Soundscapes in the Postpandemic Era

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Introduction

From 2019 to 2022, the world went through the disaster of the COVID-19 pandemic. It was a dramatic period during which people were isolated, when businesses shut down, and when traffic by air, land, and sea declined significantly. Clearly, COVID-19 has been so much more than a health crisis (Adhanom Ghebreyesus, 2023). Due to the pandemic restrictions that affected all areas of personal and professional life, new formats for business meetings and social communication were developed and established to overcome the loss of real-time, in-person interactions with colleagues, friends, and family members. The home office became popular, as did meeting on virtual platforms for conferences or friendly exchanges, eliminating the commute to a workplace and travel to corporate or scientific meetings that required taking planes, trains, or cars. For many people, the home environment has continued to be the place where personal and professional daily activities take place (Torresin et al., 2021).

Lynch and Church (2023) reviewed the COVID-19 pandemic as a global event that not only affected social aspects of human life but also affected the acoustics of soundscapes everywhere. There is overall agreement that the pandemic led to dramatic changes for all living situations. Regarding acoustic environments, there was a reduction in the number of trips by automobiles and commuter trains. The significant drop in traffic led to soundscapes with a reduction of the overall sound pressure level due to the pandemic in general and the lockdown in particular, but there were also perceptual shifts and long-term changes in human activities and their acoustic environments (e.g., Yildirim et al., 2022).

Figure 1 illustrates the result of a co-occurrence network analysis (van Eck and Waltman, 2014) using title, abstract, and keywords to indicate the focus of soundscape studies in the context of the COVID-19 pandemic (VOSviewer version 1.6.19; see vosviewer.com). Different clusters appear with frequently found items related to noise effects and other environmental aspects (e.g., air quality) as well as health- and traffic-related topics. Remarkably, published analyses of psychological, emotional, and perceptual aspects of pandemic-induced behavior are rare and additional studies are needed.

After three years of impacts from the COVID-19 pandemic, both scientific and media sources claim that we have entered a new period: the postpandemic era. This conjecture was recently supported by the World Health Organization (WHO; 2023), which has stated that although the COVID-19 disease is entering its fourth year, surveillance has declined dramatically, and countries should transition from critical emergency response activities to long-term, sustained COVID-19 disease prevention, control, and management. Accordingly, Tedros Adhanom Ghebreyesus, Director-General of the WHO, declared in May 2023 that COVID-19 is over as a global health emergency (Adhanom Ghebreyesus, 2023). Similarly, the United States Department of Health and Human Services (2023) declared the end of the COVID-19 public health emergency on May 11, 2023. In addition, German health experts are talking more and more about a transition from the pandemic response to addressing an endemic disease (Rabe-Menssen et al., 2023). These developments and the increased use of the term *postpandemic* in a wide variety of contexts suggest that social and professional aspects of life in general and, of particular interest for this discussion, soundscapes, have changed again.

Postpandemic soundscapes can be described as soundscapes that take place after the pandemic has ended, whether as an outcome of new developments and social change or as an approach to former soundscapes as experienced before

