Green and healthy —age effects in use and perception of urban green spaces and their impact on personal health and well-being during COVID-19 pandemic

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Keywords:

Urban green areas; health; urban health, emotional health, physical health, well-being, nature, environmental medicine; COVID-19; SARS-CoV-2 pandemic; Vienna; Austria, environmental perception, pandemic, human nature relationship, recreation, age

Abstract:

The COVID-19 pandemic drew public attention back to the living conditions related to housing, access to green areas in close neighbourhood and nearby recreation. Several studies confirm that visiting green spaces improved the health and wellbeing in times of crisis. This representative study for the metropolitan area of Vienna, Austria's capital, confirms the high relevance of contact with nature, particularly for citizens to cope with the negative consequences and perceived stress, anxiety, nervousness and many other negative symptoms experienced during the health crisis. It highlights the importance of nearby smaller but also medium to large scale green areas in cities for health and wellbeing of the population. Moreover, it specifically adds novel insights on age effects in use and perception of urban green spaces during COVID-19 pandemic.

The online panel survey (n=1012) was conducted in summer 2021. In order to obtain a representative sample reflective of the population's characteristics, a (stratified) random sample was selected by applying the quota method. The objective was to obtain a sample which represented gender, age and regional distribution of the population of the City of Vienna as well as the immediately surrounding local communities.

Interestingly, particularly young people spent more time outside in green areas during the pandemic, discovered novel spaces for the first time and stated a high relevance of contact with nature for their wellbeing. Elderly people above sixty five, on the contrary, stayed more frequently at home. Significant differences are visible between the age groups also with regard to negative symptoms experienced in case of restricted access to green areas due to strict pandemic measures such as lockdowns and quarantine. All age groups, however, similarly acknowledged the importance of green areas for their physical, mental and emotional health in general during the pandemic.

 doi:10.20944/preprints202209.0209.v1

1. Introduction

Contact with nature is widely believed to have positive effects on human health and well-being (Hartig et al, 1999; Bowler et al. 2010; Hartig et al 2014). Especially, in urban populations, suffering from greenery shortage, each nature experience opportunity is of high importance (Markevych et al. 2014; Tyrväinen et al. 2014). Spatial planning concepts considering sustainable urban development, underline the role of green and open spaces in shaping resilient, liveable and inclusive living environments (Elmqvist et al. 2015). Recently, COVID-19 pandemic drew public attention back to the living conditions related to housing, access to green areas in close neighbourhood and nearby recreation (Plecak et al. 2022; Ciesielski et al. 2022; Rice et al, 2020). Numerous studies underlined beneficial effects of green areas on emotional and physical health during pandemic particularly in urban environments (Labib et al. 2022; Jackson et al, 2021; Heckert & Bristowe, 2021; Birch et al 2020).

New patterns developed in the use of green spaces as a result of lifestyle changes, such as (increased) remote work, home-schooling, and caring for nursery-aged children at home, as well as limits to people's personal range of movement due to lockdowns, self-isolation rules, and closed leisure facilities (Astell-Burt and Feng 2021; Taff et al, 2021; Ugolini et al. 2020). During the pandemic, urban and suburban green spaces fulfilled a variety of needs.

Studies, such as the one conducted by Robinson et al. (2020), confirm that people visited green spaces in order to improve their personal well-being. In the study of Atalan (2020), the majority of participants indicated that nature had helped them cope with the pandemic. On the contrary, restrictions on access to green areas could negatively impact emotional and physical health. Early during the pandemic also Pouso et al al. (2021) researched the role of green areas when struggling mentally with the pandemic and also investigated the rise in connectedness to nature. Similarly, Soga et al. (2021) examined the extent to which personal contentment and subjective well-being were connected to people's distance to green and blue spaces as well as their access to them during the pandemic. Shentova (2021) confirmed the impact of access to green areas on mental health and emotional resilience in the challenging times of the global health crisis. An unequal access to nature could before, during and after the pandemic result in unequal physical and mental health (Spotswood et al. 2021). Marques (2021) emphasized the need for valuable and usable free and particularly green structures and spaces in urban areas. A lack of free space led to a worse mental state and higher mortality rate. To counteract loneliness, free spaces had a special significance during the pandemic.

In times of lockdowns private green areas were the only facilities to be used regularly in some countries. Several studies such as Theoduro et al. (2021) showed their importance and examined particularly the role of gardening to cope with the stress and other negative implications of the pandemic). Egeter et al. (2020) pointed out also aspects such as food provision and economic security next to benefits on physical and mental health.

Urban green areas can affect the subjective feeling of well-being, mental health, physical health and emotions in a positive way (Uchiyama et al. 2020, Berdejo-Espinola et al. 2020, Bherwani 2021, Larson et al. 2022, Birch et al. 2020, Pouso et al. 2021). This can have a direct or indirect effect on the population. (Uchiyama et al. 2020) Being active outside in a natural environmental such as urban

green spaces also contribute to enhancing the health and well-being (Bherwani 2021, Huerta et al 2021). This applies for adults as well as young adults (Larson et al 2022).

Age and other sociodemographic factors are mentioned to be of high relevance on how to forecast the usage of open spaces and green areas (Da Schio 2021, Uchiyama et al. 2020) In the beginning of the crisis the reduction of visiting green areas was evident concerning especially older women aged 65 and above, as well as women aged 30 to 34 years (Huerta et al 2022). The study which was conducted by Berdejo-Espinola (2020) included 1002 participants leads to a different conclusion that the overall direction showed the increase of using open greenery spaces during the COVID-19 pandemic. With regard to age, older people were not prone to go along with this trend, on the contrary the results indicated the declining usage of urban green spaces. The reclining use of open spaces with respect to age was also found in Da Schio's survey (2021). The reduced use of outdoor activities brought along the perception of more negative emotions as example stress, feeling sad, being afraid, feeling irritable and preoccupied. Being worried about the pandemic increased the chances of limiting the time outside in nature. On the other hand, young students who chose to be active in green spaces had a positive impact on their health and well-being (Larson et al. 2022).

Pouso (2021) and Jackson (2021) both agree that the well-being of adolescents decreased during the pandemic and depression and anxiety symptoms increased. Normally symptoms concerning mental health increase with age, but in the study case of Pouso (2021) the group of younger people showed more mental health symptoms. This could relate to the higher need of younger people to stay more in contact with friends and socialize. Another explanation found in literature suggests, adolescents are hit harder by the pandemic than older people due to less economic stability and fluctuation. Which results in more difficulties, increasing the level of stress and desperation (Huerta et al. 2021). This heightened stress and negative emotion level of young adults or children caused by the COVID-19 crisis could lead to more health disorders and lower well-being in the future (Jackson et al. 2021). A solution would be to offer the youth more possibilities to use green open spaces in proximity to their living area (Huerta et al. 2021, Khalilnezhad et al. 2021). Green open spaces are associated with more positive emotions and happiness and can help reduce negative emotions (Kahlilnezhad et al. 2021). Furthermore Jackson (2021) recommends being active outdoor can help bolster mental resiliency to stress, Larson (2022), Huerta (2022), Berdejo-Espinola (2020) and Birch (2020) are of the same opinion also suggesting that it also helps to improve general well-being and health. But not only the young people are affected by the Covid-19 pandemic, the older generation as well suffers from mental health issues and loss of opportunities to socialize (Carpentieri et al. 2020) Not only mental health problems occurred, the physical health was reduced in lack of physical exercise. Especially younger people and older people missed doing sports (Khalilnezhad et al. 2021) People above 60 have different needs concerning the use of urban green areas, such as socializing, being active in a mellow way and searching for calm and shaded areas in parks (Carpentierei et al. 2020). In order to reduce the risk of depression and fear for older people, due to social distancing, more green areas are needed in the closer range of them (Berdejo-Espinola et al. 2020).

There are various reasons for elderly people to visit green spaces but these can depend on sociodemographic values as example the health status (Loukaitou-Sideris et al. 2016). Main needs which are stated by Wen (2018) are accessibility, as well as safety issues and aesthetic landscapes (Ennsle and Kabisch 2020; Young et al. 2016). Regarding accessibility a high quality of pathways is favored and sitting opportunities to rest should be available (Sugiyama et al. 2009). Social contact and networking are of major importance for older people in order to feel part of the community and

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also to enhance psychosocial health (Yung et al. 2016, Carpentierei et al. 2020). Additionally, literature suggests that older people prefer natural elements as example trees in green open spaces. For younger people trees were not as important as for the older generation, due to trees providing shade which can play a huge role with rising temperatures (Palliwoda and Priess 2021).

