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Human-Nature Interactions during and after the COVID-19 Pandemic in Moscow, Russia: Exploring the Role of Contact with Nature and Main Lessons from the City Responses

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Abstract: Urban green spaces (UGS) as essential elements of the urban environment provide multiple ecosystem services including benefits for physical and mental health. Impacts of the COVID-19 pandemic and related restrictions have influenced human relationships with nature. Based on empirical research, this article explores the pathways and implications of human-nature interactions during and after COVID-19 and how human health and well-being could be supported by contact with nature. The article discusses the reasons that attract people to visit UGS (value of UGS, their perceptions, ways of contact with urban nature, etc.). It also analyses the effects of social isolation on the usage and perception of UGS during and after the COVID-19 pandemic. The research revealed current needs for UGS and their role in adaptation of urban development and greening strategy. For this purpose, an online questionnaire survey among residents of Moscow was conducted in April–July of 2020 when restrictive measures were imposed in the city in response to the COVID-19 pandemic. Additionally, non-participatory observations and photo documentation were used to supplement the data on UGS visitation and use. The GIS mapping method was applied to analyze the UGS provision (availability and accessibility of UGS). Moreover, expert interviews were conducted aiming to explore the implications of the COVID-19 pandemic on the urban fabric and life of the citizens. The aim was to reveal the main tendencies that can be used in the adaptation of urban development plans, especially regarding UGS and human-nature interactions. The results show that citizens (both survey respondents and experts) highly value urban nature as a tool for coping with COVID-19 challenges. They underlined a need for accessible UGS, most notably for breathing fresh air, reducing stress, relaxing, and observing and enjoying nature. The survey also revealed the particular health effects resulting from the reduction of UGS visitations due to COVID-19 restrictions. Several changes in human-nature interactions were also observed: many respondents especially missed spending time outdoors and meeting other people. That highlights the fact that while UGS normally provides places for social integration and socializing, during the COVID-19 isolation UGS were especially valued in regard to physical health and well-being (self-recovery). Both respondents and experts expressed their opinions regarding the future development of UGS network and how the UGS's structure and design should be adapted to the current challenges. The claimed interests/preferences included the need for providing all residents equal access to UGS in a time of pandemics and post pandemics. A set of limitations and directions for future research of UGS was suggested.

Keywords: green infrastructure; urban green space; human-nature relations; COVID-19 pandemic; green recovery in a (post) COVID world

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1. Introduction

Urban green spaces (UGS) such as parks, gardens, forests, etc. are a vital element of the urban environment that provides healthy, sustainable living conditions and enhances the quality of life [1–3]. Defined as all urban land covered by vegetation of any kind [4], UGS include a diversity of ecosystems and their ecological processes, which support urban blue and green infrastructure and provide multiple ecosystem services (ES). Many recent studies confirmed that contact with nature in vegetated and water-rich urban areas improves people's physical and mental health by reducing stress in everyday life [3,5,6]. It also stimulates physical activity [7,8], enhances human wellbeing and mental state, and improves the quality of life [9–15]. Contact with nature facilitates social cohesion and inclusion [3,16–18], contributes to a sense of place, and shapes regional identity [19–21]. UGS increase resilience to climate change and environmental shocks by moderating the urban heat island effect, noise, chemical pollution, and excessive storm water run-off. UGS promote biodiversity conservation and sustainable lifestyles [1,22–25].

Accelerated urbanization and current societal challenges, especially during the COVID-19 pandemic and associated social isolation, increased stress and spatial recalibration of everyday life. It is also demonstrated that urban nature can play an essential role for the resilience of urban society by providing significant positive impacts on the physical and mental health of individuals and communities [2,26,27]. The extraordinary circumstances surrounding the worldwide coronavirus (COVID-19) pandemic, when billions of people over the globe were locked down with limited access to UGS, highlighted the importance of contact with urban nature for human well-being and shaping human-nature relationships and the recovery in the post-pandemic world [28–32]. In order to address the declaration of WHO measures to slow or prevent the spread of COVID-19, many cities worldwide had to implement various restrictions that affect individual mobility and public life, including limited access to services and facilities outside their neighborhoods, whilst lowering the intensity of their usual physical activity. In several cities, it also resulted in the closure of some public parks and other open spaces to help encourage physical distancing [29,33,34]. Thus, UGS within local neighborhoods has become more important than ever not only in hosting people's outdoor activities but also in allowing secure socializing [28,33,35]. In this regard, the quality of UGS and their availability, green planning and landscape design characteristics should receive special attention.

This study aims to explore the pathways and implications of human-nature interactions during and after the COVID-19 pandemic and how health problems and pandemic challenges can be mitigated through contact with nature (therapeutic value of nature). In particular, the study addresses the following research questions: (a) how COVID-19 impacted human life and personal well-being and what activities were undertaken by citizens to cope with COVID-related challenges; (b) what are the reasons that normally attract visitors to UGS (e.g., claimed as perceived personal benefits from UGS, value of UGS/role of nature, ways of contact with urban nature, etc.); (c) how COVID-19-related restrictions changed the human-nature interactions (visitation, usage, and availability of UGS); (d) what are the current preferences and needs for UGS and what are COVID-related adaptations of UGS to sustainable planning and management strategy. Following previous studies on effects of the COVID-19 pandemic on the use and perceptions of urban green space [2,26–28,31,33–35], UGS accessibility and availability [27,29,30,32], value of UGS from the planners' perspective [28,34], we conisder a wide diversity of human–nature interactions and how COVID-19 can affect their dynamics. Moreover, we aim to explore what novel actions and adaptation strategies can be established that can have positive outcomes for both humans and nature. There is an increasing number of studies on COVID-19 and UGS use published in 2020–2021; however, they are still dominated by European Union countries, followed by the USA. Insights from other countries, including Russia, remain underrepresented. In this sense, Moscow presents an interesting case, which can provide a different perspective. Moreover, this exploratory study adds to the literature by implementing an integrated approach of combining a social survey (as a pilot study) with expert

interviews, GIS mapping and non-participatory observations providing the insights from UGS perception and use in a megacity demonstrating the impact of COVID-19 and how it is addressed in the city greening strategy. In particular, an online questionnaire survey among residents of Moscow has been conducted in May–July of 2020 when restrictive measures were imposed in response to the COVID-19 pandemic. In addition, non-participatory observations and photo-documentation were used to supplement the data on park visitation and the use of UGS, as well as GIS mapping to analyze the availability and accessibility of UGS. Other methods were semi-structured interviews with experts in January–March 2022 aiming to reveal the main tendencies in the adaptation of urban development plans to planning, design, and use of UGS during the pandemic.

Our prime hypothesis is that regular contact with nature and a variety of human-nature interactions is vital in ensuring resilience and sustainability under the (post)-COVID conditions and in times of continuous decline of nature in cities. The paper has the following structure: we begin by reflecting on the results of the questionnaire survey and non-participatory observation with photo-documentation regarding the human-nature interaction, e.g., the subjective values assigned to UGS and their importance for mental and physical well-being, especially during and after the COVID-19 pandemic. Then, we discuss the issues of UGS access and preferences, followed by suggestions for designing UGS. Finally, we compare the survey results with the UGS provisions and benefits maps based on the spatial proxies (e.g., availability of UGS, the total area of parks/maintained UGS, nearest distance to parks, averaged land surface temperature, number of tree/bird species, and urban heat stress index). We also elaborate on the role of UGS in adaptation to the new circumstances based on the analysis of expert interviews. This analysis also revealed the main tendencies in the adaptation of urban development plans regarding planning, design, and use of UGS. We also discussed some limitations and directions for future research, which are vital for creating resilient and livable cities promoting healthy lifestyles and habitats after the pandemic.

2. Materials and Methods

The study involved a three-step process (Figure 1) starting with the pre-investigation phase (preliminary research) aiming to identify the key issues related to research on human-nature interactions and identifying research gaps. That is followed by suggestions on how they can be covered by the presented research (identifying research questions and methodology) using a literature review. The next step refers to data collection and analysis. For this purpose, different methodologies were used (questionnaire survey, non-participatory observation, GIS mapping, and interviews with experts), and each of them refers to the particular research question (see main outcomes at Figure 1). The final step deals with data interpretation and comparison with previous studies as well reflecting on limitation and identifying directions for future research.

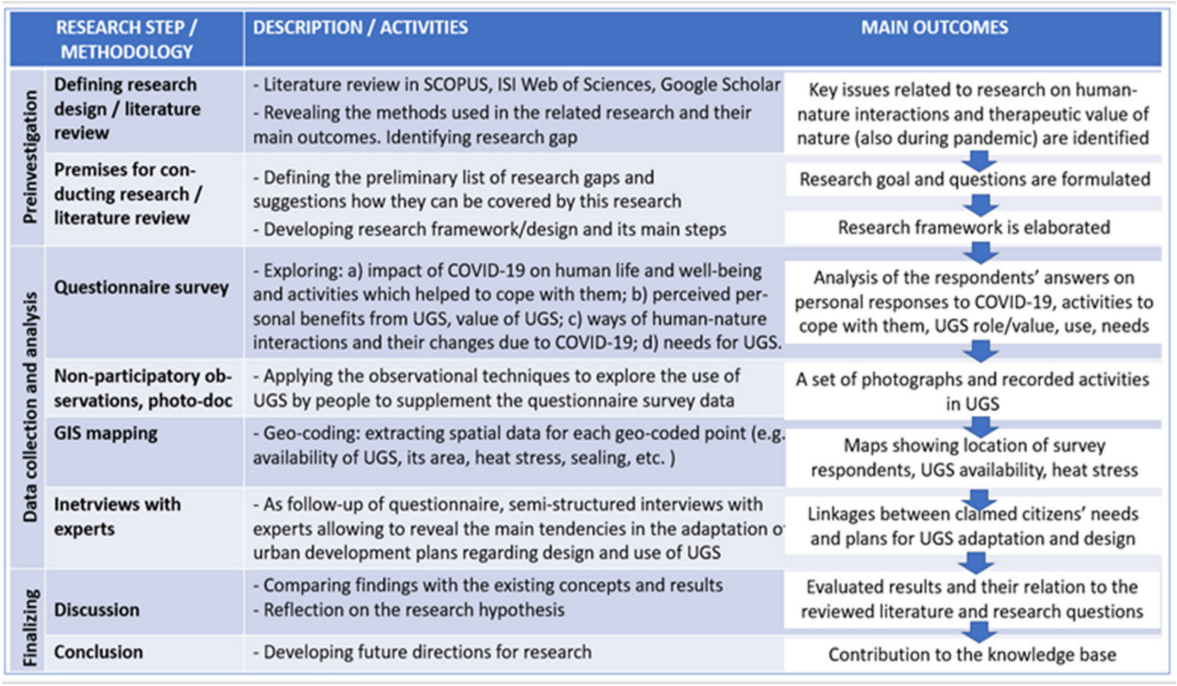


Figure 1. Research framework.

