Soundscape Support for People with Dementia: A Systematic Literature Review

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Abstract. As the global ageing trend intensifies, new technologies to provide support for people with dementia have become a research hotspot in related fields. Studies have shown that listening to music or sound effects has a specific impact on the recovery of people with dementia. At the same time, the supportive effect of soundscape on the environment can also positively impact patients' health and well-being. The supporting role of soundscapes for people with dementia is getting more and more attention in practice. This article uses a systematic literature review method to review the current worldwide research on providing supportive soundscapes for patients with dementia and analyse how they use soundscapes. The purpose of this review is to find techniques and methods that can offer soundscapes to people with dementia. Finally, the future development direction of using new technology to help people with dementia is proposed. This review hopes to improve people's well-being and behaviour with dementia in terms of treatment and life.

Keywords: Dementia, Soundscapes, Music, Technology, Improve Health, Quality of Life.

1 Introduction

According to a report from the World Health Organisation (WHO), the number of cases of dementia continues to increase at a rate of 10 million cases per year. Currently, there are approximately 50 million people with dementia in the world.[1] By 2050, the number of cases of dementia will be more than three times the current number, but dementia is largely ignored. Many family members believe that dementia is an inevitable phenomenon of human ageing. Dementia is a chronic or progressive syndrome caused by various brain diseases that affect memory, thinking, behaviour, and ability to perform daily activities. Alzheimer's disease is the most common cause of dementia and is likely to cause up to 70% of dementia cases. Although people with dementia live in all countries, more than half (58%) live in low- and middle-income countries. By 2050, this proportion will rise to more than 70%.[2]

Dementia is usually a chronic brain disorder caused by a brain disease. It will affect the thinking of the elderly, make people's judgment ability difficult, memory decline, middle and late patients will have difficulties in self-care. As the disease progresses, patients with dementia will increasingly need caring from other people.[1] Moreover, dementia is irreversible. Shekhar Saxena, the head of the WHO mental health department, said no drug could cure dementia.[3] With the deepening of research, non-drug treatment methods have become new due to the advantages of common side effects and relatively low cost.[4]

Among non-pharmacological treatment methods, many studies believe that art can provide

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support for patients with dementia.[5] Hearing impairment is not usually considered the main feature of dementia,[6] so some researchers in related fields have begun to design soundscapes for patients with dementia. Soundscape refers to the human perception of the auditory environment in context. Canadian musician, Murray Schafer, first promoted the concept of the soundscape. There are sounds of positive value in the background, such as natural sounds and cultural sounds. Studies have shown that these positive voices have a positive impact on health.[7] Soundscape has also been introduced into the hospital environment to alleviate the suffering of patients and improve their healthcare experience. At the same time, music medical methods have also been widely studied and used in stroke, mental illness, and post-operative rehabilitation.[8]

This article will conduct a systematic literature review of the current soundscape support for patients with dementia, aiming to determine the recent research progress in this field and understand the methods and results achieved by soundscapes designed for dementia patients. This literature review will summarise the previous research and aim to help related research in the future.

2 Methods

This review focuses on the soundscape-related research literature supporting patients with dementia and mainly refers to Keele's systematic literature review guidelines.[9] This review method is divided into three stages.

2.1 Plan review

The concept of soundscape is broad, including natural sounds and human-created sounds, and these sounds are diverse. Different groups of people have different perceptions of the soundscape. According to the purpose of this review, the question of this literature review is raised. The results of this SLR will provide practical help in providing supportive soundscapes for patients with dementia and provide useful starting information for future research. This review intends to solve the following research questions:
RQ1: What types of soundscapes does the research provide for people with dementia?
RQ2: What kind of support do different soundscapes provide for patients with dementia?

After determining the research questions, the selection criteria for this review can be proposed based on the two research questions. First, determine the keywords and subject areas to be searched. The soundscape is defined as auditory scenery, including natural and artificial sounds, including music and sound effects.[10] Alzheimer is the primary disease of dementia, so it should also be included in the search category. The search keywords are determined: dementia, Alzheimer's disease, soundscape, sound, sound effect, and environmental sound. Many studies have confirmed the method of music intervention in the treatment of dementia. This review mainly provides soundscapes for dementia patients daily, including music as a soundscape to support dementia patients, but music therapy is performed in hospitals. Related research is not included in the scope of this review.