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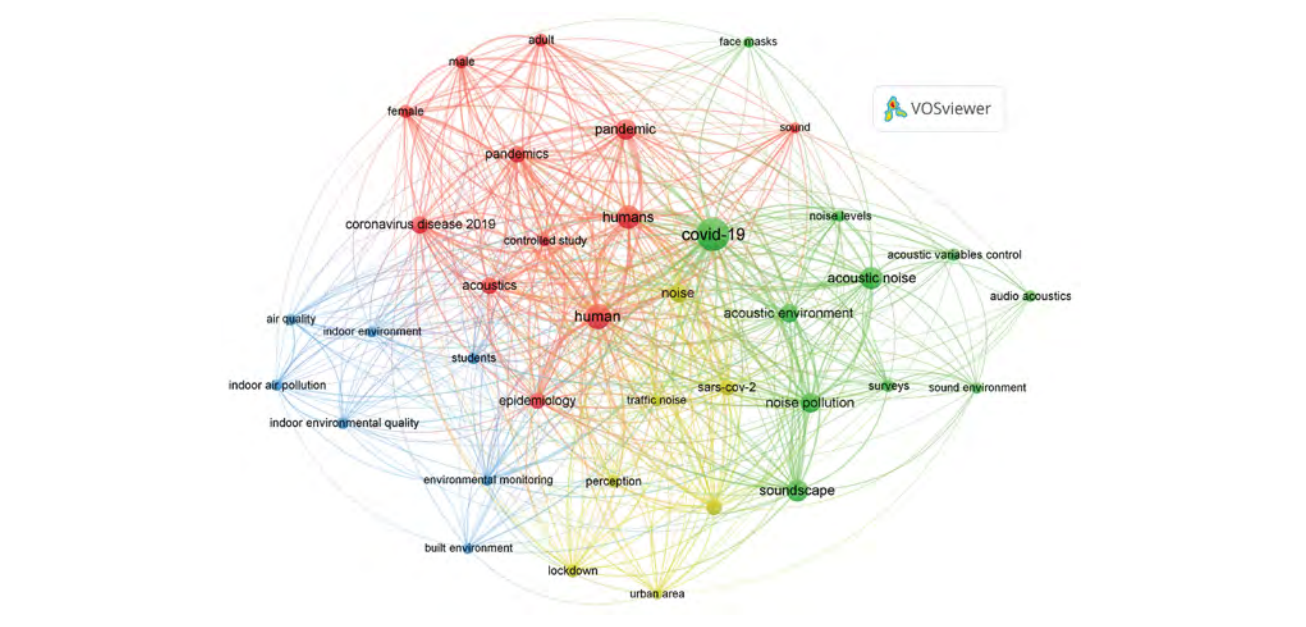


Figure 1. *Map of co-occurrence network of 183 papers found in Scopus searching for "soundscape, acoustic environment, COVID-19, pandemic." Titles, abstracts, and keywords were considered for the co-occurrence network analysis. Terms closer to each other and the same color are terms that co-occur more frequently. Items with fewer than eight occurrences were removed. Created using VOSviewer (see vosviewer.com).*

the pandemic. In May 2023, a conference organized by the WZB Berlin Social Science Center featured discussions of responses to the COVID-19 pandemic, in particular asking whether human activities would simply return to normal in these times of climate change and geopolitical crisis (WZB, 2023). Questions on how to combine work and social life in the future; on how technological, political, and social changes affect daily life; and on which long-term changes might affect how future populations live together were addressed at the conference. The answers are still unclear.

Researchers assert that the COVID-19 pandemic offered a unique opportunity to test soundscapes and assess how the outdoor and indoor living environments changed under extreme circumstances (Bartalucci et al., 2023). Similarly, Hasegawa and Lau (2022; also see Hasegawa and Lau, 2024) concluded that the COVID-19 pandemic will substantially influence numerous facets of daily lives for years. A number of studies explored pandemic impacts on soundscapes worldwide, and there are multiple studies that quantified changes in sound pressure levels in cities due to less traffic (e.g., Haselhoff et al., 2022), but there is little research thus far that provides a better understanding of the effects of those soundscape changes on humans. In addition, the previous efforts have not been reviewed comprehensively or systematically, which reflects a lack of prospective soundscape goals based on the available global evidence (Hasegawa and Lau, 2022).

This article presents observations and findings made over the last year about the pandemic consequences on soundscapes and poses questions to be addressed for better soundscapes in the future, taking into account appropriate social and technological changes. The following questions are considered.

(1) Are there consistent changes in soundscapes that can be described as postpandemic soundscapes?
(2) Do postpandemic soundscapes represent novel soundscapes or a return to previously described soundscapes from times before the pandemic?

