

A pilot study of a nature-based virtual reality program on mental health among Korean immigrants during the COVID-19 pandemic

Yongseop Kim MPH^{a,*}, Junhyoung Paul Kim PhD^b, Richard Kim^c, Sungho Yoon^c

^aDepartment of Health & Wellness Design, Indiana University, Bloomington, Indiana, United States; ^bDepartment of Health Behavior, School of Public Health, Texas A&M University, Texas, United States; ^cSt. Mark's School, Southborough, Massachusetts, United States; *Corresponding author: yk67@iu.edu

Abstract

Background: The health disparity between non-immigrant and immigrant adults in utilization of formal health services as well as community-based programs has been a critical issue. The social contact restrictions imposed by the COVID-19 pandemic have been an additional contributor to mental health problems as Asian immigrants encounter barriers to interacting with others and engaging in meaningful activities.

Objective: The purpose of the study was to capture health benefits reported by Korean immigrants after experiencing a nature-based VR program.

Method: We carried out semi-structured in-depth interviews with six participants.

Results: Four important themes were identified as health benefits that nature-based VR participation provided for the participants: (1) enjoyment, (2) positive emotion, (3) reduction of stress, and (4) positive interaction.

Conclusion: These themes indicate that nature-based VR can be an effective treatment program for health promotion among Korean immigrants.

Keywords: health, immigrants, nature-based intervention, virtual reality, COVID-19, qualitative approach

INTRODUCTION

Asian immigrants underutilize community-based programs and formal health services, and experience cultural and ethnic barriers to participating in leisure-time physical activities (Derr, 2016; Yang et al., 2020). One major reason for this underutilization of programs and activities is related to the adaptation challenges encountered by Asian immigrants in navigating new cultural values and beliefs, such as a language barrier, cultural and ethnic differences, limited social networks, and experiences with discrimination (Xu & Chi, 2013; Zhang et al., 2013). Due to these adaptation challenges, Asian immigrants report high levels of psychological challenges such as loneliness, depression, and anxiety (Dewan, 2008). Research suggests that innovative programs and activities are needed to reduce the psychological challenges faced by Asian immigrants and promote greater well-being.

One therapeutic intervention has been found to promote physical, cognitive, and mental health among diverse groups of individuals including older adults, people with disabilities and disorders, and veterans (Barsasella et al., 2021; Cikajlo et al., 2017; Falconer et al., 2016; Kampmann et al., 2016) is the provision of appropriately se-

lected virtual reality (VR) programs. For example, Barsasella et al. (2021) explored the relationship between an immersive VR intervention and health-related aspects such as quality of life, happiness, and functional fitness among older adults in Taiwan. They found that participants who experienced an immersive VR intervention reported higher levels of happiness than did a control group. In addition, Gilbert et al. (2013) found that people with disabilities experienced significant improvements in positive emotion, life satisfaction, and self-esteem through participating in VR interventions. These studies suggest that VR can minimize the physical and structural barriers that prevent individuals from fully engaging in VR-based programs. Moreover, programs can be personalized based on interests and preferences and administered individually for comfort and convenience as well as to accommodate any mobility constraints (Cikajlo et al., 2017; Falconer et al., 2016; Kampmann et al., 2016).

While most research has focused on the positive effects of VR (Dębska et al., 2019; Gilbert et al., 2013; Zeng et al., 2017), some studies have identified negative aspects of VR programs such as cybersickness (e.g., nausea and dizziness, vulnerability to anxiety, and negative emo-

tional responses) (Yildirim, 2020; Yu et al., 2018). These findings underscore the importance of understanding and mitigating the negative consequences associated with VR use. Thus, it is critical to explore both the positive and negative effects of VR experiences so that the latter can be reduced, which will then allow participants to fully benefit from their experience.

To address gaps in the current literature on the VR experiences of immigrant populations (Gao et al., 2019; Quesnel & Riecke, 2018; Wagler & Hanus, 2018), this pilot study was guided by two research questions: (1) What benefits do Asian immigrants accrue through their VR experiences? and (2) What challenges do Asian immigrants encounter while participating in VR programs? The goal of this qualitative investigation was to provide researchers with preliminary information on the health-related outcomes of VR program use by immigrant participants, and the identification of the challenges to their participation as a basis for the design of a follow-up experimental study to further explore the VR experiences of Asian immigrants.