2.2 Search process

The search was conducted on May 6, 2021. First, search the ACM, SPRINGER, and PMC databases. Then, check the questions one by one and delete duplicates. Search the titles and abstracts of the documents in the database based on the keywords that have been determined, and create filters based on the research selection criteria from different database search methods to filter out the documents for analysis and reporting. After a preliminary search, it was found that the number of related studies that provided soundscape support for patients with dementia was relatively small. Then, a reverse search was started, and the investigation was carried out based on the references of the searched documents to increase the number of records in this review.

2.3 Conduct review

Judgment is done on whether the searched literature is related to the research question through the title and abstract. Then, read the content of the documents that meet the requirements one by one to determine the relevance to this review. (1) The research must be designed for supportive soundscapes for patients with dementia. (2) The test results of the soundscape should be explained in the literature. (3) It must be an experiment in which patients with dementia participate in the test. Use this as a standard to screen out documents that can be included in this review. Table 1 summarises the results of each electronic database.

Table 1. Summary of Search Result

Electronic Database	Search Results
ACM	22
PMC	68
Scopus	34
Total	124

2.4 Report results

After deleting duplicates, 15 articles were finally included in the scope of this review. The two research questions identified in the preparation phase are the focus of this review. A thematic analysis of the literature was conducted to determine in detail what soundscapes are provided for patients with dementia in the study and what support dementia patients receive? After screening, evaluate the paper and read the full text. Figure 1 uses the PRISMA flow diagram to illustrate the process of this systematic literature review. The literature of this review will be summarised in the third section.