Soundscapes During the COVID-19 Pandemic

The pandemic response, especially the drastic lockdowns imposed by governmental authorities in which people were required to limit activities and public contact outside of the home, resulted in extended confinements and behavioral changes in all areas of life. For example, people tended to get

Figure 2. *Impacts of the pandemic: empty restaurants, deserted playgrounds, and lack of tourists, for example, at the Berlin Wall Memorial in Berlin, Germany. Photos by A. Fiebig and B. Schulte-Fortkamp.*

less exercise (Manz and Krug, 2022), generally had a lower activity rate, and traveled less. In addition, people tended to buy more products and food online, socialized less regularly in clubs or restaurants, and spent considerably more money on digital media content and streaming services. Most students indicated more difficulties in coping with examinations. The former sense of "normality" was affected as established routines were suspended (see **Figure 2**).

Those forced and drastic changes in behavior also had an impact on health. Studies have established that the COVID-19 pandemic created an environment in which many determinants associated with poor mental health were exacerbated (COVID-19 Mental Disorders Collaborators, 2021). Meta-studies after the SARS-CoV-2 infection provided indications that mental illnesses were diagnosed more frequently (Rabe-Menssen et al., 2023). One international meta-study showed an increase in symptoms of depression among children and adolescents during the COVID-19 pandemic in a prepandemic comparison; the evidence indicated that the pandemic-related restrictions were a major cause (Ludwig-Walz et al., 2022). The reasons for pandemic-associated mental disorders in children and adolescents are manifold and range from loss of daytime structure and reduction of social contacts to increased conflicts in the parental home (Plötner et al., 2022).

Restrictions that limited contact among people also caused significant adjustments in work and business. During the pandemic, the number of persons who had a "home office" increased significantly compared with before pandemic times, and this included both part-time home office workers and full-time home office workers (Hans-Böckler-Stiftung, 2021). These types of substantial changes that are related to everyday procedures and routines affect urban and rural acoustic environments alike.

From 2020 to 2023, several studies explored the impacts of the COVID-19 pandemic on the environment, focusing on vehicular traffic flows, sound pressure levels, and air quality, to deepen the understanding of the repercussions of the pandemic on environmental pollution and the well-being of individuals (Hasegawa and Lau, 2022). Lecocq et al. (2020) showed that high-frequency seismic oscillations, which are highly correlated with anthropogenic mobility behaviors, decreased worldwide by 50%. According to the authors, the pandemic changes in mobility caused the longest and the most prominent quiet period of high-frequency seismic oscillations on record.

Additional topics were covered in *The Journal of the Acoustical Society of America* (2023) Special Issue on the COVID-19 Pandemic Acoustic Effects. Various acoustic phenomena were linked to the effects of face masks on speech production, speech intelligibility, and acoustic changes in speech, which also affected recall performance due to speech intelligibility and degradation. Changes in noise levels in buildings and in urban soundscapes were also documented. With respect to acoustic environments, some studies focused on the reduction of overall environmental noise (e.g., Alsina-Pagès et al., 2021), whereas others evaluated level changes related to specific sound sources such as air traffic noise (e.g., Greco et al., 2022).

In the context of acoustic environments, most of the research has focused on the impact of governmental restrictions (intended to prevent and control the spread of the virus) on the acoustic environments as measured in terms of sound pressure levels. Researchers observed COVID-19 impacts on urban noise on the country level, city level, or even individual level of experience (Hasegawa and Lau, 2022). Monitoring campaigns were designed, and projects were set up to collect recordings and metadata sets of sounds during the period of the COVID-19 pandemic (cf. Bartalucci et al., 2020). Those studies reported repeatedly on