For this study, we selected a sample of Korean immigrants as they represent one of the growing ethnic minorities living in the U.S. that are understudied in the VR literature. Also, this group is known to underutilize healthcare services and community-based programs due to low English proficiency levels and perceived challenges to participation in leisure-time physical activities (Jang, 2016).

To understand the VR experiences of Korean immigrants, the present study adopted the technology acceptance model (TAM) proposed by Davis et al. (1989) which provides a multidimensional framework for assessing user acceptance and adoption of technology. This model has been applied in various technology usability evaluations and is one of the most influential and commonly used models in this type of research. This model postulates that two key criteria, namely perceived usefulness (PU), and perceived ease of use (PEOU) have a substantial impact on user attitudes toward and intention to use technology. The TAM has been incorporated into other theories to extend its usability and consequently entails four key elements, including performance expectation, effort expectation, social influence, and facilitating conditions. This theoretical framework supports the idea that individuals use novel technologies as a preferred means to safely deliver health outcomes. For example, Chen et al., (2020) employed the TAM to explore how the perception of acceptability of the use of a social robot based in a mental health intervention changes following a direct engagement. This study found that the attitudes of individuals toward technology and its perceived usefulness improved as a result of their

interaction with this technology.

METHODOLOGY

Our research team employed semi-structured, in-depth interviews to explore the VR-use experiences of Korean immigrants. Crabtree and Miller (1992) defined the in-depth interview as “a particular field research data-gathering process designed to generate narratives that focus on fairly specific research questions” (p. 93). This method allowed our research team to explore the personal and social experiences of participants and capture the unique perspectives of Korean immigrants in relation to their use of VR (Hesse-Biber & Leavy, 2010).

Participants and data collection

We used a purposeful criterion sampling strategy suggested by Patton (2002) that stipulated participants must: (a) have immigrated from Korea to the U.S., (b) be 18 years of age or older, and (c) have no prior experience with a VR program. After obtaining approval from the university Institutional Review Board (IRB), the research team obtained permission from local Korean churches, Korean student organizations, and Korean community groups to contact potential participants. Those interested contacted us by email or phone, and we provided them with the necessary forms and information (e.g., consent/assent form, explanation of the study purpose, and withdrawal procedures). After obtaining completed consent forms from six potential participants, the research team created an individualized plan with each participant to drop off and pick up the VR equipment at their home, in accordance with COVID-19 management guidelines. The team also assisted with setting up the equipment and provided instructions. Each of the six individuals participated in the program twice per week for 40 to 50 minutes during the four-week study period, which was determined based on previously conducted VR studies (Cho & Lee, 2019; Kim et al., 2020; Szczepańska-Gieracha et al., 2021). The demographic information describing the six participants is detailed in *Table 1*. This sample size was determined to be sufficient on the basis of data saturation when no new themes emerged after analysis of the six interviews, as suggested by Guest et al. (2006).

VR equipment and program content

Oculus Quest 2, the most advanced all-in-one VR system, is engineered to adapt virtual worlds to user engagement and is equipped with a headset and handheld controllers. The Nature Treks software program was used, as this program contains 11 carefully crafted themed natural environments (i.e., red savanna, blue ocean, green meadows, black beginning, white winter, blue deep ocean, turquoise oasis, white water-

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Table 1. Demographic information

No.	Name	Gender	Age	Marital status	Education level
1	Helen	Female	63	Divorced	College graduate
2	Hana	Female	40	Married	Graduate school
3	Sophia	Female	35	Married	Graduate school
4	Mike	Male	38	Married	Graduate school
5	Walter	Male	40	Married	College graduate
6	Yoseph	Male	34	Married	Graduate school

*These names are pseudonyms

fall, red autumn, violet dawn, and orange sunset) with numerous interactive features, such as discovering over 60 different animals in over 500 locations. The program also offers a range of locomotion options from which users can choose to explore these environments, including blink teleport, free movement, snap rotation, and arm-swinger. Participants could customize the weather, take control of the time of day or night, and shape the virtual world in multiple other ways. For example, they could summon birds, insects, and other fauna for authenticity and activate the audio accompanying the visualizations to fully engage in a variety of nature-based experiences.

