AUDIO-VISUAL PERCEPTION OF OUTPATIENTS IN AN ONCOLOGY POLYCLINIC

A Master's Thesis

by

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Ankara

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To my dear parents,

Ayşe Nur and Mehmet Uğurlu

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ABSTRACT

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This study aims to analyze the effects of auditory and visual perception in a hospital environment to provide comfort for the outpatients. The research focused on the waiting area of an oncology polyclinic. The binaural audio recordings and 360° photographs were taken from three different locations (reception area, courtyard area, and corridor) on the site. Audio recordings were visualized through signal processing, and the photographs were evaluated through image analysis via MATLAB to show the auditory and visual differences among the locations. These three locations differed from each other in their auditory and visual environments. Regarding the hospital auditory environment, sound sources are human activity-related and technology-based. The reception area has an indoor opening, the courtyard area has indoor and outdoor openings, and the corridor area has none.

Voluntary oncology outpatients in three locations in the polyclinic were given questionnaires (n=66) and interviewed (n=20). Questionnaires were analyzed in IBM SPSS Statistics, and interviews were analyzed with the Grounded Theory method in ATLAS.ti software. Equivalent Continuous A-Weighted Sound Level (LAeq) measurements were taken within the interview hours and at one-hour intervals from three locations. The questionnaire revealed that the courtyard area is calmer and more pleasant than the other areas. The conceptual framework created with semi-structured interviews showed how the auditory and visual environments affect the outpatients' perception. The conceptual framework revealed audio-visual perceptions in the hospital environment with the existing condition and outpatients' preferences and proposed suggestions for a hospital environment.

Keywords: Audio-visual Perception, Grounded Theory, Hospital Environment, Indoor Soundscape, Signal Processing

ÖZET

ONKOLOJİ POLİKLİNİĞİNDE AYAKTA TEDAVİ GÖREN HASTALARIN GÖRSEL-İŞİTSEL ALGILARI

Uğurlu, M. Zeynep

İç Mimarlık ve Çevre Tasarımı Yüksek Lisans Programı

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Bu çalışma, hastaların konforunu sağlamak için hastane ortamında işitsel ve görsel algının etkilerini analiz etmeyi amaçlamaktadır. Araştırmada, bir onkoloji polikliniğinin bekleme alanına odaklanılmıştır. Poliklinikte üç farklı konumdan (resepsiyon alanı, avlu alanı, koridor) binaural ses kayıtları alınmış ve 360° fotoğraflar çekilmiştir. Seçilen üç farklı konum arasındaki işitsel ve görsel farklılıkları göstermek için MATLAB programında ses kayıtları sinyal işleme ile görselleştirilmiş ve fotoğraflar görüntü analizi yapılarak incelenmiştir. Bu üç konum, işitsel ve görsel ortam bakımından birbirinden farklılık göstermektedir. Hastane işitsel ortamıyla ilgili, ses kaynakları insan faaliyetleriyle ilgili ve teknoloji tabanlıdır. Resepsiyon alanı iç mekânda açıklığa sahiptir, avlu alanı iç ve dış mekanlarda açıklıklara sahiptir ve koridor alanında açıklık yoktur. Poliklinikte üç konumda gönüllü onkoloji hastalarına anket (n=66) verildi ve görüşmeler (n=20) yapıldı. Anketler IBM SPSS

Statistics programında, görüşmeler ise Grounded Teori yöntemiyle ATLAS.ti yazılımında analiz edilmiştir. A-Ağırlıklı Eşdeğer Ses Düzeyi (LAeq) ölçümleri, görüşme saatleri içinde ve birer saatlik aralıklarla üç konumdan alınmıştır. Anket sonuçları, avlu alanının diğer alanlara göre daha sakin ve hoş olduğunu ortaya koydu. Yarı yapılandırılmış röportajlarla oluşturulan kavramsal çerçeve, işitsel ve görsel ortamların hastaların algılarını nasıl etkilediğini göstermiştir. Kavramsal çerçeve, hastane ortamındaki görsel-işitsel etkileşimlerin mevcut durumunu ve hastaların tercihlerini ortaya koymuş ve hastane ortamı için önerilerde bulunmuştur.

Anahtar Kelimeler: Görsel-İşitsel Etkileşim, Grounded Teori, Hastane Ortamı, İç Mekân İşitsel Peyzaj, Sinyal İşleme

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LIST OF ABBREVIATIONS

dB	Decibel
dBA	A-weighted decibels
GT	Grounded Theory
HVAC	Heating, ventilation, and air conditioning
ISO	International Organization for Standardization
kHz	Kilohertz
LA90	A-weighted sound level, just exceeded for 90% of the measurement period
LAeq	Equivalent continuous A-weighted sound level
LAmin	A-weighted minimum sound level
LAmax	A-weighted maximum sound level
LCpeak	C-weighted, peak, sound level
PCA	Principal Component Analysis
RT	Reverberation time
SEM	Structural Equation Modelling
SII	Speech Intelligibility Index
STFT	Short-time Fourier transform
STI	Speech Transmission Index
T30	Reverberation time, the first 30 dB of sound decay
VR	Virtual reality
WSP	World Soundscape Project

CHAPTER I

INTRODUCTION

Hospitals are significant environments for taking healthcare. As doctors and nurses work in these environments, patients also spend time in hospitals for treatment. Thus, acoustic and visual environments could affect the patients' perception. Some hospital soundscape studies (Bliefnick, Ryherd, & Jackson, 2019; Mahapatra, 2011; Shield, Shiers, & Glanville, 2016) focused mainly on the acoustical measurements and did not pay much attention to the perception of patients or hospital staff. However, users' perceptions should also be considered as they are the occupants of the space, and their thoughts could give significant inferences for improving the hospital environment. Thus, some studies focused on the perception of soundscape (Mackrill, Cain, & Jennings, 2013a; Watts, Khan, & Pheasant, 2016). These studies presented that for a positively experienced hospital soundscape, there should be more than just decreasing the sound level. In order to understand patients' perceptions and preferences about soundscape, questionnaires may be given to patients, or they may be interviewed to express their thoughts freely. In addition, the visual environment could affect the soundscape perception (Li & Lau, 2020; Liu et al., 2013) as there are many aspects of the visual environment in terms of form, material, color, lighting, fixture, and furniture. The audio-visual perception provides an environment that is perceived more positively (Deng et al., 2020). This suggests that audio and visual elements should be evaluated together. The users of the space, in this case patients, could evaluate the audio-visual environment differently compared to the actual features of the environment.

1.1. Aim and Scope

Hospital environments are crucial for patients' physical and mental health care as they visit hospitals to get treatment for their illnesses. Therefore, acoustic and visual parameters of hospital environments should be designed accordingly. The studies on hospital soundscapes mostly searched the perception of the sound environment with quantitative methods such as surveys and the acoustical data such as sound levels (LAeq), reverberation time, and speech transmission index (STI). However, the hospital soundscapes should also be searched with qualitative methods as those can give additional information about the hospital soundscapes. Thus, quantitative and qualitative methods can be combined to understand the hospital soundscapes better. Additionally, as the visual environment may affect the perception, the soundscapes can also be evaluated by considering visual perception.

There are hospital soundscape studies that are conducted with listening tests (Dalirnaghadeh & Yilmazer, 2022; Mackrill et al., 2013b, 2014), and there are studies in which the participant groups were not patients (Dalirnaghadeh & Yilmazer, 2022; Mackrill et al., 2013b, 2014; Mahapatra, 2011) as the users of the hospital environments. Therefore, there is a need for qualitative research that evaluates patients' perception of the audio-visual elements in a real hospital environment, along with quantitative research. This study aims to understand the patients' perception of sound and visual environments in a real hospital environment and investigate the differences between the audio-visual environment and patients' perception of it. Thus, the research is conducted in an outpatient oncology polyclinic's waiting areas (reception area, courtyard area, and corridor). Quantitative and qualitative data were collected in these areas, and results were compared for further analysis. Quantitative data were collected as equivalent continuous A-weighted sound level (LAeq) measurements that were taken in-situ with Brüel & Kjær 2230 sound level meter. Signal processing and image analysis were made with MATLAB R2021b, and ISO/TS 12913-2 Method A questionnaire was analyzed with IBM SPSS Statistics software. Qualitative data were collected through semi-structured interviews and analyzed with the Grounded Theory method in ATLAS.ti software.

1.2. Structure of the Thesis

This thesis has six chapters. In the first chapter, "Introduction," basic information about soundscapes is given, and the importance of this research is explained. Then, the aim and scope of the research are explained, and the structure of the thesis is given. In the second chapter, "Literature Review," the soundscape approach, evaluation methods of soundscapes, and previous studies on indoor soundscapes are explained. Evaluation of quantitative parameters, which are Equivalent Continuous A-Weighted Sound Level (LAeq), questionnaire and soundwalk methods as suggested by ISO/TS 12913-2:2018 data collection and minimum reporting requirements, and signal processing and image analysis techniques, are given. After, evaluation of qualitative parameters, which are semi-structured interview method as suggested by ISO/TS 12913-2:2018 data collection and minimum reporting requirements, is given, and the Grounded Theory method is explained. Lastly, hospital environments and hospital soundscapes are explained with the previous hospital soundscape studies, and the importance of audio-visual perception is given.

In the third chapter, "Method," the design of the study and research questions are stated, and the research method is extensively explained. The site of the study, participant group, and acoustic and visual environments of the site are presented. After, data collection and analysis are given as the processes of LAeq measurements, signal processing and image analysis, questionnaire survey, and Grounded Theory are explained. In the fourth chapter, "Results," results of sound level measurements, signal processing and image analysis, questionnaire survey, and semi-structured interview are presented. The questionnaire survey is analyzed with Spearman’s rho correlation test, one-way ANOVA test, and assessment and appropriateness of surrounding sound and visual environments.

In the fifth chapter, "Discussion," the research results are critically analyzed and compared with the previous indoor soundscape research. The similarities and differences among the three areas in the polyclinic are discussed. In the sixth chapter, "Conclusion," this research's findings are summarized, suggestions for future work are given, and the thesis ends.

CHAPTER II

LITERATURE REVIEW

This chapter explains the literature on soundscapes. It gives information on evaluation methods of soundscapes and previous studies on indoor soundscapes. After, studies on hospital soundscapes and the importance of audio-visual perception are explained.

2.1. Soundscapes

The soundscape is a term first defined by the composer R. M. Schafer, and the soundscape research has been increasing ever since. Schafer was interested in how the acoustic environment is perceived by humans (1977). He categorized the typology of sound in three parts: keynote sounds, signals, and soundmarks (Schafer, 1977). Keynote sounds are the background sounds that people hear without noticing. They are shaped by the environment people are living in. Signals are the foreground sounds that people listen to, knowing that there is a particular sound. Soundmarks are the unique sounds that describe belonging to a particular environment. In 1969, Schafer started the World Soundscape Project (WSP), which deals with many aspects of acoustic design. The research consisted of topics on different areas of acoustics such as "aural perception, sound symbolism, noise pollution" (Schafer, 1977, Glossary of Soundscape Terms). This project was accepted as a fundamental for the soundscape research, as it provided the first glance into the soundscapes (Truax et al., 2014).

Until 2011, the soundscape term had no specific definition, and studies were not following any standard method accepted by the authorities (Brown et al., 2011). Thus, Brown et al. (2011) defined the soundscape as it "exists through human perception of the acoustic environment of a place" (p. 388) and proposed a classification for the acoustical environment in a taxonomy (Figure1). The taxonomy divides the acoustic environment into two main categories: indoor acoustic environment and outdoor acoustic environment. The outdoor acoustic environment has four parts: urban, rural, wilderness, and underwater. The indoor acoustic environment is shown as having the same classification as the outdoor acoustic environment.

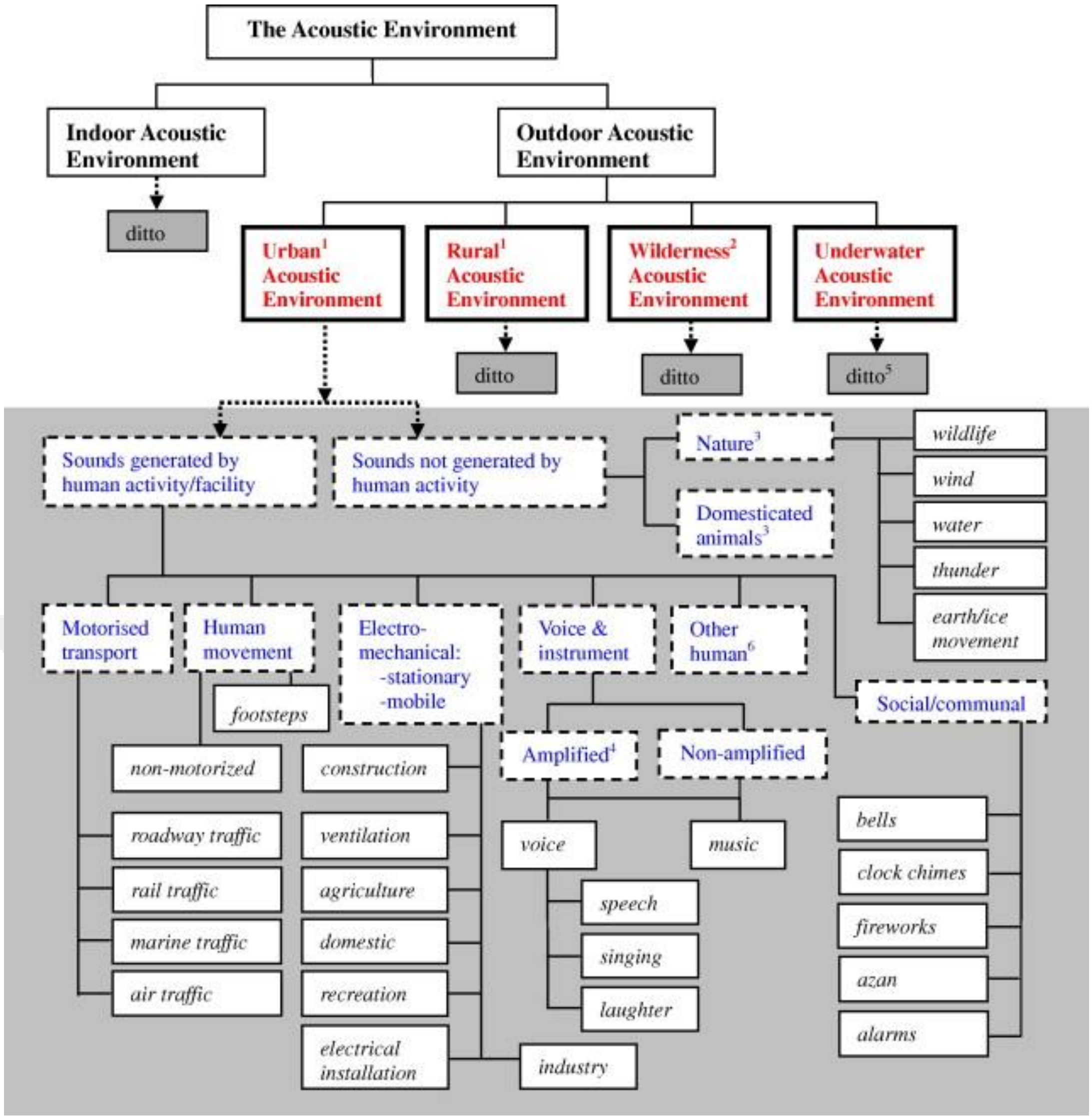

Figure 1. Taxonomy of the acoustic environment for soundscape research, by Brown et al. (2011, p. 390)

In 2014, International Organization for Standardization (ISO) defined the soundscape as an "acoustic environment as perceived or experienced and/or understood by a person or people, in context" (p. 1). Thus, the soundscape is a subjective term that presents the relationship between the acoustical environment and people (Aburawis & Dokmeci Yorukoglu, 2018; Brooks et al., 2014; Kang et al., 2017; Yang & Kang, 2013). This relationship is explained by ISO 12913-1 (2014) within a soundscape framework (Figure 2).

The framework consists of seven elements: namely as, context, sound sources, acoustic environment, auditory sensation, interpretation of auditory sensation, responses, and outcomes (ISO/TS 12913-1, 2014). The context is the core category, meaning that the other elements are shaped around context. According to the context, sound sources emerge. Sound sources create the acoustic environment in a specific context. The human ear perceives the acoustic environment within the context through auditory sensation and interprets it to understand it. As a result of this interpretation, humans give responses to the acoustic environment in context. These responses could change the context. The responses cause outcomes that have a long-term effect on humans (ISO/TS 12913-1, 2014).

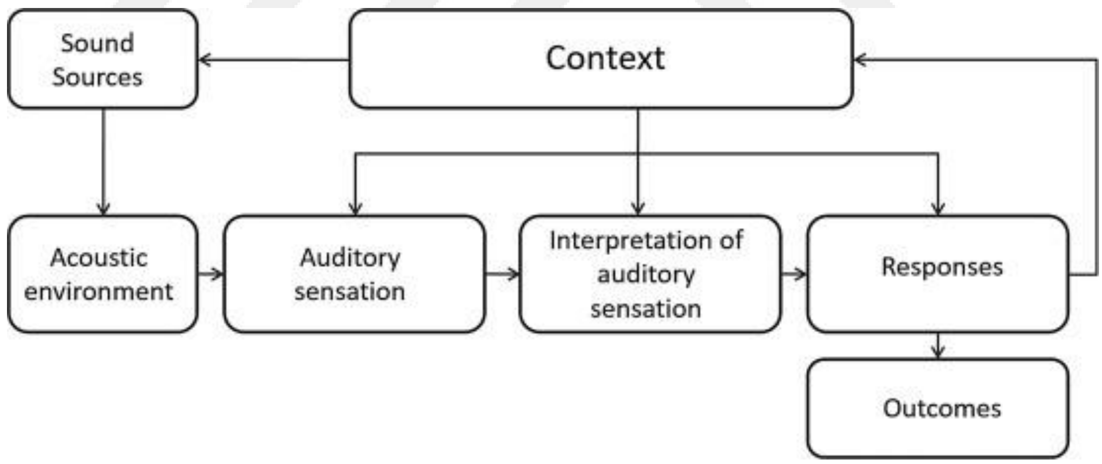

Figure 2. Soundscapes Framework created by ISO/TS 12913-1 (2014, p. 2)

2.1.1. Evaluation of Quantitative Parameters

In 2014, International Organization for Standards (ISO) explained the definition and conceptual framework of the soundscapes in ISO/TS 12913-1.

