouping procedure see Material and Method section.

Number of respondents	270	192	53	109	161
Percentage of positive responses	Overall	Active Users	Passive Users	Order lover	Others
I use our RG...					
to get fresh air	86	89	83	88	84
to walk/sit	53	59	39	48	57
to enjoy sun	39	41	37	38	39
to escape heat	59	56	60	58	59
in winter	45	61	31	50	43
to meet people	65	67	55	64	65
to exercise	72	81	53	73	71
for gardening	15	19	13	14	16
Children use our RG	81	88	76	83	79
Perception					
It feels healthy to spend time in our RG*	78	79	67	73	81
I feel safe in our RG*	64	66	63	54	71
I feel safe in our RG only at daytime	24	23	25	29	20
Our RG is clean, orderly and well-kept*	59	52	63	37	73
I like to watch nature in our RG*	77	81	73	75	78
I like the natural sounds of our RG*	91	92	91	90	92

Beyond these general patterns, use differed between study sites. Thus, 60–70 % percent of respondents walked and sat in the neighborhoods Sprengelkiez/Wedding, Ideal Passage/Neukölln, Alte Jakobstr./Mitte and Gropiusstadt/Neukölln. For the other neighborhoods no preference can be reported. Only in Alte Jakobstr./Mitte did the majority of respondents answer to enjoying the sun in the RG. In this neighborhood, in the Ideal Passage and in Gropiusstadt, both in Neukölln, the majority of the respondents aimed to escape heat in the residential greenery. Half or more than the half did exercises, except in Marzahner Promenade/ Marzahn, where it was only 40 %. At all sites, respondents rarely indicated doing gardening activities in their RG. The highest numbers of gardening activities were mentioned at Alte-Jakobstr./Mitte and Ideal-Passage/Neukölln. In these neighborhoods and in Gropiusstadt/Neukölln, the majority of the respondents indicated using their RG in order to exercise. In the other neighborhoods, about the half of the respondents did exercises, except in Marzahner Promenade/ Marzahn. In contrast to the other neighborhoods, most of the respondents of Gropiusstadt/Neukölln, Alte Jakobstr./Mitte, Sprengelkiez/Wedding, Ideal Passage/Neukölln, and General Barby Siedlung/Reinickendorf stated that spending time in the RG did not feel healthy (Table 2).

3.4. Perception of residential greenery by residents

Of all respondents, 40 % are classified as ‘Order Lovers’, claiming maintenance and order problems in their RG. This group is highest in Sprengelkiez/Wedding (50 %) and Marzahner Promenade/Marzahn (47 %), and lowest in Ideal Passage/Neukölln (30 %) and Haselhorst/Spandau (34 %). On average, these respondents had lived longer in the neighborhood and also visited parks more often. Only a few features of RG were mentioned differently by these groups: compared to other residents, ‘Order Lovers’ walked and sat more often, and indicated feeling less safe in the RG (Table 4).

Half of the respondents were classified as ‘Active Users’. They mentioned high scores for park visits, gardening or other active uses in the open question, and more often had children and/or dogs. ‘Passive users’ were those with low scores for these uses and who did not mention

Table 5
Comparison of survey results from 2018 (Säumel et al. 2021) and from 2021 (this study) of respondents’ use and perception of residential greenery RG using chi-squared test. df and p-values are given. For differences within neighbourhoods, see Appendix D.

I use our RG...	2018		2021		x ²	df	p
	% (N = 158)		% (N = 270)				
	Y	N	Y	N			
to get fresh air	94	6	86	14	6.704	1	0.010
to walk/sit/rest	65	32	53	47	6.857	1	0.009
to enjoy sun	61	39	39	61	18.923	1	0.001
to escape heat	53	47	59	41	0.955	1	0.328
in winter	48	50	46	54	0.196	1	0.658
to meet people	44	54	65	35	15.263	1	0.001
to exercise	20	74	72	28	97.561	1	0.001
for gardening	12	88	15	85	0.584	1	0.445
It feels healthy to spend time in our RG	78	22	78	21	0.041	1	1
I feel safe in our RG	61	8	64	12	3.137	2	0.208
Our RG is clean, orderly and well-kept	57	42	59	41	0.019	1	0.889
I like to watch nature in our RG	84	16	77	23	5.274	1	0.022
I like the natural sounds of our RG*	94	5	91	9	1.257	1	0.262

active use modes (Table 4). The percentage of ‘Active Users’ as highest in Sprengelkiez/Wedding (77 %) or Ideal Passage/Neukölln (67 %), and lowest in Haselhorst/Spandau (30 %) and Paul-Hertz-Siedlung/Charlottenburg (37 %). Both groups appreciated many features of RG such as using RG to get fresh air, enjoy sun or escape heat. Some uses were mentioned less often by passive users, such as exercise, walking and sitting, meeting people, using the RG in winter, and gardening. Passive users less often watched nature and felt healthy in the RG. Interestingly, more passive users perceived the RG as clean, orderly and well-kept compared to the active user group.