Interview protocol

At the conclusion of the four-week program, the research team conducted individual semi-structured, in-depth interviews of 40 to 90 minutes duration to capture participant experiences with the nature-based VR program. The interviews were conducted in Korean based on participant preference, audio-recorded, and translated into English. The research team developed the interview protocol to include content-mapping and content-mining questions as suggested by Legard et al. (2003). The purpose of the content-mapping questions was to broadly explore the VR experience of each participant. Examples include "Could you tell me about your overall VR experience?" and "Did you have any challenges using the VR equipment?" The content-mining questions were asked to capture detailed evaluations of their experiences, such as "What benefits did you experience when participating in this VR program?" and "What role, if any, has this program had in helping you deal with the challenges in your life during the COVID-19 pandemic?" Data collection and analysis were conducted concurrently, which enabled us to incorporate the emerging themes into subsequent interviews.

Data analysis and trustworthiness

To analyze the data in a robust manner, we followed Creswell's (2016) five steps of qualitative data analysis including: (1) creating raw data (e.g., transcriptions, field notes), (2) organizing and reading each data set, (3) generating general themes illustrated with direct quotes, (4) articulating themes/sub-themes, and (5) interpreting the results. After generating the raw data, the primary investigator organized the data set, and

two investigators individually read each transcript to gain a broad overview of the experiences of participants after which each investigator developed an overarching theme for each transcript. Then, they collaborated to compare their findings within and among the transcripts to find patterns throughout the sample and identified similarities and differences in the reported behaviors, experiences, and perspectives of the participants. This resulted in the final set of themes and sub-themes. During the process, we compared the main themes and sub-themes with those emerging using the constant comparative method (Merriam, 1998), which strengthened our consensus on data saturation and data interpretation.

Two main strategies were used to improve the credibility of the data analysis in this study. First, we conducted member-checking to allow participants to explore multiple paragraphs of direct quotes written in Korean and our interpretations of them and express their satisfaction/dissatisfaction (coded 1-satisfied, 2-unsatisfied, 3-NA) with our data interpretations from their perspective. Participants indicated they were satisfied with our data interpretations. Second, to ensure an authentic representation of participant voices, our team verified the accuracy of the translation from Korean to English using a back-translation process, which involved randomly extracting paragraphs from each Korean transcription that were then translated by two Korean-English bilingual graduate students.

FINDINGS

Based on the experiences of participants with the VR program, this exploratory qualitative study yielded findings corresponding to the two research questions that concerned the benefits and challenges experienced by Korean immigrant participants related to their use of the VR program. Regarding possible positive outcomes of VR experiences, two main themes emerged: psychological benefits and personal connection with simulated environments. This finding suggests that the nature-based VR program can serve this population as a therapeutic tool to improve mental health. On the other hand, there were three main challenges that participants reported experiencing while they engaged with the program: (a) challenges in the immersion experience itself, (b) difficulties navigating with the controllers, and (c) cybersickness. These challenges suggest further avenues of investigation for researchers in refining this approach.

Positive outcomes of the VR experience

Psychological benefits

Experiencing psychological benefits was the most salient theme in the data. Each participant

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noted that they had experienced psychological benefits while participating in the VR program. There were two subthemes related to psychological benefits, enjoyment, and positive emotion.

Enjoyment

All participants described the simulated experiences in nature provided by this VR program as enjoyable. For example, Yoseph (male, 34) indicated that he used a feature that summoned animals (e.g., a giraffe) with whom he enjoyed interacting in different contexts. In a similar manner, Mike (male, 38) stated that while there were some differences in perceptions between reality and a virtual world, his simulated experiences were exciting, and he enjoyed being immersed in nature. According to Helen (female, 63), *“While I engaged in this VR program, I sat on the beach and saw turtles swimming around me. It felt real and enjoyable.”* She also indicated that her immersion in a VR program stimulated her imagination, which made her feel happy. Sophia (female, 35), who had frequently participated in scuba diving, immersed herself in virtual underwater habitats that she enjoyed, especially as experiencing the senses of touch and sound made the immersion *“more real.”* Yoseph (male, 34) observed that having different types of whales approach him in the deep ocean setting felt more real and was more enjoyable than observing whales in an aquarium.