However, there was still no standard for the soundscape studies on collecting data and evaluating it. Thus, in 2018, ISO/TS 12913-2 defined standards for soundscape research data collection and reporting requirements. ISO/TS 12913-2 suggested how to evaluate humans, acoustic environment and context, and explained how to report participants and acoustic environment of the study. Thus, the standards on ISO/TS 12913-2 explained the minimum reporting requirements on participants and the acoustic environment, binaural measurement methods and suggested three methods for data collection: questionnaire as Method A, soundwalk as Method B, and guided interview as Method C. Acoustic environment should be reported with giving the sound sources, weather and wind conditions, time of the year and day, measurement points, and what measurements were taken (such as LAeq, LCeq). It was suggested to use several methods together for triangulation of the study (ISO/TS 12913-3, 2019). Further, ISO/TS 12913-3 (2019) defined guidelines for analyzing the data gathered from Method A, Method B, and Method C. Additionally, the acoustic and visual environments can be analyzed through signal processing and image analysis to visualize the data.

2.1.1.1. Equivalent Continuous A-Weighted Sound Level (LAeq)

The equivalent Continuous A-Weighted Sound Level (LAeq) is the sound pressure level with an A-weighting filter in a specific period of time (Brüel & Kjær, n.d.). It can be measured with a sound level meter, and the unit is the decibel (dB). Soundscape studies use LAeq measurements widely because it disregards low-frequency sounds like the human ear (Egan, 1988; Orhan, 2019). Thus, human perception can be compared with LAeq measurement better than sound pressure levels with other weightings.

2.1.1.2. ISO/TS 12913-2:2018 Method A Questionnaire Survey and Method B Soundwalk

ISO 12913-2 proposed three methods for the data collection on human perception: Method A is the questionnaire, Method B is soundwalk, and Method C is the semi-structured interview. Method A questionnaire is used in some soundscape studies (Erdoğu & Yilmazer, 2021; Şahin, 2020). The questionnaire has four parts aiming to evaluate the acoustic perception of people in a context. These parts are sound source identification, perceived affective quality, assessment of the surrounding sound environment, and appropriateness of the surrounding sound environment. However, ISO/TS (2018) claims that other questions related to the context of the study can be added to the questionnaire. At the beginning of the questionnaire, participants should be acknowledged about the aim of the research, their participation is entirely on voluntary basis, and they have the right to choose not to answer some questions, if they feel uncomfortable (ISO/TS, 2018).

The first part of the questionnaire is about defining the types of sound in the context of the study. ISO/TS (2018) categorizes the types of sound as "sounds of technology," "sounds of nature," and "sounds of human beings" (p. 14). Participants are expected to define the dominancy of these sounds. The second part of the questionnaire has eight adjectives, and participants are expected to choose how much they agree with these adjectives. The third and fourth parts of the questionnaire are about assessment and appropriateness of the sound environment. Each part has options with a five-point Likert scale. ISO/TS 12913-3 (2019) suggested statistically analyzing the questionnaire with correlation analysis, linear regression, or ANOVA. Also, the results of the perceived affective quality part with eight adjectives can be presented in a two-dimensional model, as these adjectives correspond to each other (ISO/TS 12913-3, 2019).

Method B soundwalk requires the researcher's utmost attention as the procedure that should be followed is strict. There are instructions for each role in the soundwalk method, such as for the person leading the soundwalk, the person performing the binaural measurements, and the participants (ISO/TS, 2018). Soundwalk data collection has three parts: assessment of the sound environment, sound source recognition and ranking, and subsequent comments. The first part asks about participants' perception of loudness, unpleasantness, appropriateness of sound, and their want to revisit the place. The second part expects the participants to note the sound sources according to their dominance in the space. The third part requires participants' thoughts and feelings about the soundscape in that specific location.

2.1.1.3. Signal Processing and Image Analysis

A signal is a physical parameter that may be an audio, image, video, speech, or sensor (Moura, 2009). The audio is a signal with features such as frequency and amplitude, which can be presented in different domains such as time and frequency. Signal processing analyzes a signal to explain it in a different format. Signal processing provides information on a signal by applying different techniques (Abraham, 2017; MATLAB, n.d.). These techniques, such as coding, filtering, transforming and reproducing, represent the signal in the desired format (MATLAB, n.d.; Moura, 2009). It can be analyzed digitally with software such as MATLAB, Python, and GNU Octave to analyze various operations (Smith, 2022). Audio signal processing mainly analyzes the filtering of the signal. MATLAB is a digital tool that can process the audio signal and provide visualization of the output (MATLAB, n.d.). The interpretation of the processed signal would be easier as it focuses on the data that wanted to be displayed. In order to reach the visualization of a signal in MATLAB, either self-written codes with the help of Mathworks (Mathworks, n.d.-b) or the Signal Analyzer app in MATLAB can be used. This thesis uses self-written codes (Appendix A1 and A2) as they provide the information that needed to be delivered better.

An audio file can be best explained visually by showing the signal in the time domain because humans perceive the sound in a specific time period. The signal in the time domain can be presented to show the signal's amplitude/intensity (dB), or frequency and amplitude. Short-time Fourier transform provides information in the time-frequency domain (Smith, 2011). Short-time Fourier transform (STFT) provides a spectrogram, a visual representation of the signal in the time-frequency domain (Acun, 2021; Smith, 2011).

Like audio signal processing, images can be processed, and information can be extracted from them through image analysis via MATLAB coding. Particular areas of an image can be separated into components. This can be achieved by Image Segmenter and Color Thresholder apps in MATLAB. Image Segmenter app creates automatic segmentation of a grayscale image, which the segmentation can also be adjusted manually (Mathworks, n.d.-c).

Color Thresholder app creates automatic segmentation of a colored image, and similar to the Image Segmenter app, the segmentation can also be adjusted manually (Mathworks, n.d.-a). With these segmented images, percentages of white or black areas can be obtained with self-written codes with the help of Mathworks (Mathworks, n.d.-b).

2.1.2. Evaluation of Qualitative Parameters

ISO/TS 12913-2 (2018) explained semi-structured interviews in Method C. It is a qualitative data collection method. The interviews can be analyzed with the Grounded Theory method, which is also suggested by ISO/TS 12913-3 (2019).

2.1.2.1. ISO/TS 12913-2:2018 Method C Semi-structured Interview

Method C semi-structured interview is a more tolerant method than the other two, as there are no strict rules of this method. The researchers would prepare questions about the acoustic environment in a specific context before the interviews; however, there may be other questions during the interviews. ISO/TS 12913-2 gave examples of interview questions about a residential soundscape study. These questions were suggested to be adapted to a study by considering the context. However, ISO/TS (2018) also stated that not all the questions might be adaptable to some contexts, and new questions may arise according to the course of the conversation. The interview data can be analyzed with Grounded Theory, a qualitative analysis method (ISO/TS 12913-3, 2019; Strauss, 2010). Grounded Theory provides information from the users without confronting them with any bias (Bhattacherjee, 2012).

2.1.2.2. Grounded Theory

Grounded Theory arose in 1967 due to a sociological research program by Glaser and Strauss (Charmaz, 2014; Glaser & Strauss, 1967; Walker & Myrick, 2006). Grounded Theory is the primary method used among the qualitative analysis methods, as the researcher presents a theory after data collection (Dey, 1999; Walker & Myrick, 2006). This provides flexibility to the researcher and makes it easier to reach out information that is unconsidered before the data collection. Corbin and Strauss (1990) claimed that interviews could be systematically analyzed with the Grounded Theory method by following its procedures. The procedure states that the data collection and analysis should be done simultaneously. As the first interview answers are collected, data analysis can be started. The answers would be analyzed through a coding process with three stages: open coding, axial coding, and selective coding. At the beginning of this process, key ideas would be extracted as concepts. These concepts are derived from the raw interview data, and the analysis is made with constant comparison to form categories (Corbin & Strauss, 1990). Categories would be created with some of the concepts uniting together. Then, the relationship between the categories is defined, and a theory would be formed.

2.1.3. Previous Studies on Indoor Soundscapes

In the beginning, soundscape research was focused on urban environments (Hong & Jeon, 2013; Jennings & Cain, 2013; Raimbault & Dubois, 2005; Yong Jeon et al., 2013). However, there is also a growing research area on indoor soundscapes (Torresin et al., 2020). Indoor spaces are different from outdoor spaces because there are surfaces in indoors which may be in different shapes and materials, and their function may differ. Thus, the indoor soundscape should be evaluated in its context. Context can be a space or a function of a space. Some of the indoor soundscape research have already studied in different contexts such as school environments (Acun & Yilmazer, 2018a; Çankaya & Yılmazer, 2022), offices (Acun & Yilmazer, 2018b; Jo & Jeon, 2022), museums (Acun & Yilmazer, 2019; Orhan & Yilmazer, 2021), mosques (Yilmazer & Acun, 2018), libraries (Dokmeci Yorukoglu & Kang, 2017; Xiao & Aletta, 2016), metro station (Yilmazer & Bora, 2017), dental clinic (Uğurlu & Yilmazer, 2021), and concert halls (Erdoğu & Yilmazer, 2021).

Acun and Yilmazer (2018a) explored the soundscape of four open study areas at Bilkent University. Study areas consisting of the dormitories, Fine Arts building, library, and the Faculty of Science building were compared in terms of users' satisfaction, coping methods, and perceptual dimensions. LAeq measurements were taken, and a questionnaire was given to 120 students studying in the selected areas. Results showed that different sound levels in the four areas did not affect the students' soundscape satisfaction. Speech, laughing, and walking were the dominant sounds in all four areas, and it was perceived as the most disturbing sound by the students. Students also stated that these sounds have a reasonable effect on their concentration. They developed coping methods such as leaving the study area, moving to a quieter place or putting on earphones to keep their concentration.

Çankaya and Yılmazer (2022) conducted a study in İhsan Doğramacı Foundation Bilkent High School. A classroom and a computer laboratory were compared to identify the variations in students' auditory perception. Equivalent Continuous A-Weighted Sound Level (LAeq), Reverberation Time (T30), and Speech Transmission Index (STI) were measured. The study used a mixed-method: questionnaire survey as quantitative method and semi-structured interviews as qualitative method. A total of 117 students filled out the questionnaire, and 50 of them were interviewed. Questionnaire results were analyzed with SPSS v.20, and interview results were analyzed with the Grounded Theory method. Results showed that sound levels are not the only parameter affecting the perception because responses to the space changed according to the context of the sound source. The context is formed by the activity type and the content of the lecture. The findings were presented in a conceptual framework, which showed the relationship between the built environment, acoustic environment, and students' perception.

Acun and Yilmazer (2018b) investigated two open offices to interview the employees for their responses related to the soundscape. One of the offices was an engineering office, and the other was an architectural office. Sound sources in the offices were identified, LAeq measurements were taken, and acoustic simulations were made with Odeon Room Acoustics Software for STI values. A total of 49 employees were interviewed with the Grounded Theory approach, and a conceptual framework was created. Results showed that perception is affected by context, which is formed by environmental factors, activity, and task type. Context affected the sound preference, along with the employee characteristics. Employees have responded to the soundscape negatively, if they lost concentration. In order to focus, they found coping methods such as intervening to the sound source, accepting and habituating, or putting on headphones. Employees also stated that they prefer neither silence nor noise. The keyboard and mouse sounds were encouraging the employees to work.

Jo and Jeon (2022) studied soundscape perception in open-plan office environments. Two experiments were conducted in four virtual open offices with different audio-visual characteristics to evaluate preference of employees and their perceived productivity. The first experiment searched the relationship between satisfaction and work performance with visual complexity and acoustical variability. A total of 34 participants experienced 24 audio-visual stimuli and filled out a questionnaire on audio-visual content and overall satisfaction with the office. The second experiment searched the effects of sound sources on perceived affective quality and work-related quality of employees. A total of 41 participants experienced 36 audio-visual stimuli and filled out a questionnaire. Results showed that a small amount of acoustic and visual elements should provide satisfaction and work performance. Also, comfort and content are found to have an increase in the satisfaction and productivity of the workers.

Acun and Yilmazer (2019) conducted a study at Rahmi Koç Museum to explore the visitors' responses to the sound environment. LAeq measurements were taken, 15 visitors were interviewed, and 113 visitors filled out a questionnaire. Interviews were held with the Grounded Theory method, and a conceptual framework was formed. The framework categories were controlled with Structural Equation Modelling (SEM) to analyze the correlations between the categories. SEM analysis was made to understand the degree of relationships between the categories. Results showed that the categories that were expected to have relationships actually do not have any relationships, despite being predicted to be related during the interviews. It has been found that designed sound environments can be beneficial for improving the museum experience for visitors.

Orhan and Yilmazer (2021) explored museums regarding visitors' perception of auditory and built environments. They compared Rahmi M. Koç Museum with a historic built environment and Erimtan Archaeology and Arts Museum with a contemporary built environment. LAeq measurements were taken, and 60 visitors filled out a questionnaire survey. Also, 13 visitors were interviewed with the Grounded Theory method to learn what they expect and perceive from the museum environment they are experiencing. A conceptual framework was formed as a result of the interviews. Results showed that visitors prefer historical exhibitions in historic built environments. They wanted a soundscape in accordance with its context. The sounds as the exhibition elements were perceived positively as they contributed to the auditory environment in context.

Yilmazer and Acun (2018) investigated Hacı Bayram Mosque to determine the users' expectations and interpretations of soundscape in a religious space. LAeq measurements were taken, T30 and STI values were obtained with Odeon Room Acoustics Software. There were 15 users that participated in a semi-structured interview with the Grounded Theory approach, and a conceptual framework was created with the participants' answers. Results showed that as the function of the building is religious, the participant group ignored the auditory environment and did not pay attention to what they expected from a religious space's soundscape. However, participants defined the place identity by considering the sound elements of the mosque, but they did not realize these elements helped them in describing the place identity. Thus, the context had a significant role in the participants' expectations and preferences of soundscape, and these two provided participants' interpretations of the soundscape.

Dokmeci Yorukoglu and Kang (2017) studied developing a soundscape questionnaire for public indoor environments and tested it in three libraries. In the questionnaire design, there were three factors considered: demographic factors, space usage factors, and psychological factors. Psychological factors consisted of perception, expectation, and reaction. A total of 270 participants in Sheffield's three main university library foyer areas completed the developed questionnaire. The dominant sound was the whispering sound. Results showed that psychological factors are affected by demographic and space usage factors. Gender and education level affected the perception and expectation of soundscape. The expectation was found to be affected by preference.

Xiao and Aletta (2016) conducted a study on a modern public library to explore acoustic comfort. Perceived sound environment quality and appropriateness of the spatial organization for conducting reading and writing activities were measured in the Library of Birmingham. The library was modern in terms of its architectural form as it was an open-plan library. There were 12 participants that were divided into four groups, and each group took a soundwalk on one of the four main floors of the library. Each group’s LAeq levels were measured. Also, they defined the sound sources, and evaluated the perceived sound environment's overall soundscape quality and appropriateness. Results showed that human sound was the primary sound source in the library. The overall soundscape quality has been changed according to the different floors and different functions. However, it was independent of the LAeq levels and appropriateness of the perceived sound environment. Participants' perception was affected by both the visual and acoustical properties of the library. Thus, different plan layouts were found to have an effect on acoustic comfort.

Yilmazer and Bora (2017) studied the Akköprü metro station and its surroundings to explore its soundmarks. LAeq measurements were taken at eight different points. Audio recordings were also taken at these points, and a listening test was conducted to understand if the soundmarks help to differentiate the defined spaces. A total of 60 participants evaluated the eight sound clips and filled out a questionnaire. Results showed that half of the participants could define the space functions of the sound clips that they have listened to. Natural soundmarks, soundmarks of the entrance of the metro station, and soundmarks of the metro helped the participants to match the sounds with its space. Participants chose to define the outdoor sounds more positively than the indoor sounds. Females and younger participants were better than males and older participants in defining the sound sources.

Uğurlu and Yilmazer (2021) studied audio-visual perception of a dental clinic users. Audio-video recordings of the clinic were made, and an online listening test was given to 33 participants. Participants were divided into three groups according to the auditory and visual aspects of the recordings. One of the recordings had an additional nature sound, one of them had both additional nature sound and nature visual, and one had no additional audio-visual element. After watching the recordings, participants filled out a questionnaire about their emotional state. Results showed that participants who watched the nature sound recording perceived the soundscape more positively than those who watched the nature sound and visual recording. For future research, the study suggested using the nature visual in a different proportion and conducting the study in a dental clinic with a different visual design.