As various age groups faced different challenges during pandemic, our study explores the age effects in use and perception of urban green areas as a resource for personal health and well-being. Our investigation is based upon empirical data collected in Vienna - the capital city of Austria.

The main research questions are related to age effects on: i) the relevance of green spaces for personal emotional and/or physical health and well-being in times of crisis ii) time spent in urban and suburban green areas before and during the pandemic. Finally, the article discusses implications for spatial and green area planning and management of metropolitan areas with regard to the demand of various age groups.

2. Methods

2.1. Case study area

The presented findings are based upon a case study carried out in the City of Vienna (the capital city of Austria) and the surrounding municipalities. It focuses on a variety of green and open spaces, including protected areas. At more than 50%, the proportion of green spaces in the City of Vienna makes it one of Europe's greenest cities. Unfortunately, these green spaces are not evenly distributed throughout the City of Vienna. As an instrument for the future development and maintenance of Vienna's green and open spaces, the functional concept for green and open spaces, which is part of the City of Vienna's urban development plan (STEP 2025), states key figures for the provision of green and open spaces. Figure 1 illustrates the location of major green areas in the study area.

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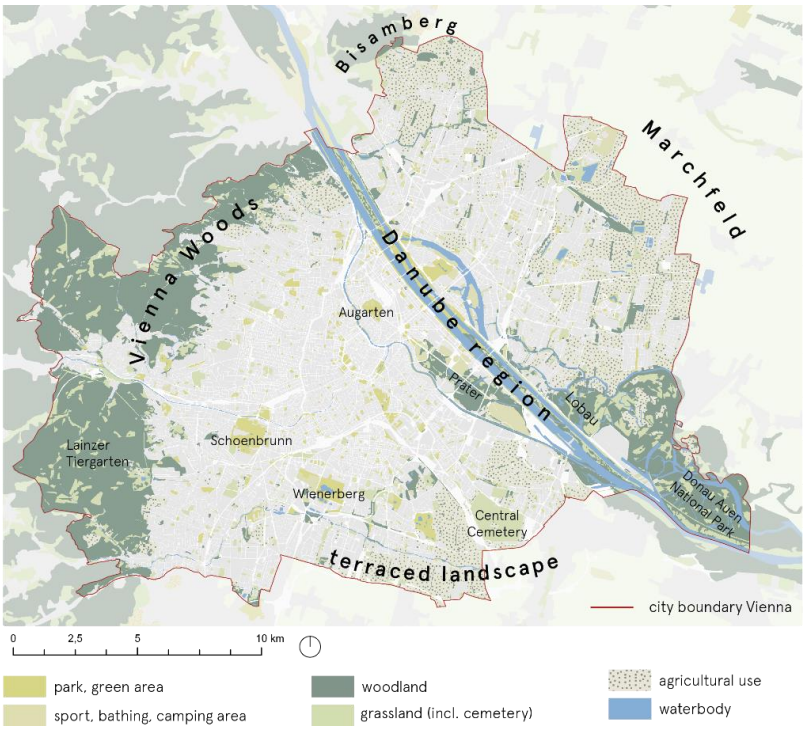

Figure 1 *The location of major green areas in the study area -the City of Vienna and its surrounding municipalities.*

2.2. Data collection

The quantitative approach was applied to examine the habits and views of inhabitants related to urban green spaces and their perceived health and well-being effects. Data collection was carried out using online panel survey between 1. -12. 07.2021. At this time, many public health measures were still in place in Austria to contain the second and third waves of the COVID-19 pandemic. The previous full lockdown in Vienna and the surrounding area was around one month earlier.

Online survey technique was applied to investigate Viennese population perspective. Lime Survey was used to design survey form and corresponding database. The respondents were recruited via commercial online panel (Marketagent). A total sample of 1012 respondents completed the survey. The responses were anonymous (no personal data nor IP-addresses of the respondents were stored in Lime Survey database). In order to obtain a representative sample reflective of the population's characteristics, a (stratified) random sample was selected by applying the quota method. The objective was to obtain a sample which represented gender, age and regional distribution of the population of the City of Vienna as well as the immediately surrounding local communities.

The sample consisted of 51% female and a, 49% male respondents. Participation was open to the respondents aged 16 years or more. 2.5% of the sample were in the age bracket 16-18, 38.3% were aged 19-39, 39.7% were between 40 and 64 years of age, and 19.5% of participants were over 65.
The quotas were also aligned with the population distribution in the Viennese districts and the surrounding communities. Seven regional clusters were considered in the target sample design: C1 Vienna Centre (15,5%); C2 Vienna Central East (9,4%); C3 Vienna West (24,2%); C4 Vienna South (24,8%); C5 Vienna North-East (17,2%); C6 Surrounding communities North East (3,5%); C7 Surrounding communities South-West (5,4%).

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The online standardized questionnaire captured socio-demographic characteristics of the respondents as well as behavioural and psychographic data related to Viennese green spaces. List of survey questions related to the presented results can be found supplementary material (S1).

2.3. Data analysis

Survey data were processed and analysed using statistical software packages: IBM SPSS and R. Descriptive statistics was used for data exploration. Chi-Square Test, Fisher Exact Test and non-parametric test were used to investigate the differences between specific age categories and relationships between categorical and ordinal variables.

3. Results

3.1. Perceived impact of contact with nature on personal health and well-being during COVID-19 pandemic

Overall large majority of Viennese population acknowledged the importance of contact with nature on personal health and well-being during COVID-19 pandemic (Table 1). 86% of the respondents stated that contact with nature was very important (53%) or important (33%) for their physical health, while 12% of the interviewees regarded contact with nature as unimportant for their physical health. Similar results were obtained for mental and emotional health and well-being. 89% of the respondents acknowledged an important role of nature for their mental health and well-being, and 88% for their emotional health and well-being.

Table 1. Perceived impact of contact with nature on personal health and well-being in Viennese population (n= 1012)

	Perceived impact of nature on		
	physical health and well-being	mental health and well-being	emotional health and well-being
very important	535 (53%)	562 (55%)	529 (52%)
important	338 (33%)	331 (33%)	364 (36%)
not important	71 (7%)	57 (6%)	58 (6%)
not important at all	49 (5%)	46 (4%)	45 (4%)
missing	19 (2%)	16 (2%)	16 (2%)
n =	1012 (100%)	1012 (100%)	996 (100%)

Similar opinions were shared by all age groups. The youngest respondents differed slightly with regard to the importance of contact with nature on their physical and emotional health. Respondents aged between 16-18 years attributed less importance of nature contact for their physical health (35% very important; 43% important), however they recognized nature contact value with regard to their emotional health (39% very important; 57% important) in comparison with older study participants.

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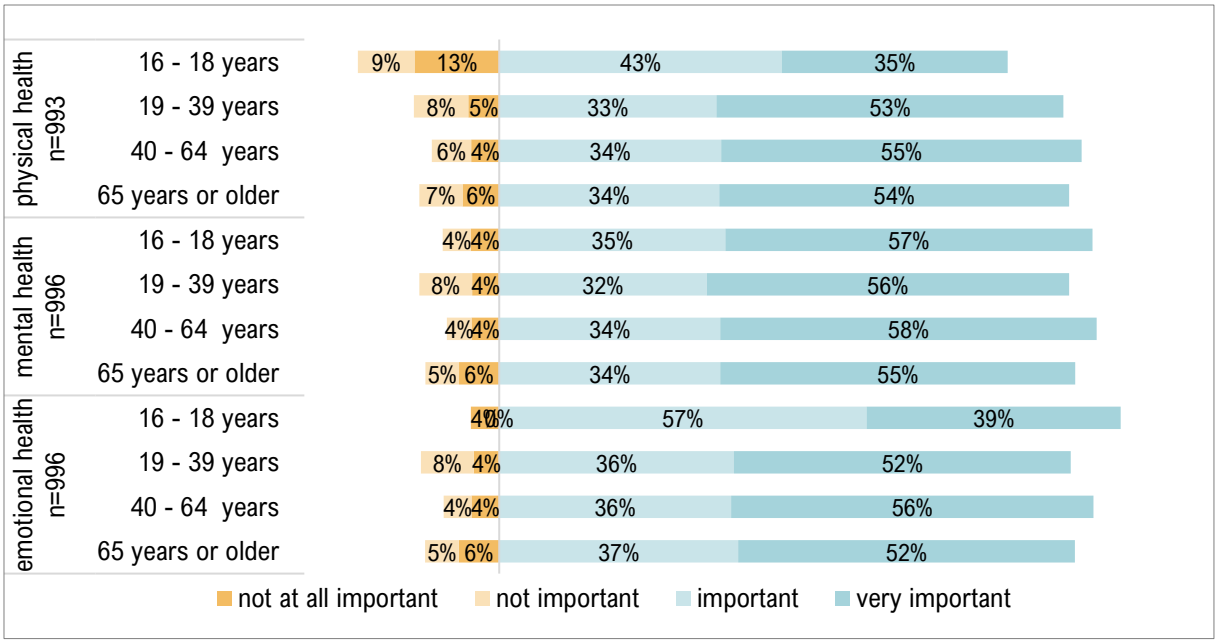

