



Original Article

A nature-immersive virtual reality intervention to support hospice family caregivers: Qualitative findings from a pilot study

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ARTICLE INFO

Keywords:

Hospice
Family caregiver
Virtual reality intervention
Nature
Mental health
Feasibility

ABSTRACT

Objective: Family caregivers (FCGs) of cancer patients who are in hospice experience psychological challenges and poor quality of life (QOL) as a consequence of caregiving demands and anticipatory loss. Supportive interventions are needed. Exposure to nature offers a source of relaxation; however, FCGs are often homebound and have limited opportunities for respite. Technology-mediated nature experiences delivered via virtual reality (VR) may be an alternative. The purpose was to explore the perspectives of hospice FCGs who completed a nature-immersive VR intervention for the enhancement of their emotional health and QOL.

Methods: Nine scenes, including a tropical beach, green meadow, underwater ocean, and red savanna, were offered. Participants were asked to select one scene to view for a minimum of 10 minutes for five consecutive days at home. Semi-structured interviews were conducted via videoconferencing software and audio-taped, then transcribed, coded, and analyzed using content analysis.

Results: Nine participants (aged 33–76 years old) were interviewed. Two content categories included 1) feasibility and 2) acceptability. Participants reported ease-of-use and denied encountering difficulties. Scenes were relaxing and calming, providing mindfulness and escapism elements. Participants enjoyed the interactive, multisensory experience, offering views of wildlife and nature sounds. Two reported motion sickness and eye strain with longer use. Suggestions included extending the study duration and the option to explore other scenes.

Conclusions: Findings provide preliminary evidence for the efficacy of a nature-based VR intervention. Larger, diverse samples, with group randomization, are warranted. Technology-mediated nature experiences offer support for the emotional health and QOL of hospice FCGs.

Introduction

The provision of end-of-life care (EOLC) to a loved one can be emotionally and cognitively demanding. FCGs often put their own needs second to their loved one's needs, neglecting their own health and well-being.¹ Because of the stressors of caregiving, moderate to severe anxiety and depression occur in one-third and one-quarter of hospice FCGs, respectively.² Given these challenges, innovative strategies are needed to promote the quality of life (QOL) and emotional health of FCGs as they shoulder the burden of caregiving while experiencing the impending loss of their loved one.

Nature is known to benefit and restore individuals' diminished emotional health.³ Hospice FCGs experience high stress levels due to the

increasing burden of caregiving and the need to balance multiple responsibilities; thus, nature-based environments can serve as a crucial support mechanism.³ Incorporating natural settings into their daily lives can help FCGs manage stress more effectively, improve their mental well-being, and enhance their overall capacity to provide care.³

Theoretical foundations for the benefits of nature

Two theories provide the theoretical underpinnings for addressing the cognitive and emotional benefits of nature. Caregiving is a mentally demanding role, requiring various components of cognitive functioning, e.g., information processing, decision-making, and task initiation, all of which require sustained attention. The attention restoration theory by

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Received 2 August 2024; Accepted 6 November 2024

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Kaplan (1995) posits that restorative environments, such as nature, provide opportunities for reducing fatigue from directed attention.^{4,5} For nature to provide restoration from directed attention fatigue, it must offer several benefits. First, nature must offer a chance to “be away” from the mental activity required by directed attention. Further, nature should offer “soft fascination” (e.g., colorful flowers in a meadow, vividly blue ocean water, etc.), redirecting thoughts away from mentally fatiguing activities afforded by directed attention. Lastly, the natural environment must be rich and engaging enough to constitute a worldly change from habitual activities and offer compatibility to one's purpose and inclinations.

The second theory, Ulrich et al. (1991)'s stress reduction theory, postulates that natural landscapes can reduce states of arousal and negative thoughts through psychophysiological mechanisms.⁶ Both theories are rooted in explaining early evolution, as humans were naturally predisposed to seek resource-abundant natural spaces, which were indicative of improved survival. Thus, humans have an innate response to react positively to nature exposure. Overall, nature experiences offer the potential for replenishing diminished cognitive reserve and emotional distress experienced by FCGs.

Despite these benefits, FCGs are typically unable to enjoy the advantages of nature without having to arrange respite for their absence at the bedside. Therefore, remote delivery of nature experiences may increase access to nature. Virtual reality (VR) may provide FCGs with an opportunity for remote, flexibly delivered restoration.

