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A STUDY ON THE RELATIONSHIP BETWEEN SOUNDSCAPE PERCEPTIONS OF URBAN POCKET PARK USERS AND THE ASSESSMENT OF HEALTH RESTORATIVE BENEFITS

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1. Abstract
As urban population increases and urban land resources decrease, pocket parks have gradually become the best choice for urban residents to take outdoor recreation. Although international research on soundscape perception in pocket parks is relatively comprehensive and specific, the impact on residents' physical and mental health varies due to different value cultures, uneven urban development, and inconsistent economic levels. This study was derived from evidence of soundscape perception in urban pocket parks in Hefei, China. Six pocket parks in Hefei city were selected by sampling from September 1 to September 5, 2022, and hypotheses were made between the three dimensions of soundscape perception, restorative evaluation, and health benefits to construct an index system and questionnaire combining soundscape perception and mental health. The questionnaires were distributed online inside the pocket parks and 431 valid questionnaires were collected. SPSSAU software was used for data statistics and analysis, and the Cronbach's α of the variables ranged from 0.755-0.844, respectively, with strong reliability. The study concluded that (1) soundscape perception has no direct effect on health benefit assessment but can have an indirect effect through restorative evaluation. (2) Consistency, compatibility, attractiveness, and distance can all effectively reflect the soundscape restorative evaluation. Among them, consistency has the greatest influence on restorative evaluation, and the rest are compatibility, attractiveness and distance in order. (3) The explanatory power of soundscape perception for restorative evaluation is higher than that for health benefit assessment. In addition, the sound of human activity in soundscape perception was the most important latent variable. (4) Soundscape perception had a significant positive effect on restorative evaluation, and restorative evaluation had a significant positive effect on health benefit assessment.

2. Keywords: Pocket Park; Soundscape; Sound perception Restorative; Health benefit assessment

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3. Introduction

The health impacts of the modern urban environment, which serves as the majority of people's homes, have recently drawn more attention [1]. The outbreak of the novel coronavirus (COVID-19) pneumonia in early 2020 has had an impact on human health and public health safety, and the isolation of living at home for long periods of time has made people more vulnerable both physically and mentally [2]. The normalization of the epidemic has led to a breakdown in travel plans and the ability to move around within the confines of everyday life, causing anxiety and stress in people's lives. The pocket park was first proposed by American scholar Robert Zane in 1963, and its prototype is scattered in high-density urban centers, patchily arranged, a small park for local people to use. Studies have found that pocket parks are located in central and busy locations in cities, widely built-in commercial areas, residential areas and around public buildings, from point to point, uniting and connecting, like "acupuncture" to open up the city's veins and stimulate urban vitality. As opposed to other urban parks and green areas, pocket parks have the ability to offer comparable advantages because of its compact size, accessibility, high usage rates, and capacity to maximize human engagement with the natural environment [3]. However, little is known about the soundscape of pocket parks and how they contribute to these advantages. Smaller size and more central placement set pocket park apart from larger parks and offer a unique viewpoint on the implicit link between park users' perceived advantages, the psychological health and soundscape of parks in busy urban area [4].

The field of research related to soundscapes is growing [5], are a part of the study of auditory ecology [6] and an important factor influencing their visitation experience helping to relieve stress [7], as well as one of the key factors in achieving psychological and physical recovery [8] and developing a healthy habitat [9]. "There is a positive link between the concept of 'sound as a resource' [10] and the pocket park as a public space. Although the role of pocket park research in responding to urban public health emergencies is limited, it also plays a very important role in helping the public to rebuild their mental health after an epidemic [11]. This study further utilizes research in soundscape and restorative perception theory to connect respondents' mental health benefits by focusing on urban pocket parks. Therefore, using Hefei, China as the study site, we selected six typical representative samples of urban pocket park environments, extracting natural sounds, man-made device sounds and human activity sounds from urban pocket park environments to explore the potential for positive soundscapes in urban pocket parks. To investigate the quality of the urban pocket park experience, we investigated users' subjective evaluations of soundscape perception and delve into what type of individual differences may further moderate differences in the mental health benefits of urban pocket parks. The aim is to provide theoretical guidance for the enhancement and renewal of pocket parks in the post-popular era and to guide the design of urban pocket parks in terms of soundscapes.

The paper is divided into sections as follows: Section 2 provides a literature review on soundscapes, restorative evaluation, and health benefit assessment in pocket park public spaces.

Section 3 outlines the data collection and analysis methods and briefly describes the six pocket park contexts and soundscape types. Section 4 details the results constructed based on the structural equation models discussed. In Section 5, we discuss the findings of the research questions as well as the gaps in the study and the expected future outlook. Finally, we conclude in section 6 with an overview of the implications of the main findings in the context of the literature and the contributions to theory and practice.

4. Literature Review

4.1. Urban pocket park soundscapes

A growing body of research suggests that urban parks have a positive impact on users, for example, by having a mitigating effect on users' mood and stress [12,13]. Researchers [14-16] have measured and assessed urban soundscapes through both quantitative and qualitative methods, and soundscape descriptions are often used to help interpret or predict park user recovery assessment studies. Some researchers have focused on greenery in large urban or regional parks from a restoration [17] and quiet perspective, which has been shown to be associated with low decibel levels, and urban studies have shown that too much 'volume' in cities can induce stress growth. However, it is an open question whether these advantages still apply when parks are reduced in size. Pocket parks are located in various areas of the city, making use of marginal, abandoned, unused and green areas in the city, and are planned and built according to local conditions, widely in commercial areas, residential areas and around public buildings. Unlike other urban parks and general green spaces, pocket parks are small in size, highly accessible, frequently used and can meet the needs of people in contact with the natural environment to the maximum extent [18].

For example, Balai Kerishnan et al. [19] suggest that both individual parts (green floor hide, shrubs, plants, potted plants, and waterfalls) and factor considered (personal taste for green landscapes; serene ambience; security) are generally reported to be extremely responsible for diseases. Parks have traditionally been associated with "quietness," but some researchers have begun to shift the focus of soundscape research from "quietness" to other park-related factors. Additionally, studies have suggested a potential connection between expected sound and social relationships [20], such as Van, Kang et al. who discovered that soundscape perception was significantly influenced by individual preferences and sensitivities as well as demographics related to soundscapes [21-25]. And Liu and Kang (2015), Luo (2013) et al. suggest that the quality of sound and type of sound are critical factors in creating sustainable urban parks [26,27].

4.2. Theoretical research on the evaluation of psychological recovery

The effect of sound on recovery activities has been studied in additional follow-up research programs from training inquiries or particular sound treatments in mindfulness with certain type of planned behavior [20,28,29]. Aletta et al. discovered that noises with a favorable influence had a beneficial impact on health in general [30].

Regarding the restorative function of restorative assessment on human mental health, there are two well-known views. One is the Kaplan and his wife's media exposure recovery hypothesis, which suggests a straightforward scale framework to make it easier to measure environmental restorative evaluation. It is based on the notion that elevated public areas could indeed improve psychological health through four factors: charisma, distance, compatibility, and congruence. The other is the theory of stress recovery, proposed by Ulrich, which values evidence of physiological indicators and promotes integration with the modern field of neuroscience. These two basic theories explain that park environments can be beneficial to people's mental health from different perspectives. Researchers have successively proposed the Perceptual Recovery Scale (PRS) based on attention recovery theory, and since then, the PRS has been widely used in empirical research. Later Payne and gustation et al. further improved the Perceived Restorative Soundscape Scale (PRSS), which was developed from the Conscious Recovery Scale (CRS) by linking the four components of the PRS to the location of the park site and the physical environment surrounding [31].