2.1. Study Area

The investigation was conducted in Moscow, Russia's capital city (Figure 2), which covers an area of 2500 square kilometers and is inhabited by over 12.5 million citizens (including the New Moscow district) (2018 census). It is the biggest Russian city and center of political, economic, and cultural life. The city is situated on the banks of the Moskva River. The climate is humid continental with long, cold winters usually lasting from mid-November to the end of March, and warm summers. The cold climatic conditions (snow is present for about five months a year, from mid-October to the beginning of April) and the recent change in Moscow's regional climate due to global warming (extreme heat is more frequent in the city and has reached 37.8–38.2 °C) act as limiting factors for outdoor recreation. Nevertheless, the city is characterized by a high percentage of green spaces (55% of the city territory). Green infrastructure framework dated back to 1935 when the initial City Master Plan was implemented. This Master Plan defined the protection and management of a Green Belt around the city, the establishment of seven major green zones stretching from the outskirts to the center, and a connecting system of boulevards and parks. During the Soviet period (1917–1991), UGS and their network were an important part of spatial planning. At the beginning of the post-Soviet time (1990′s), many UGS were neglected, which is linked to the economic and political changes and instability. The administrative reform of 2012 resulted in a doubling of the urban area. Due to city limits, expansion arable lands occupy now the second place by size (12.43%). When comparing "Old" Moscow with the "New" Moscow, the total share of UGS is almost three times higher in New Moscow (75%) than in the "Old" part (28%). Moscow is an exceptional case of a European city where both inherited features of central planning from the Soviet time and modern methods of greening were integrated.

With 14 square meters of green spaces per capita, Moscow could be considered a city with a well-developed green infrastructure. The city includes the following types of UGS: (1) remnants of native vegetation (recreational forest and forest parks are the biggest UGS type making up 33% of the total area), (2) historical gardens and parks as the monuments of landscape architecture, (3) public district and local community parks and green spaces within local neighborhoods (residential block of houses), (4) green plazas and boulevards in neighborhoods, (5) alley and street green in all parts of the city, (6) rain gardens, swales, and

other bioretention facilities to manage stormwater and rainwater run-off by planting native flora into depressions or channels; (7) natural and designed bogs in the nature parks and the residential districts, (8) rivers and canals as public waterways for recreational purposes, (9) ponds and creeks for recreational purposes, (10) specific blue spaces—artificially created water reservoirs that are used for recreational purposes. A great number of public parks and residential green spaces was established in the Soviet era. Moscow has an extensive forest-park zone for short-term recreational use based on native forests but containing planned and designed elements. Usually, natural forests in Moscow are part of specially designed nature-protected areas. The dominant protected areas in Moscow are natural and historical parks (10 parks in total) [33].

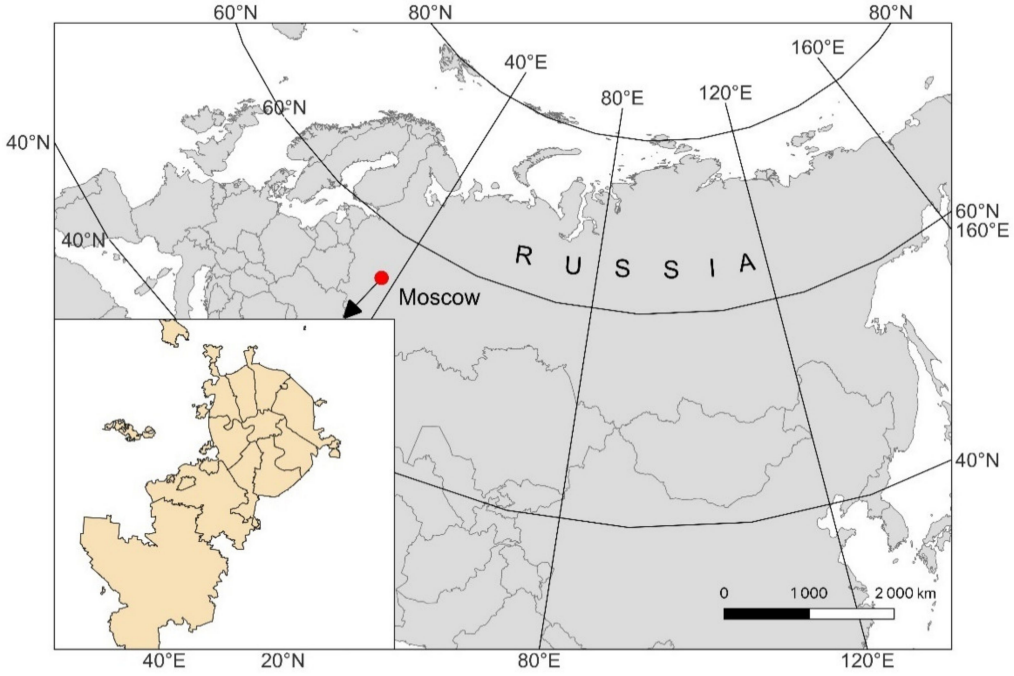


Figure 2. Study area.

2.2. Social Survey: Data Collection and Processing

Data on Moscow residents' perceptions of the personal impact of COVID-19-related restrictions and values of UGS was received via an online survey. An online survey tool Survio (survio.com (accessed on 20 May 2020)) was used to provide a fixed item, anonymous questionnaire. The questionnaire was composed of 25 questions written in the respective local language (Russian).

The survey focused on the use of UGS and their value augmented during and after the first wave of the COVID-19 in Moscow. The questionnaire was active from May to July 2020.

The general components of the questionnaire were composed according to the following logic. The first step was related to the area of residence (to confirm the study area—Moscow city) of the respondent and the duration of lockdown (number of days that the respondent spent at home). The second part of the questionnaire rated the subjective values assigned to UGS using multiple-choice questions with options that were derived from the scholarly literature [36,37]. The importance of UGS for mental and physical well-being was assessed using six-point Likert scale questions (from very unimportant to very important and additional options for answering "I don't know"). The third component included the subjective assessment of perceived impacts on daily routines and personal wellbeing of COVID-19 related restrictions such as lockdown, social distancing, working from home, and combining full-time remote (home) working and home schooling of children. In the fourth step, self-reported impacts of COVID-19 restrictions on access to UGS

were examined. Three questions asked respondents to indicate from a list of options how frequently they accessed UGS before, during, and after COVID-19 restrictions respectively. The fifth step was to find out the abundance and quality of UGS in the respondents' local neighborhoods. A filter question with three options (agree, disagree, and don't know) was used to assess the sufficiency of UGS. Then, subsequent question requested the respondent's preferred additional UGS types by selecting options from a list (including "nothing" and "other") [38,39]. The final part consisted of demographic questions such as gender, age, level of education, current occupation, resident postcode, dwelling type, and the number of people living in the household. The survey template can be found in Questionnaire S1 of Supplementary Material.

To recruit participants, a targeted advertisement was created on the Vkontakte social network (vk.com (accessed on 20 May 2020)). Vkontakte is one of the most popular and frequently used social networks in Russia. According to the data presented by the network in 2020, 78% of Russian residents visit VKontakte at least once a month and 50% of residents visit the social network at least once a day (https://vk.com/press/q2-2020-results (accessed on 18 May 2022)). An important criterion is the representation of different groups of users by age categories that is more differentiated than on Instagram or Facebook. The target audience was limited only by the factor of residence in the Moscow agglomeration. This was important to ensure the participation in the survey of people with different socio-demographic characteristics, views, and life experiences. In total, 119,385 people have seen the advertisement, 988 of them visited the entry page of the survey, and 280 of them completed the survey. After reviewing the results, 59 respondents were excluded as they were not from Moscow. The final sample included 216 respondents.

Analysis of the data was conducted using the SPSS software (IBM SPSS v24). This analysis included descriptive statistics, χ^2 test and nonparametric tests (such as Mann–Whitney U and Kruskal–Wallis tests) for ordinal data.

2.3. Non-Participatory Observations and Photo-Documentation

In order to supplement the data on visitation and use of UGS, non-participatory observations and photo-documentation were conducted following the approach of Clark et al. [40] providing observational techniques for exploring the use of UGS by different social and activity groups. Non-participatory observation methods are widely used by experts to capture and assess human/local visitors' behavior without taking an active part in the situation under scrutiny [21,40–42]. During the observations, different types of UGS (public parks, gardens, urban forests, and small UGS such as playgrounds, alleys, boulevards, sport facilities, and front- and backyards of multi-story housing complexes) were visited randomly at different times of the day (between 09:00 and 19:00) in working days and weekends in two weeks in July 2019 and July 2020 (during COVID-19 lockdowns most of them were closed) to survey the types of visitors' activities that took place in these UGS. In total, five big urban parks and two forest-parks (Zaryadye, Gorky Park, Neskuchny Sad, Sokolniki, Bitzevsky Park, Timiryasevsky park, Kolomenskoe Park, Park VDNKh of All-Russian Exhibition Center) as well as selected alleys, boulevards, front- and backyards, sport facilities, and playgrounds of several housing complexes from different districts of Moscow were visited randomly.

The observers selected an observation point with a clear view of the entire place (where possible) in each UGS or selected several points in the big parts according to the functional zones of the parks and recorded all activities taking place in the spaces during observation hours using special fieldwork protocols.

2.4. GIS Mapping

Since the Survio service does not allow geotagging, we geo-located the respondents according to their postal codes. Moreover, some respondents have indicated their full home address within the questionnaire. We assigned the geospatial coordinates of the house in case the address has been provided. Otherwise, we assigned the coordinates of the postal

office with the mentioned postal code to each questionnaire. The geo-coding was performed using python 9.3. The number of respondents that indicated their postal code/address was 147 out of 216. For each geo-coded point, we have extracted spatial data representing the environmental conditions/quality of the surroundings. These spatial data were averaged within the regular hexagonal grid (size ~ 48 ha) to better characterize the surrounding area. These spatial data include: availability of UGS (green stands, lawns, shrublands) per capita (m^2 $pers^{-1}$), the total area of parks/maintained UGS, nearest distance to parks, averaged land surface temperature, urban heat stress index, the proportion of the sealed area.