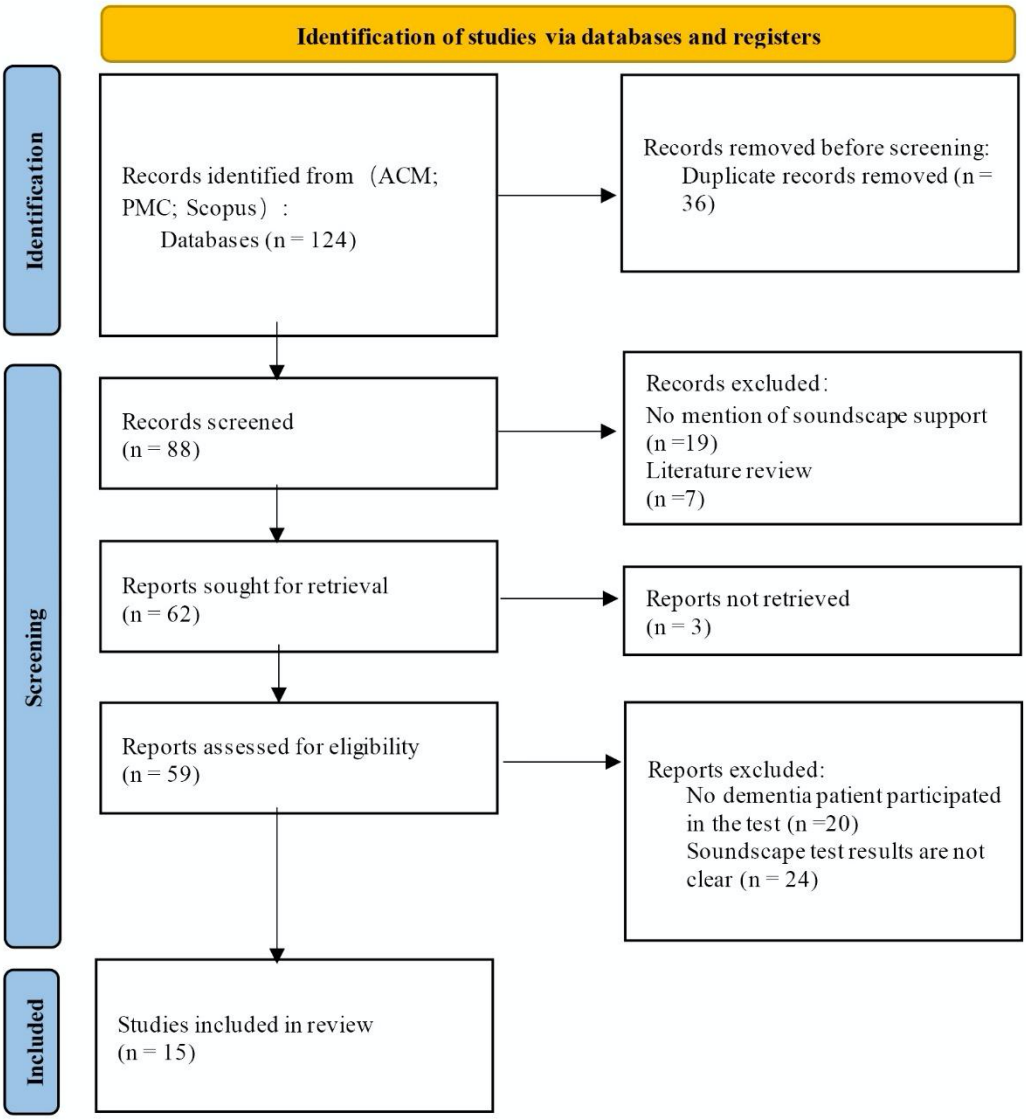

Figure 1. Process of review using a PRISMA flow diagram.

3 Results

In this search, a total of 203 related documents were searched in four electronic databases. After screening, 15 documents met the criteria of this review. The search results show that in the research to provide help for patients with dementia, the research on soundscape is relatively

lacking. In the research in healthcare, most researchers regard soundscape as a means of reducing noise. [11][12] Improving the soundscape can relieve stress for patients, increase patience and work enthusiasm for medical staff, and enhance the comfort of the hospital environment.[13] Some studies have proved that soundscape as a non-pharmacological intervention can positively affect people suffering from diseases in recent years. Providing a natural soundscape can reduce pain for patients, and music therapy has also been proven to improve the mental state of patients.[14] After studying the 19 documents included in this review, the documents are summarised in Table 2 according to the research questions.

Table 2. Summary of review results.

Numbering	Research purposes	Sample size & demographics	Soundscape provided	Research results & soundscape support
[15]	Use music to aid the memory of Alzheimer's patients	10 people with dementia	Provide each person with Alzheimer's disease with songs they are familiar with.	Nine patients awakened their memories through familiar music.
[16]	Explore the influence of music on the mood and cognition of women with dementia	25 people with dementia in two groups	Playing music while people with dementia are exercising	The cognitive ability of the exercise group has been significantly improved.
[17]	Explore the soundscapes that can evoke the memories of people with dementia	14 elderly people with dementia	Design life onomatopoeia for people with dementia	The subject will respond to sounds that were once familiar.
[18]	This research aims to explore the influence of emotional music stimulation on autobiographical memory information retrieval	25 Alzheimer's patients	The soundscape provided includes happy, sad, unemotional sounds and ambient sounds.	Sad music is the most effective way for patients to recall the past.
[19]	Explore why music is good for the health of people with dementia	12 people with dementia, 15 family caregivers, 14 nursing home staff, and 8 music therapists	To provide different music according to the nursing home environment, including classical music, nostalgic music, etc.	Music can alleviate behavioural and psychological symptoms, and music can help improve the nursing home environment.
[20]	Use soundscapes to improve the quality of life of people with dementia and to improve the experience of patients and medical staff	People and staff with dementia living in 5 nursing homes	Monitor the noise intensity, soundscape composition and response of patients with dementia in the living rooms of five nursing homes.	Several soundscape quality attributes and the perception of sound source types are significantly different. There is a moderately positive correlation between voice level and the number of people.
[21]	Use the soundscape method to improve the quality of life of patients with dementia and reduce the behaviour and psychological symptoms of patients with dementia	People and staff with dementia living in 5 nursing homes	Observe the living rooms of five nursing homes in Belgium and collect soundscape data	Daily patterns and time-varying acoustic landscape strategies can manage the acoustic environment of nursing homes to improve the overall experience of residents.

