

The evaluation of the Jigsawdio program on the cognitive and mental health of people living with dementia: Mixed methods study

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Abstract

Introduction: Jigsawdio is a multi-sensory personalized puzzle system that blends images and audio to stimulate cognitive function and emotional well-being in people living with dementia. This pilot study was designed to provide evidence of the effect of the use of the Jigsawdio program on cognitive function and depression among people living with dementia.

Methods: This was a single-arm, mixed-method pilot study designed to test pre-/post-changes in cognitive function and mood among people living with dementia. A total of 19 participants (people living with dementia n=9, caregivers n=6, and facility staff n=1) participated in the study. The program was designed to be implemented twice a week for six weeks, with each session lasting 30-40 minutes. We measured the baseline of the people living with dementia before the first session, and the final posttest was conducted at the end of the last session (n=9). After completion, semi-structured interviews were conducted with people living with dementia, caregivers, and staff members (n=16).

Results: Significant differences between the pre and post intervention assessments (post – pre) were found in cognition and depression scores (M: 4.55, SD = 2.92, $t = 4.68$, 95% CI: 2.31 – 6.80, $p < .05$; M = -1.00, SD = 1.00, $t = -3.00$, 95% CI: -1.76 – -0.23, $p < .05$). Qualitative findings indicated that participants experienced enhanced cognitive function and improved emotional health, though some participants also reported experiencing difficulties in solving the puzzles that led to a sense of frustration and emotional attachment to past experiences that should be considered by researchers of future clinical trials involving people living with dementia.

Discussion: The findings of this study indicate that participating in the Jigsawdio activity can be instrumental in promoting improved cognitive function and reduced depression among people living with dementia participants and that this technology-based multisensory jigsaw puzzle program can be added to the inventory of promising innovative interventions designed to improve the cognitive and emotional health of people living with dementia.

Conclusion: The study findings also emphasize the importance of technology-based jigsaw puzzles that integrate narration, photos, and music to provide a novel and fun experience that results in improvements in the cognition and emotional health of people living with dementia.

INTRODUCTION

Neurodegenerative diseases, such as Alzheimer's disease, are clinically characterized by the loss of cognitive abilities and a decline in emotional well-being, often accompanied by depression (Leyhe et al., 2017; Potter et al., 2007; Tetsuka, 2021). Participation in cognitively stimulating activities and cognitive training exercises has been positively associated with a reduction of developing dementia (Hall et al., 2009; Sajeev

et al., 2016). Numerous studies have stressed the importance of sustained cognitive engagement in preserving and enhancing cognitive function that can contribute to improved cognitive reserve (Bahar-Fuchs et al., 2019; Gates et al., 2014).

While there are many types of cognitive stimulation (Chen et al., 2019; Hall et al., 2013; La Rue, 2010; Spector et al., 2008), emerging evidence

The evaluation of the Jigsawdio program

suggests that engagement with Jigsaw puzzles can strengthen cognitive abilities and improve emotional health in older adults (Fissler et al., 2018; Lin et al., 2023). Jigsaw puzzle use has been shown to improve artistic expression, foster creative processes, and deliver physiological and cognitive benefits such as memory, visuospatial, attention, and concentration among cognitively healthy older adults (Fissler et al., 2018). Mechanistic pathways suggest that regular puzzle engagement increases the level of dopamine secretion, thereby improving memory, attention, speed, and concentration abilities (Fissler et al., 2018). Moreover, studies that focused on older adults living with dementia have demonstrated that jigsaw puzzle activities positively impacted cognitive function even in individuals experiencing cognitive decline (Erwanto & Kurniasih, 2020). These findings highlight the potential of jigsaw puzzles as an accessible and effective intervention to promote both cognitive and emotional well-being in cognitively healthy older adults and those with dementia.

It is important to recognize the variations in jigsaw puzzle design and application, particularly in the context of reminiscence therapy. Recent studies have incorporated reminiscence into jigsaw puzzle activities, demonstrating its efficacy in enhancing cognitive function and verbal skills of people living with dementia (Stallings, 2010). Jigsaw puzzle activities embedded with reminiscence enable people living with dementia to resonate with their experiences, valued events, and specific memories (Lazar et al., 2014). A systematic review of 24 studies involving nearly 2,000 participants revealed that reminiscence therapy improved quality of life, reduced depression, and decreased agitation and other behavioral symptoms among older adults living with dementia (Park et al., 2019).