Spatial distribution of UGS/sealed surface was retrieved from satellite data. Land and cover classes were identified based on the mosaic of cloud-free Sentinel-2A MSI (level 2A), and optical satellite images were taken on 6 June 2019, available at ESA Copernicus Scientific Data Hub. The image pre-processing included resampling to 10-m spatial resolution of 10 bands with initial 10 and 20 m spatial resolution and mosaicking. The stepwise sub-pixel and per-pixel classification was performed to classify the surface into the following land cover classes: water, sealed areas, bare soil, lawns/grasslands, trees, and shrubs based on spectral signatures of these classes. The pre-processing and classification were performed within the Google Earth Engine cloud computing platform [43]. The population data were parsed from the open data portal of the Department of Housing and Utilities. The vector park contours were downloaded from the open data portal of the Moscow government (www.data.mos.ru (accessed on 15 April 2022)). The land surface temperature was calculated based on the mosaic of Landsat-8 (thermal infrared sensor, TIRS) satellite data (taken 6 July 2021). The spatial analysis was performed in the python 3.9 environment. Urban heat stress index was based on the physical equivalent temperatures [44,45] derived from the air temperature simulation by the COSMO-CLM model. The model was calibrated for the Moscow city environment [46,47] and projected heat stress for July 2010 (one of the hottest months in history of meteorological monitoring in Moscow) with 500 m spatial resolution [48].

2.5. Expert Interviews with Different Stakeholders

In addition to the questionnaire survey, which reflects the perspectives and opinions of citizens in general, the semi-structured interviews with the experts were conducted to allow a deeper exploration of specific aspects derived from the survey. In particular, the interviews aimed to reveal what are the main implications for urban planning and development resulting from the COVID-19. The interviews were also intended to explore specific urban planning strategies to address the current needs of citizens and issues of urban sustainability, resilience, and human-environmental interactions adapted to the new reality (post-COVID time). In the search for experts, the main selection criterion was a thorough knowledge of urban development, planning and environmental policy as well as practical implementation of greening projects in present and in the recent past. Using the snowball technique, 13 expert interviews were conducted (both face-to-face and online) with different stakeholders of Moscow in January–March 2022. From the experts who participated in the study, three experts were from public authority and decision making, four from academia and research institution, three from landscape design and architecture, and three from NGO and citizen groups. The interviews with experts ranged from 19 to 56 min, were recorded using a digital device and further transcribed; the process of manual inductive coding was applied. The experts according to Meuser and Nagel [49] were persons possessing institutionalized authority and knowledge with the potential of conditioning the actions of others in a meaningful way. Therefore, expert interviews facilitate gaining insights and context knowledge central to the research questions that cannot be deduced from other methodical approaches. A group of stakeholders (experts) was presented by representatives from public authorities and decision-makers (city administration, city planners), universities and research institutions (scientists), practitioners (architects and landscape architects), and civil society groups/organizations (representatives from NGOs, urban communities, volunteers).

In our interviews, we asked the experts to provide their perspectives on the following questions:

(a) what are the main lessons from the city's responses to COVID-19 regarding the development of the city and the change in the lifestyle of citizens?
(b) how COVID-19 pandemic influences the design and development of urban spaces in Moscow in general and regarding UGS and human-nature interactions?

The obtained data were analyzed to reveal the main tendencies in the adaptation of urban development plans regarding the use of UGS and to formulate the proposals for UGS management strategies.

3. Results

3.1. Impacts of COVID-19 on the Population (Citizens) Based on a Questionnaire Survey and Non-Participatory Observations

3.1.1. Respondents' Characteristics

The demographic characteristics of the survey respondents are presented in Table 1. The sample was dominated by women (73.0% vs. 27.0%). The age range distribution was characterized by two dominant categories 21–30 years old and 31–40 years old. The majority of respondents (80%) had a university diploma or higher obtained level of education. More than 40% were full-time employed. This was the dominant category along with studying at university (19.7%) and part-time employed (13.8%). More frequently, Moscow dwellers lived in a flat, apartment, or townhouse (81.4%). The prevalent number of families had no children and lived in the respondent household—63.9%.

Table 1. Demographic characteristic of respondents (*n* = 216 Moscow citizen).

Characteristics	Share of Respondents
Gender	27%—male 73%—female
Age	10.6%—less than 20 years old 31.9%—21–30 years old 26.4%—31–40 years old 12.0%—41–50 years old 10.2%—51–60 years old 8.8%—more than 60 years old
Highest obtained level of education	9.3%—School diploma 6.5%—Secondary special education 67.6%—University graduation (BSc., MSc., diploma) 13.4%—Post-university graduation (PhD., Dr., or similar) 3.2%—Other
Type of housing	13.9%—House 81.4%—Flat/Apartment 4.7%—Other
Current employment status	40.5%—Full time employed 13.8%—Part time employed 5.9%—Casual employment 4.5%—Stay at home (home duties) 3.7%—On parental leave 4.8%—Unemployed 2.2%—Temporarily laid off due to COVID-19 19.7%—Student 4.8%—Retired

Table 1. *Cont.*

Characteristics	Share of Respondents
Living/family circumstances	63.9%—Family without children 15.5%—Family with 0–6-year-old children 12.9%—Family with 7–12-year-old children 7.7%—Family with 13–17-year-old children

3.1.2. Impact of COVID-19 on Moscow Residents

The first wave of COVID-19 related restrictions in Moscow started on 26 March 2020. There were some measures in the first month of the pandemic where playgrounds, restaurants and cafes, and sports infrastructure were closed, universities were switched to remote mode, and social distancing and self-isolation for aged people were recommended. Self-isolation mode was prolonged until June 2020. However, in April and May, the measures in Moscow became stricter, including not only the closure of 55 public parks and banning UGS visits but a full lockdown for 1.5 months (Figure 3). The self-isolation regime (home quarantine) in Moscow lasted from 30 March to 9 June 2020. There were few exceptions to the restrictions that allowed going outside, for example, a necessity to be at the workplace, shopping at the nearest food store or pharmacy, walking pets within a distance of 100 m from the place of residence, taking out the garbage, seeking emergency medical help, or a direct threat to life and health. From 12 May 2020, wearing protective masks and gloves was mandatory in public transport and other public places. The majority of respondents answered that COVID-19 restriction measures such as lockdowns and working from home have not influenced their wellbeing: lockdowns (43.1%), working from home (44.4%) (Figure 4a). A slightly negative impact was identified in the case of social distancing (37.5%). At the same time, the impact of combining full-time remote (home) working and home schooling of children was statistically significant for families with 0–6-year-old children ($\chi^2 = 18.795$, $p = 0.002$) and with 7–12-year-old children ($\chi^2 = 28.282$, $p = 0.000$), while for families with 13–17-year-old children it was not ($\chi^2 = 1.969$, $p = 0.853$). For families with 0–6-year-old children, the impact of combining full-time remote (home) working and home schooling of children has two dominant categories: slightly negative (39.4%) and neutral (39.4%) (Figure 4b). For families with 7–12-year-old children, the most frequent answers were the same, but about a quarter of respondents (24.1%) defined the impact of COVID-19 restrictions as very negative.

Figure 3. *Cont.*

Figure 3. Closure of many parks and public spaces in Moscow (first line) and neighbourhood UGS (playgrounds, second line) due to COVID-19 restrictions, March–May 2020 (signboards indicating prohibiting visits to parks and playgrounds): Park Zaryadye (**top left**), Park VDNKh (**top right**), playgrounds in the multi-story housing complexes in the southern district of Moscow (**bottom images**). Photos: E. Kosenkov.

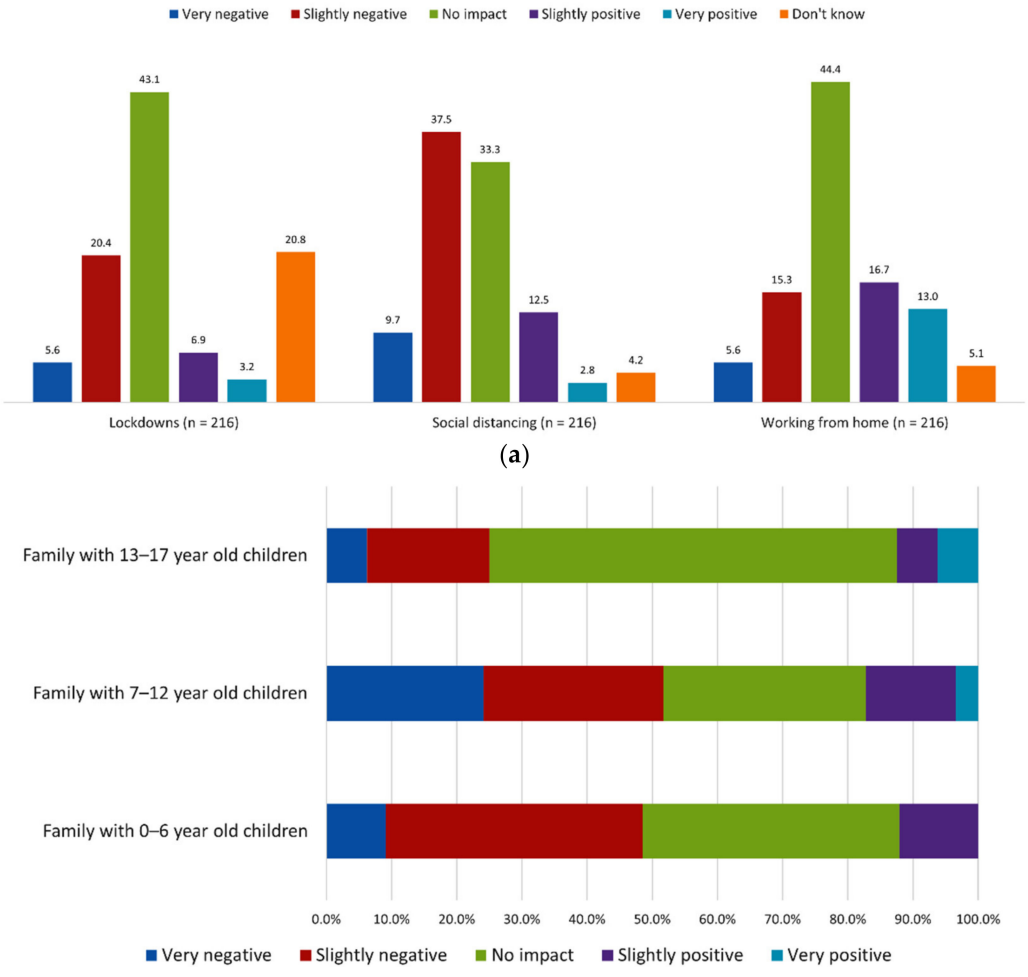


Figure 4. Impact on respondent's personal wellbeing of COVID-19 restrictions: (**a**) Lockdowns (n = 216), Social distancing (n = 216), and working from home (n = 216) and (**b**) combining full-time remote (home) working with home schooling of children (n = 171).