[22]	Describe, explain, and verify the potential of sound art in people with Alzheimer's disease	30 people with dementia, 6 paramedics, and 4 doctors	To study specially designed sounds, the prototype includes three types: natural soundscape, musical instrument soundscape and abstract soundscape.	The patient's response to the natural soundscape is active and comfortable. The patient is happy and dedicated to the soundscape of the musical instrument. The patient is calm and tired with the abstract soundscape.
[23]	Provide soundscapes for dementia care centres to improve the well-being of patients and staff	Dementia patients and staff living in 5 nursing homes	Natural soundscape, restaurant soundscape	The soundscape can stimulate the behaviour of residents at the right sound level.
[24]	Provide health-based interventions for patients with dementia by designing soundscape triggering devices.	11 early to mid-stage dementia patients	Dementia soundboards that provide soundscapes for people with dementia, mainly based on natural environment soundscapes.	Soundscape can trigger personal associations of people with dementia, stimulate memories, and increase personal confidence. It also relieves stress for nursing staff.
[25]	Provides a convenient pillow sound player Vita for patients with dementia and proposes the design significance of everyday sounds in dementia care	19 people with Alzheimer's disease	The daily life soundscape can be provided based on the personal experience of the dementia patient.	Everyday sounds played by Vita can evoke associations for people with dementia
[26]	Use soundscapes to create an atmosphere to improve people's quality of life.	17 people with dementia	A custom database is composed of natural sounds, environmental sounds, and music. The control panel can be used to provide patients with personalised soundscapes.	Soundscape has a positive effect on patients' anxiety, pain, night sleep, stress, and life treatment
[27]	Provide a soundscape adapted to the environment for people with dementia, and detect the response of people with dementia to the soundscape.	14 Alzheimer's patients	Provide patients with corresponding soundscapes according to the environment, including natural sounds, human society sounds, animal sounds, etc.	A soundscape adapted to the environment can provide support for people with dementia.
[28]	Provide interactive background music playback function for the elderly in the dementia care centre.	8-10 people with dementia	Provide background music for patients and observe their behaviour and emotions	The creative interaction of many people with dementia is achieved through music. Music can evoke memories.
[29]	Use songs for people with dementia and caregivers to reduce the burden and improve the quality of life.	24 dementia patients and 22 family members responsible for caring for the patients	Provide patients with various types of songs	Most patients' emotions are positive, which can improve concentration, and songs they do not like will trigger a negative association

The soundscape is the human perception of the sound environment in the context. People will experience the auditory experience from the sound environment in life, and the resulting perception of the sound environment can become a soundscape.[30][31] A popular research believes that soundscapes can evoke different responses from individuals. Since the two problems planned in 2.1 are mutually progressive, the following will classify the soundscapes in the study and explain the support that soundscapes provide to patients with dementia.

3.1 Natural soundscape

The natural soundscape positively impacts the therapeutic environment and can help the patient's mental health recovery and other broader well-being. In this review, a total of seven studies provide natural soundscapes for patients with dementia. In a study by Dr Kamal Sabran, researchers designed three types of soundscapes for 30 patients with dementia in two nursing facilities. In the design, psychoacoustic theory, sound perception theory, and good therapy theory are applied to soundscape creation, and the research adopts the methods of case study and qualitative research. The data gathered found that natural soundscapes can calm people with dementia and reduce anxiety.[22]

After testing the soundscapes in the living room in five nursing homes in Belgium, the researchers continued the research and sampled the created soundscapes in a 24-hour loop playback in the nursing homes. The soundscape played contains natural sounds, the sounds of birds singing, and leaves blowing in the wind. The volume was adjusted to an appropriate level. Most of the sounds are in the low-frequency range. By detecting the patient's heartbeat and observing feedback, it is found that the patient is happy and the heartbeat is stable. In turn, it produces a positive response to medical activities.[23]

A study in 2019 provided dementia patients with a dementia soundboard that can trigger the soundscape. The soundscape provided includes two soundscapes: beach and forest. The experimental results show that the soundboard evokes the personal thoughts and emotional responses of dementia patients by creating sound scenes. The patients can associate the sound of the beach with their previous travel experiences.[24]

In addition, a 2020 study provided people with dementia with soundscapes from the natural world, such as the sound of rain, bonfires, and singing crickets. Observing residents' verbal and non-verbal responses found that natural voices have more positive feedback than artificial voices.[27] Many studies have proved that natural soundscapes have a therapeutic effect on patients with dementia. Natural soundscapes are generally believed to make patients feel happy and calm, and some studies believe that they can bring memories of dementia patients. However, there are many kinds of sounds in nature, and which sounds may cause uncomfortable responses to patients with dementia need to be further verified.