RRS are increasingly used, for example, to study the restorative effects of campus green spaces [32] and different urban park landscapes [33]. Furthermore, Berto et al. used a pro-biotic design learning environment that, in addition to being considered more restorative, was more effective than traditional learning environments in supporting students' attentional performance and, over time, enhanced students' sense of belonging to nature. This case study brings to light the potential for high-quality spaces with pro-biotic design to have a long-term impact on restorative learning environments and work performance [34]. Peschardt, K. K. and Stigsdotter, U. K. argue that the potential for social activity in parks is considered an important factor in recovery [35]. Overall, the PRS uses people's subjective perceptions as a starting point to obtain an assessment of the restorative nature of the environment, which better reflects the restorative effects of the pocket park soundscape.

4.3. Research related to the health benefit theory

Recently, some environmental psychologists have judged that people prefer natural environments to urban environments because natural landscapes are more conducive to recovery. It has been recognized since ancient times that the appreciation of beautiful natural environments can help to release mental stress and reduce patient distress [36]. Early studies have found that frequent viewing of hospital courtyards by post-operative patients can reduce the likelihood of post-operative complications and shorten hospital stays. In addition, the natural environment can help reduce stress, anger, depression and tension, and increase feelings of well-being [37]. In summary, the three main effects of ornamental landscape environments on the health of park users are: short-term recovery from psychological stress or fatigue, recovery from or reduction in physical illness, and long-term and overall well-being. The contribution of the natural ecologic to individual health is multifaceted and there are various measures of health, such as frequency of medical visits, days from surgery to hospital discharge, EMG values, doses of painkillers, affective tests, self-reported emotional states and self-assessment of health [38,39]. Among these, the health benefits perceived by recreationists can be obtained quickly and effectively through recreationists' health benefit

assessment of the environment, as measured by Kim et al, Saya et al and Hao et al in their studies on the role of the environment on individual health [40-42]. In addition, considering the difficulty of obtaining health data, this study also used health benefit assessment as a measure.

5. Materials and Methods

5.1. Study Areas

5.1.1. Site Survey of the Study Area: From the data reported on Anhui News as of September 2022, we know that there are currently 16 pocket parks in Hefei, Anhui Province, 15 of them have been completed, which were sampled using the simple random sampling survey method in this paper. Cases were randomly selected as a sample from the total number of completed pocket parks, with each case having an equal probability of being selected. The six pocket parks not only have a high pedestrian flow and a good service infrastructure (Figure 1), they are used by all age groups, including children, teenagers, middle-aged and elderly people, they are places for daily leisure and fitness, recreation and entertainment for Hefei residents. But also contains an integrated complex of residential, commercial and public service areas, which can better reflect the different types of pocket parks. It is also conducive to the collection of a large amount of basic experimental data, its soundscape environment is well suited to the needs of this paper. The research team and the expert group gave suggestions and combined with previous studies to categories the pocket parks into three types of six representative pocket parks. Table 1 illustrates the primary attributes of each park.

The study team performed on-site research in each pocket park over the course of five consecutive working days in September 2022 to gain a deeper knowledge of the shifting patterns of the soundscape there. Then conducted field research and filmed the six pocket parks several times, using audio and video recording to capture more of the soundscape attributes and to give a sense of immersion. The camera was fixed on a tripod at the edge of the pocket park scene at a horizontal viewpoint height of 1.60 m. The camera moved slowly from one side of the scene to the other to fully capture the scene features. The full set of captured scenes was combined into 15-second videos for 40 seconds each. Based on previous research that found that it takes at least 15 seconds to have a physio-psychological effect with landscape images as a stimulus source [43].

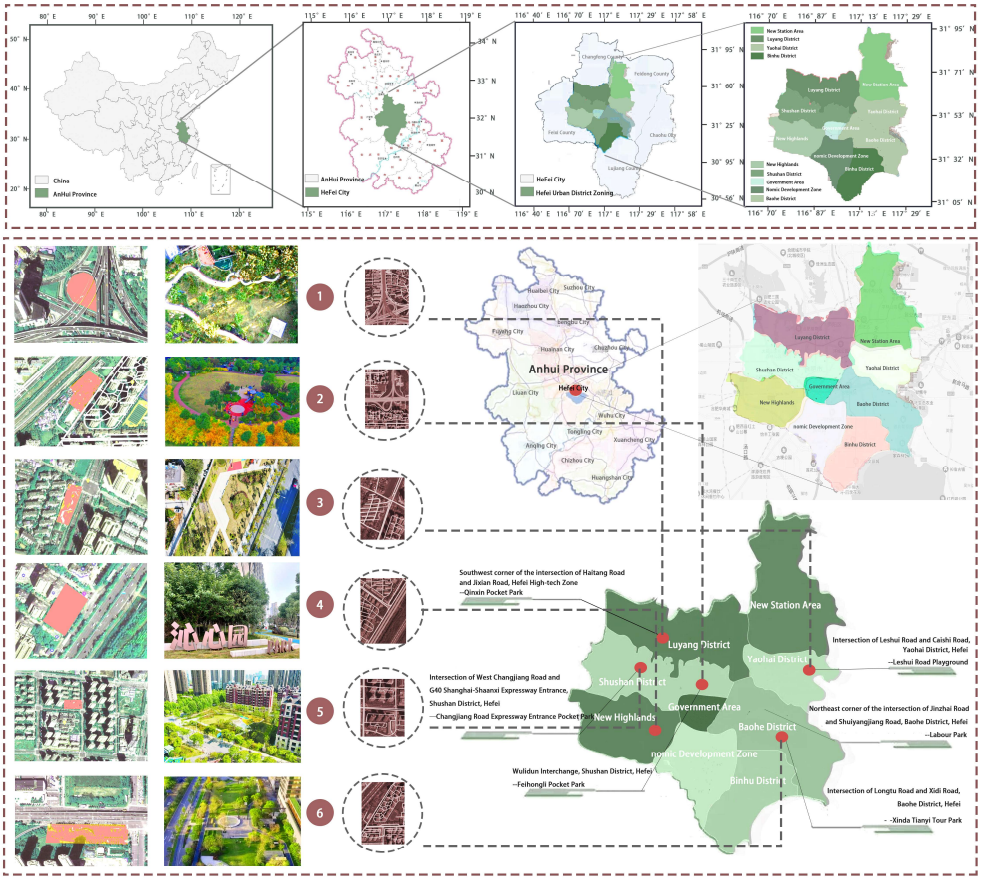

Figure 1: Study area siting function partition and sampling point distribution.