The situation with the impact of COVID-19 restrictions on daily routines was different. In the case of lockdowns, it was assessed as more negative, 42.6% of respondents called the impact slightly negative (Figure 5a). Social distancing on the contrary was identified as not so negative for daily life: neutral for 37.5% of respondents and slightly negative for 30.1%. The impact of working from home was in total more positive for 38.0% of respondents (slightly positive for 21.8% and very positive for 16.2%) or neutral for 34.7% of respondents. For families with 0–6-year-old children (χ^2 = 22.735, p = 0.000) and with 7–12-year-old children (χ^2 = 22.653, p = 0.000) the impact of combining full-time remote (home) working and home schooling (standing) of children was a real challenge. The majority of the respondents (50.0% and 36.7% respectively) assessed it as slightly negative and 20% of respondents with 7–12-year-old children have chosen the "very negative" category (Figure 5b). At the same time, for more than half (64.7%) of families with 13–17-year-old children it was not statistically significant (χ^2 = 4.411, p = 0.492), and they have not seen any changes.

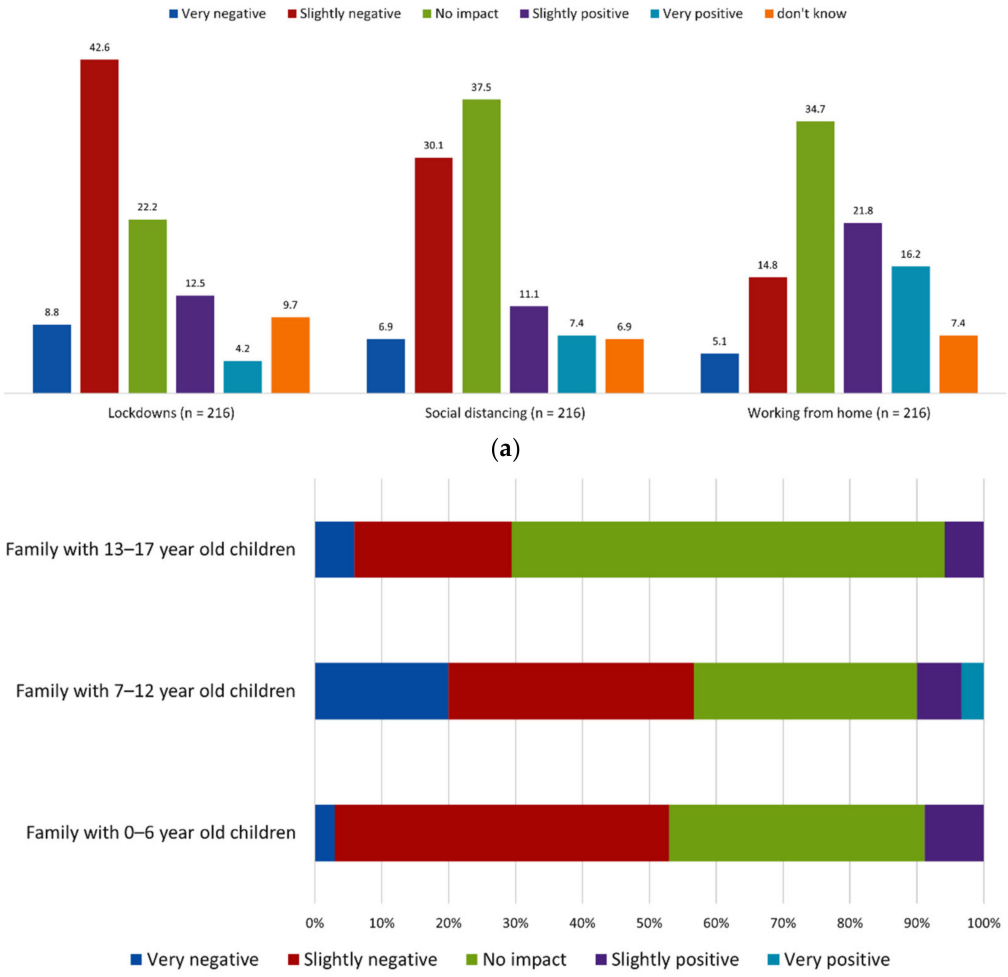


Figure 5. Impact on respondent's daily routings of COVID-19 restrictions: (**a**) Lockdowns (n = 216), Social distancing (n = 216), and working from home (n = 216) and (**b**) combining full-time remote (home) working with home schooling of children (n = 171).

There was not a significant difference in activities that helped to cope with COVID restrictions. They were depending on the respondents' age: I take a walk (if it is allowed) (χ^2 = 4.569, p = 0.471); I do some outdoor physical/mental exercises (χ^2 = 3.406, p = 0.638); I do some physical/mental exercises at home (χ^2 = 1.375, p = 0.927); I am connected with the world via Internet (χ^2 = 3.554, p = 0.615); I have developed/undertaken activity which

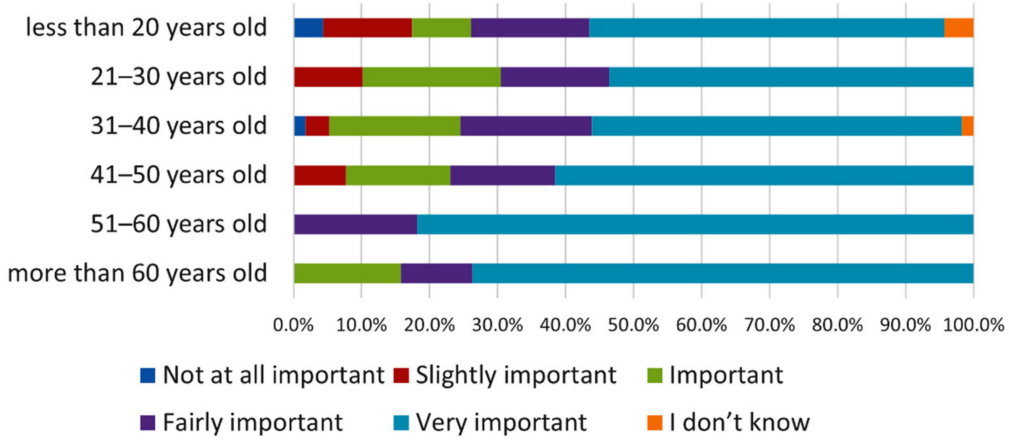
helps me to reduce stress (χ^2 = 4.794, p = 0.442); Other (χ^2 = 2.530, p = 0.772). For two age categories (31–40 years old and 41–50 years old) the most frequently selected activity to cope with COVID-19 restrictions was taking a walk (33.0% and 29.3% respectively) (Table 2). For other age groups including respondents younger than 30 and older than 50, the dominant activity was doing indoor physical or mental exercises.

Table 2. Activities to cope with COVID restrictions according to the age of respondents (n = 216).

Activities	<20 Years Old	21–30 Years Old	31–40 Years Old	41–50 Years Old	21–60 Years Old	>60 Years Old
I take a walk (if it is allowed)	28.2%	28.7%	33.0%	29.3%	28.9%	24.1%
I do some outdoor physical/mental exercises	7.7%	7.0%	5.7%	7.3%	2.6%	0.0%
I do some physical/mental exercises at home	30.8%	33.9%	26.4%	29.3%	31.6%	37.9%
I am connected with the world via Internet	17.9%	13.0%	18.9%	14.6%	23.7%	20.7%
I 've developed/undertaken activity which help me to reduce stress	10.3%	9.6%	11.3%	9.8%	5.3%	3.4%
Other	5.1%	7.8%	4.7%	9.8%	7.9%	13.8%

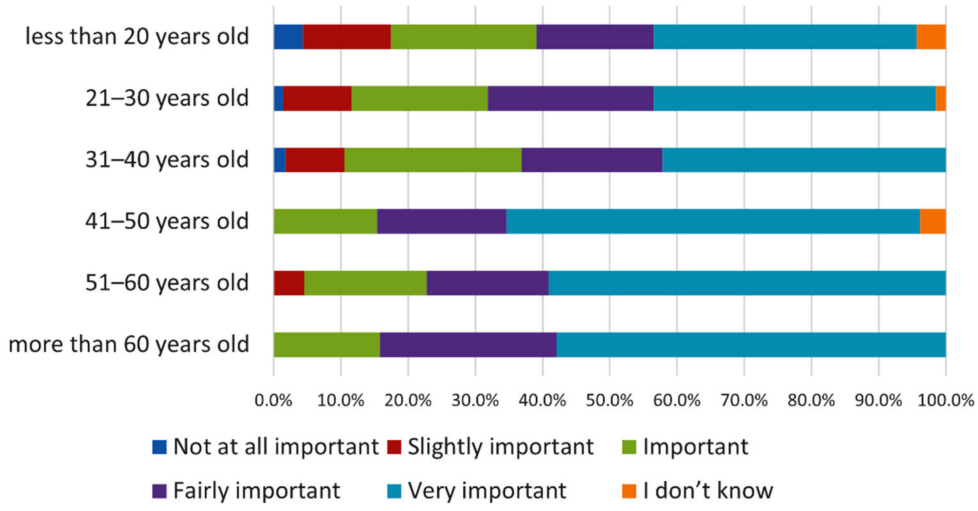
3.1.3. Importance of Contact with Nature for Physical and Mental Well-Being

All respondents highly valued UGS for physical and mental well-being. The importance of contact with nature was not dependent on age group. Mental health and well-being (χ^2 = 25.311, p = 0.445) noted at least by 70% of the respondents (Figure 6a) and physical health and well-being (χ^2 = 17.439, p = 0.865) at least by 56% of the respondents (Figure 6b). At the same time, there is a tendency: the older the respondents, the more positive answers (related to the importance of nature) they choose. Participants from age groups of 51–60 and 60+ assessed the role of UGS exclusively positively, especially for mental health and well-being (73.7% of 60 + years old and 81.8% of age group 51–60 years old). Among the younger groups of respondents, the variability of the chosen answers increases. However, the total absence of impact ("Not at all important" category) is noted only by 1.4–4.3% of respondents younger than 40, and an insignificant impact ("Slightly important" category) by 3.5–13.0% of respondents of the same age.