VR offers a remote delivery of an immersive nature experience and can be an alternative for home-bound FCGs. There is a growing body of research examining the use of nature-based VR relaxation in community and clinical populations, particularly among general FCGs and patients with cancer, including those actively undergoing cancer treatment and those with metastases.^{7–17} These studies evaluated the post-VR intervention improvement of various symptoms, including pain, fatigue, psychological well-being, sleep, and QOL, through survey data and physiological measures, such as blood pressure and EEG and EKG activity.^{14–16} Sessions were administered across various durations, with some testing improvement after a single session and others testing the effects of several sessions across a range of 1–3 weeks.^{10–17} Overall, most studies reported positive trends for post-intervention improvements in their targeted outcomes, with fewer reporting significance. These emerging studies offer promising findings but are often limited in design and sample size. Moreover, most of these studies are patient-centered; there is limited knowledge of this application for FCGs, who are often older themselves and may have a limited skill set and experience with technology-mediated supportive strategies.^{7–17} Research is needed to evaluate a nature-based VR intervention among hospice FCGs who warrant strategies to manage their QOL and well-being.

Therefore, this study aimed to evaluate hospice FCGs' perceived feasibility and acceptability of a nature-immersive VR intervention to support their QOL and improve emotional health outcomes. The following research questions guided this pilot study:

1. What are participants' perceptions of the feasibility of a nature-immersive VR intervention?
2. What are participants' perceptions of the acceptability of a nature-immersive VR intervention?

We hypothesize that most participants will report positive perceptions about the ease of use of a nature-based VR intervention and highlight the appealing features and benefits.

The interviews sought to complement the quantitative component of this study; findings have been reported elsewhere.¹⁸ Briefly, feasibility, acceptability, and QOL were measured using validated measures.^{19,20} Across the FCGs who completed the intervention, findings demonstrated high feasibility (13.94 ± 2.43 , range 0–16) and acceptability (14.46 ± 1.77 , range 0–16). Furthermore, there was significant improvement in anxiety ($t = 2.206$, $P < 0.05$) and favorable trends on other QOL dimensions.

Methods

Design

The study utilized a one-group pre-post design. The intervention phase was conducted between September 2022 and May 2023, with follow-up semi-structured interviews conducted from January 2023 through July 2023.

Participants and setting

The inclusion criteria were as follows: 1) ages 21 years or older, and 2) a friend or family caregiver providing care to a patient enrolled in hospice services. For this study, “family caregiver” was defined as anyone who had a close relationship with and was involved in the patient's care; “family” was not limited to biological or legal relations. FCGs who had apprehensions towards natural elements such as mountains, birds, or water were excluded.

For the intervention, FCGs were recruited using convenience sampling through various methods. First, staff (i.e., nurses and social workers) from two Michigan hospice agencies referred FCGs who could be eligible for the study. The staff provided a brief study overview to each FCG, including the goals and purpose of the research; if interested, FCGs agreed to share their name and contact information with the study team to be contacted. Additionally, the study flier was posted in Facebook group forums specific to community members in the greater Lansing, Michigan area. Subjects were also recruited by word-of-mouth from fellow caregivers who completed the study. Lastly, a local news outlet discovered the study online and invited the principal investigator (R.L.) to discuss the study on television, which promoted community awareness and encouraged those who might be eligible and interested to contact the study team. The study project manager contacted interested FCGs and evaluated their eligibility. Across these various recruitment methods, 15 participants completed the informed consent, were enrolled, and completed the intervention.

Relationship with participants. During the intervention and data collection stages, the first author was a staff nurse at one of the hospices used as a recruitment site. As such, she had previous working relationships with several of the participants. Because of this previous working relationship, participants may have had increased motivation to participate. All participants were aware that the first author was a PhD student interested in examining hospice FCG well-being. The rest of the team had no prior contact with the participants.

Using a nested sampling of the 15 who had completed the study, a subset participated in a post-intervention interview. On the written informed consent form, participants were asked if they were willing to be contacted for an interview to share their experience with the VR study. Twelve agreed and were contacted to be interviewed.

VR device and software

The intervention was delivered using the *Pico Neo3*, which included a wireless head-mounted device with auditory and visual immersion and two hand controllers. The VR device presented content with a 360-degree view.

The software, *Nature Treks VR*, provided a nature-immersive experience. A total of nine nature scenes were offered: *Black Beginning* (an outer space journey for a planetary experience); *Blue Deep* (an underwater experience in the ocean to view sea life, such as dolphins and fish); *Blue Moon* (an evening sky and peaceful night); *Blue Ocean* (a tropical beach with palm trees, surf sounds, seagulls, and turtles); *Green Meadow* (a spring meadow with a flowing stream and gentle wildlife); *Orange Sunset* (a wooded forest with tall trees and glowing red sunset skies); *Red Savanna* (a wide-open sunset Savanna with grazing safari animals, such as elephants); *Red Fall* (a fall meadow with mountains and trees with falling colorful maple leaves); and *White Winter* (a winter scape with snow, wildlife, and mountains in the distance).