Type	Site name	㎡	Longitude	Dimensionality	Pocket Park Shape	Signalment
Cultural type	S1:Xiangshuwan Pocket Park	≈10000 ㎡	117°15′34″E	31°53′18″N	Approximate rectangle	Renovating loess piles and integrating scattered small plots has become a good place for nearby residents for sports, leisure, culture and entertainment
Ecological type	S2:FeiHongLi Pocket Park	5500㎡	117°15′7″E	31°51′13″N	Approximate water drop type	The site is rich in vegetation, and has a certain sound insulation function, integrating culture, entertainment, greening, recreation,

						recreation, recuperation as one
Community type	S3:Leshui garden	4800㎡	117°20′46″E	31°51′25″ N	Regular rectangle	Provide venues for the surrounding residents to rest, entertainment and fitness, located around the residential area
Cultural type	S4:Qinxin garden	3900㎡	117°12′22″E	31°48′51″N	Regular rectangle	Leisure trail multi-level vegetation landscape, equipped with fitness equipment, tree pool rings and benches and other leisure facilities and rest benches
Ecological type	S5:Changjiang Road express way entrance park	≈10000㎡	117°01′35″E	31°50′44″N	Regular rectangle	With a certain recreational function of the park green activity site, public buildings, campus surrounding
Community type	S6:Cinda tianyu garden	5000㎡	117°13′21″E	31°48′22″N	Regular rectangle	Square, pavilions, children's amusement facilities, fitness facilities for the elderly, located around the residential area

Table 1: Environmental characteristics of the sample sites.

5.1.2. Types of sound sources in the study area: The primary acoustic factor influencing soundscape perception is the type of sound source. The classification of origins has a substantial influence on the quality of soundscape perception, and the specification of source categories is vital for the assessment of soundscape perception [44]. Pocket parks contain a rich variety of soundscapes, with reference to previous studies [45,46]. Previous research has indicated that the new edition of the worldwide standard ISO226 is based on the results of many nations, and because there are regional population variances, the loudness perception characteristics of different regional groups must be studied independently. On the basis of availability and pocket park generalizability, nine sampling locations were chosen from six pocket parks in Hefei, Anhui Province, prior to data collection. Using the International Organization for Standardization (ISO) norms for iso-response curves as a guide, the selected signal frequency range for the Chinese audience is the center frequency of the 1/3 octave from 100Hz to 1,000Hz. The sound sources in

the study area were selected from three categories of sound sources: natural sound, man-made equipment sound and man-made activity sound. Three typical sound sources, namely insect chirping, breeze blowing leaves and birdsong, were selected from natural sounds; traffic sounds, radio and music sounds and construction sounds were selected from man-made equipment sounds; and human speech, footsteps and fitness activities were selected from man-made activities sounds, as shown in Table 2.

	Sound source type 2	**Sound source name 3**
Q Pocket Parks	Qa Natural sound	Qa1 the sound of insect chirping
		Qa2 the breeze blows through the leaves sound
		Qa3 bird song
	Qb Artificial equipment sound	Qb1 traffic sound
		Qb2 Broadcast Music Sound
		Qb3 construction site construction sound
	Qc Human activity voice	Qc1 talk sound
		Qc2 footsteps sound
		Qc3 fitness activities sound

Table 2: Urban forest park sound landscape elements.

5.2 Evaluation system construction

In order to investigate the connection between subjective perception of soundscape and health restorative, a broad variety of individuals' perceptions of health restorative soundscape components were conducted on a large sample of participants based on attention restorative theory and health benefits assessment theory. This study employed hierarchical analysis to build an evaluation system for the effect of soundscape perception on stress alleviation based on the scale's content. The scale was broken down into several levels, working from top to bottom, making it easy to design the indications for each level of the assessment system, including three levels: the target level, the criterion level and the evaluation factor level.

The criteria layer consists underneath the single layer and refers to a number of elements that have an influence on this target layer (Table 3). The first target layer is separated into "evaluation of the perceived restorability of sound sources in pocket parks(R)" and "health benefits assessment(C)." The indicator layer refers to the variables that have an effect on each component in the standard layer, and the evaluation factor layer, which is the third layer, reflects the second standard layer.

Level 1 indicator (target layer)	Secondary index (standard layer)	Specific Description (evaluation factor layer)
R Recovery evaluation	R1 extend	unaccustomed, uncomfortable, incompatible-customary, adaptive, compatible
	R2 compatibility	dissent, messy, uncoordinated-consistent, harmonious and coordinated
	R3 fascination	annoying, repellent-fascinated, engaging
	R4 be away	deeply constrained and troubled-uninhibited, unworldly
C Health benefit assessment	C1 allaying tiredness	feeling tired-feeling refreshed
	C2 rejuvenation	Inlock-rejuvenated
	C3 calm mood	crusty, anxious-emotionally stable, calm
	C4 focus attention	be distracted, distracted focus, avoid distractions, and improve focus

Table 3: Hierarchy structure of soundscape perception and evaluation system.

5.3. Questionnaire design

The scales in the questionnaire for this study are divided into four main sections. The first part is an anonymous survey of the audience. It includes age (18 and below, 18-30, 31-40, 41-50, 50 and above), educational background (middle school and below, high school and college, undergraduate, postgraduate), number of people going to the pocket park (1 person alone, 2 people, 3-5 people, small family, large family), distance to the nearest pocket park (0-500m, 500-1500m, 1500-3000m, 3000-4500m, >4500m), frequency of pocket park use (multiple times in a year, once a month, once a week, 2-3 times a week, daily), length of visit stay (<30 minutes, 30-1 hour, 1-3 hours, >3 hours) and whether family isolation was experienced and how often.

The second part focuses on individual soundscape perception. The definition of sound source types is important for the evaluation of soundscape perception, while the soundscape in the pocket park forms the basis of this study's perception of the environment, sound source classification has important implications for the quality of soundscape perception [47]. We inhabit a myriad of ecosystems full of bigophones (sounds from living organisms) and geophones (sounds from geophysical processes) and cognitively process these sounds as cues that provide us with information about our surroundings. Referring to the studies by Liu, J and Markou, D et al [48,49],

and combining previous literature on soundscape perception and restorative evaluation with the design of corresponding indicators based on the types of sound sources occurring in the study area, it was finally concluded that soundscape perception is divided into three main categories of sound sources: natural sounds, man-made equipment sounds and man-made activity sounds; natural sounds include insects chirping, breeze blowing leaves and birdsong; man-made equipment sounds include traffic sounds, radio and music sounds and building construction sounds. Human activity sounds include human speech, footsteps and fitness activity sounds, which contain 3 dimensions and 9 questions.

The third part of the study uses attention to restorative theory, which was able to validate the restorative effects of different pocket park public spaces [50,51]. The Perceived Restorative Ness Soundscape Scale (PRSS), developed by Payne, was used as one of the components of the questionnaire for this study. This questionnaire, which assesses the observed gain value of the soundscape in four components: "Fascination, Compatibility, Extent, Being Away," was developed using the PRSS, which has the soundscape as its primary purpose. “The PRSS was translated from English to Chinese by the researchers involved in this project to ensure a concise and fluent presentation on the basis of accurate translation.

The Health Benefits Assessment Scale is the last section (HBS). The presence of sickness or disability and a condition of comprehensive physiological, mental, and social well-being are the definitions of health given by theoretical study. The frequency of medical visits, electromyographic readings, affective testing, self-emotional evaluations, etc. are all ways to measure health. Perceived health advantages are one of the study's key outcome factors. Kim et al., Saya et al. and Hao et al. have all used the health benefits Kim et al., Saya et al. and Hao all used measures of health benefits assessment, which suggests the feasibility of this method in the study of the relationship between soundscape perception and health. Therefore, this study draws on these research methods to reduce the difficulty of obtaining health data on the one hand and to validate the scale on the other. The specific content of the Health Benefit Assessment Scale consists of four questions on eliminating fatigue, rejuvenation, calming mood and concentration.