(**a**)

Figure 6. *Cont.*



(**b**)

Figure 6. Importance of UGS for (**a**) mental health and well-being (n = 216) and (**b**) physical health and well-being (n = 216) according to subjective views of different age groups.

An analysis of responses on the value of nature showed that, depending on age, the results associated with social activity. "Meet other people" (friends, relatives, or simply to feel social inclusion) is statistically significant (χ^2 = 23.505, p = 0.000); "Have fun" (χ^2 = 19.861, p = 0.001). Additionally, the variable "Spend time with family and visiting playgrounds" is statistically significant and it is not only dependent on an age group (χ^2 = 12.904, p = 0.024), but also family status—having children (U = 3315, p = 0.000). Among perceived personal benefits of UGS use (Figures 7–10), the majority of respondents (12.3–16.8%) in all age groups named "breathe fresh air" (Table 3). The most frequently selected benefits are also "mental health benefits (to reduce stress etc.)" (12.2–12.8%), "enjoy scenic beauty" (11.3–13.6%), and "a place to relax and unwind" (11.1–14.4%). These categories did not depend on the age group of the respondents and rather expressed the unity of views of Moscow residents on UGS and their benefits for people.

Table 3. Perceived personal benefits of UGS by Moscow residents of different ages (n = 216).

Values to Be in Nature/ Urban Green Space	<20 Years Old	21–30 Years Old	31–40 Years Old	41–50 Years Old	21–60 Years Old	>60 Years Old
A place for physical exercise (jogging, running, etc.)	8.2%	8.4%	9.6%	7.2%	10.4%	11.2%
Breath fresh air	12.3%	14.9%	15.0%	16.8%	16.5%	16.3%
Sun bathing	4.1%	4.6%	5.4%	3.2%	6.1%	6.1%
Mental health benefits (to reduce stress etc.)	12.3%	12.2%	12.6%	12.8%	12.2%	12.2%
A place to relax	11.6%	11.9%	11.1%	14.4%	12.2%	14.3%
A safe place to be	4.8%	4.8%	4.2%	4.0%	5.2%	6.1%
Spend time with family and visiting playgrounds	2.1%	2.0%	5.7%	7.2%	3.5%	6.1%
Meet other people (friends, relatives, or simply to feel social inclusion)	9.6%	4.8%	3.3%	1.6%	4.3%	2.0%
Escape from the urban environment	8.9%	9.1%	8.7%	8.8%	7.8%	4.1%
Connect with nature	6.8%	9.6%	9.9%	8.8%	9.6%	8.2%
Have fun	6.8%	4.6%	2.4%	1.6%	0.9%	1.0%
Enjoy scenic beauty	12.3%	13.2%	12.3%	13.6%	11.3%	12.2%

Figure 7. UGS use for breathing fresh air, relaxing, and escaping from the crowded city (Photos: D. Dushkova, A. Konstantinova).

Figure 8. UGS for spending time with family and children (Photos: D. Dushkova).

Figure 9. UGS as a space for physical exercises and outdoor sport activities (Photos: D. Dushkova).

Figure 10. UGS for socializing (meeting other people) (Photos: D. Dushkova).

3.1.4. Changes in UGS Visitation

The change in UGS visitation before and during the pandemic was especially evident due to the strong lockdown and restriction of park visits and the use of playgrounds and sport facilities (Figures 11 and 12). Almost 30% of respondents have never visited UGS during the lockdown and 12.5% visited less than once per month (Figure 13). At the same

time, some Moscow residents retained the frequency of visits despite the limitations; for example, 23.1% visited UGS a few times per week. After the pandemic, an increase in the number of everyday visits and a few times per week visits (almost 7%) was identified. It was higher than in the pre-pandemic period. Such visits to UGS respect hygienic norms and rules for social distance (Figure 14).

Figure 11. Closure of urban parks due to COVID-19 restrictions.

Figure 12. COVID-19 restrictions for use of playgrounds and sport facilities.

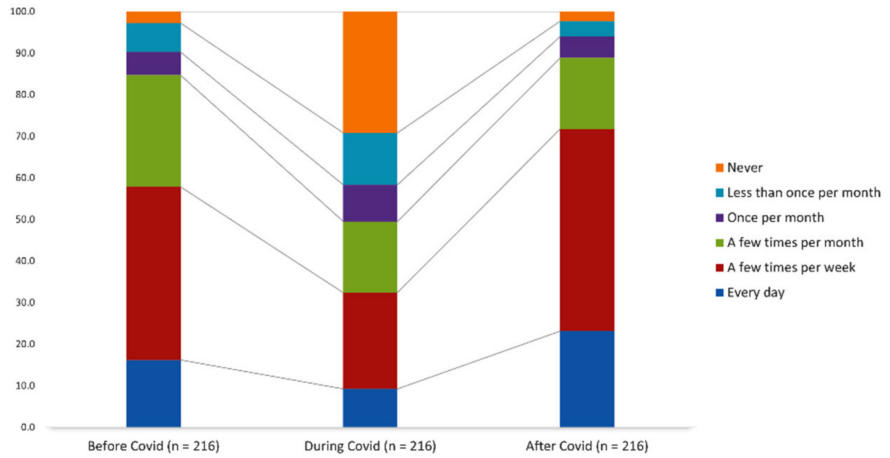


Figure 13. Frequency of UGS visits before, during, and after the COVID-19 restrictions (n = 216).

Figure 14. Social distancing (signboards indicating respect for social distancing of no less than 1.5 m) in Zaryadye park (**first line**) and Kolomenskoe Park of Moscow (**second line**). Photos: D. Dushkova, A.Konstantinova.

3.1.5. UGS Demand, Quality, and Preferences

In Moscow, the demand for UGS can be rated as rather high. More than 65% of respondents agreed that the city needs more UGS (Figure 15). At the same time, 47.2% assessed the quality of existing UGS as inadequate, and 15.3% could not assess UGS at all.

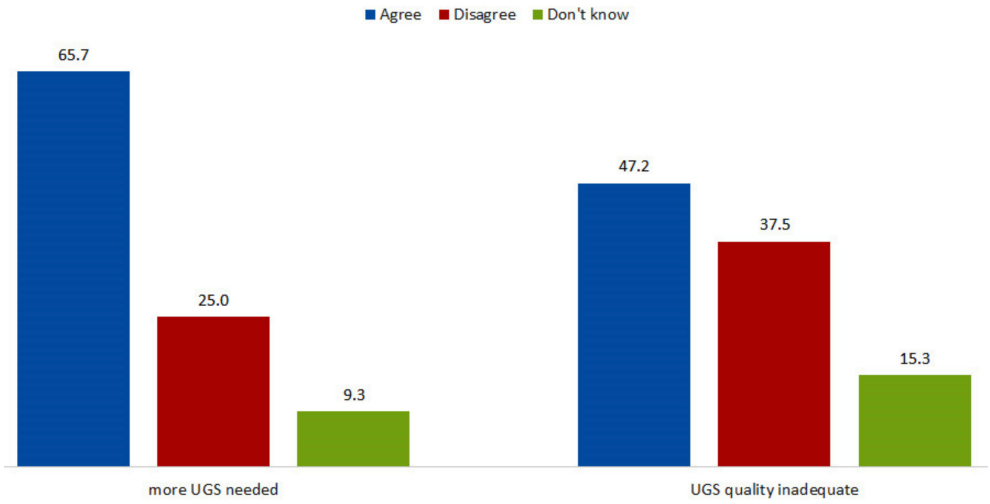


Figure 15. Demand for UGS (n = 216) and its quality (n = 216) according to Moscow residents' opinion.

Regarding the current needs for additional types of UGS, statistical significance was noted for children's playgrounds. The data is depending on the presence of children in the family (U = 4261, p = 0.000) and especially in families with 0–6-year-old children (χ^2 = 16.538, p = 0.000). For families with 7–12-year-old children, pocket parks and small gardens/squares for silent recreation are more desirable types of UGS (χ^2 = 4.633, p = 0.031). Otherwise, the dependencies are not determined. Most respondents made their choice in favor of greening in their neighborhood or district (Table 4). The most frequently selected types of UGS were "Green front- and backyards" (10.8–14.8% depending on the family type), "More green spaces near your house (trees, shrubs, etc.)" (one of the most popular answers for families with 0–6-year-old children–12.2%), "More pocket parks and small gardens/squares for silent recreation" (11.7–14.8%). At the same time, more street greening was indicated as the most desired measure (11.5–16.7%). Another frequently selected measure by respondents was to transform vacant lots and brownfields near their houses into more designed and managed green spaces.

Table 4. Additional required types of UGS mentioned by respondents (n = 216).