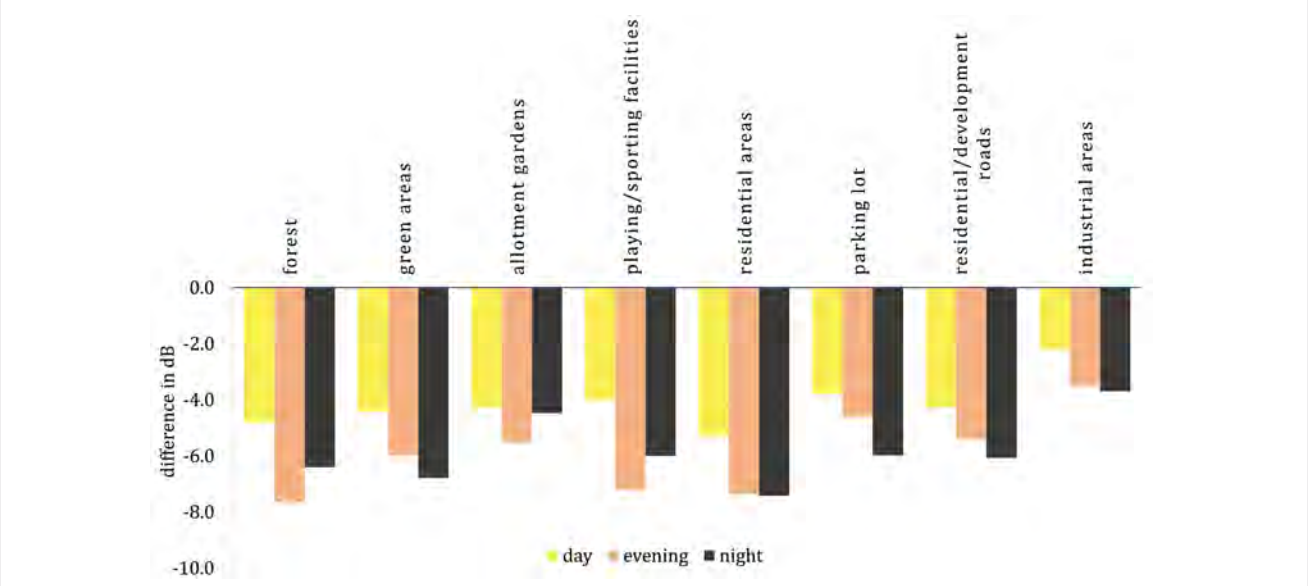
significant reductions in traffic noise in urban areas that led to level reductions of several decibels (Hornberg et al., 2022.; Aumond et al. (2022) determined that the lockdown had a drastic impact not only on the overall sound levels but also on the activity of sound sources in the urban environment. Alsina-Pagès et al. (2021) observed that anomalous noise events increased during lockdown in Milan and in Rome but returned to the former condition in the postlockdown period. As expected, the degree of level reductions varied over land use types (see **Figure 3**). Alsina-Pagès et al. (2021) observed in Girona, Italy, that there were drastic changes in the A-weighted energy-equivalent continuous sound pressure level (L_{Aeq}), especially in areas of the city that previously had an active nightlife, moderate L_{Aeq} changes in commercial and restaurants areas, and only low L_{Aeq} changes in dense traffic areas. Altogether, analyses of the sound levels in numerous studies showed an average decrease in energy-equivalent sound pressure levels of about 5-10 dB(A) (cf. Aumond et al., 2022).

Unfortunately, although many studies in multiple cities focused on decreases in urban noise levels due to stay-at-home orders during the COVID-19 pandemic, fewer studies have examined noise complaints using municipal noise complaint data collected during the pandemic (cf. Ramphal et al., 2022). However, it seems that online tools and surveys were increasingly popular because people were at home, and they could easily participate in online surveys.

Regarding noise complaints, the pandemic seems to have created an inconsistent picture. Unexpectedly, the number of noise complaints increased and decreased at the same time, for example, with respect to specific noise sources considered, e.g., transportation noise versus construction noise (Yildirim et al., 2023). This shows that when considering pandemic-related noise complaint behaviors, there is no one-size-fits-all pattern. However, when examined from a global perspective, it seems that complaints related to traffic noise decreased during the pandemic, whereas the perceptual relevance of construction and neighborhood noise seemed to increase (Tong et al., 2021).