In this study, three dimensions, namely the degree of soundscape perception, restorative evaluation and health benefit assessment of urban pocket park users, were used as evaluation indicators of mental health restorative. Each evaluation indicator was scored on a 9-point Likert scale, where 1 represents completely disagree while 9 represents completely agree, with each dimension corresponding to a score of 1 to 9. The composite restorative evaluation score is the total score of the 3 dimensions.

5.4. Research hypotheses and an analytical framework

Environmental sound is treated as a resource that may be controlled in urban planning initiatives, and soundscapes are a paradigm that puts the needs of people first. People's interactions with a

particular location through their sense of hearing create the soundscape, or the acoustic environment as experienced or comprehended by a person, a group, even a community. Previous study revealed that multiple sound signals can affect perception at the same time [52]. A soundscape is defined as "a sound environment that humans experience and comprehend in context"[12] because individuals react to their sound environment on an emotional level by understanding the sensory information it provides. Numerous studies have shown that being in regenerative settings helps lessen mental tiredness. According to several studies, acoustic surroundings can promote pleasant emotions, aid in regaining focus, and counteract the physiological changes brought on by negative emotions, which lessens mental weariness. In addition, soundscapes are a key factor in green space management and are associated with a higher drop-in pulse rate [8]. This suggests that soundscapes in parks may play a key role in stress relief, restorative processes, and other aspects of improving community health. This shows that soundscape perception and restorative assessment may be intrinsically linked with the strength of park users' soundscape perception influencing the strength of park users' evaluation of restorative evaluation. This leads to the following hypothesis:

H1: The soundscape perception of urban pocket park tour users has a significant and positive impact on their recovery evaluation.

Each feature's own soundscape varies, changing the environment's overall healing quality. A restorative soundscape is a naturally occurring aural environment that fosters psychological well-being. To identify four crucial aspects of soundscapes that have restorative effects, Payne created the Perceived Restorative Soundscape Scale (PRSS). It is commonly acknowledged that the COVID-19 pandemic has an impact on people's emotional as well as physical health. Using the stress reduction theory proposed by Ulrich et al. (1991) and the restorative environment theory proposed by Kaplan et al. (1983), many studies have concentrated on understanding how good health develops from soundscapes. Increasingly, researchers are looking at how to promote mental health benefits in terms of perceived restorative characteristics. Research on the restorative nature of environmental health in western countries has shown that exposure to soundscape environments has restorative effects on people's physical and psychological health, specifically in terms of lowering blood pressure, improving negative emotions and increasing concentration. The significant health effects of restorative environments are mainly in the areas of stress reduction, mood regulation and cognitive enhancement. Therefore, analyze the link between restorative assessment and health advantages is crucial, which gives rise to the following hypotheses:

H2: Recovery evaluation of urban pocket park tour users has a significant and positive impact on their health benefit assessment.

Environmental psychologists such as Van [21] and Kang [9,16,23] have argued that parks with high levels of naturalness reduce anxiety, enhance well-being and are more beneficial to human health recovery than urban environments. According to research by Deng et al [52], appealing natural aesthetics that are linked to happiness have been demonstrated to affect how soundscapes are assessed and are beneficial for regaining health. Recreationists can experience three different levels of effects on themselves by observing a highly naturalized landscape, including psycho-

emotional recovery, short-term physical relief from illness and long-term improvements in overall well-being. The term "health benefits of soundscapes" refers to how soundscapes are viewed in relation to health, either positively or negatively, depending on how the listener interprets the auditory environment. One of the main challenges in soundscape research is the relationship between better health outcomes (such as improved recovery, fewer stress triggers, etc.) and positive soundscape perceptions (such as pleasant, tranquil). Environmental stress reduction is highly correlated with positive soundscapes, with positive soundscapes increasing restorative effects at the perceptual level and thus achieving positive effects on physical and mental health; attenuating negative soundscapes (e.g., reducing sound annoyance) is significantly associated with conscious health status. The study suggests that sound perception can act as an enhancer of the human experience in the urban realm from a health-related perspective. The study of the relationship between soundscape perception and health benefits is therefore of particular importance, leading to the following hypothesis:

H3: The acoustic landscape perception of urban pocket park tour users has a significant positive impact on their health benefit assessment.

Based on the above theoretical research, it can be found that all three theoretical studies have matured. There is a direct or indirect relationship between soundscape perception and restorative evaluation, and restorative evaluation and health benefit assessment are interrelated. Therefore, this study uses soundscape perception as a cognitive evaluation of the environmental elements of the pocket park, restorative evaluation as a response evaluation of the overall soundscape environment, and health benefit assessment to analyze the health benefits of the pocket park for users' hearts and minds. The conceptual model constructed according to the above research hypotheses is shown in Figure 2.

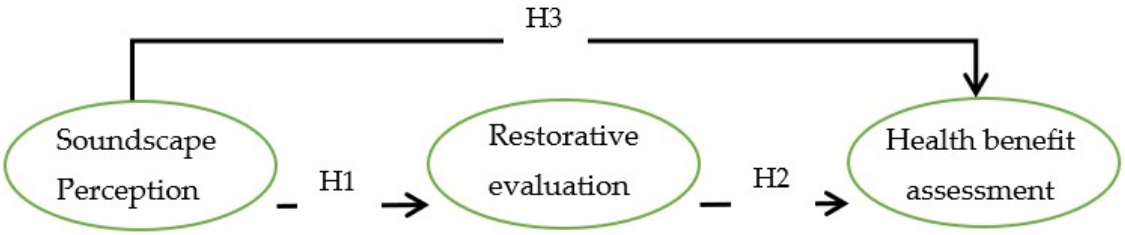

Figure 2: Supposed to build conceptual models.

5.5. Data collection and study methods

5.5.1. Data collection: The evaluation survey of urban pocket park users was designed to understand the method of assessing and capturing the health benefits of park soundscape perception on people's hearts. Members of the research team conducted field research in six pocket parks in Hefei from 1 September to 5 September 2022 and ensured that park users understood the content of the questionnaire by communicating with users and providing the necessary explanations and clarifications regarding the survey content. Users of the tiny parks were given an online survey, and basic data about each respondent was gathered. On September 5, 2022, an

anonymous online questionnaire was made available on the survey website. It was then collected on September 20, 2022, with a 15-day turnaround. A return rate of 95.2% was achieved with the distribution of 500 surveys and the collection of 476 questionnaires. After eliminating incomplete and apparently random responses, as well as user information that could not be perceived visually (e.g., missing or refusing to answer more than 30%, contradicting each other, etc.), A total of 431 valid surveys were gathered, with an accuracy rating of 86.2%. To guarantee that the data was entered correctly, extremely skilled researchers from the study team entered the data in a neutral and objective manner.

5.5.2. Research method: The purpose of this study is to experimentally analyze a model for determining how pocket park users perceive the soundscape and its advantages for their mental health. Exploratory Factor Analysis (EFA) and structural equation modeling were the two approaches used in the study's research methodology. First, a questionnaire was chosen to determine the variables influencing the soundscape, and exploratory factor analysis was used to create the scale's indicators accurately reflect the degree of perceived soundscape as well as to highlight their strengths and flaws; secondly, SPSSAU software was used to process the questionnaire data and conduct a structural relationship model validation analysis.