Types of Green Spaces	Family with 0–6 Year Old Children	Family with 7–12 Year Old Children	Family with 13–17 Year Old Children	Family without Children
Green front- and backyards	10.8%	12.2%	14.8%	12.2%
More green spaces near my house (trees, shrubs, etc.)	12.2%	7.8%	7.4%	11.3%
More playgrounds for children	7.9%	4.3%	3.7%	2.4%
More green space for active recreation (also with installation for physical exercises)	3.6%	7.0%	7.4%	6.6%
More public parks	10.8%	8.7%	7.4%	11.3%
More street greening	11.5%	13.0%	16.7%	13.3%
More community gardens	9.4%	9.6%	11.1%	11.1%
More school and kindergarten green spaces	8.6%	9.6%	5.6%	7.7%
More pocket parks and small gardens/squares for silent recreation	12.2%	14.8%	13.0%	11.7%
To transform vacant lots and brownfields which we have near our house	11.5%	11.3%	11.1%	9.7%
Other	1.4%	1.7%	1.9%	2.7%

3.2. UGS Provision (Availability and Assessibility of UGS) in Moscow Based on GIS Mapping

UGS cover more than half of the Moscow city area, whereas 38% of the city is sealed. The percentage of green spaces is comparable to such cities as Rostov-on-Don [50], Milan [51], and Madrid [52], but it is less than in Berlin [53]. The major part of the sealed areas is concentrated in the central and eastern parts of the city, which were historically occupied by industrial areas, whereas the north-west and south parts are sealed by less than 25% and considered more environmentally friendly and comfortable for life. Respondents live in areas that are 9.7–72.5% sealed (median ± sd = 41.6 ± 14.1%) (Figure 16). The level of soil sealing did not have a particular effect on the presence (n = 16) or absence (n = 131) of outside sport activity during lockdown (paired t-test, p-value = 0.614). Respondents that indicated the outside sport activity in their everyday life live closer to parks (181 m on average compared to those who do not—288 m, p = 0.05). Similarly, the permeable surfaces in the neighbourhoods have not affected answering positively (n = 54) or negatively (n = 71) concerning the demand for new UGS during the lockdown (paired t-test, p-value = 0.21). Respondents that indicated the need for additional UGS live closer to parks (190 m, n = 36) than those who answered negatively (278 m, n = 100), $p < 0.05$. Herewith, the overall UGS area in the surroundings did not affect answers of respondents. The nearest distance to parks had a minor influence on how often respondents visited these parks (Figure 17). Almost 90% of the respondents had a green space of at least 2 ha within 8 min walking distance. This fact indicates the high accessibility of green spaces in Moscow.

The availability of UGS in the central part of the city is lower compared to the suburbs and as a rule, it is below 50 m^2 per capita, which is considered in a health threshold/guideline for Moscow [54,55]. The highest availability of UGS was reported for New Moscow, south-western and north-eastern suburbs, where the close proximity to urban forests (e.g., Elk Island or Bitsevsky Forest) resulted in values of availability of UGS above 500 m^2 per capita. The availability of UGS (m^2 per capita) as well as its different components (trees/shrublands/lawns) did not influence how respondents indicate their potential needs for additional UGS ($p > 0.05$).

The locations of all respondents were within the highly urbanized area. Therefore, there was a little difference between extracted heat stress index and satellite-based land surface temperatures. There were no statistically significant effects of these hydrometeorological parameters on the willingness to go outside during the lockdown or the indicated need for additional UGS.

Although the availability and accessibility of UGS are widely accepted as indicators of the quality of life in cities. The composition and patchiness of UGS in Moscow are also highly important. For example, green spaces in the central area were dominated by small (less than 10 ha) parks with the vegetation composed mainly of lawns and shrubs with less than 30% covered by trees. Such green spaces are less beneficial for climate regulation compared to the larger patches dominated by tree stands [46–48]. It is clearly visible from the heat stress map, where the highest temperatures were shown for the city's centre, whereas the areas close to urban forests did not experience heat stress.

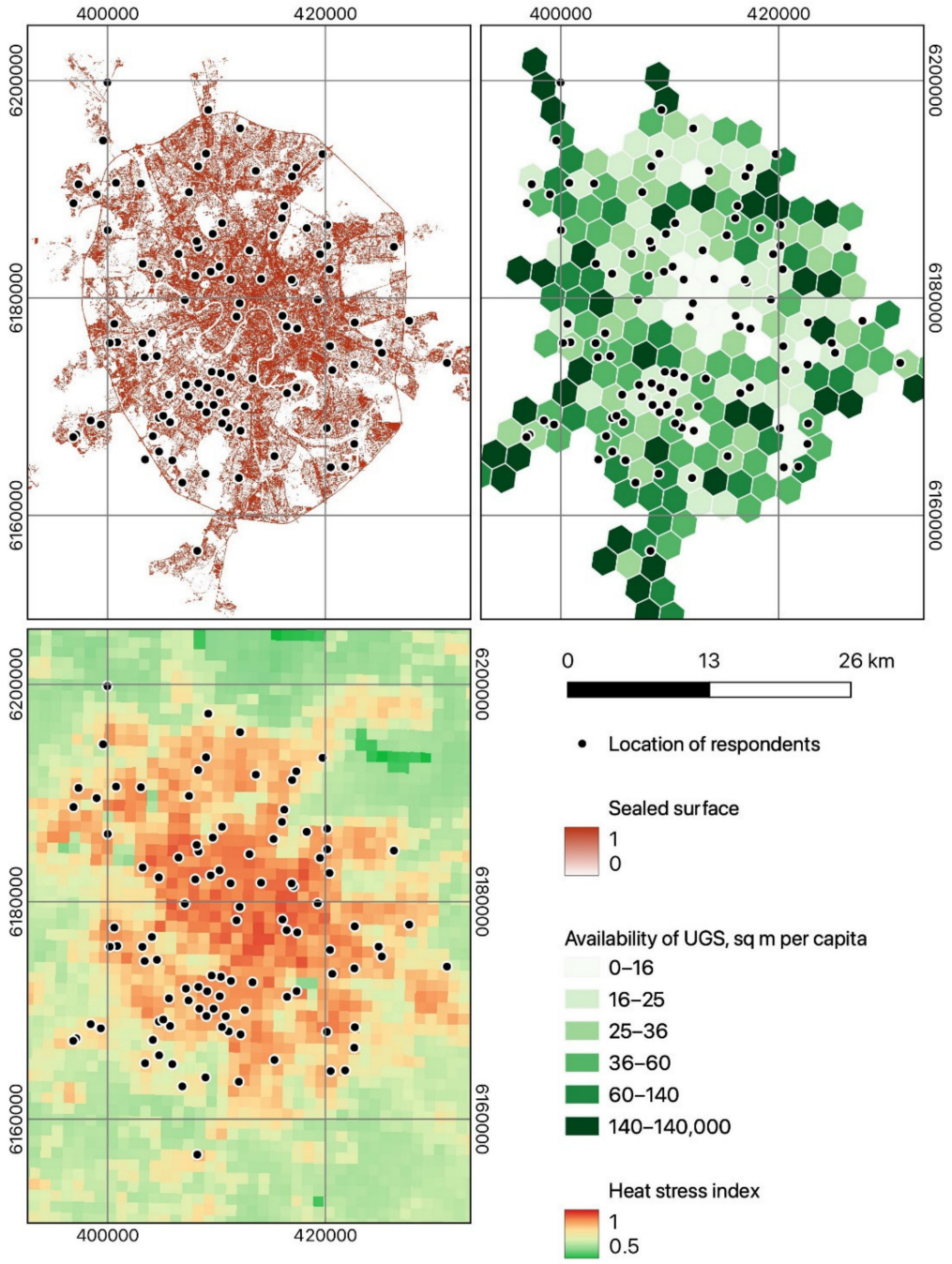


Figure 16. Location of survey respondents (**top left**), UGS availability (**top right**), and the heat stress index (**bottom left**) in Moscow.

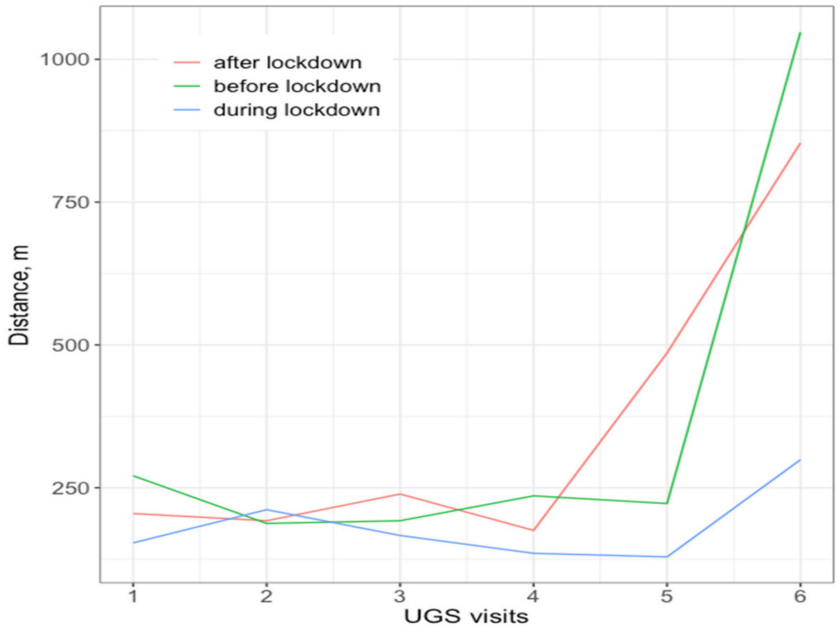


Figure 17. UGS visitation by survey respondents (1—every day, 2—> once a week, 3—several times in a month, 4—once a month, 5—< once a month, 6—never).

3.3. Needs for UGS and COVID-Related Adaptation of Urban Planning and Design in General and in Regard to UGS Based on Expert Interviews

All of the interviewees stated that the COVID-19 pandemic has become a kind of the point of no return for previous unsuccessful urban development and urban life: it has exposed all existing problems such as climate change or social inequality and has accelerated the negative transformations that started before the coronavirus. The COVID-19 pandemic challenged the system "work–home–rest" and narrowed it down to the home office and home school with limited access to outdoor facilities for rest and relaxation. This negatively impacted human health and well-being, e.g., through the increase in computer visual syndrome and stress due to social isolation as well as through a decrease in contact with nature and outdoor activities.

Like many other megacities, Moscow is a complex system that attracts many people, with well-developed economic and social infrastructure, rich cultural life, and job opportunities. At the same time, as stated by the scientists and academia, due to the high density of population, city life is characterized by close contacts, which are perceived as the main risk in the context of the spread of the COVID-19 pandemic, and pronounced inequality. With the closure of cities and quarantines, only the necessary items that support livelihood remain (food, medicine, and transportation).

Both these aspects—narrowing of spatial configuration of the system "work–home-rest" and appearance of virtual working/schooling modes along with the perceived risk of high spread of COVID-19 infection—resulted in the deurbanization process:

> *"The megacity, so attractive as a center of growth and development, with a diversity of services and movement, increasing density of population, communications and building development, is now losing its former universality. In the months of self-isolation, there was a tendency for an "escape" from big cities to nature"* (from interviews with practitioners: architects and landscape architects).

These two identified problems revealed the need to re-organize public spaces in order to ensure social distancing and provide an alternative option for contact with nature when the most parks, street alleys, playgrounds, and outdoor sport facilities in Moscow were closed (period of March–June 2020) as a measure to stop the spread of the COVID-19 pandemic.