Some participants enjoyed customizing the natural environment by generating various elements and interactions in different settings, such as modifying the weather and taking control of the time of day. For example, Hana (female, 44) found pleasure in transforming the colors and shapes of the mountain and trees, while Helen (female, 63) enjoyed generating and stopping rain showers, changing the time of day and night, planting trees and flowers in her chosen locations, and providing prey for animals. Also, Mike (male, 38) stated that it was fun to redesign nature according to his own ideas and determine the shape of the VR world, which deepened his appreciation of the natural environment.

Positive emotions

All participants indicated that their positive emotions increased while they were engaging in the VR program. In particular, they mentioned that the various natural environments helped them find peace and mental composure. Yoseph (male, 34), who explored the blue ocean and green meadow, found both mindfulness and peace of mind in his surroundings. He also mentioned that the VR program helped him reduce the negative feelings associated with his work stress. Mike (male, 38) stated that when he observed animals and sunsets on the beach, his simulated experiences fostered mental peacefulness and positivity.

Some participants selected their favorite natural settings (e.g., space, blue ocean, green meadow, orange sunsets, and others) when they felt depressed and stressed. They mentioned that these specific environments helped them to reduce negative emotions. In particular, as the COVID-19 pandemic was causing life challenges and psychological distress, they found that participating in this program helped them cope with these problems. For example, Sophia (female, 35) stated *“Occasionally, when I felt lonely and depressed, I explored the Blue Ocean and Green Meadow and walked through these places. It helped distract me from stress, put me in a more positive mood, and made me feel good.”*

Similarly, Walter (male, 40) shared that the ocean views, blue sky, and interactions with animals and underwater creatures boosted his positive mood and overall mental well-being. Some participants mentioned that the VR program helped reduce stress by providing a distraction from its sources and calming them. In particular, due to COVID-19, participants were spending most of their time at home experiencing concerns related to health, safety, and confinement that engaging in VR natural environments helped them with. For example, Walter (male, 40) found that the mental peace and composure that he experienced during space and deep ocean explorations reduced his stress.

Helen (female, 63) stated that peaceful sounds in nature (e.g., birds singing, water flowing, and animals rustling) helped reduce some of the stress related to doing household chores and taking care of her grandchildren in her free time. In the context of the white snow segment, Sophia (female, 35) found that observing snow on the mountain and interacting with the snow reduced her stress related to COVID-19.

Personal connection with the simulated environment

Participants also reported building personal connections with the features of the program, which helped them feel connected to the natural environments. They mentioned that the program allowed them to feel actively involved, such as in creating plantings, summoning, and feeding birds and animals, touching fish, and walking down the beach with turtles. For example, Hana (female, 40) indicated *“In the White Winter setting, I saw some rabbits hopping around in the field, and when I fed them, they gathered around me. Also, I played and ran with them. It totally made me feel great.”*

Hana also mentioned that through feeding other animals, she felt that they had become her own virtual pets and that she had created a unique

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bond with them. Similarly, Helen (female, 64), who created a virtual garden, said that she enjoyed planting trees and flowers in the virtual setting. She customized the types and colors of flowers and trees in the meadow and near the beach, and she indicated that this creative activity helped her form a unique bond with nature. Yoseph (male, 34) interacted with animals through the program and experienced stretching out his arms to touch and feed them, giving him a sense of connectedness with the animals. Hana (female, 40), who visited Red Fall, said she felt she wanted to climb the mountain and jump into the lake.

These examples indicate that the participants enjoyed the simulated experiences in nature that increased their positive emotions and reduced their stress by allowing them to actively interact with and manipulate the various contexts provided by the program and experience a sense of personal connectedness with nature. It can be concluded that the nature-based VR program allowed the participants to enjoy various simulated nature-based activities while customizing natural environments.