The questionnaire was completed while the user watched the audio-visual video of the pocket park. The combination of audio-visual stimuli was more effective in promoting psychological recovery than the visual stimuli alone, which is consistent with previous research [53]. The questionnaire data were then subjected to a simple statistical analysis before being entered into the statistical analysis software SPSSAU for data processing and conceptual model validation analysis. Secondly, based on the underlying theory, the theoretical model was constructed and the factor structure of the soundscape of the pocket park was derived by applying exploratory factor analysis with dimensional reduction and rotation to the 431-questionnaire data. Afterwards, the measurement model was analyzed for reliability and goodness-of-fit tests. Finally, the quantitative analysis of the structural equation model, goodness-of-fit tests and hypothesis tests were conducted. The results can be used to provide a scientific and systematic explanation of the influence mechanisms between multiple observed and latent variables.

6. Statistical Analysis

6.1. Analysis of basic information of the questionnaire

As shown in Figure 3, among the 431 valid samples of the questionnaire, the proportion of male and female users were 52.3% and 47.7% respectively, indicating that pocket parks in Hefei, Anhui Province, are attractive to both male and female users with little difference. In terms of age composition, visitors aged 18-30 and 51 and above predominate, accounting for over 60% of the total, indicating that pocket parks in Hefei, Anhui Province are more popular with young and older visitor groups, which will be the main source of users for pocket parks. In terms of educational background, the proportion of people of all educational levels is relatively even. In terms of the

number of people interviewed, the majority of visitors are in pairs or small families, indicating that apart from the retired elderly group and the small family mode of visiting the park, the young group of two people are more interested in the park.

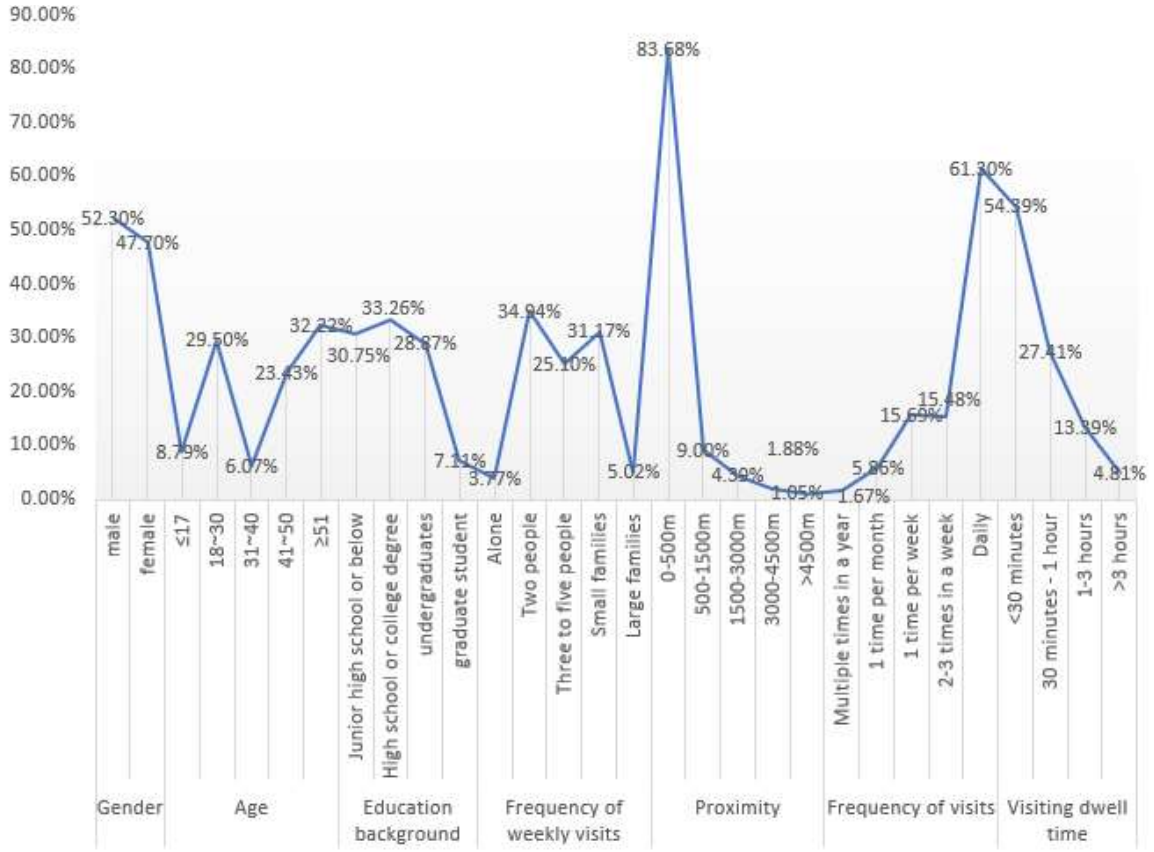

Figure 3: User Information.

6.2. Exploratory factor analysis of soundscape perception

An initial test of the questionnaire was conducted using exploratory factor analysis to identify potential factors influencing the perception of the soundscape of the pocket park. An appropriateness study of the research data is necessary before using factor analysis for information enrichment investigations. An exploratory factor analysis was performed to test the structural validity of the scale. The results indicated that the data could be used for factor analysis research because the Cronbach's internal consistency was 0.929 and the KMO was 0.950, both of which were greater than 0.6 and correlated at a significance level of 0.000. These values met the prerequisite requirements for principal component analysis. The study's data met the criteria for factor analysis and passed the Bartlett's sphericity test with a chi-square approximation of 2382.390, df = 36 (p=0.05). If the factor loading coefficient has an absolute value greater than 0.4, it means that the item and the primary component are related.

As seen in Table 4, factor analysis was conducted using the maximum variance rotation approach and principal component analysis, and components with eigenvalues of 1.0 or higher were chosen as common factors of the evaluation indexes. After the main factors were determined in advance by principal component analysis, factors with contribution rates over 63 % were obtained from factor analysis. Three common factor indicators were retrieved using the principal factor and variance rotation approach, with the variance interpretation rate of the first indication being the greatest. The common factor was 73.328%, using the gravel diagram as a reference, it can be seen from the table that all of the research items have common degree values greater than 0.4, indicating that they match the predetermined latent variables. There is a strong correlation between the research items and the principal components. And the principal components are capable of extracting the information effectively. The overall principal component analysis eigen root value of this scale is greater than 1, the variance explained by this principal component is 63.724%, the cumulative variance explanation rate of 63.724%, as well as the test yielded three stable factors with cumulative variance contribution rates of 71.83%, 72.095% and 73.328% respectively. The analysis showed that three factors could be extracted to explain the correlations between the nine items, and they were labelled accordingly.

Nomenclature	**Factor loading coefficient**			**Single-term and sum correlation**
	Factor 1	**Factor 2**	**Factor 3**	
Qa1	0.794			0.630**
Qa2	0.788			0.621**
Qa3	0.782			0.612**
Qb1		0.808		0.652**
Qb2		0.812		0.659**
Qb3		0.772		0.606**
Qc1			0.815	0.664**
Qc2			0.788	0.622**
Qc3			0.824	0.679**
characteristic value	2.155	2.163	2.2	
rotation variance is loaded（%）	71.83	72.095	73.328	
Rotation variance is loaded cumulatively（%）	71.83	72.095	73.328	

Table 4: Exploratory factor analysis.