Erdoğu and Yilmazer (2021) explored the soundscape perception of audience in concert halls. Presidential Symphony Orchestra Concert Hall and CSO Grand Hall in Ankara were compared as their geometric layouts were different. Presidential Symphony Orchestra Concert Hall was in shoebox form, and CSO Grand Hall was in vineyard form. Pre-recorded songs from these two concert halls were given to the participants as an online listening test. A total of 40 participants were divided into two groups and filled out a questionnaire about soundscape perception. Results showed that CSO Grand Hall was perceived more positively than Presidential Symphony Orchestra Concert Hall. Participants found CSO Grand Hall more pleasant and eventful than the other.

2.2. Hospital Environments and Hospital Soundscapes

Hospital environments are crucial for providing physical and mental care to patients. Many patients come to hospitals to be examined by a doctor or nurse for routine check-ups of their illness and to receive small-scale medical interventions or large-scale medical operations such as surgery. Depending on the type and severity of the disease, the time spent by the patients in the hospital environment may also vary. Therefore, healthy hospital environments should be appropriately designed to enhance relaxation (Mackrill et al., 2014), perceived tranquility (Watts et al., 2016), and wellbeing (Apps & Sunderland, 2021) of the patients. The research on hospital environments was conducted in patient rooms or wards (Bliefnick, Ryherd, & Jackson, 2019; Mackrill et al., 2013a, 2016; Shield, Shiers, & Glanville, 2016; Talebzadeh et al., 2020), polyclinic waiting areas (Dalirnaghadeh & Yilmazer, 2022; Watts et al., 2016), ward corridors (Mackrill et al., 2013b), and emergency department (Mahapatra, 2011). These studies mainly focused on noise (Bliefnick et al., 2019; Mahapatra, 2011; Shield et al., 2016), perception of soundscape (Mackrill et al., 2013a, 2013b, 2016), and positive soundscape interventions (Mackrill et al., 2014; Watts et al., 2016).

Bliefnick et al. (2019) studied the perception of soundscapes in five hospital units. The patients filled out a questionnaire about the quietness. LAeq, LAmin, LAmax, LCpeak, and LA90 measurements were taken in 15 patient rooms and five nursing stations. Questionnaire results were correlated with the acoustical data. Average LAeq values in five units were between 52 dBA and 61 dBA. All five units received poor ratings on the Speech intelligibility index (SII). Occupied noise formed by speech had created a wide frequency range between 250 Hz and 4000 Hz. Correlation results between the questionnaire items and measurements of acoustical data showed relationships between minimum sound levels, sounds in low frequencies, and patients' perceptions of these parameters. LAeq results were compatible with questionnaire results, such as loud units were perceived to be negative. For future studies, it was suggested to consider other design features, such as materials and layout of the space, as they may affect the perception of patients.

Mahapatra (2011) conducted a study on the emergency departments of six hospitals. LAeq, LAmin, and LAmax measurements were taken in many locations of each hospital. Also, speech intelligibility ratings and sound level distributions were analyzed. Hospital staff filled out a questionnaire about their perception of the sound environment in the emergency department. Results showed that work areas and patients' rooms had exceedingly high sound levels. Speech intelligibility ratings were poor. Staff members explained that they were struggling to keep their concentration on the noise. Background noise was found to be a distracting element when staff is talking with the patients or other staff.

Shield et al. (2016) investigated noise in five inpatient hospital wards in the UK. LAeq, LAmax, and reverberation time (RT) measurements were taken at single-bed rooms, multi-bed rooms, and nursing stations. Patients were given a questionnaire for a couple of days to evaluate noise and define sound sources. Results showed that sound levels were high because of the reverberation times and activities with high sound levels. It was realized that the sound sources could be controlled by changing the equipment and layout of the rooms.

Mackrill et al. (2013a) explored soundscape perception in a cardiothoracic ward in a hospital in the UK. They claimed that sound level is just one parameter defining the soundscape, and there should be other elements. Therefore, semi-structured interviews were conducted with 27 patients and nurses. Interviews were analyzed with thematic coding, and a conceptual model of perception was developed. Results showed that soundscape is formed by many elements such as sound sources and perception in a context where the sounds are heard. The soundscape contains positive and negative elements together, and people have coping methods to deal with the soundscape elements that they find to be negative. For future studies, it was suggested to make interventions to the hospital soundscape to provide a positively perceived sound environment. Additionally, information about the sound sources in the context can be given, as people perceive the sounds more positively if they understand what they are. Also, the gender and age of the participant group should be considered in order to cover a large group of people.

Mackrill et al. (2013b) claimed to propose a perceptual model for the hospital soundscapes. A semantic scale was formed by listening to the sound environment of cardiothoracic hospital wards and ward corridors. A total of 18 participants were given a listening task with 19 sound clips from the ward soundscape, and they were expected to express their feelings on each clip. The 15 bipolar adjective pairs with a 7-point Likert scale were presented. After, other 30 participants were expected to evaluate these clips with the prepared semantic scale. Principal Component Analysis (PCA) was made to understand which semantics were useful for the scale. Then, a two-dimensional model consisting of emotion and cognition parameters was presented. The presented model provided testing soundscape interventions in hospital environments in order to reach positive perception.

Mackrill et al. (2014) explored the effects of positive soundscape interventions on the perception of the soundscape. A total of 24 participants evaluated 48 sound clips, each one 20 seconds. There were 12 clips; however, natural sound, steady-state sound, and written sound source intervention were applied to these clips as the positive interventions. Participants were given a questionnaire for each clip asking about their relaxation, interest, and understanding. Results showed that natural sound intervention was perceived as more relaxing than the others. Also, written sound source information was perceived as relaxing, which means that when participants understand the sound source, they perceive it more positively. For future studies, it was suggested to conduct the study in real hospital environments and with other patient groups as the interventions could affect them differently.

Watts et al. (2016) studied the effects of sound and visual environment on patients' anxiety and perceived tranquillity in a student health center waiting area. Sounds and images of nature, as sound and visual stimuli, were implemented in the waiting area to compare the effects of nature elements with the no stimuli condition. There were 14 people that were given 12 recordings of seascapes, and they evaluated each one from 0 to 10 according to the perceived tranquillity. The highest scored recording was chosen as the sound stimuli. Similarly, 20 images of seascapes and landscapes were given to 46 people, and the highest tranquillity scored image was chosen as the visual stimuli. There were 81 participants that experienced no stimuli condition, nature sound and visual stimuli condition, and again no stimuli condition. Participants filled out a questionnaire on anxiety levels and perceived tranquillity in each condition. Results showed that nature elements help patients increase perceived tranquillity; however, they do not significantly change anxiety levels. There is no variation among the three conditions in terms of anxiety levels.

Dalirnaghadeh and Yilmazer (2022) explored how sound affects getting information about a space. A video recording was made in the real polyclinic environment, and a virtual outpatient polyclinic environment was prepared. Different audio and visual elements were implemented on this simulated polyclinic. There were four groups: only visual, only audio, no audio nor visual, and audio-visual group. Visual signages and landmarks were put, and audio was added to the related groups. A total of 80 participants watched the video of the assigned virtual environment and evaluated it with a series of tasks. These tasks were landmark placement on a sketch, direction choosing at decision points, sketch mapping, and pointing tasks (Dalirnaghadeh & Yilmazer, 2022). The audio group and audio-visual group were also given ISO/TS 12913 Method A questionnaire. Results showed that only visual signages and landmarks do not improve spatial knowledge, but the audio should also be added to the environment for better performance. Dalirnaghadeh and Yilmazer (2022) explained that the audio-visual group was better than the other three groups in spatial knowledge acquisition.

The outcome of these studies showed that patients and staff in the hospital generally complain about the sound environment as there are many sounds derived from mechanical equipment, a wide range of services, and functional units in the hospital (Ryherd et al., 2011). Further, sounds derived from human activities have a significant contribution to the hospital soundscape (Mackrill et al., 2013a). However, decreasing the sound level was not enough for a positively experienced hospital soundscape (Mackrill et al., 2014). These studies on hospital soundscapes mainly used quantitative methods such as surveys and acoustic measurements to evaluate the hospital environment. However, a limited number of studies analyzed the sounds of a hospital environment with a qualitative method such as interviews (Mackrill et al., 2013a) and signal analysis with a spectrogram for the visualization of the sound environment (Aletta et al., 2017; Dalirnaghadeh & Yilmazer, 2022; Watts et al., 2016; Yilmazer & Uğurlu, 2022). Therefore, there is a need to gather qualitative data on hospital soundscapes in order to have a different perspective of the perception in hospital environments.

2.3. Audio-visual Perception

Similar to the acoustic environment, the visual environment is also one of the elements that help to evaluate a space. For a positively perceived acoustic and visual environment, the relationships between these environments should be considered. For example, the sense of sight or visual environment affects soundscape perception (Li & Lau, 2020; Liu, Kang, Luo, & Behm, 2013). Therefore, the sound and visual environments should be evaluated together because audio-visual components can improve the soundscape (Hong & Jeon, 2013). The space should be evaluated with audio and visual elements as they act together in people's perceptions. The research on audio-visual perception was generally held in urban environments (Liu et al., 2013; Zhao, Xu, & Ye, 2018; Annerstedt et al., 2013) and with listening tasks, photographs, pre-recorded videos, and virtual reality (VR) tools (Zhao et al., 2018; Annerstedt et al., 2013; Echevarria et al., 2017; Pheasant et al., 2015). The studies conducted in a real environment are limited.

This chapter examined the evaluation methods of soundscapes and the previous studies on soundscapes in the literature. This chapter also examined hospital soundscapes and audio-visual perception. The next chapter will explain the method of this research.

CHAPTER III

METHOD

This chapter examines the method of this research. It gives information on the design of the study and research questions and explains the site, participants, and acoustic and visual environments. This chapter also explains the data collection and analysis of quantitative and qualitative parameters of this research.

3.1. Design of the Study

This study analyzes the patients' perception of the audio-visual environment in an outpatient oncology polyclinic. The oncology polyclinic of Ankara City Hospital was chosen as it represents a sample plan type of a polyclinic environment of this hospital. Three areas from the polyclinic were compared, as these areas have some different auditory and visual characteristics. Quantitative and qualitative methods were used together to approach the audio-visual polyclinic environment comprehensively. Quantitative and qualitative methods supported each other to fully understand the relationship between the audio-visual environment and patients' perception of it. Qualitative research proceeded as oncology patients in the waiting areas such as the reception area, courtyard area, and corridor were interviewed. A conceptual framework for an outpatient polyclinic environment was formed via the Grounded Theory (GT) method. The quantitative research proceeded in parallel as patients were given a questionnaire, Equivalent Continuous A-weighted Sound Level (LAeq) measurements, and signal analyses (time histories and spectrograms of the sound environment were taken, and image analysis of the visual environment were made.

3.1.1. Research Questions

This study aims to answer the following questions:

1. How does the acoustic environment affect the patients’ perception in the outpatient oncology polyclinic?

2. How does the visual environment affect the patients’ perception in the outpatient oncology polyclinic?

3. What are the differences between the audio-visual environment and patients’ perception of the audio-visual environment?

3.2. Method

3.2.1. Site

The study is conducted in the oncology polyclinic of Ankara City Hospital. The hospital is located in Bilkent neighborhood, a district known for the Bilkent University. The hospital started to provide service in 2019. It consists of 8 building masses, each representing a different hospital unit: namely as, Cardiology, Pediatrics, General Hospital, Obstetrics and Gynecology, Neurology, Oncology, Main Building, and Physical Therapy and Rehabilitation (Figure 3 and Figure 4). The study is conducted in the oncology polyclinic because every polyclinic is located in a similar manner in the hospital, and oncology patients are one of the most sensitive patient groups in terms of physical and mental health. The wall material is white wall paint on concrete, the ceiling material is aluminum metal ceiling tiles, and the floor material is vinyl sheets. In this polyclinic, there is no medical equipment that produces alarm sounds. This equipment is located in a different area in the Oncology Hospital, and this selected area is only for waiting purposes.

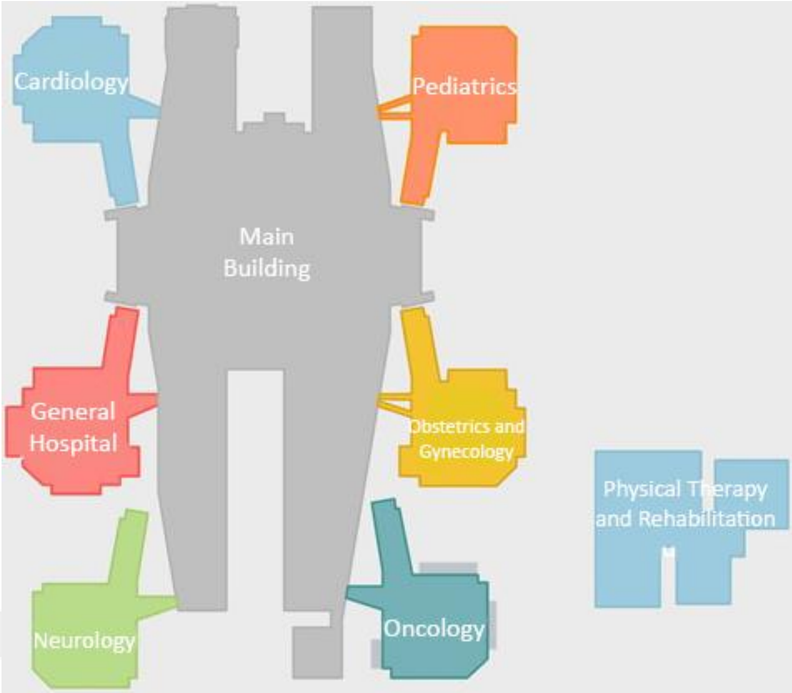

Figure 3. Oncology Polyclinic building area in Ankara City Hospital plan

Figure 4. Outside view of Ankara City Hospital by CCN Group (2020)

The polyclinic is on the second underground floor of the Oncology building. There are 10 medical oncology examination rooms, three algology examination rooms, and three geriatrics examination rooms in the polyclinic (Figure 5). In the areas shown as A, B, and C, oncology patients were the majority. A is the reception area, B is the courtyard area, and C is the corridor. The reception area and the courtyard area are 92 m² separately, and the corridor is 52 m². Although these three areas are in the same space, some aspects make these areas differ from each other in terms of their auditory and visual content.

Figure 5. Ankara City Hospital Outpatient Oncology Polyclinic plan

3.2.2. Participants

The participants were selected by convenience sampling. A total of 66 voluntary oncology polyclinic outpatients waiting in the polyclinic area participated in the study. Among the participants, 31 male and 35 female, age distribution has a range from 25 to 80 (μ age = 54.86; SD age = 11.88 years), filled out the questionnaire. Among 66 outpatients, 21 patients were waiting in the reception area (11 male, 10 female), 24 patients were in the courtyard area (11 male, 13 female), and 21 patients were in the corridor (9 male, 12 female) (Table 1).

Table 1. Gender distribution of the participants in the reception area, courtyard area, and corridor

	Male	**Female**	**Total**
Reception Area	11	10	21
Courtyard Area	11	13	24
Corridor	9	12	21
Total	31	35	66

The 20 of the 66 outpatients also participated in the semi-structured interview. There were 10 male and 10 female, age distribution ranging from 25 to 79 (μ age = 53.20; SD age = 13.45 years), answered the interview questions. The 7 of these patients were waiting in the reception area, 8 of them were in the courtyard area, and 5 of them were in the corridor.

These patients' time of diagnosis varied from no diagnosis had been made yet to 15 years ago. Patients' frequency of visits changed from once in six months to three times a week. Patients' familiarity with this oncology polyclinic changed from the ones who are coming for the first time to the polyclinic to the ones coming from the beginning of the hospital opening, which was three years.

3.2.3. Acoustic Environment

Unlike other polyclinic environments, there is no medical equipment in this polyclinic. Thus, there are not many alarm sounds and device sounds produced by the mechanical equipment. The overall polyclinic was expected to be quiet as the oncology patients are tired because of the chemotherapy treatment. However, it was noisy and the sound levels were high. The primary sound sources in the three areas were coming from human-based activities, such as speech, coughing, footsteps, and rattling. All the sound sources included heating-ventilating-air-conditioning (HVAC) sound, beeping (coming from printers, computers, device for taking a turn in the queue), telephone ringing, unintelligible and intelligible speech of both male and female, coughing, footsteps, door closing, knocking, squeaking, rustling, rattling, clunking.

Additionally, the sound of a cleaning machine was heard occasionally. The speech and footsteps of other units' patients, doctors, and nurses passing by the oncology polyclinic were added to the sound environment. The corridor was expected to be quieter than the reception area and courtyard area as there is less floor area for the patients in the corridor. Additionally, ISO/TS 12913-2 categorizes the sound sources as "sounds of technology," "sounds of nature," and "sounds of human beings" (2018, p. 14). Therefore, all the sound sources in these three areas are listed according to this categorization in Table 2.

Table 2. Sound sources in the three areas of the oncology polyclinic

Sound sources	Reception area	Courtyard area	Corridor
Sounds of technology	HVAC, beeping (printers, computers, device for taking a turn in the queue), telephone ringing	HVAC, beeping (printers, computers), telephone ringing	HVAC, telephone ringing
Sounds of nature	-	-	-
Sounds of human beings	Unintelligible speech (F/M), intelligible speech (F/M), coughing, footsteps, door closing, knocking, squeaking, rustling	Unintelligible speech (F/M), intelligible speech (F/M), coughing, footsteps, door closing, rattling, clunking	Unintelligible speech (F/M), intelligible speech (F/M), coughing, footsteps, door closing, rattling

3.2.4. Visual Environment

The oncology polyclinic has three adjacent spaces that have different visual characteristics. The reception area has an indoor opening as the area for receptionists and has sitting units for patients waiting (Figure 6). There are paintings hanging on the walls made by the patients taking chemotherapy, and technological devices such as computers, printers, screens and device for taking a turn in the queue. The courtyard area has both an indoor opening as the area for the secretary and an outdoor opening as the courtyard that has a garden and has sitting units for patients waiting (Figure 7). Similar to the reception area, there are paintings hanging on the walls, and technological devices such as computers, printers, and screens. Corridor has no opening but only has sitting units for waiting patients (Figure 8). There are only screens mounted above the examination room doors as technological devices.