Description of intervention

The nature-immersive VR intervention was delivered across five consecutive days. On days 1 and 5, a study team member assisted participants with the VR device and collected data. On days 2–4, participants completed their VR sessions independently.

On day 1 of the intervention, a team member provided an orientation to the VR device to the participant. Team members were trained using a study manual with protocols and performed a return demonstration at > 90%, as evaluated by the study trainer. Once seated comfortably, the participant was asked to turn on the device and wear the headset. Next, they were immersed within the *NatureTreks* portal, where they first viewed the main virtual lobby displaying a panel array of the nine nature scenes. Participants were encouraged to take time to explore each scene. Subsequently, they were asked to choose one preferred scene, where they would be asked to spend a minimum of 10 minutes daily for the study duration. After scene selection, participants remained in that scene to complete their day one session. The participants could pause or stop the session as they wished.

After the first session, participants were given laminated handouts of VR device instructions and a troubleshooting guide. Participants were encouraged to contact the team if they had questions or difficulties. Based on the participant's preferred method of contact (i.e., phone call or text message), team members conducted check-ins on days two and/or three to follow up and answer questions from the participant. On day 4, participants received a phone call and/or text message reminder for the day five in-person session with a team member. On the fifth day of the intervention, a team member joined the participants during their final VR session. After the session, participants were thanked for their time during the study.

Interview procedure

An e-mail invitation was sent to the 12 participants who agreed to be contacted post-intervention for an interview. The e-mail instructed those who were interested to respond with their availability. A maximum of three invitations (one initial and two follow-ups) were sent to each participant. Based on their availability, a team member scheduled a 30-min time slot for the interview.

All interviews were held via videoconferencing technology, Zoom. At the beginning of the interview, the team member reminded the participant that the interview would be audio-recorded for data analysis purposes. The interview was conducted remotely in a private location for the interviewer and a preferred location for the participant. Participants were encouraged to request clarification on any questions or to pause or stop the interview at any time.

After the interviews, participants were emailed a \$25 gift card as compensation for their time. They were encouraged to contact the study team if they had follow-up questions regarding their study participation.

Data collection

Demographics were collected on day 1 of the interventional study while the team member set up the device in the home. Using a qualitative approach, semi-structured interviews were conducted, seeking detailed, in-depth descriptions of FCGs' perspectives on the feasibility and acceptability of a nature-immersive VR study. Before the interviews, an interview protocol was developed by the first author (A.P.) in collaboration with experienced qualitative researchers (R.L. and G.W.). The protocol consisted of a script and pre-determined questions, pilot-tested in a previous study with general caregivers of patients with chronic illnesses.⁷ The questions were created using feasibility and acceptability measures with strong psychometric properties as reference.¹⁹ Table 1 presents the questions.

Using the protocol, the interviews were conducted by A.P., who at the time was a Ph.D. student with advanced beginner proficiency in qualitative research, and G.C., a trained undergraduate research assistant. Follow-up questions were asked to clarify and expand on areas that were revealed to be of most interest or concern to the participant. Field notes

Table 1
Interview questions.

Category	Interview Questions
Opening	<ul style="list-style-type: none">• Describe your experience with the VR during the caregiver study that you took part in.
Category 1: Feasibility	<ul style="list-style-type: none">• Describe the components of the VR study that you found easy to use.• Describe the components of the VR study that you found difficult to use.
Category 2: Acceptability	<ul style="list-style-type: none">• Describe the benefits you feel are available through using VR.<ul style="list-style-type: none">◦ In what ways did you find VR appealing, or not?◦ What did you like most about VR?• Describe any unpleasant sensations that you may have experienced while using the VR.• To clarify, did you experience any nausea, vertigo, dizziness, difficulty focusing, headache, etc.?• During your time in the study, describe the conditions of your caregiving situation.<ul style="list-style-type: none">◦ Did you experience any challenges related to your patient's condition and your caregiving that may have affected your participation in the study?
Closing	<ul style="list-style-type: none">• What are some suggestions that you have for our research team related to the study?<ul style="list-style-type: none">◦ Any suggestions on the study set-up, VR software, VR device, instructions, organization?• Is there anything else about your experience in the VR study or comments related to the VR that you would like to share?

VR, virtual reality.

were taken, which documented interviewer observations made during the interview. Interviews were conducted until data saturation was achieved, as indicated during the analysis stage when no new categories emerged after three consecutive interviews. No repeat interviews were carried out.