According to Maggi et al. (2021), confinement brought a decrease in mechanical sounds during the lockdown and an increase in audible biological sounds that were associated with feelings of tranquility and happiness. However, behavioral changes and confinement measures also significantly affected the number of noise complaints. For example, in Zurich, Switzerland, the reduction in aircraft traffic led to a significant decrease in aircraft noise complaints (Neue Züricher Zeitung, 2021); however, at the same time, new noise conflicts apparently occurred. Because people were forced to spend a lot of time at specific safe

Figure 3. *Sound level reductions at different times of day at various locations due to the pandemic-related lockdown in April 2020 compared with 2019 in the city of Bochum, Germany. Adapted from Fiebig et al., 2021.*



locations outside (e.g., parks), an increase in the number of recreational noise complaints was observed in many places.

In the Park am Gleisdreieck in Berlin, the number of noise complaints due to leisure noise increased by 10 from 2019 to 2021 (*Berliner Abendblatt*, 2022). Consequently, a member of the Berlin State Parliament concluded that the need and demand for outdoor lounging has grown significantly because of the pandemic, especially in districts of the city that are undersupplied with green spaces. On the other hand, at the Berlin Wall Memorial, level differences of only a few decibels were observed compared with nonpandemic conditions due to the character of the memorial site (Jordan and Fiebig, 2021).

Several studies considered changes in noise levels received or generated indoors. In Zurich, almost 50% more complaints about party noise were observed during the pandemic in 2021 compared with before pandemic times (Neue Züricher Zeitung, 2021). In India, an online cross-sectional survey showed that people assessed indoor environments as noisier during the 2020 lockdown, which adversely affected productivity and online education and was attributed to increased home entertainment usage, video calling, and family interactions (Mimani and Nama, 2022).

In the United States, noise complaints in New York, New York, increased the most in the most economically distressed communities, contrary to some evidence of urban quieting in other places (Ramphal et al., 2022). Economic distress was increased for many individuals because businesses and restaurants closed during the COVID-19 pandemic and unemployment caused more people to be at home.

Based on their review of hundreds of studies related to the impacts of COVID-19 on soundscapes, Hasegawa and Lau (2022) concluded that although beneficial aspects of the COVID-19 pandemic on soundscapes were identified, substantial adverse consequences were observed for human health and well-being. Locations previously dominated by traffic noise were judged as more pleasant. On the other hand, locations that previously had been human- and natural-sound dominated tended to become less pleasant despite the sound level decrease (Mitchell et al., 2021).

All in all, the impacts of the COVID-19 pandemic on soundscapes were varied and site dependent, creating a heterogeneous, complex picture. Reduced traffic noise as well as changed social interactions and routines affected soundscapes in ways that were beneficial and disadvantageous at the same time.

Are We Back to the "Old Normal"?

If we consider the period before the COVID-19 pandemic as the old normal and the current period as a kind of postpandemic era based on official declarations of the end of the public health emergency (Adhanom Ghebreyesus, 2023; Department of Health and Human Services, 2023), we can investigate and compare the characteristics of the old and new soundscapes. Although some of the current levels of environmental noise appear to approximate the noise burdens from the times before COVID-19, that does not automatically result in a similar perception and assessment of the acoustic environments by humans. Permanent noise monitoring systems frequently document sound levels that indicate a return to "normal" sound levels as measured prior to the pandemic in many places. At the same time, Carfagni et al. (2023) determined that in areas less affected by road traffic noise, the current noise levels seem to be lower than in 2019, maybe due to a change in the habits of local citizens. Moreover, Bartalucci et al. (2023) conducted extensive interview-style surveys and claimed that a comparison of pre/during COVID restrictions and post-COVID perceptions highlighted a different perception of soundscapes in the postpandemic period compared with the period before COVID-19 spread. New functions of home life, such as consistently working from home in spaces designated as a home office, will continue in the postpandemic era. Over recent years, the proportion of people working in a home office has increased steadily (HBS, 2021). Detached home dwellers and apartment building occupants have a new vulnerability to the acoustic conditions around their home when there is a home office, resulting in more demand for high-quality acoustic environments (Torresin et al., 2021).