Figure 2 Perceived impact of contact with nature on personal health and well-being grouped by age. Health & Age

Stronger age effects were visible in the perceived symptoms during the COVID-19 pandemic. Significant differences among different age groups with regard to the reported symptoms, such as fear ($p < 1e\text{-}07$, Fishers-z), depression ($p < 1e\text{-}07$, Fishers-z), muscular tension $p < 1e\text{-}07$, Fishers-z) and insomnia (($p < 1e\text{-}07$, Fishers-z) were observed (Figure 3).

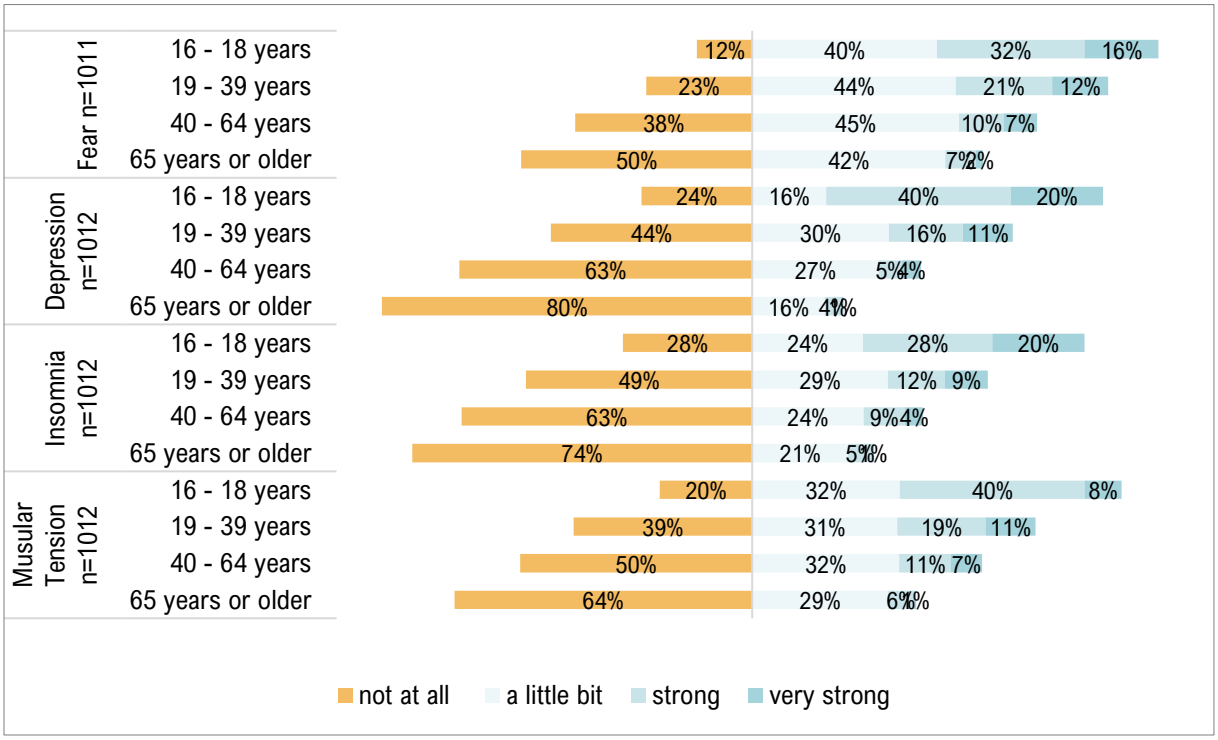

Figure 3. Perceived symptoms during initial phase of the COVID-19 pandemic grouped by age.

More than half of the 19-39-year-olds displayed very strong and strong symptoms of muscular tension, around 38% of the 40-64-year-olds also showed very strong symptoms of muscular tension.

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65-year-olds and plus indicated that they only had experienced a little bit to no muscular tension at all (18% a little bit, 26% none at all). The age-groups of 19-39 and 40-64 years experienced very strong and strong forms of insomnia, whereas the people above 65 years only experienced a little or no symptoms of insomnia (16% a little, 24% none at all). Depression was the symptom which was the most prominent of all symptoms. Over 60% of the 19-39-years indicated to have very strong and strong forms of depression. Around half of the respondents above 40 years showed no symptoms of depression at all to a little bit of symptoms. When looking at the symptom fear, the age-group of 19–39-year-olds showed the strongest response, the age group of 40–64-year-olds followed with 35%. All in all, it can be concluded that the older the people, the less symptoms they perceived or attributed specifically to the pandemic.

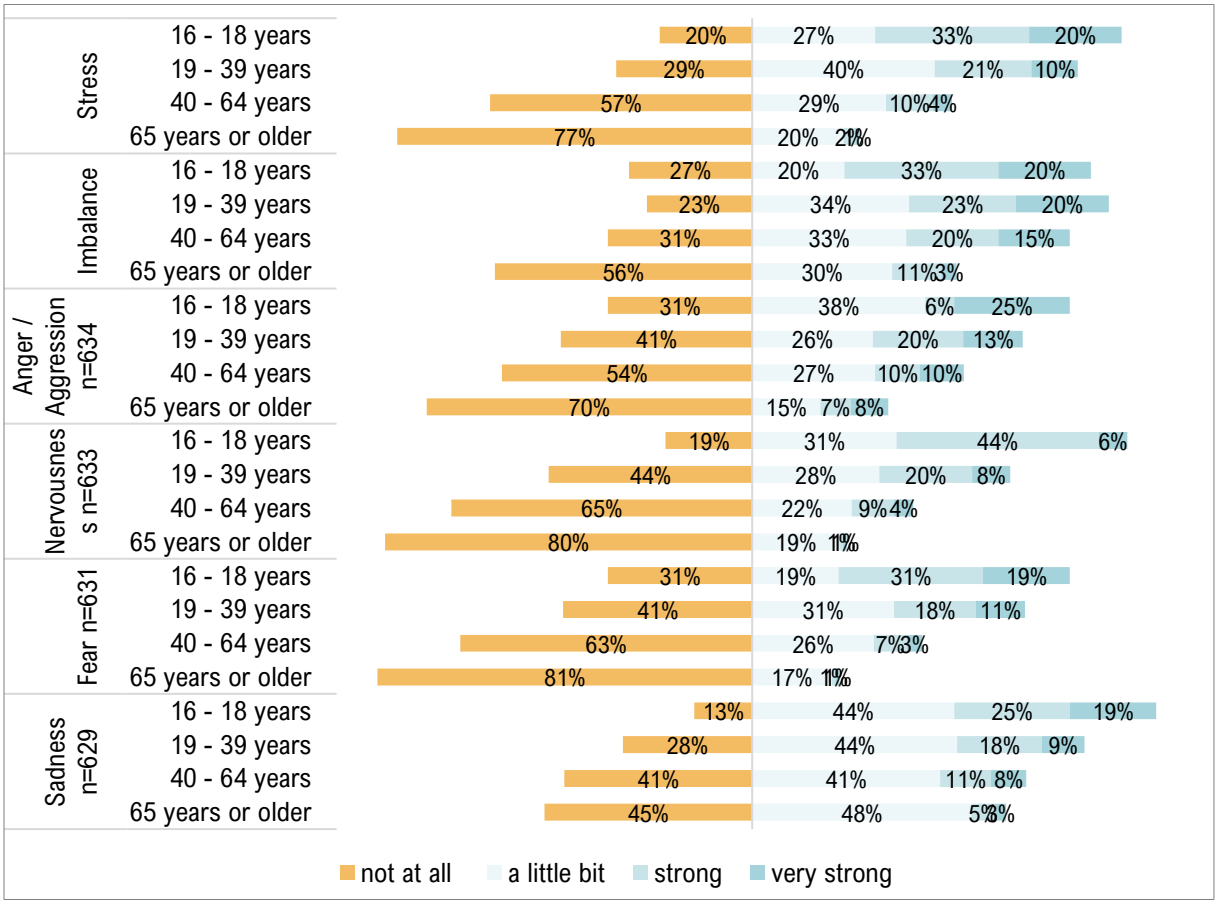

Figure 4. Perceived negative emotions related to limited access of green areas during COVID-19 pandemic grouped by age. (Age effects in experiencing negative emotions: Sadness p < 2.79e-05, Fishers-z; Anger/Aggression p < 2.7e-06, Fishers-Z; stress p < 1e-07, Fishers-z; fear p < 1e-07, Fishers-Z; nervousness p < 1e-07, Fishers-z; imbalance p < 1e-07, Fishers-z).