Negative consequences of VR experiences

Along with the positive outcomes of their VR experiences, participants identified three main challenges: (1) challenges encountered during the immersion experience, (2) difficulties navigating with controllers, and (3) cybersickness.

Challenges during the immersion experience

Some participants indicated that some nature-based content delivered via VR was not as fully developed and articulated as they were in the real natural environment, which made them lose interest and feel bored during the immersion experience. For example, Mike (male, 38) mentioned that some nature contents were not convincingly close to the real natural environments they were simulating, and after a couple of sessions, he found he was losing a sense of excitement. Hana (female, 40) shared similar experiences of boredom after several sessions of the VR program. She stated, *"It was fun to explore different contents of nature for a couple weeks. Later on, I often felt that I was wasting time doing this activity... Some people with disabilities may benefit from this program as they have limitations that prevent them from exploring the real natural world."*

Hana acknowledged that the nature-based VR program was well-designed and realistic, but she remained conscious that it was just a virtual world. Sophia (female, 35) shared similar experiences, reporting that in spite of her enjoyable engagement in the nature-based VR programs, she was always aware that the virtual world, with its limited ability to emulate nature, was illusory,

which caused her levels of enjoyment and excitement to decline.

Difficulties navigating with controllers

Complications encountered in navigating the system (e.g., manipulating controllers) caused difficulties for some participants. In particular, Helen (female, 63), who was not familiar with digital technology-based programs and the functions of electronic gadgets, stated that she had a difficult time navigating among the different nature themes, and it took an excessive amount of time for her to become competent in accessing a variety of nature content through VR. She said, *"It took me 30 minutes just to understand the controllers, and it took more time to explore and understand each nature-based theme."*

Sophia (female, 35) mentioned that there were multiple keys on the controllers, and she had a difficult time learning the function of each key and how to control it. Hana (female, 40) stated that she needed more instruction on how to operate the program as she spent a considerable amount of time learning how to use the controllers and other devices. She thought that four weeks was not enough time for her to fully engage in and enjoy the VR program. For example, she stated that once she had learned how to create her gardens, she fully engaged in this activity, but the amount of time spent learning during the study limited her enjoyment overall.

Cybersickness

Some participants experienced cybersickness, such as dizziness, during and after their participation in the VR program, particularly when they accessed virtual worlds with dark backgrounds. For example, Helen (female, 43) stated that various spatial backgrounds disoriented her, and others found that bright colors and bold patterns in various spaces caused them to experience queasiness. Similarly, Yoseph (male, 43) mentioned that his head movement to explore the submarine and space made him dizzy and uncomfortable.

A few participants reported that, while they did not experience cybersickness during their participation in the program, they sometimes felt nauseated and had headaches immediately afterward. Sophia (female, 35) shared that using VR sometimes resulted in eye strain and irritation. Mike (male, 38) stated *"When I wore the headset gear to explore the natural environments, I usually did not experience any sickness or nausea... But sometimes, when I explored the submarine or dark backgrounds, I felt somewhat dizzy and nauseated. It appeared this symptom occurred when I felt tired because of my work."*

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As this experience suggests, the current physical or mental state of participants might have influenced their VR experience.

DISCUSSION

In this exploratory pilot study, we studied the experiences of Korean immigrants with nature-based VR programs. The findings show that the participants reported positive experiences and outcomes, including psychological benefits (e.g., pleasurable experiences, stress reduction, positive feelings, and positive interactions with the virtual simulations), but also cited negative aspects, such as the inherent limitations of the VR experience, difficulties in operating the system, and cyber sickness. These findings suggest that the VR experience can be instrumental in promoting improved mental health but that possible negative effects should be mitigated to maximize the positive effects.

With regard to the content of VR activities, this study purposely selected nature-based experiences because previous findings demonstrated that traditional nature-based health interventions such as nature walks, outdoor exercise, kayaking, river trips, and wilderness adventure programs contributed to the psychological, physical, and social health of various groups of individuals such as older adults, people with physical disabilities, and adolescents (Gabrielsen & Harper, 2018; Lackey et al., 2021; Madsen et al., 2021). Our pilot study, which explored the possible effects of nature-based VR programs, extends this body of knowledge by demonstrating that VR-based nature activities may be effective in promoting the mental health and well-being of Korean immigrants.