Each interview was transcribed verbatim using the audio-video recording. The transcripts were de-identified using the participants' numerical code assigned to them after study enrollment. A.P. and G.C. verified the transcription independently before coding.

Data analysis

After de-identification, the transcripts were coded by two trained nurse researchers. Content analysis was conducted using Excel spreadsheets, and then confirmed using NVivo 12 Plus software.²¹ Content analysis allows for a systematic and objective means of describing and quantifying a phenomenon. Categories were predetermined and guided by the aforementioned feasibility and acceptability measures used in the quantitative component of this study.²² A deductive process was employed by evaluating the interview transcripts and field notes. Descriptive statistics were used to characterize the study sample.

The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist guided the reporting of this study.²³

Rigor and trustworthiness

Several techniques were used to maximize trustworthiness. Immediately following the interview, member checking was done with each participant for clarification and elaboration of their responses.²⁴ Credibility was ensured using investigator triangulation and having two researchers document field notes and independently analyze the data.²⁴ All differences in interpretation of data were resolved through discussion until a consensus was achieved.

Ethical considerations

This study was conducted in compliance with the Declaration of Helsinki and was approved by the Michigan State University Institutional Review Board (IRB No. STUDY00005799). Written informed consent was obtained from each participant.

Results

Of the 12 participants invited to a follow-up interview, three did not respond to the e-mail invitations, while nine responded and agreed to complete the interviews. The characteristics of the nine participants are described in Table 2. To summarize, the mean age of participants was 60 years old. Most were female, White, retired, and relatives of the patient. At the time of the interview, six caregivers were bereaved. The average length of each interview was 15 minutes.

Using the research questions as a guide to organize the interview findings, there were two content categories: feasibility and acceptability. In the first content category, feasibility, participants discussed their perceptions of ease of use and how practical and implementable the VR device was. Two subcategories were identified: 1) easy to use and 2) doable for FCGs with chronic conditions. The second content category, acceptability, gleaned FCGs' perceptions of the benefits and appeal of the VR experience and included three subcategories: enjoyment of the nature scenes, relaxation benefits of the VR, and unpleasant sensations from the VR imagery.

Content category 1: Feasibility

Sub-category 1: VR device was "easy to use"

All nine participants reported that the VR was "easy to use." After they were oriented by the team member, no participants reported experiencing any difficulties with the device. Before their study participation, most participants reported having little to no prior experience with VR. Because of this, many required additional time to orient themselves to the VR headset and controllers and the immersion. Participants found it helpful to refer to the laminated handouts of instructions and a troubleshooting guide during their study. One participant shared their experience regarding their adaptation to the device:

"[Like] with any new headset [and] headgear, just making sure that it felt comfortable and that I could see what I was supposed to."

Sub-category 2: Doable for FCGs with chronic conditions

Considering the older adult sample, many participants had chronic conditions. One participant had an eye condition involving cataract surgery yet denied any challenges with the visual imagery. This participant also compared the VR headset to another device that they use to manage a different health condition:

"It was kind of like having, oh, a larger version of my CPAP machine on my head [...]. Just 'cause I'm not used to [the headset]. I ignored [the discomfort] because I liked the [VR] so much."

Chronic health conditions may limit an individual's ability to sit for an extended period; however, the participants denied experiencing difficulties during their sessions. For a few, the weight of the headset caused some initial discomfort, as the previous participant quote shows; however, those who reported this also said that the discomfort decreased over time after acclimating to the headset. Overall, these quotes indicate that using the VR device and navigating within the scene was relatively easy, which is notable considering the older age range of participants and the health conditions that could have limited their physical ability to tolerate longer VR sessions.

Content category 2: Acceptability

This category highlighted participants' perceptions on the acceptability of the VR nature-immersive intervention and experience, including components considered appealing or unappealing and perceived benefits. Three sub-categories of acceptability emerged: 1) enjoyment of nature scenes; 2) relaxation of nature scenes; and 3) unpleasant sensations experienced.

Sub-category 1: Enjoyment of nature scenes

Among the nine offered, participants selected five scenes for their study: *Blue Ocean* ($n = 4$), *Deep Blue* ($n = 2$), *Red Savanna* ($n = 1$), *Green Meadow* ($n = 1$), and *Red Fall* ($n = 1$). The most selected scene, *Blue Ocean*, immersed participants in a tropical island beach scene. One participant described their enjoyment of this scene:

"One in particular, on the island ... [it] was very calling to me, and I would just sit there for the longest time, watching the birds fly by [and] flowers bloom. It was wonderful."