The results show a significant age effect in experiencing negative emotions when not being able to visit green areas. The younger respondents were, the stronger were their negative emotions. People aged over 40 years showed fewer negative emotions when not being able to visit green areas, while the younger generation was more affected by not being able to be outdoors. Especially, the youngest group (16-18 years) experienced strong negative emotions, such as stress, imbalance, fear, anger/ aggression, sadness, nervousness when being confronted with a limited access to green areas. All of the responses related to different emotions were quite similar to each other but as mentioned above with significant differences between the age groups.

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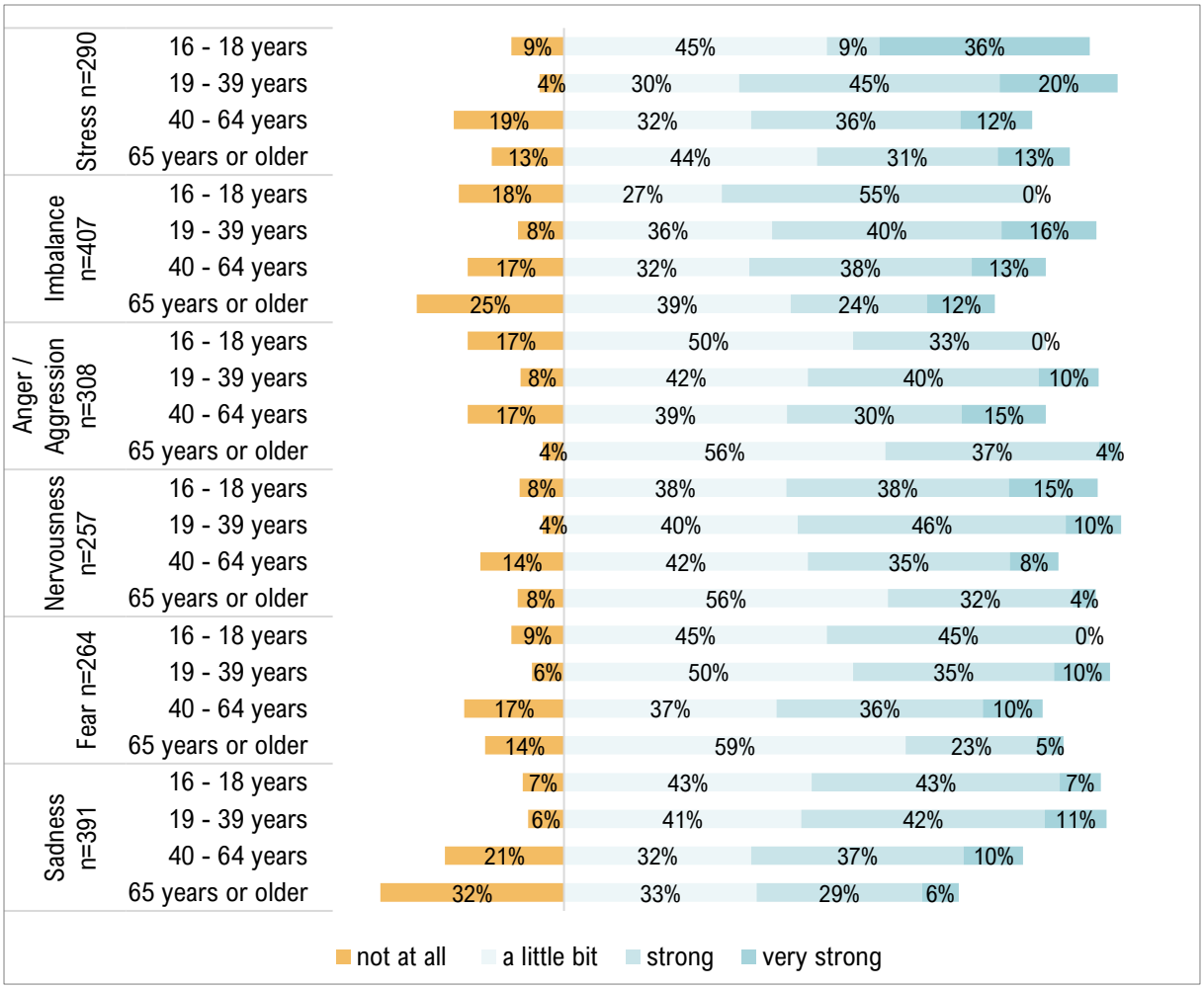

Figure 5. Perceived reduction of negative emotions after visiting a green area (when access to green areas was possible)

After spending time outside in nature, the emotional imbalance was reduced a lot concerning the young adults. More than half of them recognized a reduction of imbalance after contact with nature. Similarly, 40% of the generation of the 19–64-year-olds said that imbalance could be reduced a lot, in contrary, approximately 60% of the over 65-year-olds couldn't feel any reduction or just a little bit of a reduction after visiting green areas (p .026, Fishers-Z). As can be seen there is a tendency that more than half of the 16- to 39-year-olds could feel a reduction of being nervous when visiting nature and around 40 % of the above 40-year-olds felt less nervous, but there is no significant difference between these age groups (p .152 fisher-z not sign). No differences could be found indicating that there are significant changes in the reduction of fear after having contact with nature (p .131 Fishers-z not sig). Whereas significant changes between age and stress could be detected. 40% of the participants from age 16-18 experienced strong or very strong reduction of stress. Even more than two thirds of the 19- to 39-year-olds felt less stressed after being outside in contact with nature. Having a closer look at the above 40-year-olds, they did not feel as much reduction of stress as the younger generation (p .002, Fishers-Z). Significant changes between the reduction of anger/aggression and age could be found (p .015 Fishers-z). The majority of the respondents experienced some kind of reduction of anger/aggression after being in nature. Only a small part of the participants independent of age stated that there was no reduction of the emotion anger. The subjective experience of sadness was similar to the emotion anger. The young people from 16 to 39

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benefited from visiting green areas to reduce sadness, the generation above 40 didn't profit that much but also showed clear signs that sadness was reduced (p .000, Fishers-Z).

3.2. **Age effects in green areas use during COVID-19 pandemic**

The outcomes of our study showed significant differences between various age categories in the use frequency and overall time spent in green areas during COVID-19 pandemic. Age effects were also observed in the dimension of behavioural changes in comparison to the pre-pandemic period.

Figure 6 gives an overview of the overall time spent in green areas by Viennese population during COVID-19 pandemic and before. Before the COVID-19 pandemic urban inhabitants aged between 19-39 and 40-64 spent on average 3.75 hours per week (median) in green areas, whereas the youngest interviewees (16-18 years) and study participants over 65 only spent 1.75 hours per week in open and green spaces (median 1.75). During the pandemic the young adults (16-18 years) used open spaces more frequently (median = 3.75), whereas the 40-64 years old used them less (median 1.75). On average the amount of time spent in green areas in the oldest age group (> 65-years) stayed similar to the pre-pandemic period. Yet, in older age groups share of people who stopped using green areas during the pandemic largely increased.