Most of the experts highlighted that Moscow had several "preventive" measures which helped to react fast. The already existing strategy (e.g., State and City programs for improvement of streets and public spaces, back- and courtyards in housing complexes, multifunctional greening projects) helped to better adapt to the new COVID-19 circumstances.

However, deurbanization was not a new phenomenon: *"the since centuries existing tradition to go to summer cottages ("dachas") outside the city boundaries allows to escape from the city"* and "*to have contact with nature as another measure to cope with the COVID-19*" (from interviews with public authorities and decision-makers, practitioners, and scientists). Multistory housing areas (both as a legacy from the Soviet period and newly built complexes) also played an important role in mitigation and adaptation to the COVID-19 circumstances: *" . . . people in such housing complexes feel more comfortable than in the city center because they have a back- or courtyards, the area is already landscaped and green according to new standards providing three times more green space per capita than in the central districts"* (from interviews with public authorities and decision-makers and NGOs).

Below, we summarized the main lessons learned from the city's responses to COVID-19 related to urban sustainability and resilience and how the urban fabric of Moscow could be improved:

- during the pandemic, the number of people involved in outdoor sports activities has greatly increased since it was an alternative to many rest activities while other indoor spaces were closed;
- COVID-19 reveals the importance of nature in coping with the problems related to physical and mental health;
- there is a need to create more outdoor recreation spaces which support healthy lifestyles and contact with nature;
- UGS should be inclusive to consider the needs of different population groups, providing safe, attractive, and comfortable conditions by respecting the rules of the post-COVID period.

All above mentioned have defined that public spaces in the city and UGS should not only be re-organized but also apply a new ideology, which includes updating the concept and design of urban open spaces in terms of their multifunctionality, new aesthetical, architectural, and landscape architecture potentials (from interviews with practitioners, scientists and NGOs):

> *"UGS and parks should have an ideology–these are places that can promote and support a healthy lifestyle and ensure that people feel well there"* (from interviews with scientists).

Urban nature is perceived to provide two main values—social and environmental: "*different types of green support different sustainability aspects: parks and public spaces-for recreation, the natural areas for nature conservation"* (from interviews with scientists). All UGS have a big influence on the quality of life in the city. They shape urban living spaces. Here, smart and inclusive urban planning plays an essential role: *" . . . any intervention, even decorative, should address environmental issues and needs of end-users"* (from interviews with practitioners, scientists and NGOs).

The interviews also unlocked the interesting aspect of city greening strategy: indoor greening as a new trend (greening homes due to limited access to parks and corporate landscaping to domesticate the workplace):

> *"We have experienced a boom of indoor greening during the COVID-19–it started with greening homes as a measure of limited access to parks and continued as a corporate landscaping in order to domesticate the workplace". "As was stated by many online markets, with the pandemic the interests of citizens in potted plants grew to 50% (comparing to the year before)"* (from interviews with practitioners).

According to the data from several landscape design studios in Moscow, the demand for planting designers to decorate the large indoor spaces such as shopping malls and business centers, offices and coworking spaces have increased.

"In Moscow which has experienced severe lockdown, balconies and terraces have become places for public meetings and also seen as private green islands" (from interviews with NGOs).

The analysis of expert interviews enables us to reveal the influence of the pandemic on the general design and development of UGS in Moscow and on the character of human-nature interactions:

- various multifunctional greening and site improvement measures for the post-pandemic time are now planned:

  "The list of greening, landscaping and site improvement measures for the post-pandemic time (from 2022 onwards) is very ambitious: there are dozens of new parks, more than 2000 courtyards, more than 320 school and kindergarten green areas" (from interviews with public authorities and decision-makers);

- further integration of UGS into the urban green infrastructure as one integrated urban network of interconnected green areas as premises for better connectiveness, accessibility and availability of UGS:

  "The parks, forests, gardens, and other green spaces in the city cannot exist autonomously; they must be competently integrated into the united interconnected urban network. An important task that Moscow now faces is to form an interconnected park framework of the city with green corridors which would allow citizens to move from one park to another" (from interviews with scientists);

- better accessibility of UGS:

  "COVID-19 pandemic underlines the need for adaptation of 15-min-city-concept in Moscow with its high population density and a special urban structure connected with geological and environmental features" (from interviews with practitioners);

  "pedestrian accessibility of public spaces is important, and this should be considered in designing urban space" (from interviews with NGOs);

- ensuring social distance in UGS while enabling social partnership:

  "We now must maintain social distancing also in outdoor public spaces such as parks which role as the social institute was highly recognized, where people not only get in contact with nature but also socialize and get close to each other" (from interviews with public authorities and decision-makers);

  "Pandemic influenced the design of the urban environment" ordering landscape planners and architects to develop *"public space interventions in preparation for post-lockdown urban life"* (from interviews with practitioners);

  "Moscow has a big number of large UGS such as urban forests and forest-parks which seem to be the safest places in the city due to the possibility of social distancing", *" . . . but also many public parks actually are redesigned to be adapted to the time of social distancing"* (from interviews with scientists).

4. Discussion

4.1. Impact of COVID-19 on Citizens' Life and Well-Being and Developed Coping Strategies

Multiple studies confirmed that the current crisis has demonstrated the decisive, potentially agile role of urban areas and especially UGS in the recovery after the pandemic [56–65]. Both the survey findings and results of expert interviews revealed several impacts of the COVID-19 pandemic on urban development, urban life, and how the pandemic has accelerated the transformations that began before the coronavirus. First of all, in Moscow like in many other cities in the world, the COVID-19 pandemic affected ideas about spatial structures and the types of urban life; a spatial configuration of the system "work–home–rest" was transformed into a home office and home schooling with the limited access to outdoor facilities for rest. As result, several negative effects on human

physical and mental health appeared, also linked to a decrease in social contacts, access to nature, and outdoor activities. Secondly, the idea of a megacity as a center of economic growth, well-developed social infrastructure, safety and prosperity started to lose its universality and attractiveness during the pandemic. It was replaced by the tendency for an "escape" to nature and to the countryside. Due to the high density of population, the city life is characterized by close human physical contact, which is perceived as the main risk in the context of the spread of the COVID-19 pandemic, and pronounced inequality. Thus, the transformation of spatial configuration of the system "work–home- rest" and introducing of virtual working/schooling modes along with the perceived risk of high spread of COVID-19 infection resulted in the deurbanization process when a big part of the urban population actively used suburban and rural areas of Moscow for safe living conditions. Both identified problems revealed the need to re-organize public spaces to ensure social distancing and provide an alternative option for contact with nature when the most parks, street alleys, playgrounds and outdoor sport facilities in Moscow were closed (period of March–June 2020). The main implications of COVID-19 for current and future urban planning, landscaping, and development of resilient solutions in Moscow can be summarized as follows:

- COVID-19 reveals the importance of urban green not only for its ecological value (air purification, creating comfortable living conditions) but also for providing social benefits (contact with nature as a coping strategy to address the issues of physical and mental health resulting from isolation and lockdown);
- It underlines the need to create more outdoor recreation spaces that support healthy lifestyles and human-nature interactions (e.g., during the pandemic, the number of people involved in outdoor sports activities has greatly increased since it was an alternative to many rest activities while other indoor spaces were closed);
- UGS in the post-pandemic city should not only be re-organized but also adopt a new philosophy, which includes updating the concept and design of urban open spaces in terms of their multifunctionality, new aesthetic, architectural and landscape potentials, and opportunities for inclusive urban planning and governance (active community involvement). The recent studies [32,66,67] also underline that the involvement of citizens with different backgrounds is needed in the process of policymaking and practices of green area management in the post-COVID time. Some publications confirmed that in many cities of the world community participation arises in the time of crisis [66–68].
- New city greening strategy: indoor greening (greening homes due to limited access to parks and corporate landscaping to domesticate the workplace).

Several studies highlighted the ecological value of urban nature and the role of UGS not only for mitigating climate change but also for creating healthy living conditions and post-COVID resilience. The cooling effect of UGS has been thoroughly described and modeled [69,70], whereas the effect of UGS on air humidity is more complex. In impervious surfaces (build-up areas, roads, etc.), infiltration is minimal, and a major part of water outflow is performed by intensive evaporation and surface run-off following rainfall events. Therefore, in a long-term perspective, the impervious surfaces do not increase air humidity and provide an ecosystem disservice by strengthening urban heat islands [71]. In contrast, UGS can mitigate urban heat island by decreasing air temperature and increasing air humidity [72,73]. Based on the UGS spatial analysis, we can conclude that climate regulation services are better supplied by the larger green areas in the suburbs, whereas small green spaces in the central parts did not have a considerable effect on climate comfort what also confirmed by [74]. Nevertheless, the social value of UGS of all sizes and types was highlighted by both respondents and experts. They highlighted a range of benefits such as contact with nature, outdoor activities, and socializing.

4.2. UGS Availability and Use during and after COVID-19 Pandemic: Main Pathways and Evidence of Changed Human-Nature Interactions

The research results show that citizens highly value urban nature. They underlined a need for accessible UGS, most notably for breathing fresh air, reducing stress, relaxing, and observing and enjoying nature. The survey also revealed the particular health effects resulting from the reduction in UGS visitation due to COVID-19 restrictions and highlighted the healing value of nature in coping with a crisis such as COVID-19. These findings are also supported by several studies in different countries [56–58]. The reason is in the multifunctionality and capacity of UGS to mitigate some of the negative effects of the COVID-19 pandemic on human health and wellbeing.

Changes in human-nature interactions were also further investigated, analysed, and interpreted. In general, our research results correspond with the main findings on pandemic influence on the human-nature interactions revealed by Soga et al. [59]: (1) changes in opportunity, (2) changes in capability, and (3) changes in motivation. These three tendencies were adopted from the model of behavior developed by Michie et al. [75] where *opportunity* concerns the factors that facilitate or make interaction with nature possible; *capability* refers to individual's psychological and physical capacity to engage in interactions with nature; and *motivation* is understood as a person's brain processes that energize and direct behavior (motivation to interact with nature). Our identified changes in human-environmental interactions include:

(1) *in regard to opportunity*: decreased availability of UGS. Many respondents during the pandemic/closure of parks and outdoor facilities especially missed spending time outdoors and meeting other people. That highlights the fact that while UGS normally provides places for social integration and socializing, during the COVID-19 social isolation UGS was especially valued in regard to physical health and well-being (self-recovery);
(2) *in regard to capability:* the findings indicate that the capacity to engage with nature is strongly related to opportunity. For example, the closure of many UGS in Moscow reduced the use of nature. That is linked to stress due to social isolation and lack of socializing because public green spaces are highly valued as a place for social interaction;
(3) *in regard to motivation*: both the survey and expert interviews confirmed increased positive attitudes of citizens towards nature (increase in recreational activity after the lockdown was ended), increased interest in outdoor physical activity and being in nature as a measure for stress reduction, and decreased symptoms of depression linked to promoting the healthy lifestyle.