3.5. Changes between the summer of 2018 and 2021

Our data show that most characteristics of the respondents, such as the main transportation mode, having a dog or allotment garden (Tables 5,5b), did not change. Every fifth in 2018, and every fourth respondent in 2021 stated not visiting public parks at all. However, others visited parks more often. Weekly park visits increased significantly among all respondents independent of the neighborhood, and especially in the Haselhorst/Spandau, Alte Jakobsstr./Mitte and Marzahner Promenade/ Marzahn. Active exercising, walking or sitting and meeting neighbors in the residential greenery increased significantly across all respondents compared to pre-pandemic times. Doing active sports also increased significantly in most neighborhoods. Few feelings and perceptions reported by the respondents changed between the survey of 2018 and 2021. Our data shows an increasing appreciation of nature and getting fresh air but no changes concerning order and safety (Table 4).

3.6. Residents suggestions

The most often mentioned demands of the residents were the need for more trash bins and better maintenance of residential greenery, followed by better watering in the dry summer of 2021, and a desire for a larger size of the green, child friendly design and more plants (see Appendix C).

4. Discussion

The COVID-19 and its aftermath is a research subject in which no

researcher is not also an affected object. That the crisis has increased systemic inequalities and injustices is undisputed, and an avalanche of publications with very different disciplinary backgrounds is currently emerging. The data on concrete effects is improving every day. Initially, online surveys shed preliminary light on impacts of the crisis (e.g. Ugolini et al. 2020; Lopez et al. 2021; Noszczyk et al. 2022). The scarcity of cohort studies on COVID-19 impacts in the non-hospitalized population covering epidemiological topics, public health and wellbeing became visible (e.g. Herrmann et al. 2021; Ravens-Sieberer et al., 2021). Our study builds on a number of studies conducted before the pandemic with field observations and through face-to-face interviews (Battisti et al. 2019; Säumel et al. 2021; Schmid & Säumel 2021). Our approach allows us to avoid the biases of online studies, as we also reach those people who are regularly underrepresented in previous online studies on COVID-19 impacts, (e.g. non-internet-affine groups; Schaurer and Weiss, 2020).

Although we could not interview the same individuals before and after experiencing pandemic, the respondents do represent a typical cross-section of the population in Berlin neighborhoods (Afs, 2019), and their characteristics match the cohort from summer 2018 (Table 1, Appendix B and Säumel et al., 2021). Only ten percent of the respondents moved into the neighborhoods during the pandemic (Table 1). This stable composition of neighbors with low fluctuations can be read in two ways: on the one hand, residents are satisfied with their living environment (Krekel et al. 2015) and, on the other hand, that the housing market in Berlin continues to be very constrained, so changing apartments is also very difficult (Säumel et al. 2021).

4.1. Living the COVID-19 in a ‘Tenant City’

It is important to highlight that around 86 % of the total housing stock in Berlin are rental housing, and only 14 % are owner-occupied apartments, single family or duplex homes (SenStadt, 2011). The average of space is around 39 m² per tenant, 20 % less than the German average and in owner-occupied apartments or houses in Berlin (StBA (Statistische Bundesamt), 2021). Although minimum requirements for adequate housing sizes of at least 9 m² per person and 6 m² for children have been formulated (WoAufG Bln), home office and schooling are especially challenging for families with children. Living in overcrowded conditions and without access to open space affects mental health and overall quality of life during the crisis (Groot et al. 2022). The neighborhoods in our study are already challenged by various stressors, including a lower socio-economic status, less living space per person and lower access to public green than in other neighborhoods in Berlin (SenStadtUm, 2015). Despite this, the vast majority of neighbors perceived their residential greenery as positively as before the COVID-19 (Table 2; Säumel et al. 2021). These data are in line with other studies demonstrating an enhanced need for urban green during the crisis (e.g. Lopez et al. 2021; Robinson et al. 2021), and studies (e.g. Hedblom et al. 2017; Ode Sang et al. 2016) where, compared to men, women and elderly residents also ranked connection to green and nature as more important for health and well-being (Tables 1,3).