Participants denied any unappealing features of the study. However, when asked about suggestions for study improvement, one-third of participants shared that they desired to spend the required 10-min minimum in different nature scenes. One participant shared their feedback:

"I couldn't go into different rooms when we were doing the study. I mean, I went into different rooms, you know, but that didn't count as my time in the study. That's the only thing I really didn't like. I like being able to check out different ones, but I know that you guys wanted to just see how that worked with one. But I think I would have enjoyed going into more of them. Just, you know, it's calming, and it was nice to be able to check out other stuff."

The study design asked participants to select one scene to immerse themselves in for the entire study. The purpose was to track feasibility and acceptability through the use and selection of scenes. However, many participants stated that after exploring the same VR scene for five consecutive days, they eventually became "bored" and disengaged.

Further demonstrating the enjoyment of nature scenes via virtual administration, a subsample of participants suggested extending the length of the study. One-third of participants recommended that five days with the VR was too short and expressed their desire to have more days to experience and appreciate the virtual nature.

Table 2
Participant characteristics ($N = 9$).

Characteristics	Number	Range/Percentage (%)
Age (Mean \pm SD, years)	60.0 \pm 14.6	33–76
Sex		
Female	7	77.8
Male	2	22.2
Race		
White	8	88.9
Black or African American	1	11.1
Ethnicity		
Not Hispanic or Latino	9	100.0
Marital status		
Married/Living with partner	2	22.2
Divorced/Separated	2	22.2
Widowed	1	11.1
Never married	4	44.4
Level of education		
Some college/technical training	4	44.4
Completed college	2	22.2
Post-baccalaureate degree	3	33.3
Employment status		
Full-time	2	22.2
Retired	6	66.7
Not Employed	1	11.1
Relationship to patient		
Relative	7	77.8
Spouse	2	22.2
Children living at home		
No	9	100.0
Average number of hours		
Spent Caring/Day		
2–4 hours	1	11.1
5–7 hours	3	33.3
8+ hours	5	55.6
Care Setting		
In-patient	6	66.7
Home	3	33.3

Subcategory 2: Relaxation from the virtual nature-immersion

Participants described the virtual nature immersion as a tranquil and calming experience. Many said that the study obliged them to set aside time for relaxation, where they otherwise would not have done so. Another participant shared:

“The program kind of mandated that I spent, I think, 10 minutes per day on it [...] it forced me to do that when I normally wouldn't have spent 10 minutes relaxing.”

In addition to relaxation, many participants described elements of positive escapism, including getting out of their own world and being taken to a different mental space.

“It was certainly an escape from reality. For the time that I was immersed in that ... I felt like I was really there. I felt like I—You know, had left my house and I was sitting in the forest with these little creatures. And it was fun to watch them and just to, kinda get immersed in their reality, rather than mine.”

When asked about the perceived benefits of the nature-immersive VR experience, participants mentioned stress reduction and mindfulness. One participant shared:

“[The VR experience] just really took me out of my current world. Where I'm in the [virtual] world, I can look outside a window and see green and grass growing and trees. But inside my head is all crammed with stressful things to do and thoughts and whatnot [...] I'm looking, as well as hearing. [The VR experience] kind of helped erase the stressful thoughts for the time that I was using it.”

Overall, the nature-immersive VR was acceptable to participants as they all described the benefits of the nature scenes through relaxation, stress reduction, and feelings of calmness. This is especially important considering that at the time of the study, participants were caring for their dying person while also trying to manage care for themselves.

Sub-category 3: Unpleasant sensations related to the VR imagery

Most participants denied experiencing unpleasant sensations; however, two reported motion sickness. One participant described their experience during the beach scene:

“I got motion sickness. But I'm one of the people that gets it very easily. So, and then backing away, I couldn't quite navigate myself back enough to get away from the water.”

Another talked about vision blurriness:

“I had a little bit of blurriness every once in a while. I think that's my eyes, though. I'm not quite sure that was the [VR headset].”

Most participants denied experiencing any unpleasant symptoms. The two participants who did experience symptoms elaborated by saying that these symptoms were not necessarily new to them and stated that they were prone to experiencing motion sickness or blurred vision towards the end of their session due to continued exposure to moving visuals.