Figure 6. 360° photograph of the reception area

Figure 7. 360° photograph of the courtyard area

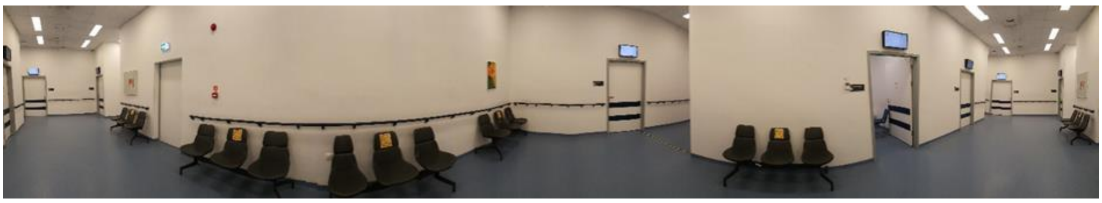

Figure 8. 360° photograph of the corridor

3.2.5. Data Collection and Analysis of Quantitative and Qualitative Parameters

This research, numbered E2-21-1086, is ethically approved by Ankara City Hospital Ethics Committee (Appendix B). The research examined the outpatients' perceptions quantitatively and qualitatively to evaluate the sound and visual environment in the oncology polyclinic. For the quantitative measurements, Equivalent Continuous A-Weighted Sound Level (LAeq) measurements, binaural audio recordings, and 360° photographs of the three areas were taken. After, the ISO12913-2 Method A questionnaire, with the addition of three questions about the visual environment, was conducted. For the qualitative measurements, semi-structured interviews were done with outpatients through the Grounded Theory approach, and eight main questions were asked. The interviews and the questionnaire are held in Turkish. The procedure of the study can be seen in Figure 9.

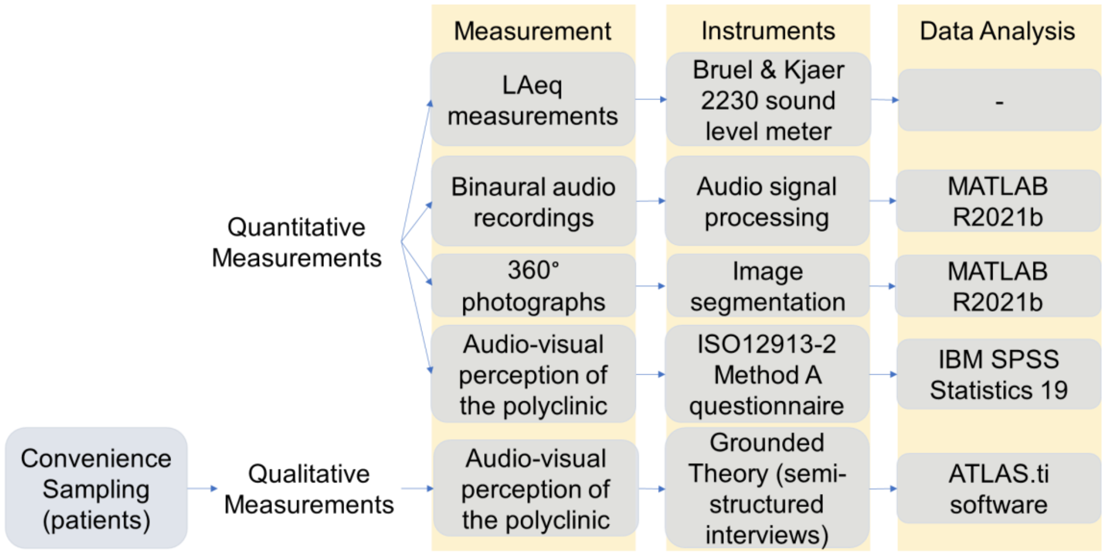

Figure 9. The procedure of the study

3.2.5.1. Equivalent Continuous A-Weighted Sound Level (LAeq) Measurements

Equivalent Continuous A-Weighted Sound Level is a physical parameter of the acoustic environment, as also defined by ISO/TS 12913-2 (2018). The LAeq measurements were taken on Thursday, 27th of January 2022, during the interview hours, between 9.00 a.m. and 12.00 a.m. These hours were selected because it was the most crowded time of the polyclinic as patients come and get in the queue and wait for their turn in the polyclinic. Afternoon hours were not selected because the same patients in the polyclinic had been waiting since morning. The measurements were made in 1-hour intervals as the sound sources were not significantly changing throughout the day. The mean values of the measurements were evaluated. The weather was cold, partly cloudy, and the temperature was 1 C°. There was no sound neither coming from outdoors nor caused by weather conditions. Equivalent Continuous A-Weighted Sound Level (LAeq) measurements were taken with a sound level meter Brüel & Kjær Hand-held Analyzer Type 2230 in the reception area, courtyard area, and corridor. It was placed at 150 cm height and in the middle of the spaces as ISO/TS 12913-3 suggested (Figure 5).

3.2.5.2. Signal Processing and Image Analysis

Binaural audio recordings were taken from the reception area, courtyard area, and corridor with a binaural microphone to capture the acoustic environment for further analysis. These binaural audio recordings were visualized through signal processing in MATLAB R2021b. The 30-second sound clips, which represent each sound environment (reception area, courtyard area, and corridor) the best, were identified from each recording. Signal processing of the audio recordings of three areas was made as time histories and spectrograms were obtained. Time histories show the changes in the amplitude of sound in the time domain. Spectrograms show the changes in both frequency and amplitude in the time domain. The peak points in spectrograms were analyzed, and each was labeled with the corresponding sound source in the 30-second clip.

Also, 360° photographs of three areas were taken to capture the visual environment and make a further analysis. The differences among the reception area, courtyard area, and corridor were analyzed via MATLAB R2021b. Image analysis of these photographs was made with segmentation, and percentages of wall surfaces and different openings were obtained. The Image Segmenter app in MATLAB R2021b was used for the reception area and the corridor. For the courtyard area, the Color Thresholder app in MATLAB R2021b was used as the green areas in the courtyard area can be better distinguished with this app. These apps provide transforming the images into black and white binary images. Thus, percentages of the white or black area are obtained from these segmented new images.

3.2.5.3. Questionnaire Survey

Before handing out the questionnaire, it was asked if the patient had any known hearing loss. The ones that specified any hearing loss were not given the questionnaire. At the beginning of the questionnaire, participants were shortly informed about the research. They were informed that their identity will not be asked, the data will be used for scientific purposes only, and participation is entirely voluntary. At last, a contact e-mail was given if they had any further questions.

The questionnaire survey has two main sections: personal information and survey. In the personal information section, the patient's age, gender, time of diagnosis, and frequency of visit were asked. In the survey section, ISO/TS 12913-2 Method A questionnaire was used. The survey section consisted of seven parts; sound source identification, perceived affective quality, assessment of the surrounding sound environment, appropriateness of the surrounding sound environment, assessment of the surrounding visual environment, appropriateness of the surrounding visual environment, and assessment of the surrounding audio-visual environment. The last stated three parts were added to the ISO12913-2 Method A questionnaire to evaluate the visual environment perception. Questions in the survey section have five-point Likert scales to evaluate patients' perceptions. The questionnaire was in Turkish (Appendix C), as the previous soundscape studies (Acun & Yilmazer, 2019; Orhan & Yilmazer, 2021) used the Turkish version for the Turkish participants. The English version of the questionnaire is in Appendix D. The patients waiting in the reception area, courtyard area, and corridor were chosen according to the convenience sampling. A total of 66 voluntary outpatients filled out the questionnaire. The collected data were analyzed through IBM SPSS Statistics software. The correlations between survey questions were analyzed with Spearman's rho correlation test, and three areas (reception area, courtyard area, corridor) were compared with a one-way ANOVA test.

3.2.5.4. Grounded Theory

ISO/TS 12913-2 Method C was the semi-structured interview. Semi-structured interviews were conducted to reveal outpatients' perceptions of the oncology polyclinic's sound and visual environments. The interview was formed of eight main questions that examine the perception of sound and visual environments (Table 3). Three questions were about the sound environment perception, the next three were about visual environment perception, and the remaining two questions were more general. These questions gave rise to other questions according to the course of the conversation, and patients also expressed their opinions in areas outside the scope of the main questions. Before starting the interview, it was asked if the patient had any known hearing loss. The ones that specified any hearing loss were not interviewed.

Table 3. The eight main questions prepared for the semi-structured interview

1. What do you hear?
2. What do you want to hear?
3. What do you expect to hear?
4. What do you see?
5. What do you want to see?
6. What do you expect to see?
7. How do you cope with an auditory or a visual factor that you do not like?
8. How do you feel in this environment?

The interviews were conducted with 20 outpatients waiting in the oncology polyclinic who also took part in the questionnaire survey. Seven of them were from the reception area, eight were from the courtyard area, and five were from the corridor. An audio recording was started as the interview content was explained to the patients. Each interview took approximately 8-20 minutes. The interviews were finalized when the collected data reached the theoretical saturation, as the Grounded Theory approach suggested (Strauss, 2010). It means that when patients' answers were getting similar, the data collection stopped. The recorded audio files have been transcribed, and the coding process began. The data was entered into a Microsoft Word file, and its content was copied to ATLAS.ti software for the coding process. ATLAS.ti software is a qualitative data analysis program that helps to code a large amount of data faster (ATLAS.ti, n.d.).

The Grounded Theory has three main coding steps: open coding, axial coding, and selective coding (Strauss, 2010). For the open coding, key ideas were identified from the raw data. After, these key ideas were grouped under categories for the axial coding. Lastly, for the selective coding, subcategories and main categories were formed. Then, relationships between these categories were formed. After, a core category was chosen, and its relationship with other categories was finalized. At last, audio and visual aspects of the polyclinic environment were generated, and a conceptual framework was formed.

This chapter examined the method of the research. It explained the site of the study, participant group, acoustic and visual environments, and data collection and analysis methods. The next chapter will examine the results of this research.

CHAPTER IV

RESULTS

This chapter examines the results of this research. It gives information on quantitative analyses’ results as sound level measurements, signal processing and image analysis, and questionnaire survey. It also provides information on qualitative analyses’ results as semi-structured interviews.

4.1. Equivalent Continuous A-Weighted Sound Level (LAeq) Results

The average Equivalent Continuous A-Weighted Sound Level (μLAeq) was 66.7 dB in the reception area, 64.2 dB in the courtyard area, and 60.2 dB in the corridor during the interview hours. The difference was as expected because there were fewer people in the corridor. LAeq measurements in the three areas were high for a polyclinic space.

4.2. Signal Processing and Image Analysis Results

Binaural audio recordings of the three areas (reception area, courtyard area, and corridor), which were cut to 30-second sound clips, were visualized through signal processing in MATLAB R2021b. First, the time histories of the three areas, reception area (Figure 10), courtyard area (Figure 11), and corridor (Figure 12), were taken. Time histories display amplitude changes in the time domain. In order to compare the three areas, the amplitude range was defined as -1 to 1 as the corridor's was the same. The range for the reception area was -0.5 to 0.5, for the courtyard area -1 to 1, and for the corridor -0.2 to 0.2. The reception area has the highest amplitude among the three areas. The courtyard area has slightly less amplitude than the reception area but has a peak sound around the 10th second. The corridor has the lowest amplitude among the three areas.

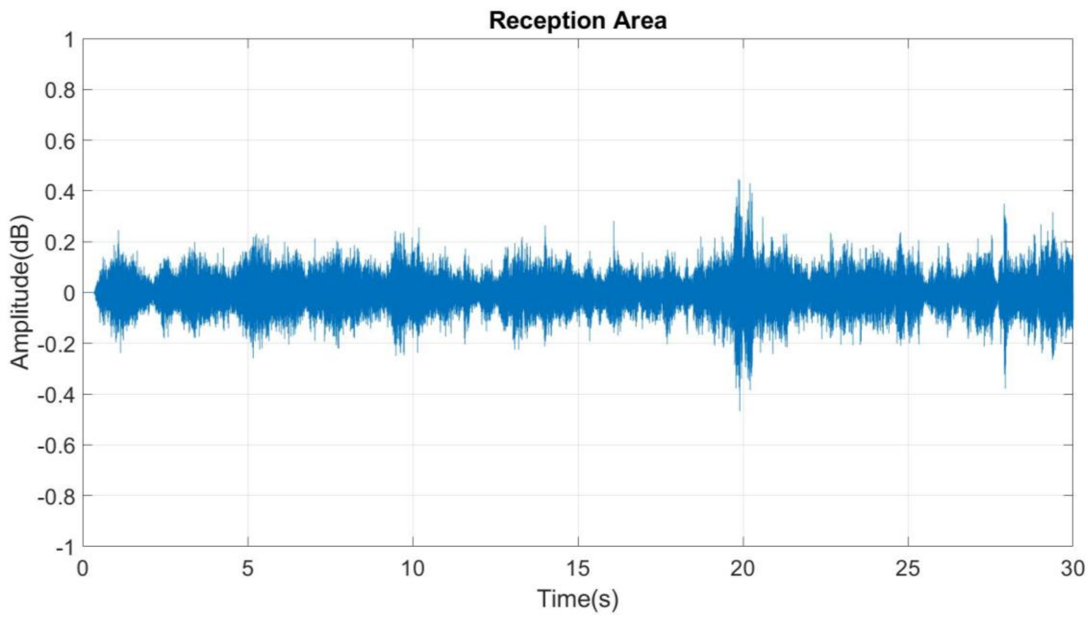

Figure 10. Time history of the reception area

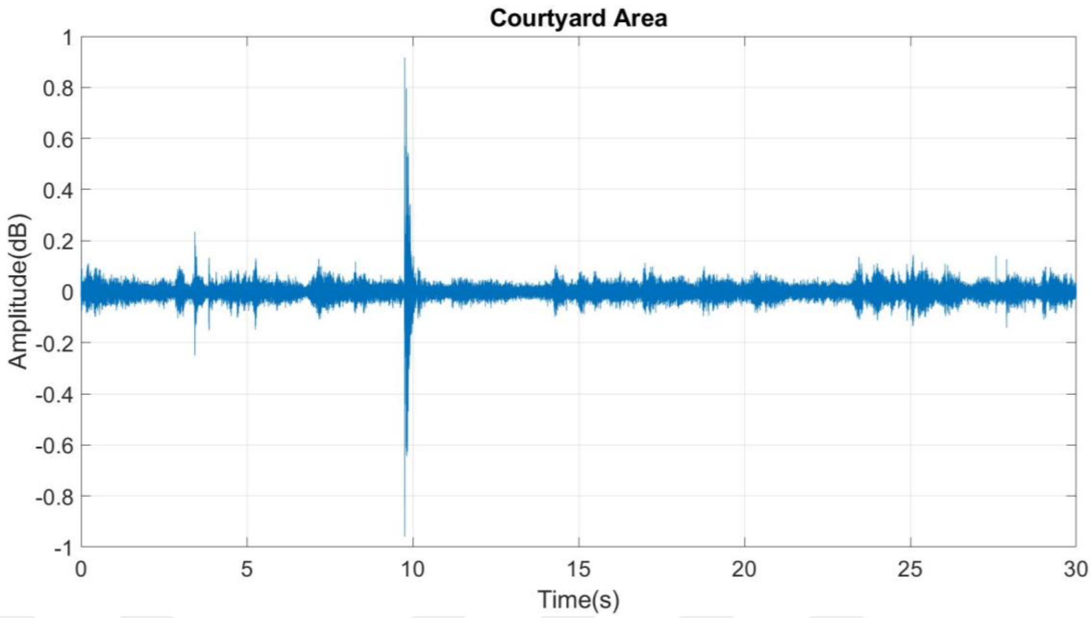

Figure 11. Time history of the courtyard area

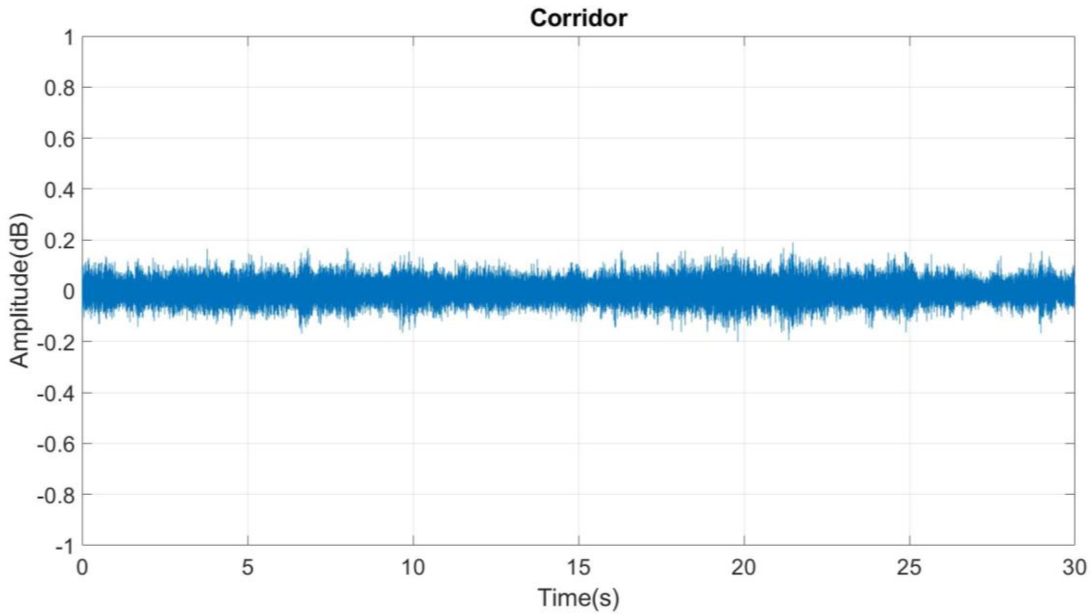

Figure 12. Time history of the corridor

After, spectrograms of the three areas were taken to fully understand how amplitude and frequency behave in the time domain (Figure 13). In order to compare the three areas and focus on the higher amplitudes in the recordings, the frequency range for the three areas was defined as 0 to 5 kHz. Many different sounds can be distinguished in these visualizations of the sound environment of the three areas. In all three areas, speech can be clearly heard and seen in spectrograms. Telephone rings, rustling, and coughing can be distinguished visually in the reception area (Figure 14). In the courtyard area (Figure 15), rattling and door closing can be distinguished. In the corridor (Figure 16), rattling and footsteps along with the HVAC sound as the background sound can be distinguished.