There is also a greater appreciation of the benefits of applying technological approaches to cognitive health training (García-Betances et al., 2015; Ge et al., 2018; Irazoki et al., 2020). Information and communication technologies (ICTs) such as digital technologies, communicative platforms, and personalized experiences have emerged as effective platforms for delivering reminiscence through personalized and engaging experiences (D'Onofrio et al., 2017; Lazar et al., 2014; Martínez-Alcalá et al., 2016; Smith & Mountain, 2012). These studies indicate that these technologies incorporate digital content such as personal photos, music, and life stories to provide strong auditory and visual stimulation for individuals with dementia. ICTs can provide user experiences that encourage participants to sustain their engagement in reminiscence therapy and remove external obstacles such as space

and equipment requirements that hinder participation (Lancioni et al., 2021; Moon et al., 2020; Subramaniam et al., 2016). However, while ICT reminiscence therapy has shown promise, such as reducing depression, its effects on cognitive function and neuropsychiatric symptoms remain inconclusive (Moon et al., 2020).

Innovative prototypes have advanced the field of reminiscence therapy, offering user-centered approaches that enhance engagement and therapeutic outcomes. One such example is Jigsawdio, a multi-sensory, personalized puzzle system meticulously designed to stimulate cognition and emotional well-being in older adults living with dementia. Jigsawdio incorporates images and audio recordings tied to significant life events, such as childhood, family, entertainment, and marriage. Family members and caregivers contribute to personalized narrations and sounds that correspond to a set of images embedded within a single puzzle frame. As participants engage with the puzzle, they interact with these images, triggering the playback of recorded sounds that foster recall and emotional responses tied to the life moments depicted. Jigsawdio not only serves as a therapeutic tool for cognitive stimulation but also as a means of promoting emotional well-being and connecting individuals with their personal histories, offering a promising avenue for enhancing the quality of life for those affected by dementia.

This pilot study investigated the cognitive and behavioral health benefits of the Jigsawdio intervention for people living with dementia, addressing the continuing interest in creating novel interventions that improve the cognitive function and overall behavioral health of people living with dementia. While previous research has highlighted the potential of technology-based reminiscence activities to achieve validated health outcomes, there are limited evidence on how individualized multisensory interventions like Jigsawdio impact cognition and emotional well-being of older adults living with dementia.

This study used both quantitative and qualitative data collection methods to evaluate the impact of the use of Jigsawdio on cognitive function and depression among people living with dementia. Our hypothesis was that participation in the Jigsawdio program would improve cognitive function and reduce depression scores after the intervention. A qualitative study was also employed to elicit the perceptions of the benefits and challenges associated with using the Jigsawdio program from multiple stakeholders including people living with dementia, caregivers, and facility staff. Thus, this pilot study was designed to provide evidence of the effect of the use of

The evaluation of the Jigsawdio program

the Jigsawdio program on cognitive function and depression among people living with dementia. As a pilot study, the main purpose of this study was to provide the foundation for designing a follow-up experimental study to further explore the benefits of Jigsawdio program used by people living with dementia.

METHODS

Design and sample

This was a single-arm, mixed-method pilot study designed to test pre-/post-changes in the cognitive function and mood of people living with dementia. Our research team collaborated with local nursing homes and memory care units located in Indiana in the US that provide health-care services to community-based programs for people living with dementia and agreed to serve as study sites. The recruitment inclusion criteria included that participants must present with a Montreal Cognitive Assessment (MoCA) score between 10 and 26, have no prior technology-based reminiscence or related experiences, and possess basic communication skills (as determined by the research team). Potential participants were excluded if they had sensory impairment, including visual and auditory issues, a severe level of cognitive impairment making it difficult to engage in meaningful interactions (MoCA scores less than 10), or diagnosed mental illnesses such as schizophrenia, bipolar disorder, and hallucinatory delusions related to dementia. In addition, caregivers and facility staff who provided services for people living with dementia participants voluntarily participated in interviews with no specific inclusion or exclusion criteria related to their participation.

A total of 19 participants were recruited, including people living with dementia (n=12), caregivers (n=6), and facility staff (n=1) from three different facilities that offered a variety of educational and recreational programs for people living with dementia. Three participants who completed the study were excluded from data analysis due to the severity of their cognitive impairment. Ethical approval of the study protocol described above was granted by the Institutional Review Board of the sponsoring institution (IRB:#13607).

Data collection

Our research team has an established partnership with local and state-wide agencies where people living with dementia participate in community-based programs and receive healthcare services. Based on the inclusion and exclusion criteria, our research team contacted the directors of these local memory care units and long-term care facilities to receive permission to contact potential participants and their caregivers who, if interested in participating, were asked to

contact the research team by email or phone. Potential participants were screened by our research team, and a trained research coordinator conducted a MoCA test in person. People living with dementia deemed eligible for participation were scheduled for a 40 to 60-minute Jigsawdio orientation and baseline measurements. Facility staff and caregivers involved in the direct care of study participants were invited to participate in the study to provide measures specifically intended for facility staff or caregivers.

Orientation sessions and baseline measurements were conducted individually by a trained research staff member, facility staff, and caregivers. At intake, the research team obtained informed consent from caregivers or legal guardians, demonstrated the operation of the Jigsawdio program, provided education on precautions, and administered the baseline questionnaire (a paper-and-pencil survey) through which eligibility was confirmed. To collect personally meaningful photos and narrations, our research team contacted the family members of participants and obtained consent forms. We conducted multiple orientation sessions with family members and obtained multiple photos, photo narrations, music, and personal life stories that were integrated into Jigsawdio.