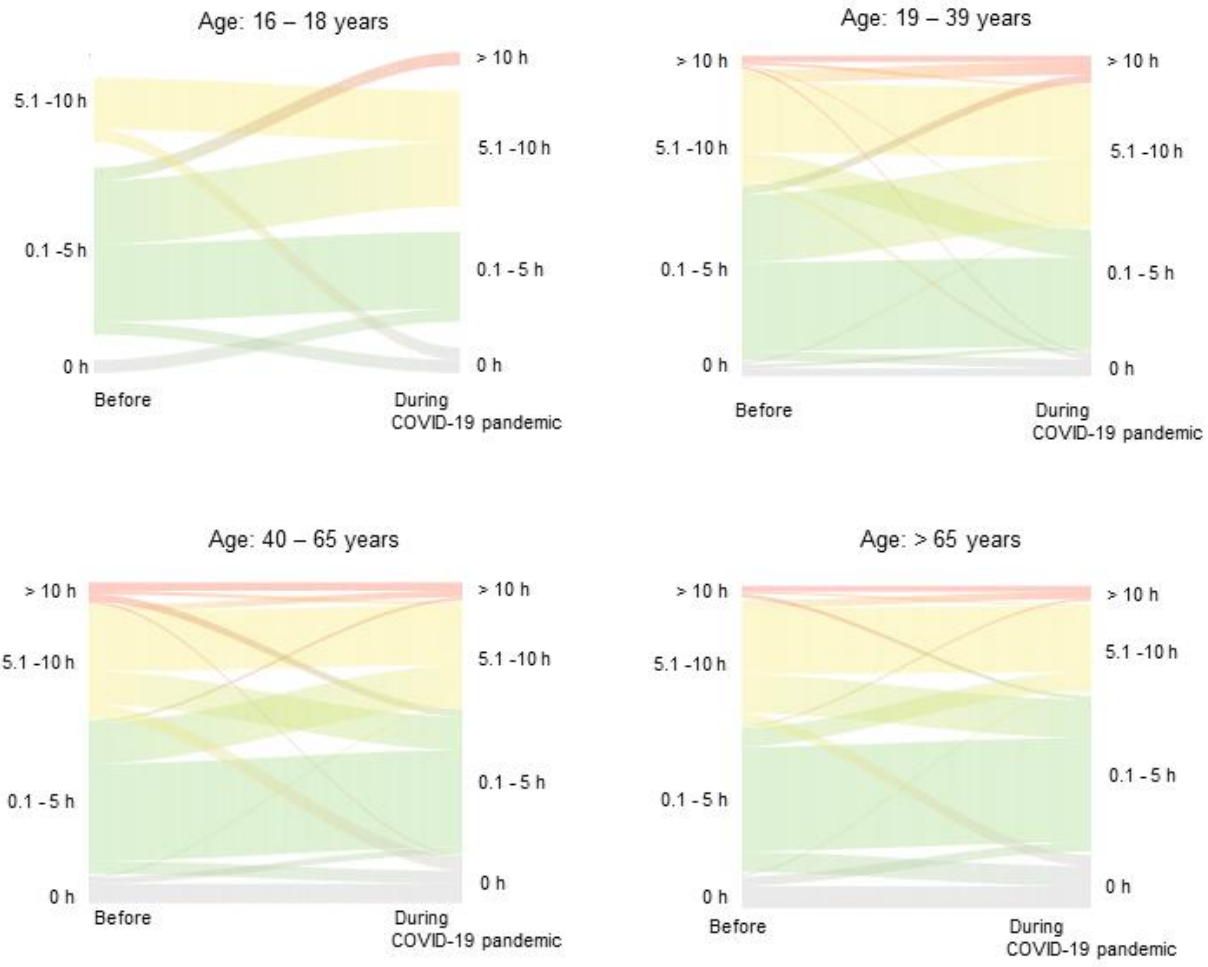

Figure 6. Time spent in green areas before and during COVID-19 pandemic grouped by age [in hours per week]. Sample size: 18-16 years (n = 25), 19-39 years (n = 388), 40-64 Jahre (n = 402), > 65 years (n = 197).

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A Kruskal-Wallis-Test was performed to investigate differences in time spent in green areas among various age groups. Before the pandemic no significant differences were found (p = 0.815). However, during the pandemic significant age effects in time spent in green areas were confirmed (p <.001). A pairwise comparison via post-hoc-test was carried out and significant differences were identified between the 19–39-year-olds and the 65 plus year olds (p <.001) as well as between the 19–39-year-olds and the 40–64-year-olds (p < .001).

Figure 7 gives an overview of changes in time spent in green areas during COVID-19 pandemic in comparison to the pre-pandemic period. The relative frequencies show, that the usage intensity of the young adults (16-18 years) and the 19–39-year-olds increased and decreased with the 40–64-year-olds and 65 years and plus. The usage intensity of green areas in population aged between 19–39-years- increased significantly (p = .009) and got lower with the 65-year-olds (p = .006).

The results reveal that the younger the person, the larger the behavioural change was observed. The majority of the youngest age group (60%) increased amount of time spent in green areas during COVID-19 pandemic in comparison to the pre-pandemic period. A reversed trend, when people are older there were less behaviour changes and also a respective share of older respondents reduced the amount of time spent outdoors during COVID-19 pandemic.

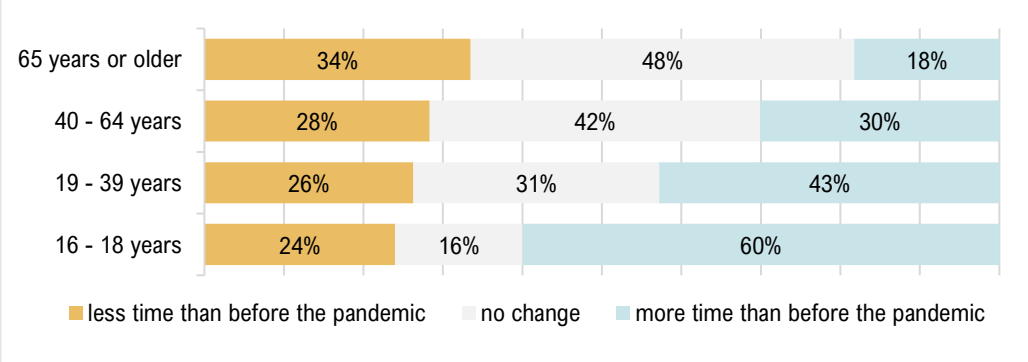

Figure 7. Change in time spent in green areas grouped by age – comparison between COVID-19 pandemic and the pre-pandemic period. Legend: red = positive ranks (more time in green areas during pandemic); grey: no change; blue: negative ranks (less time in green areas during pandemic). Sample size: 18-16 years (n = 25), 19-39 years (n = 388), 40-64 Jahre (n = 402), > 65 years (n = 197)

Figure 8 illustrates age effects in the use of various types of urban green spaces. Table 2 summarizes pairwise comparisons (post-hoc-tests) among specific age groups. Significant age effects in use frequency were found in all types of green areas, excepting forests. The largest differences could be seen between age groups 19-39 years and 40-64 years, were use frequency in almost all the types of open spaces turned out to be significantly different.