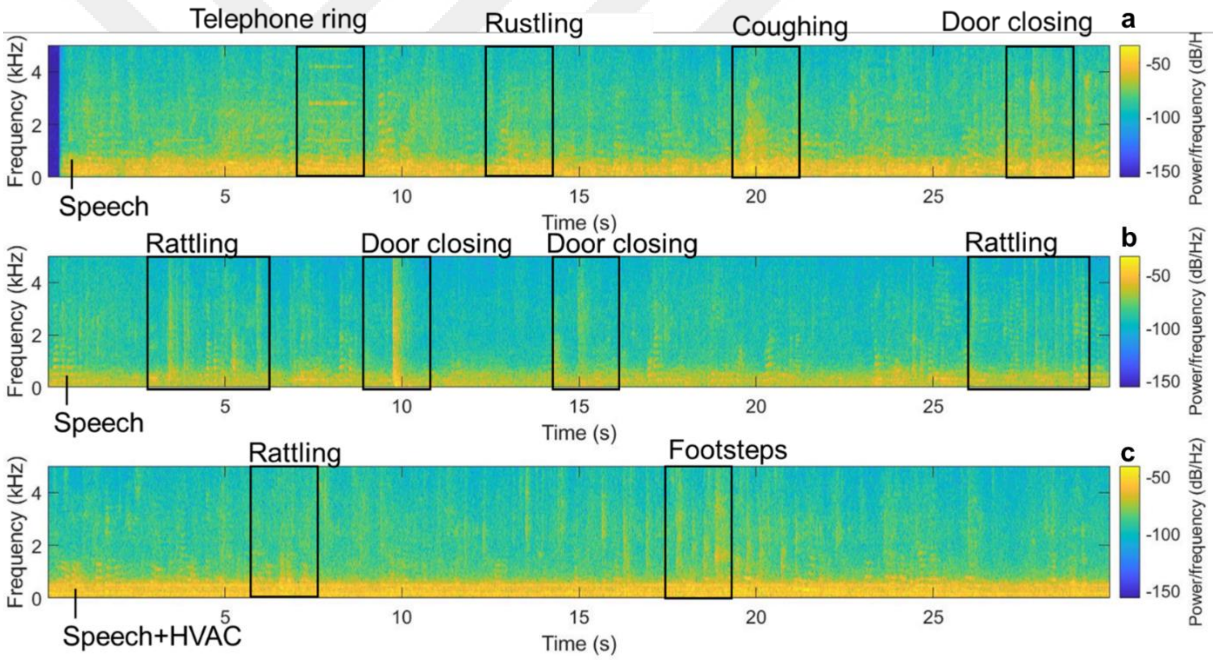

Figure 13. Spectrograms of a. reception area, b. courtyard area, and c. corridor

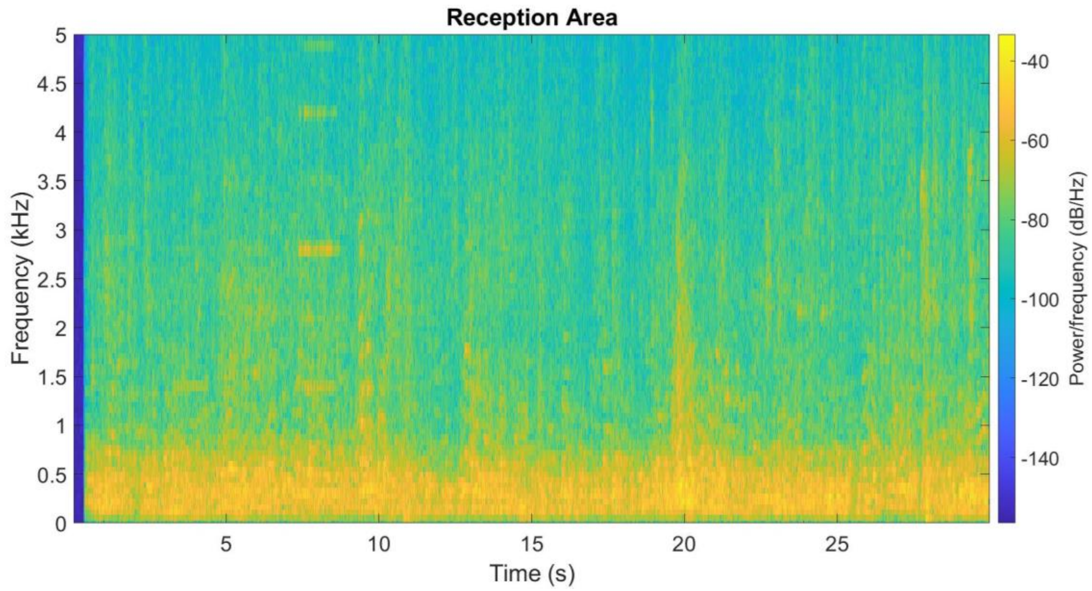

Figure 14. Spectrogram of the reception area

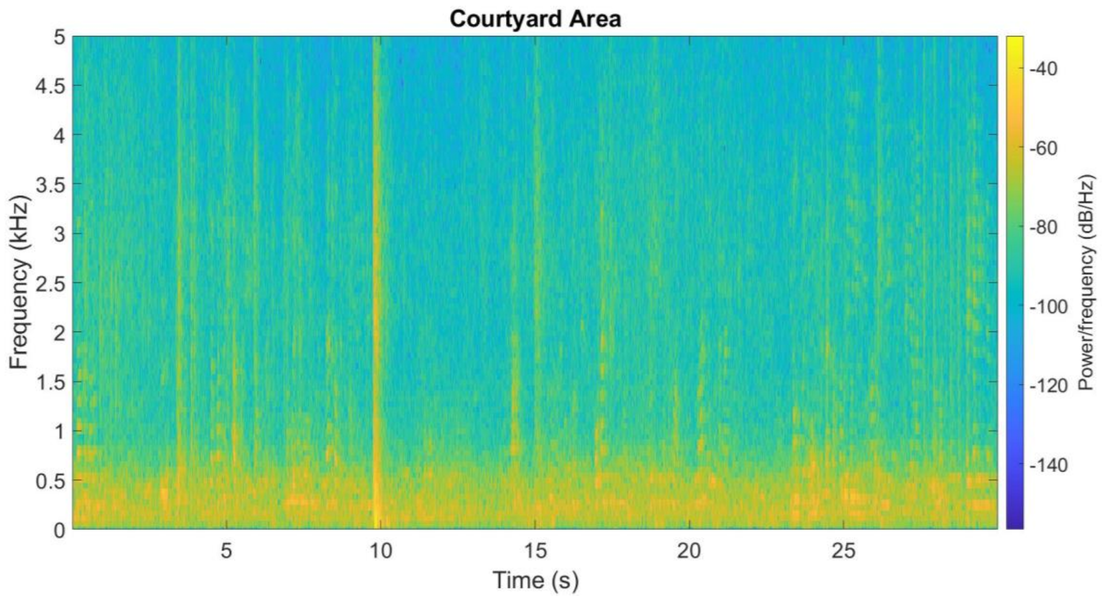

Figure 15. Spectrogram of the courtyard area

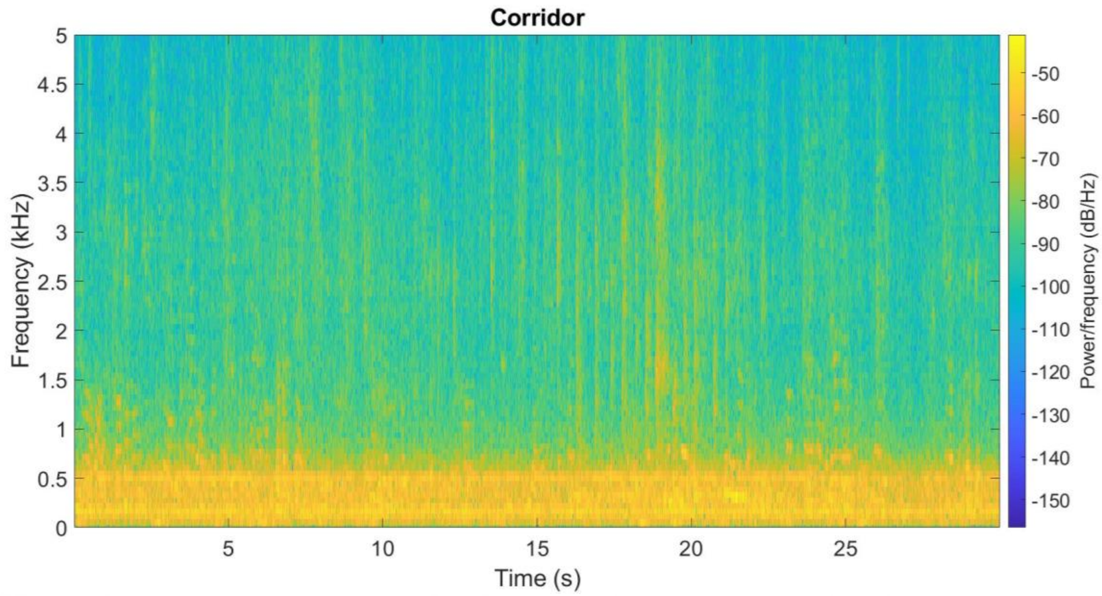

Figure 16. Spectrogram of the corridor

The Image Segmenter and Color Thresholder apps in MATLAB R2021b were used for image analysis with segmentation. For the reception area and the corridor, Image Segmenter was used. For the courtyard area, Color Thresholder was used because distinguishing the green areas in the garden was more manageable with this app. Each image was transformed into a black and white binary image with these two apps. The new segmented images were used to obtain percentages of the white areas in the total image.

Firstly, the wall-to-total area percentages were compared in three areas. According to the results, the reception area's (Figure 17) wall area was 39% of its total area, the courtyard area's (Figure 18) wall area was 40% of its total area, and the corridor's (Figure 19) wall area was 63% of its total area. Then, percentages of the reception area's indoor opening and courtyard area's outdoor opening to their total areas were obtained as these are the distinguished elements of these two areas. The reception area's indoor opening was with the reception desk and covered 5% of the visual environment of the reception area. The courtyard area's outdoor opening led to a garden and covered 14% of the visual environment of the courtyard area.

Figure 17. Image analysis of the reception area

Figure 18. Image analysis of the courtyard area

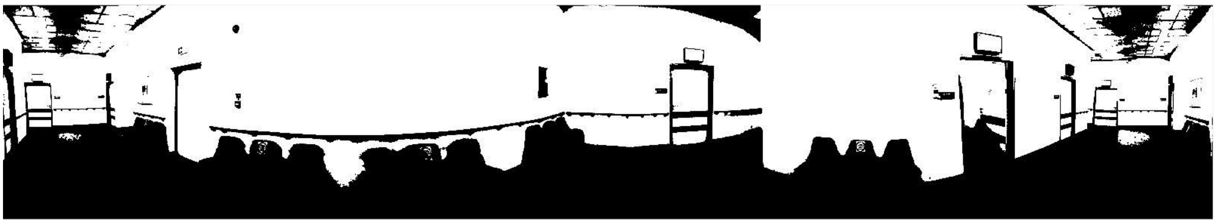

Figure 19. Image analysis of the corridor

4.3. Questionnaire Survey Results

The questionnaire was conducted with 66 voluntary outpatients in the reception area (n=21), courtyard area (n=24), and corridor (n=21) of the oncology polyclinic. The results were analyzed with IBM SPSS Statistics software. Reliability of the questionnaire, Spearman's rho correlation, and one-way ANOVA test were conducted. Bar charts were obtained for the assessment and appropriateness of the sound and visual environment. The reliability of the questionnaire was obtained with Cronbach's alpha value. The value was 0.794, which means the questionnaire is reliable as the value is higher than 0.70.

4.3.1. Spearman’s Rho Correlation Test

There were some correlations between survey questions according to Spearman's rho correlation test results. The test was conducted at %95 and %99 significance levels at 2-tailed. There were significant correlations with assessment of surrounding sound environment in the reception area, courtyard area, and corridor. In the reception area, there is a positive significant correlation with moderate relationships in calm ($r_s=0.669$, $p=0.001$), appropriateness of surrounding sound environment ($r_s=0.677$, $p=0.001$), and appropriateness of surrounding visual environment ($r_s=0.599$, $p=0.004$). There is a positive significant correlation with strong relationships in pleasant ($r_s=0.785$, $p=0.0001$) and assessment of surrounding visual environment ($r_s=0.806$, $p=0.0001$). Also, there is a negative significant correlation with moderate relationship in annoying ($r_s=-0.598$, $p=0.004$). The negative correlation shows that when patients’ assessments of surrounding sound environment were less positive, they found the space to be more annoying. In the courtyard area, there is a positive significant correlation with moderate relationships in assessment of surrounding visual environment (rs=0.454, p=0.034), assessment of surrounding audio-visual environment (rs=0.460, p=0.031), appropriateness of surrounding sound environment (rs=0.613, p=0.001), and there is a negative significant correlation with moderate relationships in technological device sound (rs=-0.650, p=0.001), human sounds (rs=-0.588, p=0.002), and annoying (rs=-0.515, p=0.014). In the corridor, there is a positive significant correlation with moderate relationships in calm (rs=0.594, p=0.005), pleasant (rs=0.523, p=0.015), assessment of surrounding visual environment (rs=0.648, p=0.007), appropriateness of surrounding visual environment (rs=0.617, p=0.011). There is a positive significant correlation with strong relationship in appropriateness of surrounding sound environment (rs=0.809, p=0.0001). Also, there is a negative significant correlation with moderate relationships in technological device sound (rs=-0.500, p=0.021) and human sounds (rs=-0.625, p=0.002), and with a strong relationship in annoying (rs=-0.824, p=0.0001). The significant correlations for *assessment of surrounding sound environment* are shown in Table 4.

There were significant correlations with assessment of surrounding visual environment in the reception area and courtyard area. In both the reception area and courtyard area, there is a positive significant correlation with moderate relationships in assessment of surrounding audio-visual environment (Reception rs=0.482, p=0.027; Courtyard rs=0.576, p=0.005), appropriateness of surrounding sound environment (Reception rs=0.540, p=0.011; Courtyard rs=0.607, p=0.003), and with strong relationships in appropriateness of surrounding visual environment (Reception rs=0.709, p=0.0001; Courtyard rs=0.724, p=0.0001). In the corridor, there is positive significant correlation with moderate relationship in appropriateness of surrounding sound environment (rs=0.501, p=0.048). The significant correlations for *assessment of surrounding visual environment* are shown in Table 5.

Table 4

Items that have significant correlations with *Assessment of surrounding sound environment*

Items	Reception area			Courtyard area			Corridor		
	rs	p	n	rs	p	n	rs	p	n
Technological device sound	0.235	0.306	21	**-0.650**	0.001	24	**-0.500**	0.021	21
Human sounds	-0.024	0.919	21	**-0.588**	0.002	24	**-0.625**	0.002	21
Calm	**0.669**	0.001	21	0.352	0.092	24	**0.594**	0.005	21
Pleasant	**0.785**	0.0001	21	0.410	0.052	23	**0.523**	0.015	21
Annoying	**-0.598**	0.004	21	**-0.515**	0.014	22	**-0.824**	0.0001	21
Assessment of surrounding visual environment	**0.806**	0.0001	21	**0.454**	0.034	22	**0.648**	0.007	16
Assessment of surrounding audio-visual environment	0.322	0.155	21	**0.460**	0.031	22	0.440	0.088	16
Appropriateness of surrounding sound environment	**0.677**	0.001	21	**0.613**	0.001	24	**0.809**	0.0001	21
Appropriateness of surrounding visual environment	**0.599**	0.004	21	0.316	0.151	22	**0.617**	0.011	16

Table 5

Items that have significant correlations with *Assessment of surrounding visual environment*

Items	Reception area			Courtyard area			Corridor		
	rs	p	n	rs	p	n	rs	p	n
Assessment of surrounding audio-visual environment	**0.482**	0.027	21	**0.576**	0.005	22	0.459	0.074	16
Appropriateness of surrounding sound environment	**0.540**	0.011	21	**0.607**	0.003	22	**0.501**	0.048	16
Appropriateness of surrounding visual environment	**0.709**	0.0001	21	**0.724**	0.0001	22	0.444	0.085	16

There were significant correlations with appropriateness of surrounding sound environment in the reception area, courtyard area, and corridor. In the reception area, there is a positive significant correlation with strong relationship in pleasant (rs=0.727, p=0.0001), and with a moderate relationship in calm (rs=0.580, p=0.006) and appropriateness of surrounding visual environment (rs=0.643, p=0.002). In the courtyard area, there is a positive significant correlation with moderate relationship in appropriateness of surrounding visual environment (rs=0.623, p=0.002). In the corridor, there is a positive significant correlation with moderate relationships in pleasant (rs=0.526, p=0.014), calm (rs=0.545, p=0.011), and appropriateness of surrounding visual environment (rs=0.632, p=0.009). Also, there is a negative significant correlation with moderate relationships in technological device sound (rs=-0.573, p=0.007) and human sounds (rs=-0.665, p=0.001). The significant correlations for *appropriateness of surrounding sound environment* are shown in Table 6.