4.2. Snapshot on moving through the pandemic city

We did not detect any change in the use of means of transport, nor increasing numbers of residents driving car or bicycle, even though the city of Berlin has implemented over 16 km of pop-up bike lines to support cycling (Infravelo, 2021). We observed a slight decrease in use of public transportation and an increase in walking, an increase also reported for Israel, Italy and Spain (Ugolini et al. 2020). Thus, having very limited other activities, people working more often from home strongly reduced their radius of movement within the city. The overall number of persons using public transportation in Berlin dropped by at least by 35 % from 2019 to 2020 (StBA, 2022), despite the widespread presumption that the use of public transportation increases risk of COVID-19

(Musselwhite et al., 2020; Shen et al., 2020) being disproven (Steinwender et al., 2021) proven in several studies (e.g. Steinwender et al., 2022). Though public transport operators are trying to disseminate this information to counteract the observed decline in public transport, the use of public transportation was not markedly reduced, at least in our cohorts. It remains unclear whether respondents continued to use public transportation due to absence of alternatives as a result of their economic limitations but reduced the frequency of use.

4.3. See, the good lies so near

The COVID-19 crisis changed the resident’s view on urban green of their living environment, and opened their eyes to their neighborhood (“I have explored the surroundings more since Corona and discovered a new park”). The most notable change was the active use pattern reported by the residents (Table 2). Two-third of the respondents became “Active Users” and one-third “Passive Users”, the reverse of the situation in 2018 (Table 4; Säumel et al. 2021). Physical exercising and getting fresh air dominate the motivations, as also reported in previous studies (Ugolini et al. 2020; Noszczyk et al. 2022). As better access to urban green increases mental health, people spent more time in nature and felt that nature helped them to cope with the pandemic (Robinson et al. 2021; Noszczyk et al. 2022). We found no direct evidence that, taking the number of people per household as a proxy, crowded indoor living conditions influenced residential green space use or perceptions (Table 3). However, some living conditions, like having children or doing home office/schooling, encouraged people to use their green space in front of the door in more active ways, such as gardening or even during winter (Table 3). This underlines the need for green around the home and home offices as lack of time hinders visits of parks and larger green structures (Noszczyk et al. 2022).

Unlike in more strict lockdowns, people in Germany were permitted go out for walks or for sporting activities (Pouso et al. 2021), although some facilities and playgrounds were closed by local administrations. This impacted hard those in neighborhoods with low access to green, especially children. In general, urban park use declined during the pandemic, and visitors became more homogenous, with low-income people particularly missing out (Ugolini et al. 2020; Larson et al. 2021; Gür 2021). Exaggerated measures (over-policing, closing playgrounds and sport facilities, blocking seating areas, etc.) stoked fears of catching COVID-19 even in the fresh air, although this was refuted by scientific studies since the beginning of the pandemic (see review Bulfone et al. 2021). Parks have been perceived as becoming crowded and causing stress for people looking for a reprieve, rather than a risk of infection, from going outside (Lopez et al. 2021). Though parks were very rarely visited in 2018, the number of weekly park visits doubled during the pandemic. We hypothesize that those who used to visit public parks continue to do so more often now.

The percentage of people concerned about the condition and cleanliness of the green spaces increased by ten percent compared to 2018 (Table 5), possibly due to the higher percentage of active users who, when using the facilities of the residential green spaces, also became aware of problems they had not noticed before. The percentage of respondents who said they did or did not meet neighbors was also reversed (Table 5). The frequency of contact with neighbors and friends changed during the pandemic (Gür 2021). Our data show a strong increase of contacts with neighbors in the residential greenery (“the garden is a good place to meet neighbors”). Here, our data contrast with other European studies that highlighted that ‘meeting people’ were not prioritized when using urban green space, yet, contradictorily, were among the things missed during the pandemic (Ugolini et al. 2020). This is surprising and perhaps an indication of self-censorship at the beginning of the pandemic (Ugolini et al. 2020, spring 2020), which was later (in our study, summer 2021) followed by a more relaxed relationship, as studies also proved human encounters in the open air to be harmless (Bulfone et al. 2021), as did personal experience. These changing motivations



Fig. 5. Balconies became important during COVID-19. More than 80 % of the respondents stated having a balcony that was mostly greened by the residents. Here are some impressions of balconies from our study areas.
Source of photographs: *Healthy Living Project*.

have been also reported in the survey on urban green use in Kraków (Poland), where fear of infection and disease were the main reasons for avoiding public green during the first 3 months of the pandemic, but became less important later (Noszczyk et al. 2022). More than 20 % of the respondents of the Kraków study indicated that the park visits reduced their sense of loneliness.