The present cannot be reliably understood and assessed without considering the repercussions from the past. Therefore, proper assessments of postpandemic soundscapes require a consideration of the immediate aftereffects of the pandemic. What happened to people during the pandemic period of restrictive confinements? How do those experiences color the understanding of

everyday life and, perhaps, set new requirements due to changing expectations and behavior?

Scientific findings of pandemic-related mental health effects are sufficiently available to allow valid assessments. Moreover, the pandemic appears to continue to have had a strong impact on mental health. For example, the proportion of children with mental health problems rose during the pandemic until the beginning of 2021 and then fell slightly by the end of 2021 and has stagnated since (Kaman et al., 2023).

A similar trend was found for self-reported symptoms of anxiousness and depression (Kaman et al., 2023). These pandemic-related aftereffects need to be studied to assess their meaning and to facilitate evaluations of health-promoting environments. The role of social changes and health effects cannot be assessed through acoustic analysis alone (e.g., simple noise level measurements); collaboration across multiple disciplines is required, which is the basis of the soundscape concept with its holistic perspective. For economically distressed communities, noise conflicts were even exacerbated during the COVID-19 pandemic, and thus appropriate community-based interventions are needed (Ramphal et al., 2022).

As Lercher and Dzhambov (2023) pointed out, soundscape approaches have provided useful input for small-scale environmental assessments, and soundscape considerations must be more closely integrated with ongoing or future large epidemiological studies. The most relevant evidence-based factors must be considered, but multiple pathways or options should be determined via moderation and mediation analyses while bearing in mind important confounders revealed in other studies (Schulte-Fortkamp et al., 2023). This approach is essential if we are to determine and understand pandemic-related health burdens.

Changes and Challenges for the Future

Current times that are classified as "postpandemic" must be examined from a multidisciplinary viewpoint. The question for the meaning of the postpandemic era for soundscapes has many facets, especially regarding new habits, behaviors, and expectations. The role of those changes cannot be simply interpreted in terms of lower or higher loudness because volume alone is not a consistent predictor of human perception (Schulte-Fortkamp et al., 2023).

Schulte-Fortkamp (2023) emphasized that work-life-balance aspects gained in significance during COVID-19 and modified what was perceived as human needs. Among other possibilities, postpandemic soundscapes could reflect changes with regard to pioneering city planning that involves the concepts of smarter growth and smarter cities based on soundscape techniques that can be applied to urban planning. It is more important than ever to bridge soundscape research and community practices with an understanding of how people react to different types of sounds, behaviorally and psychologically, in specific contexts (Aletta and Xiao, 2018). All those endeavors should mirror the established definition of soundscapes: any acoustic environment perceived or experienced and/or understood by a person or people in context (International Organization for Standardization 12913-1:2014, 2014), putting human perceptions in the center of the research. Soundscape research, due to its interdisciplinary background, offers a broad variety of methods and tools to approach the topic of pandemic-related aftereffects appropriately (Fiebig and Schulte-Fortkamp, 2020).

Habits and Expectations

A long list of changes were caused by the COVID-19 pandemic, from less noise and new needs for work-life balance, from depression to enthusiasm, and from daily needs to new viewpoints on what is the best daily life. Everyone is aware of those complex, ambiguous feelings. The dramatic changes in all living situations left their mark at the individual level as well as on cultural and social levels, which has led to questions about previous quality-of-life requirements.