6.3. Model analysis of the structural equations

6.3.1. Analysis of the reliability and validity of the measured model data: The SPSSAU was used to analyze the stability and reliability of the questionnaire through descriptive statistics as well as reliability and validity analysis in order to verify whether the measurement items accurately reflect the subject matter and content of the measurement. The Cronbach reliability coefficient was determined because the findings of the Cronbach reliability calculation more properly reflect the actual dependability, where reliability is defined as the consistency and stability of the measurement results [54,55]. As the results show in Table 5, there are no outliers in the current data and descriptive analyses can be conducted directly against the mean. The Cronbach's alpha reliability coefficients for the four measurement scales ranged from 0.755 to 0.844, higher than 0.600, indicating that the dimensions have good intrinsic reliability. As a result, it is also possible to conclude that the reliability of the questionnaire satisfies the survey's requirements and can be subjected to correlational analysis. Convergent validity states that a scale's multiple items measuring the same variable should have a high level of internal consistency. The analysis showed that the correlation between individual items and the sum reflects the content validity of the questionnaire. The analysis showed that the items were above 0.606 at the 0.01 level and were significantly correlated, and the internal structure of the scale was good. The reliability combination (CR), Average Variance Extracted (AVE), and standardized factor loadings can all be used to examine the correlation between several observable variables. The standardized factor loadings for each observed variable ranged from 0.720 to 0.864, all of which were greater than 0.5, indicating a high degree of thematic congruence and appropriateness of each measure. The combined reliability CR ranged from 0.606-0.950, all greater than 0.600, while the mean variance extracted AVE ranged from 0.571-0.740, all greater than 0.500. In light of the examination of the aforementioned findings, it may be concluded that the observed variables on this scale were largely reliable.

Scale	Metric	Mean	SD	Single-term and sum-sum correlations	Standardized factor load	AVE	CR	Cronbachα
Q Sound view perception	Qa1	6.084	1.783	0.630	0.833	0.740	0.950	0.804
	Qa2	6.29	1.798	0.621	0.863			
	Qa3	6.364	1.76	0.612	0.847			

	Qb1	6.181	1.764	0.652	0.819	0.709	0.813	0.806
	Qb2	5.944	1.806	0.659	0.834			
	Qb3	5.995	1.793	0.606	0.786			
	Qc1	6.26	1.784	0.664	0.829	0.716	0.867	0.818
	Qc2	6.128	1.784	0.622	0.802			
	Qc3	6.051	1.789	0.679	0.864			
R Recovery appraises	extend|R11	5.977	1.741	0.601	0.822	0.571	0.720	0.824
	extend|R12	6.172	1.748	0.601	0.822			
	compatibility|R21	6.749	1.814	0.631	0.830	0.635	0.745	0.844
	compatibility|R22	6.984	1.729	0.631	0.830			
	fascination|R31	6.35	1.798	0.750	0.804	0.600	0.746	0.809
	fascination|R32	6.555	1.779	0.754	0.799			
	Be away|R41	6.028	2.123	0.781	0.846	0.655	0.806	0.800
	Be away|R42	6.223	2.098	0.767	0.851			
C Health benefit assessment	C1	6.568	1.778	0.742	0.776	0.603	0.753	0.755
	C2	6.195	1.776	0.722	0.720			
	C3	5.784	1.729	0.703	0.753			
	C4	8.436	0.892	0.691	0.787			

Table 5: Model descriptive statistics, reliability and validity and validation factor analysis results.

The correlations between the variables were analyzed for discriminant validity and are shown in Table 6. When compared to the absolute value of the inter-factor correlation coefficient, which was 0.526, the soundscape perception AVE square root value was 0.769, indicating strong discriminant validity. The AVE factorial score for the restorative assessment was 0.609, which is higher than the absolute inter-factor association coefficient's highest benefit of 0.526 and suggests adequate psychometric properties. The health benefits assessment has good discriminant validity because the AVE square root value of 0.672 is higher than the actual cross - functional and cross association coefficient's highest value of 0.414. In Table 8, Soundscape Perception Q, Restorative Assessment R, and Health Benefit Assessment C AVE square root values were all higher than their statistical parameters, demonstrating the discriminant validity of these assessments. A mediating influence may exist, as the correlation study revealed a positive association among the variables. In conclusion, all parameters were quite trustworthy and accurate.

Variable	**1**	**2**	**3**
Q Sound view perception	0.769		
R Recovery evaluation	0.526	0.609	
C Health benefit assessment	-0.301	-0.414	0.672

Table 6: Correlation and discriminant validity between the variables.

6.3.2. Measurement structure relationship model goodness-of-fit test: The quality of fit of the measurement model is assessed using the fit index (IFI), Comparative Fit Index (CFI), Goodness of Fit Index (GFI), Normative Fit Index (NFI), and Adjusted Goodness of Fit Index (AGFI). The fit indices of the structural model were as follows, as shown in Table 7: $x^2/df = 2.61$ (relaxed values 1 to 5), and the root square error of approximation (RMSEA) = 0.041(standardized to less than 0.08), IFI = 0.969, CFI = 0.969, GFI = 0.923, AGFI = 0.904, TLI = 0.964. CFI, GFI, AGFI and TLI are greater than the ideal value of 0.900, which is in the good range, and PGFI and PNFI are less than the ideal value of 0.900, but still within the acceptable range. The model effectively explains the connection between the variables in the empirical research when these factors are considered, and its general goodness of fit is deemed to be perfect.

Types of commonly used indicators	**Other indicators**	**Judgment standard value**		**syntactic model**	**fitting degree**
		acceptability	**ideal value**		
Absolute fit metrics	CMIN/DF	<5	<3	2.61	good
	RMSEA	<0.08	<0.04	0.041	good
	IFI	>0.8	>0.9	0.969	good

Relative fit metrics	CFI	>0.8	>0.9	0.969	good
	GFI	>0.8	>0.9	0.923	good
	AGFI	>0.8	>0.9	0.904	good
	NFI	>0.8	>0.9	0.929	good
	TLI	>0.8	>0.9	0.964	good
Streamline fitting indicators	PNFI	>0.4	>0.9	0.808	acceptability
	PGFI	>0.4	>0.9	0.741	acceptability

Table 7: Measurement model fit test.

6.3.3. Path analysis : Figure 4 depicts the process for estimating the model's standardized parameters. Based on the indicators in the model. Firstly, the respective influencing factors and difference results of pocket park users' soundscape perception, restorative evaluation and health benefit assessment are analyzed. Secondly, the influencing mechanisms between the three in the structural model are analyzed.

（1） Soundscape awareness. The degree of soundscape perception of pocket park users could be accurately reflected by all three categories of soundscape perception-"natural sound," "synthetic device sound," and "activity recognition sound"—a conclusion that is consistent with earlier studies. The results support previous studies [56,57]. The degree of influence was in descending order of "fitness activity sounds" (0.800) > "human speech sounds" (0.794) > "radio music sounds" (0.788) > "traffic sounds" (0.788). "Traffic sounds" (0.780) > "birdsong" (0.763) > "breeze blowing leaves", "footsteps " (0.756) > "insect chirping" (0.751) > "building construction sounds" (0.735). Of the three soundscape perception elements, people rated "Qc3 fitness activity sounds" (0.800) as the highest, followed by "Qc1 human speech sounds" (0.794) and radio music sounds (0.788). Compared to the higher perceptions of natural sounds in previous studies, the perception of man-made soundscapes in the pocket parks in this study was higher than that of natural sounds. It was also found that the majority of the users chose to go to the pocket parks because of the good soundscape environment, which met their needs for physical fitness and recreation. In conclusion, the main way to improve the soundscape perception of pocket park users is to enhance the sensory experience of pocket park users and to enrich recreational activities.