4.4. Society coming apart - different perceptions of a reality or different realities?

At the same time, 20 % of the respondents do not use public parks at all (Table 1). Some respondents chose self-isolation and strongly reduced contacts mainly due to fear of infection („Because of Covid, I feel unhealthy and did not meet people nor neighbors“). Although loneliness existed long before Covid-19, many recent studies demonstrate that it became worse with the pandemic measures, and that it has emerged as a risk factor for mental distress (Fingermann et al., 2021; Mayerl et al., 2021; Pai & Vella, 2021; Grossmann et al., 2022). A subjectively assumed but not an officially announced stay-at-home order can also result in poorer mental health (Benke et al., 2020). A growing body of literature demonstrates the collateral damage, including predicting long-lasting impacts of infection protection measures and related stressors (e.g. fears, frustration, economic problems), on health and wellbeing such as post-traumatic stress symptoms, confusion, and anger (Brooks et al., 2020; Benke et al., 2020; Mucci et al. 2020; O'Connor et al. 2021; TMGH-Global, 2021). Social distancing and isolation increase the frequency of psychotic symptoms and cognitive problems with time since the last conversation, with time since the person last left home and with smaller living space (Allé and Bertson, 2021). Young adults, students, women, people with lower education or income, the economically inactive, people living alone and urban residents had a higher risk of being lonely during lockdowns (Bu et al., 2020; Loch et al., 2022). That young people use the residential greenery actively less often (Table 3) is of concern. COVID-19 measures foster segregation as mobility contraction is stronger in areas with higher inequality and lower income per capita (Bonaccorsi et al. 2020; Barboza et al. 2021;

Gür 2021). Adequate risk communication and targeted mental health recommendations are crucial for vulnerable groups (Benke et al., 2020). We also documented contrasting perceptions on the same neighborhood (e.g. Paul Hertz Siedlung “In broad daylight we observed a lady being assaulted on the pavement.”; “the area feels very village-like. Everyone knows each other because the houses are built so close to each other and some people have lived in the area for a very long time, so it tends to be a very social neighborhood”). There is an urgent need to overcome those distances that increased during the pandemic and to re-connect neighbors and living inside and outside the houses. Our data proves the functionality of residential greenery as ‘social tissue’ or ‘social hub’ of neighborhoods by fostering attachment to place and people (Säumel et al. 2021), and at the same time as healthy environments and for practices such as enjoying nature and physical activity in fresh air.

4.5. Looking for refugia in challenging times

Our group ‘Active Users’ began to appropriate, change and use the green spaces in the residential areas much more directly (Fig. 1A, 3A). “During the Covid-19 period our mobility had been very limited for several months so we created a quasi-private space within the residential greenery”. Compared to the pre-pandemic times, the spectrum of residents’ requirements and suggestions for RG expanded significantly from order and maintenance (‘Order Lovers’; Appendix C) to new aspects not mentioned in 2018, often related to user friendliness for children, gardening and comments regarding the behavior of neighbors. This also indicates a higher perception of neighbors and interaction between neighbors, for example during lockdowns.

The balcony was an emblematic space during lockdowns to look out, communicate with, and control neighbors (Peters & Halleran, 2020; Aramayona and Nofre, 2021). In our study areas, balconies had multiple roles, including as a green living room for growing flowers, vegetables and herbs, setting up a paddling pool for the children in the hot summer, drying laundry, parking bicycles or depositing junk (Fig. 5). More than 80 % of the respondents have a mostly greened balcony (Table 1). The number of greened balconies increased compared to

previous surveys in the area (Battisti et al. 2019). Having plants at home and interacting with them during the confinement periods is correlated with positive emotions (Pérez-Urrestarazu et al., 2021). This study also reported that 67 % of the respondents were interested in gardening (Pérez-Urrestarazu et al., 2021), which is also an effective stress mitigating activity during the pandemic (Lades et al. 2020). The balcony as ‘the new places of hope’ played a pivotal role during stay-at-home periods as one of the only ways to connect with the outside (Molaei et al., 2021). Thus, balconies were used more often (Gür 2021) and were the preferred place for greening measures during the pandemic (Pérez-Urrestarazu et al., 2021). Housing environments such as home size, having balcony or garden are blueprinted by socioeconomic segregation, and determine resilience and coping capacity during crisis (Horne et al., 2021; Barboza et al. 2021).

5. Conclusions

We are only just beginning exploration of impacts of the COVID-19 crisis on urban societies. Studies so far have clearly demonstrated that the weakness and shortcomings of our lifestyles and governance systems have led to much collateral damages, particularly in vulnerable groups we claim to protect, such as children, the younger generations and the elderly. The impairments and stresses suffered by these groups should not be in vain, they should serve to shape urban infrastructures in ways that strengthen health-related ecosystem services. Our study highlights the crucial role of residential greenery in dealing with inequalities in living space, and the need to conserve, restore and re-design living environments to enhance health and the resilience of urban societies, and to promote, at the same time, the health of the planet. Urban planners, neighborhood manager and housing companies should work together to unlock the potential of residential green as an effective measure of preventive medicine (Coburn, 2015). Designing an inclusive and actively usable ‘green living room’ in low income neighborhoods and beyond will reduce the divides at all times not just in times of pandemics (Collinson, 2021; Rios et al. 2021; Carreras et al. 2021) and re-connect neighbors as ‘social tissue’ of our neighborhoods.