Table 6

Items that have significant correlations with *Appropriateness of surrounding sound environment*

Items	Reception area			Courtyard area			Corridor		
	rs	p	n	rs	p	n	rs	p	n
Technological device sound	0.008	0.974	21	-0.383	0.064	24	**-0.573**	0.007	21
Human sounds	-0.365	0.104	21	-0.277	0.189	24	**-0.665**	0.001	21
Pleasant	**0.727**	0.0001	21	0.232	0.288	23	**0.526**	0.014	21
Calm	**0.580**	0.006	21	0.178	0.404	24	**0.545**	0.011	21
Appropriateness of surrounding visual environment	**0.643**	0.002	21	**0.623**	0.002	22	**0.632**	0.009	16

4.3.2. One-way ANOVA Test

To compare the three areas (reception area, courtyard area, corridor), a one-way ANOVA test was used with the post-hoc Scheffe test. One-way ANOVA test showed if there are any differences between the areas. Post-Hoc Scheffe test showed which area is different from the others. The results showed that there is a significant difference in *technological device sound* ($F(2)=4.08$, $p=0.022$), *pleasant* ($F(2)=3.26$, $p=0.045$), *calm* ($F(2)=4.31$, $p=0.018$), and *annoying* ($F(2)=5.85$, $p=0.005$) in three areas (Table 7). The significant difference in *pleasant*, *calm*, and *annoying* can be seen in the radar chart showing the perceived affective quality in three areas (Figure 20). The corridor was perceived as there was more technological device sound than the reception area and courtyard area. The courtyard area was perceived as more pleasant and calmer than the reception area and corridor. The reception area was perceived as more annoying than the courtyard area and corridor. *Uneventful* ($p=0.582$), *monotonous* ($p=0.169$), *chaotic* ($p=0.101$), *eventful* ($p=0.666$), and *vibrant* ($p=0.333$) had similar results in three areas. Additionally, in all three areas, patients found the polyclinic eventful rather than uneventful because eventful in the Turkish version of the questionnaire has meanings of moving and active. Similarly, they found the polyclinic monotonous rather than vibrant because vibrant in the Turkish version of the questionnaire has the meaning of exciting.

Table 7. Items that have significant differences among the reception area, courtyard area, and corridor

Items	df	F	p	Areas	Mean	n
Technological device sound	2	4.076	0.022	Reception area	1.95	21
				Courtyard area	1.63	24
				Corridor	2.38	21
Pleasant	2	3.263	0.045	Reception area	2.76	21
				Courtyard area	3.43	23
				Corridor	3.10	21
Calm	2	4.308	0.018	Reception area	2.86	21
				Courtyard area	3.88	24
				Corridor	3.14	21
Annoying	2	5.847	0.005	Reception area	3.19	21
				Courtyard area	2.09	22
				Corridor	2.86	21

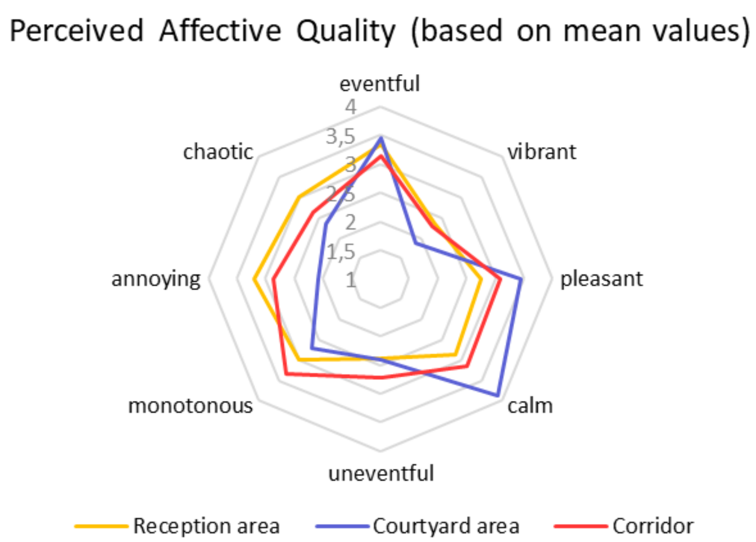

Figure 20. Perceived affective quality based on mean values

4.3.3. Assessment and Appropriateness of Surrounding Sound and Visual Environments

Even though one-way ANOVA results did not show any significant differences between the three areas, there are still small differences among them in terms of assessment and appropriateness of surrounding sound and visual environments. Assessments of the surrounding sound, visual, and audio-visual environments are shown in Figure 21, Figure 22, and Figure 23. The majority of the patients in the courtyard area rated the sound environment as *good*, while the patients in the reception area rated it between *bad* and *neither good nor bad*, and the patients in the corridor rated it between *neither good nor bad* and *good*.

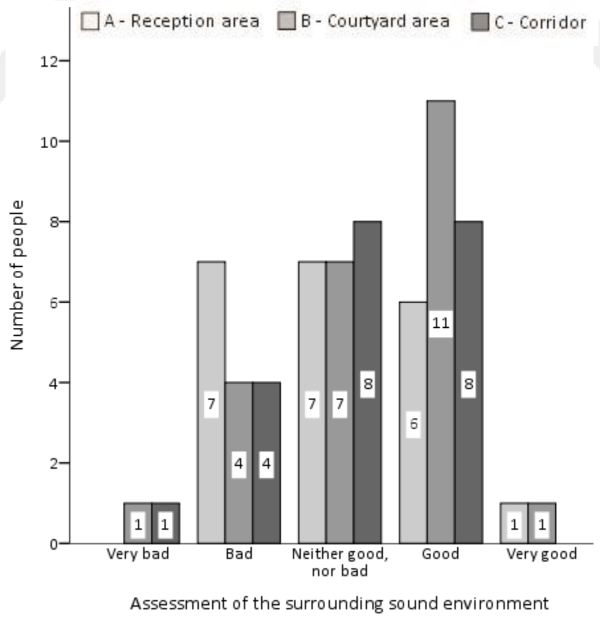

Figure 21. Assessment of the surrounding sound environment in three areas

The majority of the patients in the courtyard area and corridor rated the visual environment as *good*, while the patients in the reception area rated it between *bad* and *good*.

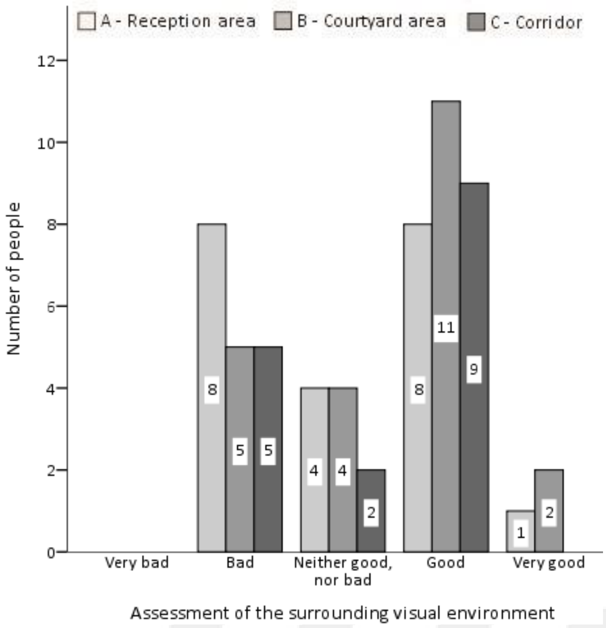

Figure 22. Assessment of the surrounding visual environment in three areas

The majority of the patients in the three areas rated the audio-visual environment as *good*.

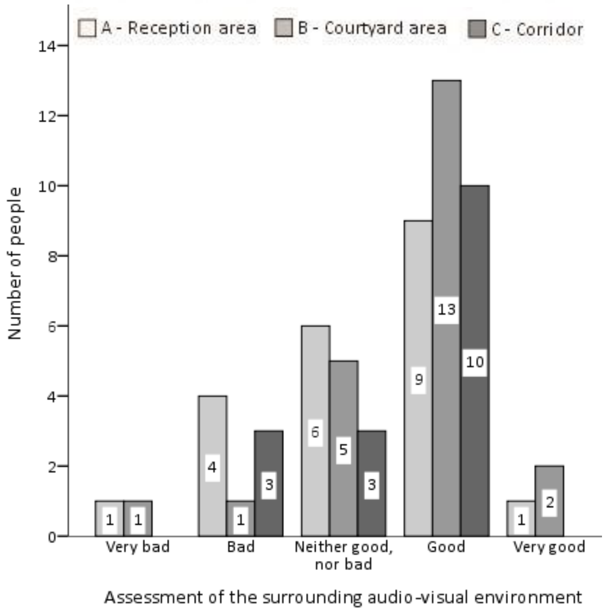

Figure 23. Assessment of the surrounding audio-visual environment in three areas

Appropriateness of the surrounding sound and visual environments are also shown in Figure 24 and Figure 25. The majority of the patients in the courtyard area rated the appropriateness of the sound environment as *slightly*, while the patients in the reception area rated it *moderately*, and the patients in the corridor rated it between *slightly* and *moderately*.

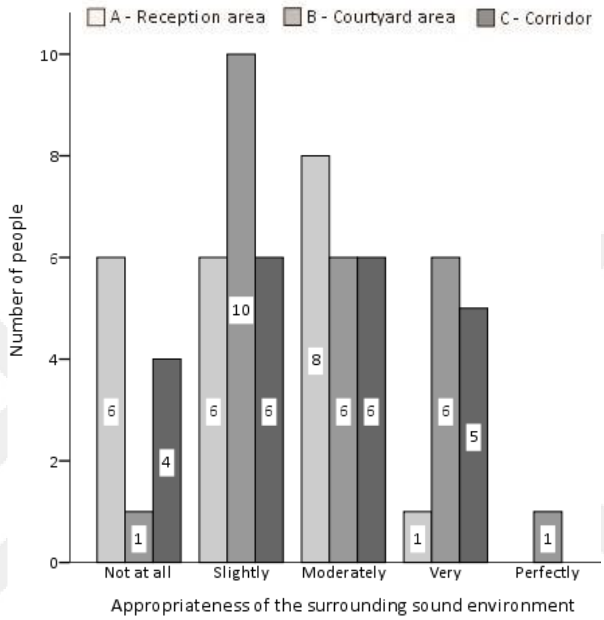

Figure 24. Appropriateness of the surrounding sound environment in three areas

The majority of the patients in the courtyard area rated the appropriateness of the visual environment between *slightly* and *very*, while the patients in the reception area and corridor rated it *moderately*. All the mean values of the items are shown in Table 8.

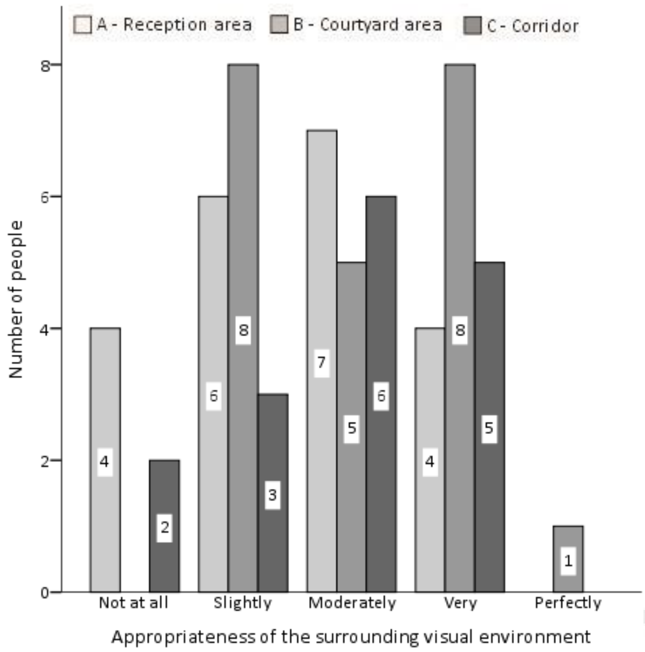

Figure 25. Appropriateness of the surrounding visual environment in three areas

Table 8. Mean values of items in three areas

Items	Reception area	Courtyard area	Corridor	Total
Assessment of surrounding sound environment	3.05	3.29	3.10	3.15
Assessment of surrounding visual environment	3.10	3.45	3.25	3.27
Assessment of surrounding audio-visual environment	3.24	3.64	3.44	3.44
Appropriateness of surrounding sound environment	2.19	2.83	2.57	2.53
Appropriateness of surrounding visual environment	2.52	3.09	2.88	2.83

4.4. Semi-structured Interview (Grounded Theory) Results

Semi-structured interviews were examined through Grounded Theory analysis in ATLAS.ti software. The data obtained as the output is shown in a conceptual framework (Figure 26). This conceptual framework revealed the audio-visual evaluation of the outpatient polyclinic environment by patients visiting the place with a specific frequency. Therefore, semi-structured interviews were conducted to learn the honest thoughts of the outpatients about the place by asking questions without creating any bias. The conceptual framework is created as the result of the coding process. The coding process has three steps: open coding, axial coding, and selective coding, respectively.

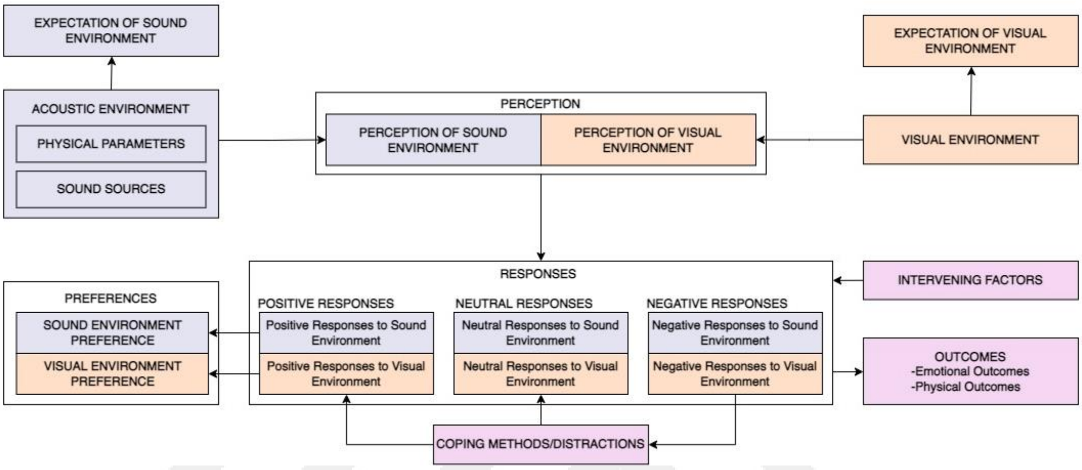

Figure 26. A summary of the conceptual framework

The interviews were analyzed by examining each sentence and coding them in ATLAS.ti software. Key phrases were extracted from every sentence, and related phrases were matched and categorized. For example, 'calm' and 'spacious' were the positive evaluations of the visual environment and categorized under 'Positive Responses to Visual Environment.' Further, positive evaluations of the sound and visual environments were grouped as the answers were related. Also, neutral evaluations of sound and visual environments were grouped. Similarly, negative evaluations of sound and visual environment were grouped. These created the subcategories of 'Positive Responses,' 'Neutral Responses,' and 'Negative Responses.' They were put under the main category of 'Responses.' After all the main categories and subcategories were identified, all these were found to be related to the core category of 'Responses.' The relationship between the core category, main categories, and subcategories was identified. Finally, these findings were visualized in a diagram of a conceptual framework revealing the audio-visual perception of the outpatients in the polyclinic environment. Items in the conceptual framework were ordered according to the frequency of their utterance.

The conceptual framework is separated into categories related to the acoustic environment, visual environment, and categories related to both acoustic and visual environments. The analysis revealed that the acoustic environment affects the expectation and perception of the sound environment. Similarly, the visual environment affects the expectation and perception of the visual environment. As the sound environment and visual environment are perceived together in the space, the perception of both sound and visual environment affects patients' responses. Also, other intervening factors affect the responses. The coping methods can transform the negative responses into neutral and positive responses. Additionally, positive responses identify the preferences. All these responses have outcomes for patients. Lastly, many patients evaluated the polyclinic in general in the three areas (reception area, courtyard area, corridor) specified in the polyclinic. Therefore, the framework did not show these three areas separately. The framework had 10 main categories and 12 subcategories. The detailed framework is shown in Figure 27.