3.2 Daily soundscapes and other soundscapes in human society

In a study in Osaka, Japan, researchers designed 100 familiar voices in life for people with dementia. The test results show that people with dementia can produce clear memories through sounds in life. The role of soundscapes varies from person to person. Women are more sensitive to the soundscape of the kitchen, and men are more susceptible to the sound of war.[17]

Francesco Aletta conducted two studies in five nursing homes in Belgium to monitor the noise intensity and soundscape composition in the living room of nursing homes at different times of the week and observe the impact of different soundscapes on patients with dementia. It is found that the composition of the soundscape in the nursing home is complicated, including

electronic sounds, human sounds, pet sounds, installation sounds, and environmental noise. They measured the intensities of different sounds, and the results showed that the soundscapes in the living room of the nursing home were different every day. Still, the overall power of the sound levels they produced during a week was the same.[20]

It shows that regular practice changes in the sound environment provide auditory safety for patients with dementia, and patients will not feel discomfort. A research suggests that the soundscape of the dementia patient care centre has a wide variety of sound sources, and quietness is not necessarily the first choice for the soundscape.[21]

Three studies[18][23][27] used the soundscape of the restaurant, including the ambient soundscape of the cafe and the soundscape of the restaurant. People with dementia will have an appetite after hearing a similar soundscape and increase their food intake. In a study in 2021, researchers set up soundscapes for different areas of the dementia centre. They set up outdoor natural soundscapes near the windows according to the time, soundscapes of kitchen utensils in the dining area, soundscapes of waterfalls and birds in the rest area, and relaxing night soundscapes in the bedroom. These provided a full range of soundscape enjoyment for the care of dementia patients. The results show that the atmosphere formed by the soundscape is accepted by most dementia patients, including the nursing staff. A soothing and elegant soundscape can elicit a positive response from the patient more than a fast-paced sound.[27]

3.3 Music soundscape

The most supportive soundscape provided for patients with dementia is music. In a study by Carol A. Prickett, researchers tried to help ten Alzheimer's patients recall the past by playing previous songs. They played music familiar to the elderly and new music. The results indicate that Alzheimer's patients can stimulate reactive participation by using familiar music. Elderly people with mild illness can improve the joy of life by learning, listening to, or humming new music.[15]

A randomised controlled trial was used in one study. Music for a group of patients during rehabilitation was provided. The types include accordion, country, folk, and other soothing music. Compared with another group of dementia patients who did not listen to music, it was found that music-based rehabilitation had positive support for cognitive recovery.[16]

In another study, researchers provided different types of music to elderly people in an Alzheimer's care centre in Spain. These elderly people are older than 60 years old, and they all maintain communication and hearing skills. In the experiment, happy music, sad music, and ambient sound in cafes were played for the elderly. The results showed that the memory performance of the subjects was significantly different with or without voice. Emotion-inducing music is conducive to the retrieval of memories. Sad music can be used as a clear and specific recall route.[18]

In a 2014 study, researchers conducted qualitative research, hoping to gain insights into the music experience of dementia patients and explore the meaning of music for dementia patients and caregivers. Patients and staff from two dementia care institutions and music therapists participated in the study. Music helps improve the nursing home environment, improve patients' quality of life with dementia, and effectively help patients with dementia relieve anxiety. This is because everyone has different music preferences, and music is of little importance to caring for patients.[19]

Music as a soundscape is sufficient to support dementia patients. Many documents believe that music soundscape is beneficial to dementia patients' memory, effectively relieves patients' anxiety, and improves patients' mood. The sound of the instrument also supports the recovery

of cognition. At the same time, the literature also pointed out that it is necessary to fully consider the patient's experience and music preferences when designing a music soundscape.