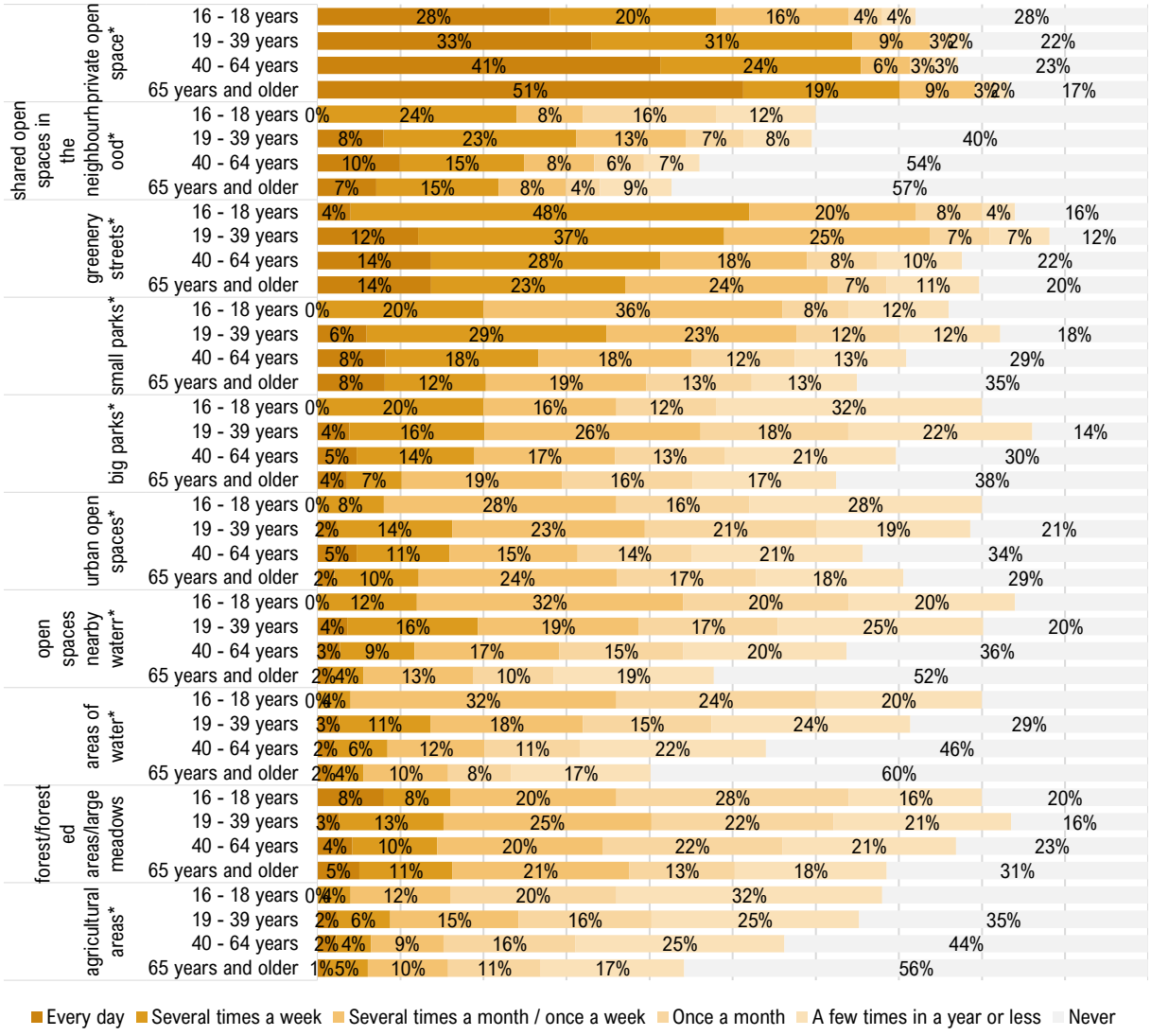

*Figure 8. Use frequency of different green area types grouped by age category. Sample size: 16-18 years (n = 25); 19-39 years (n = 388); 40-64 years (n = 402), >65 years (n = 197). * indicates significant differences between age categories.*

Table 2. Pairwise comparison of green areas use frequency among various age groups during COVID-19 pandemic

Agegroup	⇔	Agegroup	private open space	shared open spaces in the neighbourhood*	greenery streets*	small parks*	big parks*	urban open spaces	open spaces nearby waterr*	areas of water*	forest/forested areas/large meadows	agricultural areas*
16 - 18 years	0	19 - 39 years	x	x	x	x	x	x	x	x	x	x
16 - 18 years	1	40 - 64 years	x	x	x	x	< 0,001	x	x	x	x	x
16 - 18 years	2	> 65 years	x	x	x	x	x	x	0,002	0,002	x	x
19 - 39 years	8	40 - 64 years	x	0,007	0,009	0,002	< 0,001	0,002	< 0,001	< 0,001	x	0,010

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19 - 39 years	8	> 65 years	0,006	0,001	0,036	< 0,001	< 0,001	x	< 0,001	< 0,001	x	< 0,001
40 - 64 years	2	> 65 years	x	x	x	x	x	x	< 0,001	0,030	x	x

Agegroup	⇔	Agegroup	private open space	shared open spaces in the neighbourhood*	greenery streets*	small parks*	big parks*	urban open spaces	open spaces nearby waterr*	areas of water*	forest/forested areas/large meadows	agricultural areas*
16 - 18 years		19 - 39 years	x	x	x	x	x	x	x	x	x	x
16 - 18 years		40 - 64 years	x	x	x	x	< 0,001	x	x	x	x	x
16 - 18 years		> 65 years	x	x	x	x	x	x	0,002	0,002	x	x
19 - 39 years		40 - 64 years	x	0,007	0,009	0,002	< 0,001	0,002	< 0,001	< 0,001	x	0,010
19 - 39 years		> 65 years	0,006	0,001	0,036	< 0,001	< 0,001	x	< 0,001	< 0,001	x	< 0,001
40 - 64 years		> 65 years	x	x	x	x	x	x	< 0,001	0,030	x	x

3.3. **Age effects in perception and opinions on green areas during COVID-19 pandemic**

Depending on the age-group and stage of life the opinions about the behavior or the perception of green spaces and open spaces differed. Statements which show significant changes between the age-groups will be described in the following section.

The enforced controls by the executive bodies influenced young adults strongly. Half of them indicated that they avoided green spaces and open spaces due to the increased police presence, this fact also applies / applies a lot to 27% for the 19–39-year-olds. The increased police presence didn't play a role for elderly people.

The younger the participants were, the more approval they showed for statements with regard to a changed usage-behavior: young adults and 19–39-year-olds stated more often that they had *discovered / perceived or used a green space or open space for the first time.* More than half of these age-groups indicated that they searched deliberately for new green spaces, within the group of people older than 40 years it was a third that discovered new green spaces. Each age-group indicated the importance to have *more room in public spaces,* whereby 73% of the young adults approved strongly to the need of more municipal open and green space.

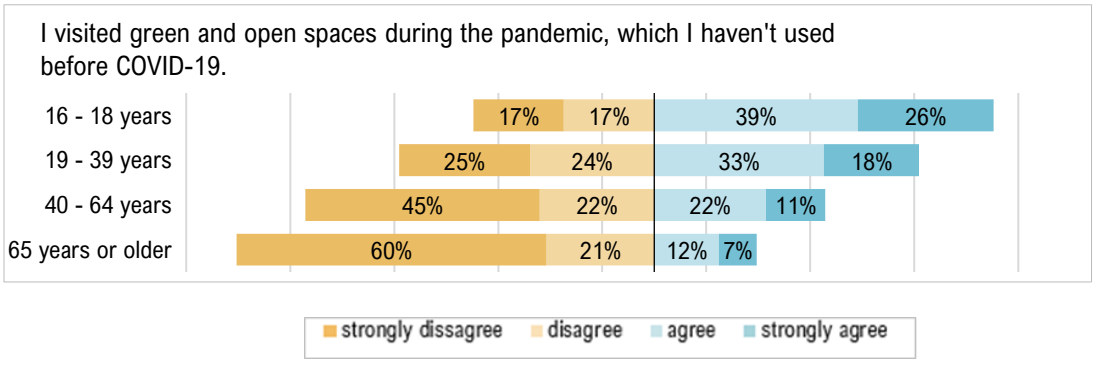

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Figure 9. Age and Agreement with the statement: I visited green and open spaces during the pandemic, which I haven't used before. Sample size: 16-18 years (n = 23), 19-39 years (n = 377), 40-64 years (n = 386), >65 years (n = 193), $x^2(3) = 82.613$, $p < 0.001$

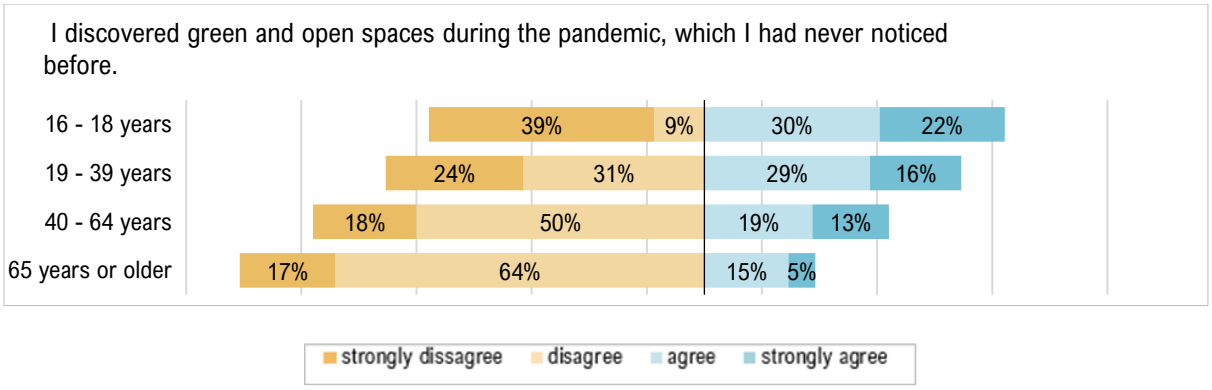

Figure 10 Age and Agreement with statement: I discovered green and open spaces during the pandemic, which I had never noticed before. Sample size: 16-18 years (n = 23), 19-39 years (n = 372), 40-64 years (n = 384), >65 years (n = 192), $x^2(3) = 67.141$, $p < 0.001$

More than a third of the respondents in each age-group experienced that *the sidewalk was too narrow* to avoid another person without feeling uncomfortable. Younger age-groups supported this statement more than the older generations.