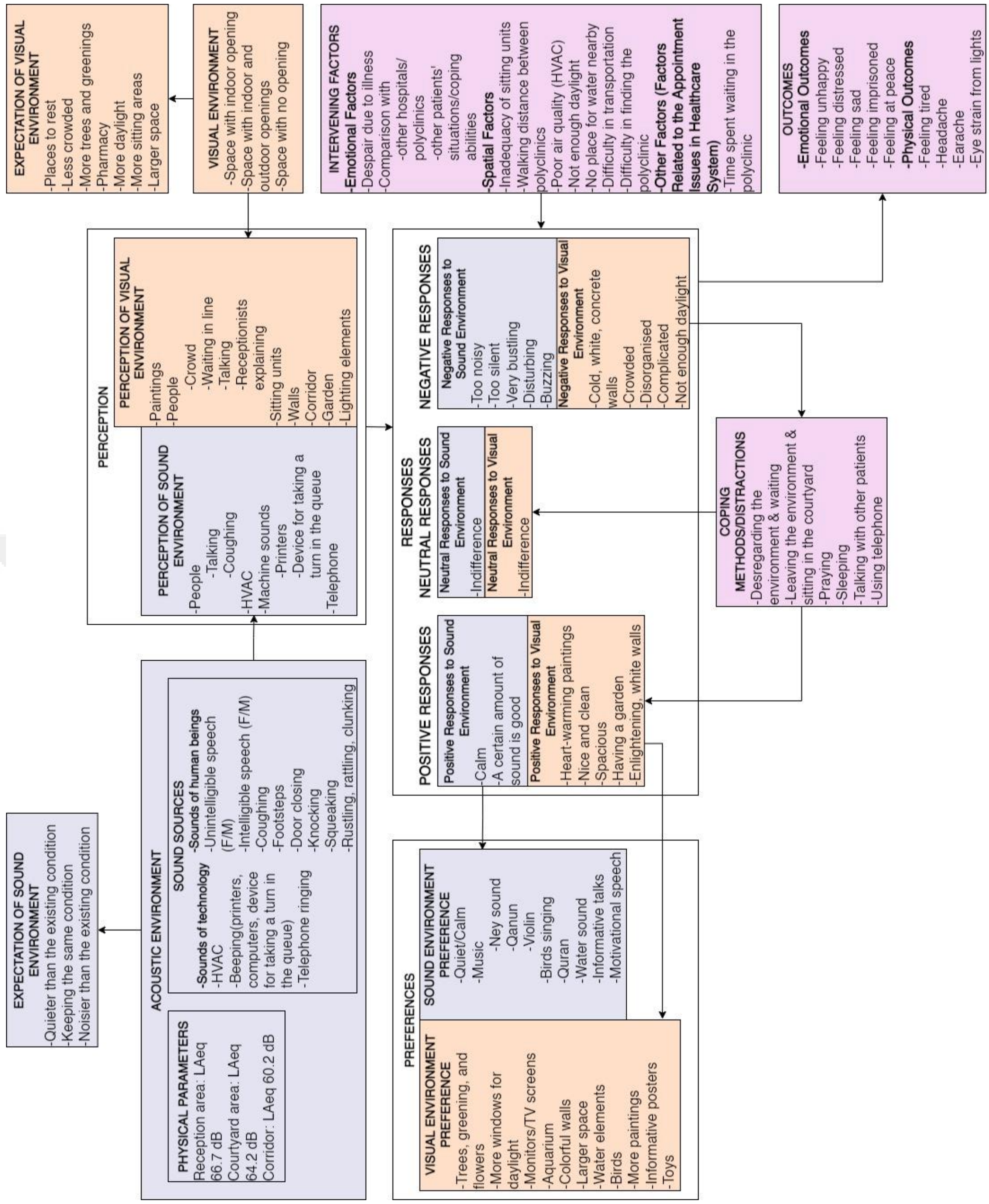

Figure 27. The detailed conceptual framework for outpatients' audio-visual perception in the polyclinic environment

Acoustic Environment & Expectation and Perception of Sound Environment

'*Acoustic Environment*' category has two subcategories as '*Physical Parameters*' and '*Sound Sources*.' These subcategories present the objective parameters of the sound environment. The acoustic environment defines how patients perceive the sound environment and what they expect from it. Thus, the acoustic environment is connected to the '*Expectation of Sound Environment*' and '*Perception of Sound Environment'* categories.

Patients' perception is a little different than the actual acoustic environment. The perception has some missing elements from the existing acoustic environment, such as the sounds of footsteps, door closing, knocking, squeaking, rustling, rattling, and clunking. Also, they explained human sounds as people talking rather than dividing the unintelligible (female/male) and intelligible (female/male) speech. Additionally, most patients expected a quieter sound environment, while others expected the same or noisier than the existing condition. Some patients expected a noisier sound environment even though they have already perceived many sounds. On the other hand, patients mostly expected a quieter sound environment as they perceived the same sounds.

A: *Normally it is quiet here, but looking at the current situation, there is a lot of noise.*

C: *It is a hospital. Of course, there will be some noise. However, it is still quiet here, not too noisy.*

Further, the perception of the sound environment was related to the perception of the visual environment as patients perceived the polyclinic's sound and visual environment together. For example, they saw people and heard them talking simultaneously. Thus, they were under the main category of '*Perception*'.

Visual Environment & Expectation and Perception of Visual Environment

'Visual Environment' category presents the objective parameters of the visual environment according to the opening types in the polyclinic space. Similar to the acoustic environment, the visual environment defines how patients perceive the visual environment and what they expect from it. Thus, the visual environment is connected to the '*Expectation of Visual Environment*' and '*Perception of Visual Environment'* categories.

Patients' perception is a little different than the actual visual environment. Rather than evaluating the visual environment as a whole, they perceived the individual elements in the polyclinic, such as people, paintings, sitting units, walls, corridor, garden, and lighting elements. Additionally, patients mostly expected to see visual elements that may increase their comfort, such as places to rest, less crowded, more trees and greening, a pharmacy, more daylight, more sitting areas, and larger space.

B: *I wish it were not this crowded. I wish I could lie down. I would like it to be an environment where patients can rest.*

Intervening Factors

The '*Intervening Factors'* affected patients' responses to the environment together with their perception of sound and visual environment. '*Intervening Factors'* category was divided into three subcategories as '*Emotional Factors*,' '*Spatial Factors*,' and '*Other Factors (Related to the Appointment Issues in Healthcare System)*.' Most of the patients were emotionally desperate due to illness and compared the polyclinic and the patients with other hospitals/polyclinics or other patients. Additionally, some spatial factors affected patients' responses to the polyclinic, such as inadequacy of sitting units, walking distance between polyclinics, poor air quality (HVAC), not enough daylight, no place for water nearby, difficulty in transportation, and difficulty in finding the polyclinic. Also, many patients mentioned their time spent waiting in the polyclinic.

A: *The air ventilation is not good enough. Sometimes there is no place to sit.*

B: *If there is someone in a worse situation than me, I give my turn. Chemotherapy is such a thing that it makes people very aggressive. It is something very different, and it cannot be explained.*

Responses & Outcomes

'*Responses*' was chosen as the core category as many other categories were shaping around it. Patients' perception of sound environment, visual environment, and other intervening factors caused '*Positive Responses*,' '*Neutral Responses*,' or '*Negative Responses*' through their evaluations of the polyclinic. The responses to sound and visual environments were different but related to each other. Therefore, responses to sound and visual environments were grouped together under positive, neutral, and negative responses.

Positive responses to the sound environment were calm, and a certain amount of sound was good. Positive responses to the visual environment were heart-warming paintings, nice and clean, spacious, having a garden, and enlightening white walls. Neutral responses to sound and visual environments were that patients' do not want any difference from the existing conditions. Negative responses to the sound environment were too noisy, too silent, very busy, disturbing, buzzing, the argues and fights, and annoying device sound. Negative responses to the visual environment were cold, white, concrete walls, crowded, disorganized, complicated, and not enough daylight.

A: *Noise and lots of crowds. So bustling. It would be better if it were calm...I am uncomfortable with the crowd and the intensity. I am trying to go somewhere quieter.*

B: *A little disturbing. No matter how calm people are, there are buzzing sounds. Even if I go home, that sound stays in my ears.*

C: *It is a spacious place. Both a high ceiling and a light color make it spacious. Not flat…It is nice that it is bright. It gives people serenity.*

Often, after patients responded to what they perceived in the environment, they also evaluated the '*Outcomes*' of these responses. As a result, '*Emotional Outcomes'* and '*Physical Outcomes'* emerged. Patients mostly felt unhappy, distressed, sad, and imprisoned, while some felt at peace. They also explained that they physically feel tired and have headaches, earaches, and eye strain from lights.

C: *Sorry, but I felt like I was in a mental hospital when I first arrived. No windows, no doors. Mentally, I felt awful. It was psychologically heavy for me...The noise of the devices is giving me a headache right now.*

Coping Methods/Distractions

As the patients gave negative responses, they also stated '*Coping Methods/Distractions*' in order not to experience negative outcomes. To turn negative responses into neutral or positive responses, patients mainly chose to disregard and wait or leave the environment and sit in the courtyard. Others found these coping methods/distractions: praying, sleeping, talking with other patients, and using the telephone.

Preferences

The patients' positive responses define their '*Preferences*' about the polyclinic environment in two subcategories: '*Sound Environment Preference*' and '*Visual Environment Preference*.' Patients responded positively to the sound environment as calm, while they also preferred quiet/calm. They responded positively to the visual environment as having a garden and heart-warming paintings, while they also preferred trees, greening and flowers, and more paintings. Sound and visual environment preferences were also related as patients want to both see and hear water elements and birds. Patients mostly preferred trees, greening, and flowers in the visual environment and quiet/calm or music (ney sound, qanun, and violin) in the sound environment. Other sound environment preferences were Quran, informative talks, and motivational speech. Other visual environment preferences were more windows for daylight, monitors/TV screens, an aquarium, colorful walls, larger space, informative posters, and toys.

A: *It would be better if it were calm.*

B: *There may be a waterfall in the garden. You can sit around and listen to the sound of water.*

C: *I would like it if there were music. For example, I love the sound of the violin. It would also suppress the air ventilation noise. It is so bustling.*

This chapter examined the results of the research. It explained the quantitative and qualitative analyses' results. The next chapter will discuss these findings.

CHAPTER V

DISCUSSION

This research examined the sound and visual environments of the hospital environment using quantitative and qualitative methods. LAeq measurements and signal analyses revealed the existing sound environment, image analysis with segmentation revealed the existing visual environment, and the questionnaire provided information about outpatients' perceptions. Since people's perception of the environment changes according to the context (Acun & Yilmazer, 2018b; Çankaya & Yilmazer, 2022; ISO/TS 12913-1, 2014; Orhan & Yilmazer, 2021), the conceptual framework formed by interviews was created in the context of the outpatient polyclinic environment. The conceptual framework showed that the '*Responses*' was the core category. The framework gave information about many parameters, such as the patients' expectations and preferences in an outpatient polyclinic environment.

Sound level (LAeq) measurements in the three areas were found high by the outpatients (reception area: 66.7 dB, courtyard area 64.2 dB, and corridor 60.2 dB). Previous studies also showed that hospital environments have high sound levels (Mahapatra, 2011; Shield et al., 2016). The majority of the sound sources were the intelligible and unintelligible speech, as seen from the spectrograms (Figure 13). Similarly, patients put forward that they hear speech intensely, and it makes the polyclinic bustling. Patients also realized the HVAC sound in the corridor was intense in that area, although there was HVAC sound in reception and courtyard areas too, but in lower intensity. HVAC sound acted as a background sound in the three areas but was more prominent in the corridor (Figure 16).

The visual environment of the polyclinic has different openings in the three areas (Figure 17 and Figure 18), and they provide different interaction points in the polyclinic. There was a reception desk in the reception area, a garden in the courtyard area, and plain, white walls in the corridor. However, the polyclinic lacked enough daylight as it was on the second underground floor and adequate sitting units as people were standing in crowded times. Especially in the corridor (Figure 19), the walls are 63% of the total area, and there is no daylight in the space. Similarly, patients explained that the polyclinic needed to be on a higher floor to get more daylight, and they needed more sitting units at the polyclinic. Even though there is a garden in the courtyard area, covering 14% of the total area, as seen in Figure 18, patients expected to see more trees and greening as the existing ones are not enough.

Further, patients claimed intervening factors lead them to give negative responses to the polyclinic environment. Most of them explained that they feel desperate due to their illness, and some spatial factors, such as poor air quality and walking distance between the polyclinics, affect their comfort. These spatial factors can be improved as Bliefnick et al. (2019) explained that patients' perception of the space could be affected if the designers consider design features of the hospital space such as materials and space layout. For example, the walking distance would not be a problem with the correct layout plan. In addition, time spent in the polyclinic was a significant issue affecting their comfort. As a result of these, they have negative impressions of the polyclinic environment, and there are emotional outcomes such as feeling unhappy, distressed, sad and imprisoned, and physical outcomes such as feeling tired, having a headache, earache, eye strain from lights. To avoid these negative outcomes, the patients had to find solutions to overcome their negative responses to the environment and turn them into neutral or positive responses. Therefore, they developed some coping methods and distractions from the polyclinic environment similar to the literature (Acun & Yilmazer, 2018b; Çankaya & Yilmazer, 2022). Many patients expressed that they either leave the environment or disregard it as they do not have another choice but to wait. The others explained that they pray, sleep, talk with other patients or use their telephones to pass the waiting time.

In general, the results were parallel with the literature (Mahapatra, 2011; Shield et al., 2016) as patients responded to the sound environment as it was noisier than expected, bustling, and sometimes there were arguments and fights. They responded to the visual environment as it was crowded and disorganized. On the other hand, the patients who liked the polyclinic environment responded to the sound environment as calm and a certain amount of sound is good, and to the visual environment as nice and clean, spacious, and having a garden as positive. The responses to the sound and visual environments correspond to each other. Thus, it was understood that the patients responded to their perceptions of sound and visual environments together. The assessment of the surrounding sound and visual environments in all three areas was *neither good nor bad*. However, the assessment of the courtyard area was found to be better than the reception area and corridor, as shown in Figure 21, Figure 22, and Figure 23. Additionally, the courtyard area, which has a garden, was perceived as more pleasant and calmer than the reception area and corridor (Table 7 and Figure 20).

The positive responses to the sound and visual environments defined patients' preferences. Patients wanted to hear a certain amount of sound rather than complete silence or noise (Acun & Yilmazer, 2018b; Bruce & Davies, 2014; Çankaya & Yılmazer, 2022; Orhan & Yilmazer, 2021). They mostly preferred to hear music that had a calming and soothing effect, consisting of ney sound, qanun, and violin. Some patients preferred nature sounds such as birds singing and water sound, which also have a calming and soothing effect. Similarly, Mackrill et al. (2014) discussed that patients perceived the natural sound intervention as more relaxing than the no nature sound situation. At the same time, these patients wanted to see nature elements such as trees, greening, and flowers, more windows for daylight, water elements, and birds. Also, some patients preferred to hear informative talks about the disease or some motivational speech that could increase the patients' mood and cheer them. These patients also wanted to see monitors/TV screens to watch the speaker or to see informative posters. Besides the preferences, statistical analysis showed that patients did not find the existing sound and visual environment appropriate for a polyclinic environment (Figure 24 and Figure 25). However, the courtyard area with an outdoor opening with greening was found to be the most appropriate sound and visual environment among the three areas. The reason may be the garden in that area. However, there is a need for a change in the polyclinic to become a more appropriate audio-visual environment for patients' preferences.

Outcomes for Polyclinic Design

Patients are uncomfortable because there is a lot of background noise (especially in the corridor-HVAC sound). Echo control can be achieved by changing the materials on the corridor surfaces. Music and nature sounds such as bird sounds and water sounds can be added to the sound environment. Also, a visual environment created with nature elements can be designed, as the visual nature elements are perceived positively by the patients in the courtyard area. As patients' sound and visual environment preferences correspond to each other, an audio-visual environment should be created in which the auditory and visual nature elements used are compatible with each other.

CHAPTER VI

CONCLUSION

Hospitals are significant environments as they provide healthcare to patients as treatments for illnesses. The previous hospital soundscape studies mainly focused on acoustic measurements rather than the patients' perceptions. Thus, this thesis explored the patients' perceptions quantitatively and qualitatively. In the existing conditions of the polyclinic, patients are already dealing with the illness, making them more vulnerable to poor environmental conditions. To increase patients' well-being and make them feel emotionally happier and physically stronger, the audio-visual design of a polyclinic waiting area is considerably essential. This study showed that nature elements, both in the sound and visual environments, can help patients feel more at peace as nature contributes to a calmer hospital environment. This study also showed that the environment should be analyzed both with quantitative and qualitative methods, as it provides triangulation.

This study showed that the sound and visual environments should be evaluated together as patients perceived them together. The audio-visual polyclinic environment affects the patients' perception, and perception leads to responses to the environment as reactions. Responses may change from patient to patient even though their perception would be the same. According to these responses, patients find coping methods and define preferences about the polyclinic environment. As the patients' responses and preferences match, the outcomes would be positive.

Limitations of the Study

The indoor environment should be analyzed with many of its features. This study only focused on sound and visual environments. However, there are other senses that form an environment as the perception of smell, taste, and touch. For analyzing an environment as a whole, as many as these senses should be considered, regardless of the context.

Recommendations for Future Research

This study only had visual nature elements; however, patients preferred both auditory and visual nature elements. Nature has a restorative effect, and it can be provided both visually and acoustically (Alvarsson, Wiens, & Nilsson, 2010). Additionally, matching the sound and visual with each other can enhance the restorative capacity of the environment (Zhao et al., 2018).