Such increased motivation for physical activity may be a key driver for increasing UGS use especially in the neighborhood with the walking distance to nearest UGS [29,31,34]. Such UGS often offer the only available alternative for recreation or socializing. Increased use of neighborhood UGS contributes to improving human health and well-being which is in line with other studies [26,35,59,61]. These studies reported that although people worried about COVID-19 and its impacts, increased nature exposure was associated with greater happiness, higher subjective wellbeing and life satisfaction. These conclusions are in line with the findings of our survey.

The positive side of the pandemic isolation was the adoption of remote working practice that has released free time for other activities. That promoted positive interactions with nature during visiting natural environments in their neighborhood. This conclusion is also in line with the findings of Soga et al. [59].

Our results also confirmed the idea of Uchiyama and Kohsaka [32] that environmental contexts might influence the motivation of visiting UGS by providing scenery and an opportunity to visit UGS next to the citizens' residential spaces (availability of UGS).

The revealed changes in the frequency of UGS during COVID-19 lockdowns also correspond with the findings of Berdejo-Espinola et al. [61] and Venter et al. [62], showing that UGS were discovered by people during the pandemic (new park users) and rediscov-

ered by other individuals (previous users, re-engaged and increased their use). Study of Korpilo et al. [63] confirmed that patterns of UGS use were associated with the quality of residential green areas. However, there is also evidence that some regular users decreased their visits to green spaces during the pandemic, which can be also explained by the uncertainty of some UGS (outdoor safety) as proposed by Freeman and Eykelbosh [35]. According to their findings, the closure of parks, amenities, and green spaces restricts opportunities for healthy outdoor activity and stress relief and may drive individuals to access less suitable and more congested spaces.

However, along with these three pathways, our research also identified the additional one—a response to COVID-19 that resulted in an impact on human-nature interaction which can be defined as an *adaptation measure*. This pathway extends all three previous ones (opportunity, capability, and motivation). The adaptation/coping strategy with restrictions for use of outdoor UGS, lockdown and risk of infection included an increase in deurbanization process (active use of summer cottages in suburban and rural areas of Moscow) and indoor greening measures.

4.3. Main Lessons Learned from the City Responses to the COVID-19 and Adaptation of Urban Development Strategy in Regard to Urban (Green) Planning and Design in Post-Pandemic Time

The analysis of the questionnaire survey and expert interviews as well as participatory observations revealed the influence of COVID-19 on further urban development strategy in Moscow, as well as design and ideology of urban open public space, including UGS. Survey claimed that respondents have in general good accessibility and availability of UGS, but the structure and quality of UGS do not fully correspond to their preferences and needs. The site improvement measures were revealed from the interviews and non-participatory observations which mostly correspond to the needs claimed by the survey respondents. The plans are to create dozens of parks, 2000 courtyards and 320 school green areas. It also corresponds with the current needs and additional types of UGS expressed by most respondents (e.g., greening in their neighborhood or district: green front- and backyards, more green spaces near home, more pocket parks and small gardens/squares for silent recreation, more street greening and site improvement, e.g., vacant lots and brownfields).

The aspects of UGS provisions (better accessibility and availability of UGS) were mentioned as one of the key directions in the urban green planning and design policies (e.g., challenges for adaptation of 15-min-city-concept in Moscow with its high population density and a special urban structure connected with geological and environmental features and pedestrian accessibility of public spaces for different categories of citizens). Several studies [76,77] have observed that the 15-20-min city is in line with concepts promoting dimensions of proximity, emphasizing walkability and social interactions within cities. This concept is becoming more acceptable and appropriate for the agenda of different global western cities. However further research is needed to demonstrate how new concepts can be replicated in other cities [78]. In the case of Moscow, one of the main tasks is to transform and renovate existing infrastructures (without major restructuring) and to benefit from bicycle lanes, parks, and greener spaces.

Moreover, the issue of social inclusion refers not only to the UGS use but also to socially inclusive governance and management, which can be achieved through stronger citizens' involvement in urban planning and greening. Several studies confirmed that public participation in urban and regional planning can increase the chance of the successful implementation of new solutions [66–68,79,80]. The revealed difference between the post-COVID and pre-COVID greening projects in Moscow has shown that stakeholders actively applied a participatory approach and strong community involvement in the discussion of the greening projects through different online tools (e.g., newly appeared program "Active Citizen" to encourage citizens to participate in decision-making process).

As a response to climate change and other societal challenges reinforced by COVID-19, eco-efficient urban infrastructure and an environmentally friendly approach to urban development has been applied (e.g., replacement of asphalt in UGS, ecologically friendly

pavements, using more environmentally friendly surfaces for sidewalks and roads; using native species in flowerbeds and lawns to support wildlife habitats, reconstruction of UGS in line with the original historical plans to preserve the identity of the place and historical heritage, etc.). As in many other cities worldwide [80,81], in Moscow, several strategies are developed and applied to further integrate UGS into the united urban green infrastructure consisted of interconnected green areas, which may allow citizens to move from one park to another. UGS nearby and contact with nature were crucial for mitigating the negative impacts of COVID-19 on quality of life by providing safe space for activities together with emotional and mental health benefits [81,82]. This issue underlines the need for further development and maintenance of UGS. A big challenge of ensuring social distance in UGS while enabling social partnership is addressed through implementing new design elements and additional walking routes and opportunities for interactions, underlining the value of UGS not only for supporting human health and well-being but also as a place for socializing.

5. Limitations and Future Research

Some limitations need to be addressed regarding this study's development in future research. The online survey method could not always provide the verified data on the respondents. Sometimes surveys do not include enough residents from older age groups and from lower educational levels [83]. That could misrepresent the sample. The sample size in our study is relatively low for such a huge city like Moscow and is biased in relation to gender, age and education level. It could be explained by the sampling method using social network websites and targeting recruitment as well as the low level of activeness in survey participation in Russia. Although the number of social media users is increasing every year, the average user profile is biased in terms of age, education, and other demographic criteria [84]. Skewedness of data toward younger users has been also observed in our study. We tried to obtain the data from people older than 50, but the sample was skewed to people 20–40 years old.

Although we have found some statistical significance and dependence on some parameters of the sample such as age and presence of children in the family. Thus, we tried not to draw conclusions according to these groups and presented the recommendations in a more general way. We used a combination of methods (e.g., GIS mapping, expert interviews, non-participatory observation, and photo-documentation) to limit possible errors of the survey method, to verify and supplement the results obtained from the questionnaire.

Limitations of data collection/availability during COVID-19 restriction have meant that the traditional way of non-participatory observation of UGS use in that time has been limited to small-scale sampling (lower number due to sporadic observation) since many of the public UGS were closed or had limited access. This cannot provide city-scale panoramic analysis and delivers only sporadic results. However, it underlines the need for further research to provide a comprehensive perspective for the public and decision-makers in the field of urban greening and design.

Another limitation is the limited number of studies on human-nature interactions during and after COVID-19 in megacities which, on one hand, does not allow us to provide a comprehensive comparative analysis, but on the other hand only reiterates the relevance of the current study and necessity for further research. There is an increasing number of studies presenting the results of surveys on outdoor recreation/UGS use and nature's contribution to human health and well-being in a pandemic situation, e.g., conducted in Oslo/Norway [62], Helsinki/Finland [63], Turku/Finland [82], Burlington, Vermont/USA [31], cities of Belgium [57], Birjand, Iran [60]. They confirm the increase in UGS usage and highlight that the perceived importance of UGS has also increased during the pandemic. Still, very little is published about the situation in densely populated cities/megacities such as Moscow, among them are insights from Nagoya City/Japan [32], a comparative study between Moscow/Russia and Perth/Australia [33], Brisbane/Australia [56], a survey from Asian cities of Hong Kong, Singapore, Tokyo, and

Seoul [58], New York/USA [85]. A European survey by Ugolini et al. [2] conducted in Croatia, Israel, Italy, Lithuania, Slovenia, and Spain, showed that in big cities, where outdoor recreation was restricted by the governments, the majority of those who previously visited urban green spaces regularly stopped doing so but expressed the need for UGS. Another international study by Pouso et al. [26] revealed that contact with nature helped people to cope with the impacts of COVID-19, especially for those under strict lockdown; and emotions were more positive among individuals with accessible UGS and blue-green elements in their views. Different from the questionnaire survey approach, the study of Barton et al. [29] conducted in New York, Barcelona, Berlin/Halle, Oslo, and Stockholm provides local perspectives on the importance of access to green space using Google community mobility statistics.

6. Conclusions

The study confirmed the role of urban nature as a critical urban infrastructure during the COVID-19 pandemic providing opportunities for recreation, restoration, and escape during the pandemic. The results of this study provide key insights for future resilient urban planning and policy that can fulfill a wide range of physical and psychological needs of citizens during a time of crisis and beyond. It was stated that urban planning and management in general and in regard to urban greening should take a specific and adaptive approach. The study in Moscow confirmed the value of implementing an approach that addresses the diverse needs, activities, and preferences of citizens (and especially UGS users). Our research demonstrated the impacts of COVID-19 on city development and revealed the major lessons for urban planning, design, and management of UGS. Moreover, the results presented and discussed in this paper may help to understand the importance of urban nature and human-nature interactions to implement measures to enhance the quality and quantity of UGS in Moscow. Given the complexity of UGS network, public space, mobility, and access of citizens to basic services and UGS, it is now a crucial task for planners, designers, and decision-makers to prioritize urban morphologies that are better integrated with modern technology, public health, and nature in the city. Finally, existing literature shows that the COVID-19 crisis provides an excellent opportunity for urban planners and policymakers to address the challenge of transformative actions toward creating cities that are more just, resilient, and sustainable [27–29,34,80,81].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land11060822/s1, Questionnaire S1: The survey template.

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