Discussion

This study evaluated the perceived feasibility and acceptability of a nature-immersive VR intervention of hospice FCGs, as well as the effects on supporting their QOL and improving emotional health outcomes. The quantitative findings that confirm these findings are published elsewhere.¹⁸ Overall, the findings from the interviews were positive. Participants described the VR device as easy to use and reported experiencing no challenges. This demonstrated clear feasibility, considering that most participants were older adults managing their own chronic conditions and health while also caregiving. Additionally, the nature-immersive VR experience provided many restorative benefits to FCGs' QOL and symptoms of anxiety and depression, which

complemented the quantitative findings from this study. After one session, most participants described feelings of calmness and relaxation. The VR study offered them respite, which they otherwise would not have had the opportunity to have amid their caregiving demands and responsibilities for their loved one in hospice.

Nature-based VR has previously been examined in FCG and oncology patient populations.^{7–18} Across studies, the virtual nature content has varied, from immersion into assorted scenes, similar to the current study, to therapeutic gardens or vast landscapes (blue and green spaces).^{12–16} Furthermore, virtual nature experiences have been delivered using various devices, including a headset,^{9,13–17} VR glasses,^{8,12} and goggles with built-in headphones.¹⁰ Regardless of the content and delivery method for the virtual nature experience, previous studies reported positive findings on feasibility and acceptability; however, fewer reported significant post-intervention differences in QOL and mood.^{9,10,12,14,16,18} One study examining group differences between a VR intervention group and a standard of care control group did not see observable differences between groups.¹³ Theoretical considerations through the mechanism in which nature improves cognitive functioning and emotional well-being may provide a more targeted approach, leading to more efficacious interventions.

Caregiving is associated with high cognitive demands, increasing the risk for high attentional fatigue. Nature offers restoration to these depleted cognitive reserves. This study contributes to the attention restoration theory as participants reported restoration after their nature immersive VR experience.^{4,5} Furthermore, the mechanism through which a nature experience intervention improves components of emotional well-being may be explicated through the stress reduction theory, which posits that stress management through nature exposure leads to a psycho-physiologically rested state.⁶ The qualitative findings reported here coupled with our quantitative findings provide empirical evidence supporting both the attentional restoration theory and the stress reduction theory.^{4–6,18}

Despite the overall positive responses to the current study's intervention, two participants reported mild unpleasant sensations (i.e., blurred vision and motion sickness). This aligns with previous studies reporting mild unpleasant experiences occurring during a VR session. For example, in a study with patients with colorectal cancer, one VR session was stopped prematurely because a participant experienced nausea during a session.⁹ However, similarly in our study, the symptoms were common occurrences for the participants who reported experiencing them. Future studies should consider the study eligibility or accommodation of those sensitive to virtual images in motion. In addition, despite the numerous advantages that VR offers, the relatively high cost of the headsets may limit accessibility and availability. This could be addressed by making headsets available for loan at libraries, waiting rooms, or recreational rooms of health care facilities.

Implications for nursing practice and research

Results from this study provide preliminary evidence that support the efficacy of a nature-immersive VR experience for FCGs who are providing EOLC. This work has several opportunities for expansion in clinical practice and research.

Implications for practice

These findings offer important clinical implications, as FCG emotional and cognitive needs are often overlooked secondary to patient needs. Nature experiences through VR could offer FCGs a short, daily respite between their responsibilities. Furthermore, nature immersion via VR bridges the gap in access to nature for FCGs due to time constraints and limited respite options. VR experiences can be implemented at home or in clinic settings as an opportunity for FCGs to restore and replenish. Additionally, a nature immersion could be a joint experience between the patient and FCG, providing an opportunity for connection and social bonding for the dyad.

Implications for research

This nature-based VR intervention could be expanded to FCGs across the care trajectory, extending benefits to those in early palliative care to those in the bereavement period. Additionally, the efficacy of this intervention could be explored in FCGs for patients with varying diagnoses, such as dementia, cancer, and heart failure.

Furthermore, different delivery methods of nature experiences could be examined to accommodate diverse populations. For example, future work could investigate the efficacy of auditory nature experiences for those with visual limitations related to motion sickness or eye conditions that prevent them from comfortably viewing digital images in movement. Prior studies have examined the efficacy of bird sounds and streams of water for general populations and found improvements in anxiety and depressive symptoms.^{25,26} These natural auditory sounds can be delivered via audio recordings through CDs or digital players, offered at a low cost, and be an easily accessible remedy for stress among FCGs.

Finally, future studies with larger samples and randomization would add more robust evidence for the efficacy of a nature-immersive VR intervention among FCGs. This work serves as the foundation for larger randomized clinical trials.