（2） Restorative evaluation. Among the dimensions of restorative evaluation, it can be found that in the restorative evaluation of soundscape perception, the perception of "consistency" is generally higher than the three dimensions of restorative evaluation of compatibility and attractiveness and awryness and is specifically shown as consistency R12 > consistency R11 > attractiveness R31 > compatibility R22 > compatibility R21 > compatibility R32 > attractiveness R42 > awryness R41. Thus, in the study, pocket park consistency is a more significant aspect of therapeutic soundscapes. In order to create a harmonious and unified composition of the pocket park soundscape elements, as well as to enhance the appearance of the pocket park soundscape environment, the soundscape should therefore be incorporated into the pocket park planning. Additionally, it is essential to enhance the sounds of natural flora and wildlife, create an ambiance in the pocket park area, and

establish a topographical hierarchy in order to improve the experience of the natural soundscape in space and form.

(3) Health benefits assessment. All four items of the health benefit assessment were effective in reflecting the health benefit assessment of the users in the pocket park. " C3 calming mood (0.753)" had the greatest impact on the assessment of health benefits, the next three in order being C4 concentration (0.637) > C2 rejuvenation (0.564) > C1 elimination of fatigue (0.038), which is consistent with previous studies. Thus, the four factors C1, C2, C3 and C4 effectively explained the health benefit assessment of pocket park users, and the emotional calmness of park users was more effective in improving the health benefit assessment of pocket parks.

(4) Soundscape perception, restorative evaluation and health benefit assessment impact mechanism. Pocket Park soundscape perception had a direct and significant positive impact on restorative evaluation, specifically, for every unit increase in soundscape perception, restorative evaluation increased by 0.596 units. This indicates that soundscape perception of pocket parks can have a direct mental health restorative benefit through visual and auditory perceptions. There is no direct effect of soundscape perception on health benefit assessment, indicating that the effect of soundscape perception on health benefit assessment requires an indirect effect on health benefit assessment through the mediation of restorative assessment; the direct effect of restorative assessment on health benefit assessment is 99.8%. Therefore, the enhancement of the health benefit assessment of pocket park users should not only satisfy people's external needs in terms of physical functions, but also consider the deeper emotional satisfaction of individuals.

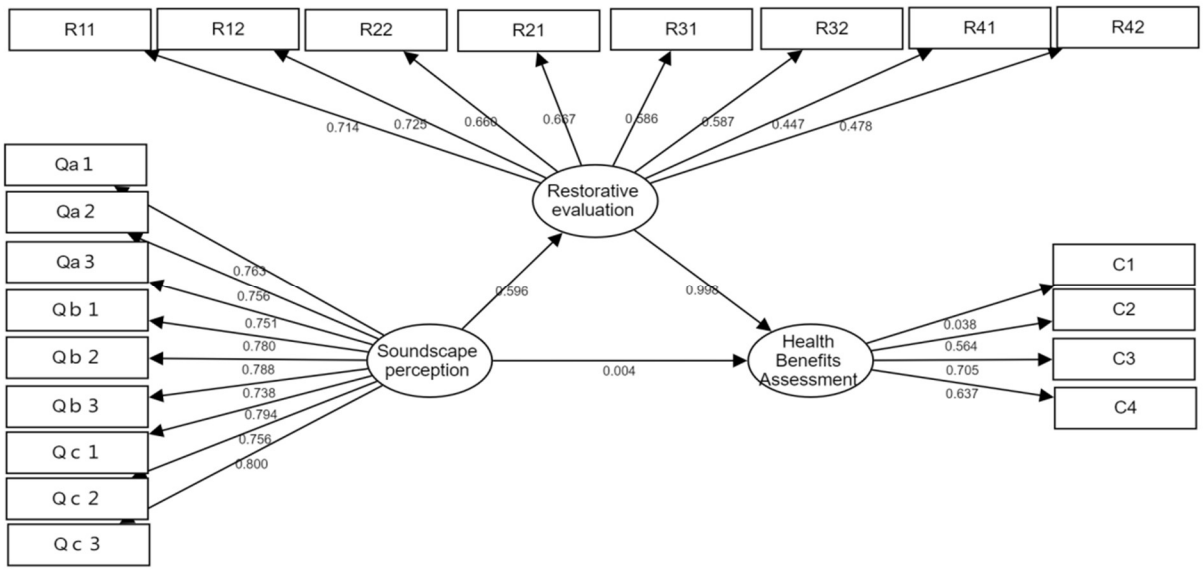

Figure 4: Pocket Park health recovery benefit impact mechanism structure equation model

6.3.4. Hypothesis test: Table 8 shows the results of the hypothesis testing, with hypotheses H1 and H3 being valid. (1) Hypothesis H1 was verified to be valid, i.e., "soundscape perception" positively and significantly influences "restorative evaluation" (β=0.596; $p<0.001$). In the direct influence pathway, soundscape perception has a positive influence on restorative evaluation with a

standardized load factor of 0.596, where the specific effect is that for every unit increase in soundscape perception, restorative evaluation increases by 0.596 units. This suggests that pocket park soundscape perception can have a direct psychological restorative benefit through visual and auditory perception. In line with most previous studies [29,30], this study found a significant positive effect of soundscape perception on restorative ratings in pocket parks, i.e., the higher the subjective ratings of soundscape perception, the greater the restorative benefits. In this study, people who enjoyed fitness activities and recreation in the park had higher consistency ratings in restorative evaluations, which in turn had better health restorative benefits. The restorative advantages for the visitors to the pocket park's mental health may be successfully fostered by strengthening the accuracy and reliability of the auditory environment in the pocket park to increase the restorative evaluation.

（2）Hypothesis H2 was not validated, i.e., the positive effect of "soundscape perception" on "health assessment benefits" was not significant (β=0.007; p=0.900). This suggests that the relationship between the dimensions of soundscape health and health benefit assessment needs to be further investigated.

（3）Hypothesis H3 was validated, i.e., 'restorative evaluation' positively and significantly influenced 'health benefit assessment' (β=0.996; $p<0.001$). According to Roe, J. et al. and Chen, Z. et al.[57,58], the specific impact was that the health benefits assessment increased by 0.996 units for every unit that the restorative evaluation increased by. This resulted in an improved and significant relationship between the restorative evaluation and the health benefits assessment, with a standardized load factor of 0.996.