4 Discussion

Dementia is now the most common cause of disability in the elderly in the world. Although some drugs can help patients with dementia reduce their symptoms, the help of drug therapy is limited. Therefore, art therapy is becoming an essential method of dementia care.[5] Designing soundscape to support patients with dementia is multi-faceted support that focuses on patients' physical health, mental health, and quality of life.[32]

According to the types of soundscapes in the review, the most commonly used natural soundscapes are insects and birds, the sound of gentle waves, the sound of forests, and the sound of rain. Based on the research results, the beautiful natural environment music can relieve stress, reduce anxiety, focus and help sleep, and other aspects of support for patients with dementia.[7] The research results also show that playing soundscapes in the courtyard or front of the windows of nursing homes is better. That is, soundscapes can be combined with scenery to achieve better results.[33][24]

In the research on the soundscape of human society, the sounds of restaurants and kitchens and the sounds of people and pets have achieved remarkable results. In this type of research, it is found that the soundscape of human society helps people with dementia to find lost memories.[6] People with dementia can recall events in the scene based on their sounds, including short-term and long-term memories. Therefore, this kind of sound setting needs to communicate with the patient and the patient's relatives in advance, and understand the patient's personal experience to make a personalised soundscape setting.[27]

The research on music intervention therapy is sufficient. Music can improve the mood and quality of life of patients with dementia. It also has the effects of recalling memories and soothing emotions. However, the choice of music should be cautious.[34] Based on the literature reviewed in this review, we find that the music therapy used for dementia patients is mainly soothing and elegant music. Some studies have shown that people with dementia may not remember all the lyrics in music, but they can usually understand the emotions in music.[15]

All soundscapes reviewed this time have clear signs that the appropriate soundscapes have significant support for the treatment and life of dementia patients. However, many of the studies in this review have limitations. At the same time, the supporting research on soundscapes for patients with dementia is also limited, which requires extensive attention from society. Soundscape's support for patients with dementia requires the cooperation of experts in multiple fields. Only when the caregivers of patients with dementia, sound artists, and medical experts cooperate, can they draw practical research conclusions.

The technology for providing soundscapes for patients with dementia has been improving. The early designs were mainly traditional audio playback devices. Recently, wearable devices and designs have gradually appeared on dementia patients, such as smart application interfaces. Appearance can help people with dementia interact with their mobile phones and can choose the soundscape they need.[35]

In the current situation of the global pandemic of new coronary pneumonia, this review also found that a website called "Music for Dementia" provides support for patients with dementia who are isolated at home, as well as other interactive network activities and conferences for

patients with dementia who are isolated at home.[36] These studies emphasise the social well-being of people with dementia, but the study's results still need to be further observed.

This search also found a diverse ways to provide soundscapes for patients with dementia. A study designed a pillow, Vita, that can play various soundscapes for patients with dementia, allowing patients to choose the soundscape they need and provide. To interact with the patient, the patient and the nursing staff can explore the role of the soundscape together and increase the patient's sense of social belonging.[25] Another study provided a soundboard (namely the dementia soundboard) for patients with dementia. Different soundscapes can be selected through the control panel. It also provides the function of interacting with new technologies for patients with dementia. The test found the cognitive ability of patients with dementia see an increase.[24]

5 Conclusion

This article aims to explore the support of soundscape for patients with dementia and explore how soundscape can improve the care environment for patients with dementia. The review results show that soundscape supports dementia patients, mainly in three aspects: soothing emotions, improving cognition, and awakening memory. Another study believes that providing soundscapes for dementia patients in a specific environment can enhance the function of the environment, such as eating meals. Providing relevant soundscapes in places can increase the patient's food intake. Another thing to note is that many studies have shown that soundscapes need to be designed according to the personal life experiences of patients with dementia, and the sensitivity of patients to soundscapes varies from person to person. At the same time, the volume setting also needs to be consulted with the caregiver in advance to confirm the hearing ability of the dementia patient.

In general, research on soundscape supporting dementia patients is increasing year by year, reflecting that with the ageing trend and the increasing incidence of dementia, paying attention to the social well-being of dementia patients has become one of the current research focuses in the world. Future research should pay more attention to the needs of dementia patients living at home and provide support to families with dementia patients. In terms of soundscape equipment, diversified product designs can be carried out to integrate soundscape into the lives of patients with dementia and improve the quality of life of patients with dementia. Artificial intelligence (AI) has been widely used in the field of healthcare. AI-based algorithms and in-depth learning functions can provide personalised soundscapes for patients with dementia.[37] The future development of the AI field will bring better well-being to patients with dementia.

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