Limitations

Due to the small size and homogeneity of the sample, participants may not be representative of the general hospice caregiver population in the U.S. Most of our FCGs self-identified as older adults, female, educated, and retired. Additionally, the study may have attracted caregivers who were more technology-savvy and curious about exploring a digital tool for supporting their health and well-being. Those who have limited digital literacy and skills may have opted out of participating due to apprehension and preconceived thoughts about the challenges associated with the technology and device. Given these limitations, further examination of VR efficacy among diverse FCG samples is warranted, with regard to age, sex, race and ethnicity, educational attainment, and digital literacy and skills.

Additionally, given that the study objectives were to determine feasibility and acceptability, there was no control group for comparison; therefore, it cannot be concluded that the benefits reported were directly related to the VR nature experience.

Furthermore, the findings may have been biased due to social desirability, as participants may not want to disclose any negative feedback about the study. To reduce this bias, we made our best attempts to assign different team members as the interventionist and the interviewer.

Conclusions

This study evaluated the feasibility and acceptability of a nature-immersive VR experience provided to hospice FCGs. Overall, there was a positive reception as FCGs reported that the VR was easy to use, appealing, and relaxing. Findings support the need for a larger randomized clinical trial with a more diverse sample. Innovative strategies are needed to support the emotional health and QOL of FCGs providing home-based EOLC. Technology-mediated nature experiences may provide benefits to the mental restoration, emotional health, and QOL of FCGs while providing EOLC.

CRediT authorship contribution statement

Arienne Patano: Data curation, Formal analysis, Investigation, Visualization, Roles/Writing – original draft, Project administration. **Mohammed Alanazi:** Writing – review and editing. **Rebecca Lehto:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review and editing. **Dawn Goldstein:** Writing – review and editing. **Gwen Wyatt:** Conceptualization, Investigation, Methodology, Validation, Resources, Writing – review and editing, Supervision, Project

administration. All authors had full access to all the data in the study, and the corresponding author had final responsibility for the decision to submit for publication. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethics statement

The study was approved by the Michigan State University Institutional Review Board (IRB No. STUDY00005799). All participants provided written informed consent.

Funding

This work was partially supported by the Michigan State University Trifecta grant (Grant No. GA013811). The funding source had no role in the study design; data collection, analysis, or interpretation; report writing; and decision to submit the article for publication.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author, R.L., upon reasonable request.

Declaration of generative AI and AI-assisted technologies in the writing process

No generative AI and AI-assisted technologies were used during the preparation of this work.

Acknowledgments

The authors thank their community partners on this project, Hospice of Michigan and Hospice of Lansing. They also express gratitude to research assistants, Grace Caldwell (G.C.) and Lily McGowan (L.M.) for their assistance in various parts of this study. Lastly, they thank the family caregivers who shared their time with the study team during a challenging period in their lives.

References

- Patano A, Wyatt G, Lehto R. Palliative and end-of-life family caregiving in Rural areas: a Scoping review of social Determinants of health and emotional well-being. *J Palliat Med*. 2024. <https://doi.org/10.1089/jpm.2023.0566>.
- Parker Oliver D, Washington K, Smith J, Uraizee A, Demiris G. The Prevalence and risks for depression and anxiety in hospice caregivers. *J Palliat Med*. 2017;04/01 2016;20(4):366–371. <https://doi.org/10.1089/jpm.2016.0372>.
- Lehto RH, Wyatt G, Sender J, Miller SE. An evaluation of natural environment interventions for informal cancer caregivers in the community. *Int J Environ Res Publ Health*. Oct 22 2021;18(21). <https://doi.org/10.3390/ijerph18211124>.
- Kaplan S. The restorative benefits of nature: toward an integrative framework. *J Environ Psychol*. 1995;09/01/ 1995;15(3):169–182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2).
- Kaplan S. Meditation, restoration, and the management of mental fatigue. *Environ Behav*. 2001;33(4):480–506.
- Ulrich RS, Simons RF, Losito BD, Fiorito E, Miles MA, Zelson M. Stress recovery during exposure to natural and urban environments. *J Environ Psychol*. 1991;11(3): 201–230.
- Alanazi MO, Patano A, Bente G, et al. Nature-based virtual reality feasibility and acceptability pilot for caregiver respite. *Curr Oncol*. Jun 22 2023;30(7):5995–6005. <https://doi.org/10.3390/curroncol30070448>.
- Reynolds L, Rodiek S, Lininger M, McCulley MA. Can a virtual nature experience reduce anxiety and Agitation in people with dementia? *J Hous Elder*. 2018;04/03 2018;32(2):176–193. <https://doi.org/10.1080/02763893.2018.1431583>.
- Schrempf MC, Petzold J, Petersen MA, et al. A randomised pilot trial of virtual reality-based relaxation for enhancement of perioperative well-being, mood and quality of life. *Sci Rep*. 2022;07/14 2022;12(1):12067. <https://doi.org/10.1038/s41598-022-16270-8>.