While a few previous studies have concluded that restorative evaluations have a significant negative impact on health benefit assessments. This study supports the findings of most studies [59] and found that restorative evaluations of pocket parks positively and significantly influence recreationists' health benefit assessments of pocket parks. This is because restorative evaluations such as consistency, compatibility and attractiveness associated with the soundscape environment of a pocket park will contribute to the health benefits of the pocket park when they somewhat alleviate the psychological stress and negative emotions of the recreationists or focus their attention. Therefore, the enhancement of health benefits assessment of pocket park users should not only meet people's external needs in terms of physical functions, but also consider the deeper psycho-emotional satisfaction of individuals. From the perspective of users' perceptions of the soundscape of the pocket park, which has played an important role in the lives of recreationists, the higher the consistency rating in the restorative evaluation, the greater the emotional involvement and the stronger the calming emotions in the assessment of health benefits.

hypothesis relation	Suppose the path			parameter estimation		standard error (SE)	Z (CR)	Significance probability values(P)	result(of inspection)
	X	→	Y	nonstandardized technique	standardization				
H1	Sound view perception	→	Recovery evaluation	0.544	0.596	0.054	10.104	0.000	The positive impact was significant
H2	Recovery evaluation	→	Health assessment benefits	0.975	0.996	0.082	11.929	0.000	The positive impact was significant
H3	Sound view perception	→	Health assessment benefits	0.006	0.007	0.049	0.126	0.900	The effect was not significant

Table 8: Structural model hypothesis test results.

7. Discussion

The assessment of the benefits of soundscape perception on mental health in pocket parks is discussed and future research design strategies are proposed, with four specific aspects in mind.

(1) Natural sound was found to be one of the important factors in constructing the restorative evaluation of the soundscape in previous studies, which is basically consistent with this study. For natural sound design strategies, greenery can be increased to nurture beautiful and pleasant natural soundscapes such as birds chirping and insects singing, and the sound of breeze blowing through the leaves. Increasing the perceived range of natural sounds, thus increasing the health benefits of the habitat, creating a good ambience for the pocket park environment, building a sensory experience of natural environmental soundscapes and compensating for the lack of public desire for nature during the epidemic.

(2) The results show that among the anthropogenic sounds, the fitness activity sound has the strongest ability to explain the variation in soundscape perception, reaching 80%, and that the anthropogenic sound is the result obtained is somewhat different from previous studies on large parks. This is related to the convenience of the pocket park and its central location in a busy city. It is also due in large part to the isolation of the epidemic and the unhealthy psychological stresses of ordinary life, as well as the isolation of homes from going outside. In the pocket park for human sound design strategy, the human support index can be enhanced through the enrichment of recreational and fitness facilities, the enrichment of residents' leisure activities, the appropriate

local sound field design for residents' fitness and recreational activities, in order to enhance the auditory experience of the activity tasks and reduce the spatial transmission.

(3) The findings validate Kaplan and Ulrich's theory that pocket park soundscape perceptions can calm users, where natural sounds promote calming emotions, evoke positive emotions, generate restorative benefits to the environment and influence the occurrence of mental health benefits. Therefore, enriching the soundscape of a pocket park from a visual and auditory perspective can effectively in improve the evaluation of the user's soundscape perception. However, soundscape perception of natural sounds is not the only criterion for evaluating the restorative nature of pocket park environments, the construction of restorative spaces in pocket parks should not only pursue proximity to nature, but also consider factors such as man-made sounds in soundscape perception. Pocket parks should pay more attention to the creation of soundscape perceptions to produce mental health restorative benefits and to be "small but good".

(4) Based on theories related to visual perception, the study uses structural equation modeling to construct an impact mechanism for the restorative effect of pocket parks, revealing the restorative effect of the internal components of the pocket park environment and the restorative effect combined with the overall environmental perception, providing theoretical guidance for the enhancement and renewal of pocket parks in the post-epidemic era.

(5) There are also limitations to the research: in terms of research methods, due to the epidemic, fieldwork was not freely available, and questionnaires were mainly used to obtain data on the subjective perceptions of the audience in measuring mental health benefits. Research findings have shown that soundscapes are an essential component in the design of restorative landscapes, and horticultural five-sensory therapy is also a well-liked method of creating restorative landscapes. Researchers have used customary physical tests such as blood pressure, electrocardiograms, and brain waves to obtain data. Some researchers have also used diagnostic testing devices to collect information from muscular system and electrooculogram testers. The study is constrained by the psycho-physical assessment of the users and the connection between the environment's aesthetic and emotional purposes and the therapeutic outcomes. Investigating how pocket parks might aid the public in lessening the effects of the pandemic through their own benefits is crucial in the context of urban regeneration.

8. Conclusion

This study takes six pocket parks in Hefei, Anhui Province, as an example, and explores the mental health benefits of users in urban pocket parks, divides the three dimensions of soundscape perception, and constructs a structural equation relationship model of soundscape perception, restorative evaluation and health benefit assessment of pocket park users, revealing the influence mechanism between the three, based on which the following five conclusions are obtained.

(1) Some of China's inner-city pocket parks appeal to both male and female users and are more popular with younger and older visitor groups. The popularity of pocket parks is relatively even across different education levels. There is a growing demand for mental health among young couples, in addition to the retired elderly group and small families visiting parks. The majority of

pocket park users choose to visit a pocket park within 500 meters of their home, demonstrating that the accessibility and convenience of pocket parks, the flexibility of their location and their discrete distribution by making use of the city's marginal, abandoned, unused and green spaces. The high revisit rate of pocket parks, the high number of revisits and the short time spent in pocket parks are also indications of the small size of pocket parks and their public openness.

(2) Soundscape perception significantly affects restorability. Soundscape perception has a stable factor structure of three: natural sounds, artificial equipment sounds, and human activity sounds. The degree of influence from highest to lowest is "fitness activity sounds" (0.800) > "human speech sounds" (0.794) > "radio music sounds" (0.788) > "traffic sounds" (0.780) > "birdsong" (0.763) > "breeze blowing leaves", "footsteps " (0.756) > "insect chirping" (0.751) > "construction sounds" (0.735), with "fitness activity sounds " has the highest degree of influence (0.800). Therefore, the humanistic construction of the soundscape of the pocket park can effectively improve the evaluation of the soundscape perception.

(3) Restorative evaluations significantly influence the assessment of health benefits for recreationists. The perception of the "consistency" dimension in the restorative evaluation is generally higher than that of compatibility and attractiveness and away-from, and the specific performance of consistency R12 > consistency R11 > attractiveness R31 > compatibility R22 > compatibility R21 > attractiveness R32 > away-from R42 > away-from R41. Park soundscape environment quality and enhancing its irreplaceability to improve restorative benefits can effectively contribute to the health benefits of pocket park recreationists.

(4) The elimination of fatigue, rejuvenation, stabilization of mood and concentration were all effectively captured in the health benefit assessment of the pocket park soundscape, with the emotional state of the pocket park being key to influencing the health benefit assessment. The health benefits were in descending order of impact: "C3 calms mood" (0.705) > "C4 focuses attention" (0.637) > "C2 rejuvenates" (0.564) > "C1 eliminates fatigue" (0.038).Among the influencing factors, calming mood has the strongest ability to explain the variance in health benefit assessment. Therefore, maintaining an emotionally stable state is an important way to improve the assessment of health benefits for recreationists.

(5) The study's findings in relation to soundscape perceived notion, restorative evaluation, and health benefits assessment indicate that restorative evaluation has a direct relationship with health benefits and has a significant beneficial impact, soundscape perception has a clear relationship with health benefits but no direct relationship with health benefits. Therefore, improving the perception of soundscape through pocket park "soundscape", improving "soundscape environmental quality" and "emotional investment" to enhance restorative benefits can effectively strengthen the evaluation of pocket park recreation. Future study on the connection between soundscape perception, restorative effects, and health benefits evaluation would benefit greatly from using this as a reference.

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