To have a private access to a green area was one of the most relevant statements for the respondents between 19 and 39 years. This statement was answered *with agree and strongly agree* by 70% of the participants out of this age group. For young adults this aspect was of the least importance compared to the other age-groups. 43% of the young adults agreed and strongly agreed that it became more essential to *plant their own vegetables*. The most approval for this statement was found with the 19-39-years. In this life stage *the increased wish to move to a more rural area* was of major relevance. *Community gardens or urban-gardening-areas* gained more importance for more than a third of the young adults or the 19-39-year-olds. The older age-groups paid little attention to this aspect. About 60% of all age-groups agreed with the heightened relevance of *spending time in nature or in green surroundings*, this relevance slightly declined with age.

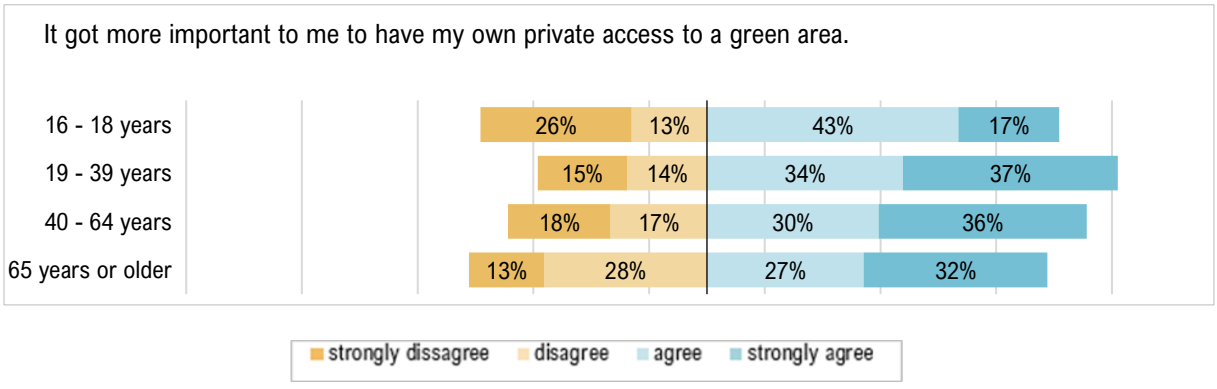

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Figure 11 Age and Agreement to statement: It got more important to me, to have my own private access to a green area. Sample size: 16-18 Jahre (n = 23), 19-39 Jahre (n = 369), 40-64 Jahre (n = 384), >65 Jahre (n = 192), $x^2(3) = 9.315$, p = 0.025

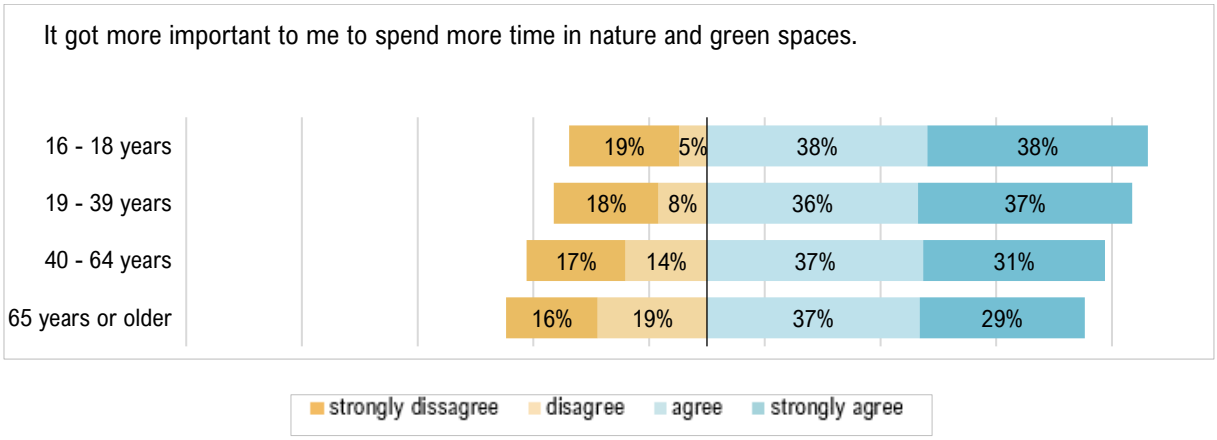

Figure 12 Age and Agreement to statement: It got more important to me to spend more time in nature and green spaces. Sample size: 16-18 Jahre (n = 21), 19-39 Jahre (n = 370), 40-64 Jahre (n = 391), >65 Jahre (n = 196), $x^2(3) = 9.266$, p = 0.026

The statement "*In order to stay active and fit, it is important for me to regularly spend time in nature and do sports (s.e.cycling..*)" can be analysed as follows: Around half of the young adults agreed with this statement, 36% of the 19-39 year-olds also agreed. One third of the 40–64-year-olds were of the same opinion and a quarter of the 65 years and plus. (p < .004, Fishers-Z).

In order to get away from my stressful and turbulent daily-routine (Home-Office, Distance-Learning, time management) it is important for me to spend time in green spaces. The majority of the 16–64-year-olds agreed or strongly agreed to statement 2. Almost half of the 65 year plus year old participants also agreed or strongly agreed that spending time in nature releases stress. (p < 1e-07, Fishers-Z)

For young adults *the contact with friends and family and spending time in nature with them* was of high importance - 80 % of them agreed or strongly agreed to this statement. Around two thirds of the 19 to the 65-year-olds and plus also thought that this statement was of relevance. Concluding, it was seen as high priority during the pandemic to stay in contact with family and friends. (p < 0.037, Fishers-Z.

Approximately 50 % of the young adults agreed and strongly agreed that *by spending time in nature they would have more courage to face life.* Furthermore between 60 and 70 % of the other participants found this statement more important than the young adults. (p < .0001, Fishers-Z)

The younger generation *feels more inspired by nature and more creative* than the other respondents (72% agree and strongly agree), but spending time in nature helps also around 60% of all other age groups (p < .049, Fishers-z)

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All in all, most of the respondents agreed and strongly agreed to *enjoy observing the nature*. The respondents of 40 years and above enjoyed observing the nature the most showing 85% agreement to this statement. ($p < .001$, Fishers-z)