10. Silva L, Machado CAM, Santana EO, et al. Guided imagery relaxation in quality of life of patients undergoing hematopoietic stem cell transplantation: a quasi-experiment. *Asian Pac J Cancer Prev APJCP*. Aug 1 2021;22(8):2453–2460. <https://doi.org/10.31557/apjcp.2021.22.8.2453>.
11. Uslu A, Arslan S. The effect of using virtual reality glasses on anxiety and fatigue in Women with Breast cancer receiving Adjuvant Chemotherapy: a Pretest-Posttest randomized controlled study. *Semin Oncol Nurs*. Oct 2023;39(5):151503. <https://doi.org/10.1016/j.soncn.2023.151503>.
12. Scates D, Dickinson JI, Sullivan K, Cline H, Balaraman R. Using nature-Inspired virtual reality as a Distraction to reduce stress and pain among cancer patients. *Environ Behav*. 2020;52(8):895–918. <https://doi.org/10.1177/0013916520916259>.
13. Czech O, Siewierska K, Krzywińska A, et al. Virtual Therapy complementary Prehabilitation of Women diagnosed with Breast cancer-A pilot study. *Int J Environ Res Publ Health*. Dec 30 2022;20(1). <https://doi.org/10.3390/ijerph20010722>.
14. Wilson K, Scorsone G. The Use of virtual reality technologies to reduce anxiety and improve experience in Chemotherapy patients during treatment. Hypothesis and theory. *Frontiers in Virtual Reality*. 2021. <https://doi.org/10.3389/frvir.2021.695449>, 2021-June-30.
15. Song R, Chen Q, Zhang Y, et al. Psychophysiological restorative potential in cancer patients by virtual reality (VR)-based perception of natural environment. *Front Psychol*. 2022;13:1003497. <https://doi.org/10.3389/fpsyg.2022.1003497>.
16. Rolbiecki AJ, Craig K, Megan P, Smith J, Ghosh P, Mehr DR. Virtual reality and Neurofeedback for management of cancer symptoms: a feasibility pilot. *Am J Hosp Palliat Care*. Mar 2023;40(3):291–298. <https://doi.org/10.1177/10499091221109900>.
17. Chin S, Cavadino A, Akroyd A, et al. An investigation of virtual reality nature experiences in patients with Metastatic Breast cancer: secondary analysis of a randomized controlled trial. *JMIR Cancer*. Jul 22 2022;8(3):e38300. <https://doi.org/10.2196/38300>.
18. Lehto RH, Patano A, Alanazi M, et al. Evaluation of a nature-based virtual reality intervention to support hospice caregivers: a pilot feasibility study. *BMJ Support Palliat Care*. Sep 18 2024. <https://doi.org/10.1136/spcare-2024-005087>.
19. Weiner BJ, Lewis CC, Stanick C, et al. Psychometric assessment of three newly developed implementation outcome measures. *Implement Sci*. Aug 29 2017;12(1):108. <https://doi.org/10.1186/s13012-017-0635-3>.
20. Cella D, Riley W, Stone A, et al. The Patient-Reported Outcomes Measurement Information System (PROMIS) developed and tested its first wave of adult self-reported health outcome item banks: 2005–2008. *J Clin Epidemiol*. 2010;63(11):1179–1194. <https://doi.org/10.1016/j.jclinepi.2010.04.011>.
21. Bengtsson M. How to plan and perform a qualitative study using content analysis. *NursingPlus Open*. 2016/01/01/ 2016;2:8–14. <https://doi.org/10.1016/j.npls.2016.01.001>.
22. Elo S, Kyngäs H. The qualitative content analysis process. *J Adv Nurs*. 2008;62(1):107–115.
23. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care*. Dec 2007;19(6):349–357. <https://doi.org/10.1093/intqhc/mzm042>.
24. Merriam SB, Tisdell EJ. *Qualitative Research: A Guide to Design and Implementation*. John Wiley & Sons; 2015.
25. Hammoud R, Tognin S, Burgess L, et al. Smartphone-based ecological momentary assessment reveals mental health benefits of birdlife. *Sci Rep*. 2022/10/27 2022; 12(1):17589. <https://doi.org/10.1038/s41598-022-20207-6>.
26. Stobbe E, Sundermann J, Ascone L, Kühn S. Birdsongs alleviate anxiety and paranoia in healthy participants. *Sci Rep*. 2022/10/13 2022;12(1):16414. <https://doi.org/10.1038/s41598-022-20841-0>.