The patients need designed audio-visual polyclinic environments with calming effects whose sound and visual qualities are compatible. This study was conducted in an oncology polyclinic waiting area. There was no medical equipment in that polyclinic, meaning that there were not many alarms and beeping sounds. Future research can be conducted as qualitative research on other polyclinics in hospital environments. The perception may differ according to the chosen polyclinics' audio-visual features and the patients' type of illness.

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APPENDICES

APPENDIX A

Example self-written MATLAB codes for time histories and spectrograms

```
%%
subplot(3,1,2)

[z,fs1] = audioread('HE_OncologyCourtyard.wav');

n=length(z);
t=(0:n-1)/fs1;
n/fs1

plot(t,z);
grid on
xlabel('Time(s)')
ylabel('Frequency(kHz)')
title('Courtyard Area')
%sound(z,fs1)

%%
spectrogram(z,800,420,800,fs1,'yaxis')
colormap default
ylim([0,5]) %frequency range
%title('Courtyard Area')
%view(-45,65)

%sound(z,fs2)
ax = gca; % current axes
ax.FontSize = 15;
```

APPENDIX B

Approval of Ankara City Hospital Ethics Committee

T.C.
SAĞLIK BAKANLIĞI
İL SAĞLIK MÜDÜRLÜĞÜ
Ankara Şehir Hastanesi
2 Nolu Klinik Araştırmalar Etik Kurul Başkanlığı

Sayı : E.Kurul –**E2-21-1086** No'lu çalışma

Ankara Şehir Hastanesi Tıbbi Onkoloji Kliniği'nden "Onkoloji Polikliniğinde Görsel-İşitsel Etkileşimi Restoratiflik Yoluyla Keşfetmek İçin Niteliksel Bir Yaklaşım(A Qualitative Approach To Explore Audio-Visual İnteraction in an Oncology Polyclinic Through Restotativeness)" konulu çalışma incelenmiş olup, Etik açıdan oy birliği ile uygun görülmüştür.

08/12/2021

Prof. Dr. Fuat Emre Canpolat
2 Nolu Etik Kurul Başkanı

Etik Kurul Sekreterliği Üniversiteler Mah. Bilkent Cad. No:1 Çankaya/Ankara	İrtibat; 2nolu Etik Kurul: B.Özkan K.Çetindağ
Tel: 0 (312) 552 66 00 Dahili:**772997--772998**	

KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

ARAŞTIRMANIN AÇIK ADI	Onkoloji Polikliniğinde Görsel- İşitsel Etkileşimi Restoratiflik Yoluyla Keşfetmek İçin Niteliksel Bir Yaklaşım(A Qualitative Approach To Explore Audio-Visual Interaction in an Oncology Polyclinic Through Restotativeness)
VARSA ARAŞTIRMANIN PROTOKOL KODU	-

ETİK KURUL BİLGİLERİ	ETİK KURULUN ADI	**Ankara Şehir Hastanesi 2 Nolu Klinik Araştırmalar Etik Kurul**
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	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ UZMANLIK ALANI	Tıbbi Onkoloji Kliniği			
	KOORDİNATÖR/SORUMLU ARAŞTIRMACININ BULUNDUĞU MERKEZ	**Ankara Şehir Hastanesi**			
	VARSA İDARİ SORUMLU UNVANI/ADI/SOYADI				
	DESTEKLEYİCİ	-			
	PROJE YÜRÜTÜCÜSÜ UNVANI/ADI/SOYADI (TÜBİTAK vb. gibi kaynaklardan destek alanlar için)	-			
	DESTEKLEYİCİNİN YASAL TEMSİLCİSİ	-			
	ARAŞTIRMANIN FAZI VE TÜRÜ	FAZ 1	☐		
		FAZ 2	☐		
		FAZ 3	☐		
		FAZ 4	☐		
		Gözlemsel ilaç çalışması	☐		
		Tıbbi cihaz klinik araştırması	☐		
		İn vitro tıbbi tanı cihazları ile yapılan performans değerlendirme çalışmaları	☐		
		İlaç dışı klinik araştırma	☐		
		Diğer ise belirtiniz:**Anket Çalışması(Melike Zaynep Uğurlu'nun tezi)**			
	ARAŞTIRMAYA KATILAN MERKEZLER	TEK MERKEZ ☒	ÇOK MERKEZLİ ☐	ULUSAL ☐	ULUSLARARASI ☐

Etik Kurul Başkanının
Unvanı/Adı/Soyadı:Prof. Dr. Fuat Emre CANPOLAT
İmza:

KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

ARAŞTIRMANIN AÇIK ADI	Onkoloji Polikliniğinde Görsel- İşitsel Etkileşimi Restoratiflik Yoluyla Keşfetmek İçin Niteliksel Bir Yaklaşım(A Qualitative Approach To Explore Audio-Visual Interaction in an Oncology Polyclinic Through Restotativeness)
VARSA ARAŞTIRMANIN PROTOKOL KODU	-

	Belge Adı	Tarihi	Versiyon Numarası	Dili
DEĞERLENDİRİLEN BELGELER	ARAŞTIRMA PROTOKOLÜ			Türkçe ☐ İngilizce ☐ Diğer ☐
	BİLGİLENDİRİLMİŞ GÖNÜLLÜ OLUR FORMU			Türkçe ☐ İngilizce ☐ Diğer ☐
	OLGU RAPOR FORMU			Türkçe ☐ İngilizce ☐ Diğer ☐
	ARAŞTIRMA BROŞÜRÜ			Türkçe ☐ İngilizce ☐ Diğer ☐
DEĞERLENDİRİLEN DİĞER BELGELER	**Belge Adı**		**Açıklama**	
	SİGORTA	☐		
	ARAŞTIRMA BÜTÇESİ	☐		
	BİYOLOJİK MATERYEL TRANSFER FORMU	☐		
	İLAN	☐		
	YILLIK BİLDİRİM	☐		
	SONUÇ RAPORU	☐		
	GÜVENLİLİK BİLDİRİMLERİ	☐		
	DİĞER:	☐	-	
KARAR BİLGİLERİ	**Karar No:E2-21-1086**	**Tarih: 08.12.2021**		
	Yukarıda bilgileri verilen başvuru dosyası ile ilgili belgeler araştırmanın/çalışmanın gerekçe, amaç, yaklaşım ve yöntemleri dikkate alınarak incelenmiş ve uygun bulunmuş olup araştırmanın/çalışmanın başvuru dosyasında belirtilen merkezlerde gerçekleştirilmesinde etik ve bilimsel sakınca bulunmadığına toplantıya katılan etik kurul üye tam sayısının salt çoğunluğu ile karar verilmiştir. İlaç ve Biyolojik Ürünlerin Klinik Araştırmaları Hakkında Yönetmelik kapsamında yer alan araştırmalar/çalışmalar için Türkiye İlaç ve Tıbbi Cihaz Kurumu'ndan izin alınması gerekmektedir.			

Etik Kurul Başkanının
Unvanı/Adı/Soyadı:Prof. Dr. Fuat Emre CANPOLAT
İmza:

KLİNİK ARAŞTIRMALAR ETİK KURULU KARAR FORMU

ARAŞTIRMANIN AÇIK ADI	Onkoloji Polikliniğinde Görsel- İşitsel Etkileşimi Restoratiflik Yoluyla Keşfetmek İçin Niteliksel Bir Yaklaşım(A Qualitative Approach To Explore Audio-Visual Interaction in an Oncology Polyclinic Through Restotativeness)
VARSA ARAŞTIRMANIN PROTOKOL KODU	-

KLİNİK ARAŞTIRMALAR ETİK KURULU	
ETİK KURULUN ÇALIŞMA ESASI	İlaç ve Biyolojik Ürünlerin Klinik Araştırmaları Hakkında Yönetmelik, İyi Klinik Uygulamaları Kılavuzu
BAŞKANIN UNVANI / ADI / SOYADI:	**Prof. Dr. Fuat Emre CANPOLAT**

Unvanı/Adı/Soyadı	Uzmanlık Alanı	Kurumu	Cinsiyet		Araştırma ile ilişki		Katılım *		İmza
			E	K	E	H	E	H	
Prof. Dr. Fuat Emre CANPOLAT	Çocuk Sağlığı ve Hastalıkları Neonatoloji	Ankara Şehir Hastanesi	☒	☐	☐	☒	☒	☐	
Prof. Dr. İlkan TATAR	Anatomi	Hacettepe Üniversitesi Tıp Fakültesi	☒	☐	☐	☒	☒	☐	
Prof. Dr. Dilek ŞAHİN	Kadın Hastalıkları ve Doğum /Perinatoloji	Ankara Şehir Hastanesi	☐	☒	☐	☒	☐	☒	KATILMADI
Prof . Dr. Mehmet Ali Nahit ŞENDUR	Tıbbi Onkoloji	Ankara Şehir Hastanesi (YBÜ)	☒	☐	☐	☒	☒	☐	
Prof. Dr. Bilgen BAŞGUT	Farmakoloji	Başkent Üniversitesi Eczacılık Fakültesi	☐	☒	☐	☒	☒	☐	
Prof. Dr. Özlem Yılmaz TAŞDELEN	Fiziksel Tıp ve Rehabilitasyon	Ankara Şehir Hastanesi	☐	☒	☐	☒	☒	☐	
Doç. Dr. Hayriye Gözde KANMAZ KUTMAN	Çocuk Sağlığı ve Hastalıkları Neonatoloji	Ankara Şehir Hastanesi	☐	☒	☐	☒	☒	☐	
Doç. Dr. Gülhan KURTOĞLU ÇELİK	Acil Tıp	Ankara Şehir Hastanesi (YBÜ)	☐	☒	☐	☒	☒	☐	
Doç. Dr. Bedia DİNÇ	Tıbbi Mikrobiyoloji	Ankara Eğitim ve Araştırma Hastanesi	☐	☒	☐	☒	☒	☐	
Doç. Dr. Ayça Tuba DUMANLI ÖZCAN	Anestezi ve Reanimasyon	Ankara Şehir Hastanesi	☐	☒	☐	☒	☒	☐	
Doç.Dr. Dilek ÖZTAŞ	Halk Sağlığı	Ankara Şehir Hastanesi (YBÜ)	☐	☒	☐	☒	☒	☐	
Doç. Dr. Muhammet Kadri ÇOLAKOĞLU	Gastroenteroloji Cerrahisi	Ankara Şehir Hastanesi	☒	☐	☐	☒	☒	☐	
Sağ. Mens. Olm. Üye. M.ehmet Hilmi ŞEÇİLMİŞ	İktisat Maliye	Emekli	☒	☐	☐	☐	☐	☐	
Av. Mesut KELEKÇİBAŞI	Hukuk	Serbest Avukat	☒	☐	☐	☒	☒	☐	
Mühendis Selahattin KAHRİMAN	Biyomedikal Mühendis	Ankara Şehir Hastanesi/ CCN Teknik	☒	☐	☐	☒	☒	☐	

*:Toplantıda Bulunma

Etik Kurul Başkanının
Unvanı/Adı/Soyadı:Prof. Dr. Fuat Emre CANPOLAT
İmza:

APPENDIX C

Questionnaire Survey in Turkish

1/3

Onkoloji Polikliniğinde Ses ve Görsel Ortam Algısı Araştırması

Bu anket çalışması, Bilkent Üniversitesi İç Mimarlık ve Çevre Tasarımı Bölümü'nde hazırlanan, algılanan ses ve görsel ortam araştırması kapsamında yapılmaktadır. Ankette kimliğiniz sorulmamaktadır. Tüm katılımcılardan elde edilen verilen kesinlikle gizli tutulup, sadece bilimsel amaçla kullanılacaktır. Katılım tamamen isteğe bağlıdır.

Araştırmayla ilgili bilgi almak için: zeynep.ugurlu@bilkent.edu.tr

A. Kişisel Bilgiler

1. Kaç yaşındasınız?....................

2. Cinsiyetiniz nedir?

◯ Kadın

◯ Erkek

◯ Diğer

3. Hastalık tanınız ne zamandır mevcut?.....................

4. Polikliniği ne sıklıkta ziyaret ediyorsunuz?........................

B. Anket Bölümü

B1. Ses kaynağı tanılama

Şu anda dinlediğiniz dört çeşit sesi hangi ölçüde değerlendirirsiniz?
Lütfen her ses çeşidi için bir yanıt seçin

	Hiç	Biraz	Kısmen	Çok fazla	Tamamen hâkim
Teknolojik cihaz sesleri (Bilgisayar, klima, havalandırma, vb.)	☐	☐	☐	☐	☐
Diğer sesler (Siren, inşaat, endüstriyel, vb.)	☐	☐	☐	☐	☐
İnsan sesleri (Diyalog, kahkaha, ayak sesi, vb.)	☐	☐	☐	☐	☐
Doğa sesleri (Kuş sesleri, rüzgâr, yağmur, vb.)	☐	☐	☐	☐	☐

B2. Algılanan etkin nitelik

Aşağıdaki her 8 ölçek için, dinlediğiniz ortam sesinin tanımlanmasına ne ölçüde katılırsınız ya da katılmazsınız?
Lütfen her tanım için bir yanıt seçin

	Kesinlikle katılıyorum	Katılıyorum	Ne katılıyorum ne katılmıyorum	Katılmıyorum	Kesinlikle katılmıyorum
-Memnuniyet verici	☐	☐	☐	☐	☐
-Kaotik	☐	☐	☐	☐	☐
-Heyecanlandırıcı	☐	☐	☐	☐	☐
-Hareketsiz	☐	☐	☐	☐	☐
-Sakin	☐	☐	☐	☐	☐
-Rahatsız edici	☐	☐	☐	☐	☐
-Hareketli	☐	☐	☐	☐	☐
-Monoton	☐	☐	☐	☐	☐

B3. Çevredeki ses ortamının değerlendirilmesi

Dinlediğiniz çevredeki ses ortamını genel olarak nasıl tanımlarsınız?

Çok iyi	İyi	Ne iyi, ne kötü	Kötü	Çok kötü
☐	☐	☐	☐	☐

B4. Çevredeki ses ortamının uygunluğu

Genelinde, dinlediğiniz var olan ses ortamı bulunduğunuz mekâna ne ölçüde uygun?

Hiç değil	Çok az	Kısmen	Çok fazla	Mükemmel olarak
☐	☐	☐	☐	☐

B5. Çevredeki görsel ortamın değerlendirilmesi

Gördüğünüz çevredeki görsel ortamı genel olarak nasıl tanımlarsınız?

Çok iyi	İyi	Ne iyi, ne kötü	Kötü	Çok kötü
☐	☐	☐	☐	☐

B6. Çevredeki görsel ortamın uygunluğu

Genelinde, gördüğünüz var olan görsel ortam bulunduğunuz mekâna ne ölçüde uygun?

Hiç değil	Çok az	Kısmen	Çok fazla	Mükemmel olarak
☐	☐	☐	☐	☐

B7. Görsel-işitsel ortamın değerlendirilmesi

Gördüğünüz çevredeki ortamı genel olarak nasıl tanımlarsınız?

Çok iyi	İyi	Ne iyi, ne kötü	Kötü	Çok kötü
☐	☐	☐	☐	☐

APPENDIX D

Questionnaire Survey in English

Research on Sound and Visual Environment Perception in Oncology Polyclinic

This survey is carried out within the scope of the perceived sound and visual environment research prepared at Bilkent University, Department of Interior Architecture and Environmental Design. Your identity is not asked in the survey. The data obtained from all participants will be kept strictly confidential and will be used for scientific purposes only. Participation is entirely voluntary.

For more information:

A. Personal Information

1. Age....................

2. Gender

◯ Female

◯ Male

◯ Other

3. How long have you been diagnosed with the disease?.....................

4. How often do you visit the outpatient clinic?.........................

B. Questionnaire Part

B1. Sound source identification

To what extend do you presently hear the following four types of sounds?
Please tick off one response alternative per type of sound

	Not at all	A little	Moderately	A lot	Dominates completely
Noise from technological devices (eg. computer, HVAC, typing)	☐	☐	☐	☐	☐
Other noise (eg. sirens, construction, industry)	☐	☐	☐	☐	☐
Sounds from human beings (eg. conversation, laughter, footsteps)	☐	☐	☐	☐	☐
Natural sounds (eg. singing birds, wind, rain)	☐	☐	☐	☐	☐

B2. Perceived affective quality

For each of the 8 scales below, to what extend do you agree or disagree that the present surrounding sound environment is…
Please tick off one response alternative per scale

	Strongly agree	Agree	Neither agree, nor disagree	Disagree	Strongly disagree
-pleasant	☐	☐	☐	☐	☐
-chaotic	☐	☐	☐	☐	☐
-vibrant	☐	☐	☐	☐	☐
-uneventful	☐	☐	☐	☐	☐
-calm	☐	☐	☐	☐	☐
-annoying	☐	☐	☐	☐	☐
-eventful	☐	☐	☐	☐	☐
-monotonous	☐	☐	☐	☐	☐

B3. Assessment of the surrounding sound environment

Overall, how would you describe the present surrounding sound environment?

Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐

B4. Appropriateness of the surrounding sound environment

Overall, to what extent is the present surrounding sound environment appropriate to the present place?

Not at all	Slightly	Moderately	Very	Perfectly
☐	☐	☐	☐	☐

B5. Assessment of the surrounding visual environment

Overall, how would you describe the present surrounding visual environment?

Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐

B6. Appropriateness of the surrounding visual environment

Overall, to what extent is the present surrounding visual environment appropriate to the present place?

Not at all	Slightly	Moderately	Very	Perfectly
☐	☐	☐	☐	☐

B7. Assessment of the surrounding audio-visual environment

Overall, how would you describe the present surrounding environment?

Very good	Good	Neither good, nor bad	Bad	Very bad
☐	☐	☐	☐	☐