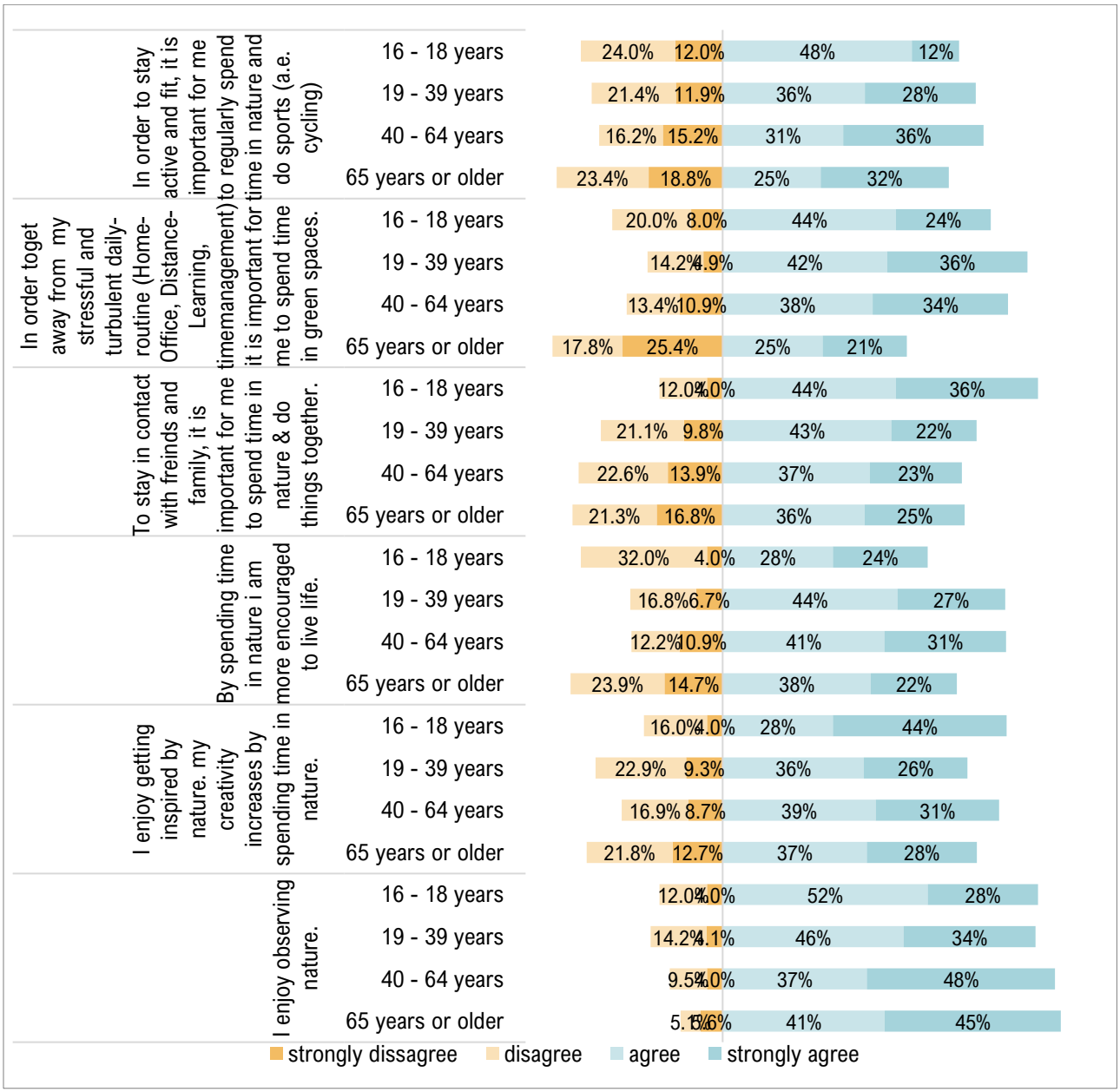

Figure 13 Age effects in the respondents' opinions related to human-nature relationships and urban green areas.

4. Discussion

Overall, the survey confirms the high value of green areas and time spent outside to cope with the health crisis and its direct and indirect effects on physical and emotional health. Similarly, an overall interest in observing nature and spending time outside was visible across all age groups. The findings from the representative survey for the Viennese metropolitan area showed strong significant differences between age groups looking at both the symptoms and negative emotional states

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perceived in relation to the pandemic and the subjectively experienced impact of contact with nature on reducing them.
Interestingly, elderly age groups reported significantly less symptoms such as muscular tension, insomnia or depression than younger age groups. This confirms studies such as from Pouso (2021) and Jackson (2021), which outlined the increase of symptoms such as stress and depression particularly among young people. On the other hand, it is a surprisingly low number of negative symptoms perceived by elderly respondents as we know from other studies such as Carpentieri et al. (2020) that the pandemic of course also negatively impacts the life of elderly people. Participants below forty were particularly negatively affected by the pandemic. One reason might be the multiple changes in life style (Astell-Burt and Feng 2021; Ugolini et al. 2020), concerns about the economic situation or other reasons explored in previous studies, another reason might be that younger age groups did not experience these symptoms before the pandemic while elderly people perceived them also suffered from the for a longer period and thus did not attribute them explicitly to the health crisis (Pouso et al. 2021, Huerta et al. 2021).

Similarly, to previous investigations such as (Soga et al. 2021, Kahlilnezhad et al. 2021) the Viennese survey confirms the strongly positive influence of contact with nature on human health and well-being. Very interestingly, it shows also the negative impact of limited access to green areas e.g. due to lockdowns or quarantine (Larson 2022). Herewith strong differences among the age groups are visible looking at the negative emotional states connected to limited access to nature. On the contrary, strong effects of reducing negative emotional states such as stress, imbalance or fear could be detected, again with significant differences between the age groups (Kahlilnezhad et al. 2021, Berdejo-Espinola et al. 2020, Jackson et al 2021). Obviously, these were important resources during the pandemic, particularly for people younger than forty years. Particularly, for the age group between 19- and 39-years green areas were a valuable resource for the reduction of stress. This stronger reduction might be correlated also to the stronger experience of stress during lockdown periods with unusually long time spent at home, which is also visible by the strong agreement to the statement "*In order to get away from my stressful and turbulent daily-routine (Home-Office, Distance-Learning, time management) it is important for me to spend time in green spaces*". Additionally, the study underlines the importance of private green area. Other studies such as (Theodorou et al, 2021) identified the positive effect of gardening on human health and well-being during the pandemic. This study also makes visible the need of private green areas as a resource of relaxation and place to spend time with kids or the entire family. Significant differences between the age groups are caused by the particular strong desire for private green areas of the age group 19 to 39 years.

Looking at the correlation between household size and negative symptoms perceived it became also obvious that households with more than three people were significantly more susceptible to negative health impacts by the pandemic than households with two or at least only three people. People in single households were again more affected by depression or fear. Green areas might have been overall, a place to compensate negative situations but also to socialize – this became particularly evident looking at young peoples' response to the statement *"To stay in contact with friends and family it was important to stay outside and spend time in nature and do things together".*

Even prior to the pandemic, studies investigating usage behaviour of urban and suburban green spaces found differences according to the participants' age groups (Ode Sang et al. 2016). The Viennese data reveals changes in time spent outside looking at the time before and during the

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pandemic for all age groups. When a closer look is taken at the present study's age groups, significant differences are visible. While the elderly participants reduced their time spent outdoors, the younger age groups, and among all groups particularly the teens, spent significantly more time in green areas. This confirms previous studies with similar findings for elderly people (Huerta et al. 2022, Da Schio et al. 2021) and also for younger people (Berdejo-Espinola et al. 2021).
Studies such as Larson et al. (2022) show also the impact of health concerns which impact personal lifestyle including the mobility behaviour (Khalilnezhad et al. 2021, Ennsle and Kabisch 2020; Young et al. 2016). Also, this survey confirms health concerns related to crowding or the use of public transport. The results also correspond with studies on extreme events such as heat waves which show a decrease in going outside of elderly citizens (Juschten et al. 2019). However, the study highlights also the increased interest in exploring new green areas by the younger age groups and especially the teens. Follow-up studies on the maintenance of this increased interest as well as likely changes in visitation behaviour of green areas could be particularly interesting to survey the younger generations' attitude towards nature in urban and suburban areas shortly after the pandemic and sometime onwards.

5. Conclusions and outlook

Our study revealed significant age effects in use and perception of urban green spaces during COVID-19 pandemic. Overall, it outlines the increased time spent outdoors by younger adults and significant decrease for elderly group. However, across all age groups there were people keeping the pre-pandemic outdoor recreation routine or changing (reducing or increasing) the amount of time spent outdoors. The study highlights age differences in the type of visited green areas during COVID-19 pandemic. While older people used more private green areas than other age groups, young respondents frequently explored near public open spaces including streets and small parks along with waterfront open spaces. All age groups similarly acknowledged the importance of green areas for their physical, mental and emotional health. However, especially younger respondents reported more symptoms, such as fear, insomnia, muscular tension and depression, experienced during the first stage of the COVID-19 pandemic, in comparison to older study participants. Younger participants also reported positive effects on their health and wellbeing (symptoms reduction) after visiting green areas during COVID-19 pandemic. Thus, our study emphasizes the necessity of considering age aspects in the urban planning practice, in order to respond to differentiated needs and expectations of various urban inhabitants' groups to provide a resilient, liveable and inclusive living environment for the heterogenic urban population. Altogether the results from the Viennese case study contribute to international discussion on urban health in metropolitan areas worldwide as they add additional insights on the changed perception and use of green areas particularly looking at young and elderly people as well as the importance of access to these resources to keep healthy.

6. Acknowledgements

Will be inserted in the final version of the manuscript in order to guarantee the double-blind review.

7. Literature

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