Bartalucci et al. (2023) observed new social habits and soundscape perceptions. They concluded that new soundscape design is needed and public outdoor spaces need to be enhanced. There are new preferences related to the inclusion of natural sounds, which are given a high preference for enhancing soundscapes.

COVID-19 restrictions caused a serious change in human habits that will give preferred soundscapes a different character in the future. Daily life changed worldwide and new habits had to be developed, starting with establishing home offices and home schooling with the family living together 24/7 in small spaces, adapting to massive restrictions for traveling and the reduction in face-to-face encounters during lockdowns. At the beginning, pandemic-related guidelines and restrictions

caused irritation and evoked feelings of helplessness for a large proportion of the population; habits were changed, especially in daily routines. How these pandemic-related changes in human habits will impact established soundscapes and how the associated effects will influence the future designs of soundscapes to benefit human social processes remain to be seen.

Conclusions

The COVID-19 pandemic had an impact on all aspects of life worldwide. Pandemic-related restrictions changed everyday activities, altered the working environment for many, affected education, and changed social interactions and social life. Due to these changes, the acoustic environment was affected as well. Many restrictions in general, and lockdowns in particular, led to significant changes of urban acoustic environments around the world. The pandemic-related confinements led to a reduction in sound levels in urban and suburban areas worldwide and a changed perception of soundscapes due to the significant decrease in traffic noise and other human-generated noises (Asensio et al., 2022). Thus, the COVID-19 pandemic response significantly affected environmental noise and modified urban soundscapes, opening an unprecedented opportunity for research in the field (Asensio et al., 2020). Changes in urban noise due to the pandemic were documented in countries around the world, including Argentina (Maggi et al., 2021), Germany (Haselhoff et al., 2022), and India (Kumar et al., 2022).

Acoustic changes resulted in beneficial as well as negative outcomes (Hasegawa and Lau, 2022), which illustrates the complex impacts of the pandemic on soundscapes. In addition, the long-term implications of the pandemic effects remain to be studied. What are prospective soundscape approaches for the current, postpandemic era? Soundscape design can be guided by the United Nations sustainable development goals to support resilient soundscapes after the pandemic and to enhance healthy living and human well-being in view of the social changes (e.g., home office prevalence) that are already known (Hasegawa and Lau, 2022).

Recent studies have shown that the coronavirus pandemic still has a strong impact on mental health, particularly for families and adults younger than 30 years (Erbguth et al., 2023). After the three years of living with the COVID-19 pandemic, psychiatrists and psychotherapists have rated the pandemic's influence on their patients' psychological complaints as very strong (Köhler, 2023). Those observations indicate that a variety of conditions and long-term effects must be investigated further, and mitigating those effects must be reflected in the assessment of the value of various acoustic environments. Collaboration across multiple disciplines is required, which is generally provided through applying the soundscape concept (Schulte-Fortkamp et al., 2023).

Postpandemic era preferences may represent a new direction for soundscape planning and city planning, which may be controlled by new concepts in community living. Moreover, the significance of new soundscape preferences for the long term and the new requirements they imply has also not been researched. Such processes take time.

Up to now there is not enough research on all the facets of life that changed across generations of people during the pandemic response. This calls for interdisciplinary scientific networks to foster international, interdisciplinary joint efforts in soundscape research, like the network Soundscapes of European Cities and Landscapes successfully realized a decade ago (Kang et al., 2013).

Soundscape changes in the postpandemic era can be understood as an opportunity for pioneering city planning involving the concepts of smart growth and smart cities based on soundscape techniques that can be applied to urban planning for communities making the best out of the pandemic response (Brooks, 2023). Taking this opportunity seriously is particularly important in these times of various global challenges, such as climate change and geopolitical crises. The soundscape concept enables informed planning and encourages communication processes through the involvement of relevant institutions, community groups, and individuals to achieve a new understanding of co-creation for livable environments.

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