CRedit authorship contribution statement

Ina Säumel: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Formal analysis, Resources, Supervision, Validation, Writing – original draft, Writing – review & editing. **Simone Jessica Sanft:** Investigation, Methodology, Data curation, Formal analysis, Visualization, Writing – review & editing.

Declaration of Competing Interest

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

Acknowledgments

This research was funded by the Fritz and Hildegard Berg Stiftung in the Deutscher Stifterverband (Germany) in the project ‘HealthyLiving - Strategie und Planungsinstrument für gesundheitsförderndes Wohnumfeldgrün in der Stadt der Zukunft’. We thank all participants and our HealthyLiving research team members Sylvia Butenschön, Lauranne Pille, Frederike Büttner, Ewelina Skulimowska, Sonja Mohr-Stockinger, Jan Hogrefe, Thomas Wachtel, Hannah-Lea Schmid, Luca Battisti and Lea Matscheroth for fruitful discussion on the health-related ecosystem services of residential greenery. Special thanks go to Serfina Bischoff, Florian Boese, Edi Emilov, Elena Heim, Vera Krause, Léa Maïm, Sophia Reitzug for field assistance. We thank Rhea Rennert for assistance with statistical analysis and visualization and Antoni Schmitz for their willingness to review the thesis of SJS. We also thank Amal Chatterjee for

improving our English.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ufug.2022.127622.