The findings of this pilot study are well aligned with the majority of previous VR studies that have documented the positive outcomes of VR participation among various groups of individuals (Gabrielsen & Harper, 2018; Gao et al., 2019; Quesnel & Riecke, 2018; Yildirim, 2020; Yu et al., 2018). For example, Yu et al. (2018) and Gao et al. (2019) found that experiencing VR forest environments increased participant vigor and decreased negative emotions such as fatigue, tension, and depression. The notable finding of the current study is that a highly dynamic nature-based VR program that enabled participants to create their own simulated explorations and interactions with a variety of natural environments may increase their enjoyment and other positive emotions and reduce their stress. This finding supports the need for future investigations of the effects of VR interventions on the mental health of Korean immigrants. Prior studies have also found that various types of VR programs were effective as an intervention to promote the psychological and emotional health of non-immigrant VR participants (Gao et al., 2019; Quesnel

& Riecke, 2018; Yildirim, 2020). These previous studies demonstrated that VR can be used as an intervention to increase psychological and emotional health by eliminating or lowering the barriers of location and cost and allowing participants to experience simulated programs realistically.

Particularly, this study reports the possible efficacy of this VR application in improving the mental health of Korean immigrants during the COVID-19 pandemic. Little research has been conducted to investigate the benefits of VR in immigrant populations, but this current study that included Korean immigrants indicates an applicable implementation for improving mental health among Korean and other Asian immigrants.

Some studies have also highlighted the negative consequences of VR programs, including cybersickness (e.g., nausea and dizziness), vulnerability to anxiety, and negative emotional responses (Yildirim, 2020; Yu et al., 2018). Our study also found that some participants had negative experiences with VR, suggesting the need for researchers, VR developers, and instructional designers to seek practical solutions to these challenges (e.g., immersive challenges, operation complexity, and cybersickness) to maximize mental health benefits. No matter their age, female participants experienced challenges in navigating the controller system and spent more than two weeks getting comfortable using the controllers.

Some limitations of this study need to be addressed. First, this was a qualitative pilot study focused on a very small age-restricted sample of participants. Employing experimental designs with larger and more diverse samples to enable the comparison of the outcomes for treatment and control groups is recommended for a more objective measurement of the effects of nature-based VR programs on participants mental health and well-being. In addition, as Browning, et al. (2020) indicated, demographic characteristics are important variables in VR studies, and in this study, only age and gender were documented but not explored for their effects, with no information on other demographic factors such as employment, education, marital status, and time elapsed since immigration. The ages of participants in our study ranged from 34 to 63, and age can play an important role in navigating and applying technology and gaining health benefits. Thus, future research is needed to examine how these demographic factors are associated with VR participation and its effect on health. Lastly, this pilot study provided 12 sessions of VR programs for participants as a potential intervention program. The duration and pacing of the intervention may be additional factors that influence the health benefits of VR programs.

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APPENDIX I - INTERVIEW PROTOCOL TO EXPLORE HEALTH BENEFITS OF NATURE-BASED VIRTUAL REALITY (VR) PROGRAMS FOR ADULTS IN THE UNITED STATES

Content mapping/mining questions

1. Please tell me your overall experience/observation about VR nature-based experience.
2. What benefits did you think that you have gained? Provide some examples.
 - 2.1. Probe: based on your experiences/observation, what role, if any, have this VR nature-based experience had in helping you to deal with challenges/stress?
 - 2.2. Probe: based on your experience/observation, what role, if any, have this VR nature-based experience had in helping you to improve health?

- What challenges did you experience when you participated in VR nature-based experience?
- Have you thought that VR nature-based experience may affect your life in any manner?

Conclusion

Thank you for your time and contribution. The information you provided me is very helpful. I appreciate your willingness to speak with me. Would you like me to keep you informed of the findings from my study?