References

- AfS (Amt für Statistik Berlin Brandenburg), 2019. Statistiken. Available online: <https://www.statistik-berlin-brandenburg.de/statistiken/inhalt-statistiken.asp> (accessed on 20 November 2021).
- Allé, M.C., Berntsen, D., 2021. Self-isolation, psychotic symptoms and cognitive problems during the COVID-19 worldwide outbreak. *Psychiatry Res.* 302, 114015 <https://doi.org/10.1016/j.psychres.2021.114015>.
- Aramayona, B., Nofre, J., 2021. The city of (dis-)trust: balconies, the biopoliticised self and the new everyday governmentality of the public space in Madrid in times of COVID-19. *Town Plan. Rev.* 92, 257–262. <https://doi.org/10.3828/tp.2020.91>.
- Barboza, M., Marttila, A., Burström, B., et al., 2021. Covid-19 and pathways to health inequities for families in a socioeconomically disadvantaged area of Sweden – qualitative analysis of home visitors’ observations. *Int. J. Equity Health* 20, 215. <https://doi.org/10.1186/s12939-021-01556-6>.
- Battisti, L., Pille, L., Wachtel, T., Larcher, F., Säumel, I., 2019. Residential greenery: state of the art and health-related ecosystem services and disservices in the city of Berlin. *Sustainability* 1815. <https://doi.org/10.3390/su11061815>.
- Benke, C., Autenrieth, L.K., Asselmann, E., Pané-Farré, C.A., 2020. Lockdown, quarantine measures, and social distancing: Associations with depression, anxiety and distress at the beginning of the COVID-19 pandemic among adults from Germany. *Psychiatry Res.* 293, 113462, [10.1016/j.psychres.2020.113462](https://doi.org/10.1016/j.psychres.2020.113462).
- Bonaccorsi, G., Pierri, F., Cinelli, M., Flori, A., Galeazzi, A., Porcelli, F., et al., 2020. Economic and social consequences of human mobility restrictions under COVID-19. *Proc. Natl. Acad. Sci. USA* 117 (27), 15530–15535. <https://doi.org/10.1073/pnas.2007658117>.
- Brooks, S.K., Webster, R.K., Smith, L.E., Woodland, L., Wessely, S., Greenberg, N., Rubin, G.J., 2020. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395 (10227), 912–920. [https://doi.org/10.1016/S0140-6736\(20\)30460-8](https://doi.org/10.1016/S0140-6736(20)30460-8).
- Bu, F., Steptoe, A., Fancourt, D., 2020. Loneliness during a strict lockdown: Trajectories and predictors during the COVID-19 pandemic in 38,217 United Kingdom adults. *Social Science & Medicine* 265, 113521. <https://doi.org/10.1016/j.socscimed.2020.113521>.
- Bulfone, T.C., Malekinejad, M., Rutherford, G.W., Razani, N., 2021. Outdoor transmission of SARS-CoV-2 and other respiratory viruses: a systematic review. *J. Infect. Dis.* 223 (4), 550–561. <https://doi.org/10.1093/infdis/jiaa742>.
- Carreras, M., Vera, S., Visconti, G., 2021. A tale of two pandemics: economic inequality and support for containment measures in Peru. *J. Polit. Lat. Am.* 13 (3), 358–375. <https://doi.org/10.1177/1866802X211035393>.
- Coburn, J., 2015. City planning as preventive medicine. *Prev. Med.* 77, 48–51. <https://doi.org/10.1016/j.ypmed.2015.04.022>.
- Collinson, A., 2021. A tale of two pandemics: Low-paid workers hit hardest by Covid class divide. TUC. September 9 <https://www.tuc.org.uk/blogs/tale-two-pandemics-low-paid-workers-hit-hardest-covid-class-divide>, accessed online 6.04.2022.
- Coughlin, S.S., 1996. Environmental justice: The role of epidemiology in protecting unempowered communities from environmental hazards. *Sci. Total Environ.* 184 (1–2), 67–76. [https://doi.org/10.1016/0048-9697\(95\)04990-8](https://doi.org/10.1016/0048-9697(95)04990-8).
- Dushkova, D., Ignatieva, M., Hughes, M., Konstantinova, A., Vasenev, V., Dovletyarova, E., 2021. Human dimensions of urban blue and green infrastructure during a pandemic. case study of Moscow (Russia) and Perth (Australia). *Sustainability* 13, 4148 <https://doi.org/10.3390/su13084148>.
- Fingerman, K.L., Ng, Y.T., Zhang, S., Britt, K., Colera, G., Birditt, K.S., Charles, S.T., 2021. Living Alone During COVID-19: Social Contact and Emotional Well-being Among Older Adults. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences* 76 (3), e116–e121. <https://doi.org/10.1093/geronb/gbaa200>.
- Grima, N., Corcoran, W., Hill-James, C., Langton, B., Sommer, H., Fisher, B., 2020. The importance of urban natural areas and urban ecosystem services during the COVID-19 pandemic. *PLoS ONE* 15 (12), e0243344 <https://doi.org/10.1371/journal.pone.0243344>.
- Groot, J., Keller, A., Joensen, A., et al., 2022. Impact of housing conditions on changes in youth’s mental health following the initial national COVID-19 lockdown: a cohort study. *Sci. Rep.* 12, 1939. <https://doi.org/10.1038/s41598-022-04909-5>.
- Grossmann, I., Twardus, O., Varnum, M.E.W., Jayawickreme, E., McLevey, J., 2022. Expert predictions of societal change: Insights from the world after COVID project. *American Psychologist* 77 (2), 276–290. <https://doi.org/10.1037/amp0000903>.
- Gür, M., 2021. Post-pandemic lifestyle changes and their interaction with resident behavior in housing and neighborhoods: Bursa, Turkey. *J. Hous. Built Environ.* 4, 1–40. <https://doi.org/10.1007/s10901-021-09897-y>.
- Hedblom, M., Knez, I., Ode Sang, A., Gunnarsson, B., 2017. Evaluation of natural sounds in urban greenery: potential impact for urban nature preservation. In: *R. Soc. Open Sci.*, 4, 170037 <https://doi.org/10.1098/rsos.170037>.
- Herrmann, Y., Starck, T., Brindl, N., Kitchen, P.J., Rädker, L., et al., 2021. Description and analysis of representative COVID-19 cases—A retrospective cohort study. *PLOS ONE* 16 (7), e0255513. <https://doi.org/10.1371/journal.pone.0255513>.

- Horne, R., Willand, N., Dorignon, L., Middha, B., 2021. Housing inequalities and resilience: the lived experience of COVID-19. *International Journal of Housing Policy*. <https://doi.org/10.1080/19491247.2021.2002659>.
- Infravelo, 2021. Temporäre Fahrradstreifen während der Corona Krise (Temporary bicycle lanes during the Corona crisis, in German). Retrieved December 12nd, 2021 from <https://www.infravelo.de/temporaere-radfahrstreifen/>.
- Krekel, C., Kolbe, J., Wüstemann, H., 2015. The greener, the happier? the effects of urban green and abandoned areas on residential well-being. *SOEP -Germ. Socio-Econ. Panel Study DIW Berlin 728–2015*.
- Lades, L., Laffan, K., Daly, M., Delaney, L., 2020. Daily emotional well-being during the COVID-19 pandemic. *PsyArXiv 1–17*. <https://doi.org/10.31234/OSF.IO/PG6BW>.
- Larson, L.R., Zhang, Z., Oh, J.I., Beam, W., Ogletree, S.S., Bocarro, J.N., Lee, K.J., Casper, J., Stevenson, K.T., Hipp, J.A., Mullenbach, L.E., Carusona, M., Wells, M., 2021. Urban park use during the COVID-19 pandemic: are socially vulnerable communities disproportionately impacted? *Front. Sustain. Cities 3*, 710243. <https://doi.org/10.3389/frsc.2021.710243>.
- Loch, A.A., Mota, N.B., Rössler, W., Gattaz, W.F., 2022. Exacerbation of psychosis risk during the COVID-19 pandemic: The disproportionate impact on the lower income population. *Psychiatry Res.* 307, 114319 <https://doi.org/10.1016/j.psychres.2021.114319>.
- Lopez, B., Kennedy, C., Field, C., McPhearson, T., 2021. Who benefits from urban green spaces during times of crisis? perception and use of urban green spaces in New York City during the COVID-19 pandemic. *Urban For. Urban Green* 2021 (65), 127354. <https://doi.org/10.1016/j.ufug.2021.127354>.
- Mayerl, H., Stolz, E., Freidl, W., 2021. Longitudinal effects of COVID-19-related loneliness on symptoms of mental distress among older adults in Austria. *Public Health* 200, 56–58. <https://doi.org/10.1016/j.puhe.2021.09.009>.
- Mayring, P., 2010. Qualitative Inhaltsanalyse. In: Mey, G., Mruck, K. (Eds.), *Handbuch Qualitative Forschung in der Psychologie*. VS Verlag für Sozialwissenschaften. https://doi.org/10.1007/978-3-531-92052-8_42.
- Molaei, P., Hashempour, P., Tang, L.M., 2021. Semi- open spaces of apartments considering COVID-19 pandemic: general expectations of balcony design in the post-pandemic world. *Archit. Eng. Des. Manag.* <https://doi.org/10.1080/17452007.2021.2021385>.
- Mucci, F., Mucci, N., Diolaiuti, F., 2020. Lockdown and isolation: psychological aspects of COVID-19 pandemic in the general population. *Clin. Neuropsychiatry* 17 (2), 63–64 <https://doi.org/10.36131/CN20200205>.
- Noszczyk, T., Gorzelany, J., Kukulska-Kozielec, A., Hernik, J., 2022. The impact of the COVID-19 pandemic on the importance of urban green spaces to the public. *Land Use Policy* 113, 105925. <https://doi.org/10.1016/j.landusepol.2021.105925>.
- O'Connor, R.C., Wetherall, K., Cleare, S., McClelland, H., Melson, A.J., Niedzwiedz, C.L., O'Carroll, R.E., O'Connor, D.B., Platt, S., Scowcroft, E., Watson, B., Zorzea, T., Ferguson, E., Robb, K.A., 2021. Mental health and well-being during the COVID-19 pandemic: longitudinal analyses of adults in the UK COVID-19 mental health & wellbeing study. *Br. J. Psychiatry* 218, 326–333 <https://doi.org/10.1192/bjp.2020.212>.
- Ode Sang, A., Knez, I., Gunnarsson, B., Hedblom, M., 2016. The effects of naturalness, gender, and age on how urban green space is perceived and used. *Urban For. Urban Green*. 268–276.
- Pai, N., Vella, S.L., 2021. COVID-19 and loneliness: A rapid systematic review. *Aust. N. Z. J. Psychiatry* 55 (12), 1144–1156. <https://doi.org/10.1177/00048674211031489>.
- Pérez-Urrestarazu, L., Kaltsidi, M.P., Nektarios, P.A., Markakis, G., Loges, V., Perini, K., et al., 2021. Particularities of having plants at home during the confinement due to the COVID-19 pandemic. *Urban Forestr. Urban Green*. 59, 126919 <https://doi.org/10.1016/j.ufug.2020.126919>.
- Peters, T., Halleran, A., 2020. How our homes impact our health: using a COVID-19 informed approach to examine urban apartment housing. *Archnet-LJAR. Int. J. Archit. Res.* 2631–6862, 10.1108/ARCH-08-2020-0159.
- Pouso, S., Borja, A., Fleming, L.E., Gómez-Baggethun, E., White, M.P., Uyarra, M.C., 2021. Contact with blue-green spaces during the COVID-19 pandemic lockdown beneficial for mental health. *Sci. Total Environ.* 20 (756), 143984 <https://doi.org/10.1016/j.scitotenv.2020.143984>.
- R Development Core Team, 2009. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
- Ravens-Sieberer, U., Kaman, A., Erhart, M., et al., 2021. Impact of the COVID-19 pandemic on quality of life and mental health in children and adolescents in Germany. *Eur. Child. Adolesc. Psychiatry*. <https://doi.org/10.1007/s00787-021-01726-5>.
- Riechers, M., Strack, M., Barkmann, J., Tscharnke, T., 2019. Cultural ecosystem services provided by urban green change along an urban-periurban gradient. *Sustainability* 11 (3), 1–10.
- Rios, C., Neilson, A.L., Menezes, I., 2021. COVID-19 and the desire of children to return to nature: Emotions in the face of environmental and intergenerational injustices. *J. Environ. Educ.* 52 (5), 335–346. <https://doi.org/10.1080/00958964.2021.1981207>.
- Robinson, J.M., Brindley, P., Cameron, R., MacCarthy, D., Jorgensen, A., 2021. Nature's role in supporting health during the COVID-19 pandemic: a geospatial and socioecological study. *Int. J. Environ. Res. Public Health* 18, 2227. <https://doi.org/10.3390/ijerph18052227>.
- Säumel, I., Hogrefe, J., Battisti, L., Wachtel, T., Larcher, F., 2021. The healthy green living room at one's doorstep? use and perception of residential greenery in Berlin, Germany. *Urban For. Urban Green*. Volume 58 (March 2021), 126949 <https://doi.org/10.1016/j.ufug.2020.126949>.
- Schaurer, I., Weiß, B., 2020. Investigating selection bias of online surveys on coronavirus-related behavioral outcomes. *Surv. Res. Methods* 14 (2), 103–108. <https://doi.org/10.18148/srm/2020.v14i2.7751>.
- Schmid, H.L., Säumel, I., 2021. Outlook and Insights: Perception of residential greenery in multistorey housing estates in Berlin, Germany. *Urban Forestry & Urban Greening*. <https://doi.org/10.1016/j.ufug.2021.127231>.
- SenStadt (Senatsverwaltung für Stadtentwicklung). 2011. Berlin - wohnswerte Stadt. Online https://www.stadtentwicklung.berlin.de/wohnen/wohnungsbau/download/ausstellung_wohnswerte_stadt.pdf.
- SenStadtUm (Senatsverwaltung für Stadtentwicklung und Umwelt), 2015. Umweltgerechtigkeitsatlas für Berlin. Retrieved December 12nd, 2021 from www.stadtentwicklung.berlin.de/umwelt/umweltatlas.
- Shen, et al., 2020. Prevention and control of COVID-19 in public transportation: experience from China. *Eviron. Pollut.* <https://doi.org/10.1016/j.envpol.2020.115291>.
- Slater, S.J., Christiana, R.W., Gustat, J., 2020. Recommendations for keeping parks and green space accessible for mental and physical health during COVID-19 and other pandemics. *Prev. Chronic Dis.* 17, 200204 <https://doi.org/10.5888/pcd17.200204>.
- StBA (Statistische Bundesamt), 2021. Wohnen. Reihe 7.1, 12/2021. Retrieved February 2nd, 2021 from www.destatis.de.
- StBA (Statistische Bundesamt), 2022. Verkehr. Fachserie 8 Reihe 1.1, 12/2021 Retrieved January 26th, 2021 from www.destatis.de.
- Steinwender, L., Holy, D., Burkhard, J., Uçkay, I., 2021. Daily use of public transportation and incidence of symptomatic COVID-19 among healthcare workers during the peak of a pandemic wave in Zurich, Switzerland. *Am. J. Infect. Control* 28 (21), S0196–S6553. <https://doi.org/10.1016/j.ajic.2021.10.022>, 00683-0.
- Steinwender, L., Holy, D., Burkhard, J., Uçkay, I., 2022. Daily use of public transportation and incidence of symptomatic COVID-19 among healthcare workers during the peak of a pandemic wave in Zurich, Switzerland. *Am. J. Infect. Control* 50 (3), 352–354. <https://doi.org/10.1016/j.ajic.2021.10.022>.
- TMGH-Global COVID-19 Collaborative, 2021. Perceived Stress of Quarantine and Isolation During COVID-19 Pandemic: A Global Survey. *Front. Psychiatry* 12: 656664. doi: 10.3389/fpsy.2021.656664.
- Ugolini, F., Massetti, L., Calaza-Martínez, P., Cariñanos, P., Dobbs, C., Ostoic, S.K., et al., 2020. Effects of the COVID-19 pandemic on the use and perceptions of urban green space: an international exploratory study. *Urban For. Urban Green*. 56, 126888 <https://doi.org/10.1016/j.ufug.2020.126888>.
- Venter, Z., Barton, D., Gundersen, V., Figari, H., Nowell, M., 2020. Urban nature in a time of crisis: recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environ. Res. Lett.* Available from: <http://iopscience.iop.org/10.1088/1748-9326/abb396>.
- Weber, F., Kowarik, I., Säumel, I., 2014. Herbaceous plants as filters: immobilization of particulates along urban street corridors. *Environ. Pollut.* 186, 234–240.
- Xie, J., Shixian, L., Katsunori Fu, Dajiang, S., 2020. Urban parks as green buffers during the COVID-19 pandemic. *Sustainability* 12 (17), 6751. <https://doi.org/10.3390/su12176751>.