Intervention

Jigsawdio is a technology platform designed for individuals with cognitive impairment and dementia that provides them with an opportunity to connect with significant aspects of their lives. Participants can enjoy the customized physical Jigsaw puzzles on a personalized digital frame. Notably, six of the puzzle pieces are equipped with the capability to play audio recordings using near-field communication (NFC) technology that provides a narrative corresponding to the image depicted by that puzzle segment.

The benefits of Jigsawdio are derived from three main elements: puzzle activity, photography, and audio (see *Figure 1*). Jigsawdio is a cognitively stimulating activity that provides a cognitive training opportunity and a sense of accomplishment. The personalized puzzle in Jigsawdio stimulates a positive mood and reminiscence, while the recorded audio, including family voices and musical favorites, facilitates connecting the dots in their memory. Thus, the participants were able to resonate with experiences in their past. The program was designed to be used twice a week for six weeks, with each session lasting 30-40 minutes.

The intervention included specific measures to ensure consistency and adherence across sessions. Each session followed a standardized procedure where participants engaged with three

The evaluation of the Jigsawdio program



Figure 1. Jigsawdio

different types of puzzles (12, 24, and 36 pieces). Both visual and audio components were incorporated to enhance the puzzle-solving experience. To monitor adherence, session facilitators completed a checklist to document participants' engagement with the puzzle features. Additionally, caregivers or staff overseeing the sessions received training during the intervention, ensuring consistency and adherence to the intervention for all participants. The training consists of instructions on how to use the device, guidance for participants in resolving technical issues, and support in implementing activities.

Quantitative measurement

A pretest-posttest study design was used to measure changes in the cognitive function and depression of people living with dementia after they engaged with the Jigsawdio program for six weeks. Our research team conducted the baseline measurement prior to the first session and conducted the final posttest at the end of the final session.

Montreal Cognitive Assessment (MoCA)

The MoCA test is an instrument widely used to assess the cognitive status of individuals with cognitive disorders across a range of severities from healthy aging to Mild Cognitive Impairment (MCI) and dementia (Ciesielska et al., 2016; Freitas et al., 2000). In this study, the MoCA test was conducted by a trained research assistant on the first and the last day of the Jigsawdio intervention. A higher score describes higher levels of cognitive function.

Cornell Scale for Depression in Dementia Short Form (CSDD-SF)

The CSDD developed by Alexopoulos et al. (Alexopoulos et al., 1988) is a screening test for depressive symptoms and relies on either a clinician-administered assessment or an interview conducted by facility staff or caregivers to evaluate depressive symptoms in people living with dementia. The CSDD-SF assesses mood using four items, each rated on a three-point scale

spanning from 0 to 2: 0 = absent, 1 = mild, 2 = severe. Facility staff or caregivers assessed depression twice, before and after the intervention, with a higher score denoting higher levels of depression. Scores range from zero, indicating no depression, to eight, indicating severe depressive symptoms. A score less than two is the cutoff for possible depression.

Analysis

All statistical analyses were conducted using SPSS version 28.0. The demographic characteristics and descriptive statistics of nine participants, except the three excluded participants, were analyzed. A paired t-test was used to determine group mean differences between before and after-intervention MoCA test scores. A paired t-test was also used to investigate group mean differences in MoCA and CSDD-SF scores before and after the intervention. Consistent with prior studies, a p-value of .05 or less was considered significant given the small sample size of the current study (Grabowski, 2016; Kwak, 2023; Leo et al., 2020). Cohen's d was employed to investigate the effect size, with Cohen's d values of 0.20, 0.50, and 0.80 used to interpret observed effect sizes as small, medium, or large, respectively.

Qualitative measurement

After completion of the program, our research team conducted semi-structured interviews with people living with dementia (n=9), caregivers (n=6), and facility staff (n=1). Caregivers and staff participated in the interviews and engaged in program implementation and depression assessment. Our research team conducted individual interviews with participants, with each interview lasting approximately 20 to 50 minutes. The interview protocol was developed by our research team, and we elicited participant evaluations of the overall Jigsawdio experience, including challenges encountered, benefits received, and overall satisfaction with the technology. To capture the experience of each participant, our research team employed open-ended questions. Examples of the questions include: "Please describe your overall experience/observation about the Jigsawdio experience." "What benefits do you think that you have gained?" "What challenges did you experience (did you observe) when you participated in (observed) the Jigsawdio program?" "Have you thought that the Jigsawdio program may affect your life in any manner?"

Our research team followed the five steps of qualitative data analysis suggested Creswell et al. (Creswell et al., 2007) that included: (a) the creation of raw data from transcriptions and field notes, (b) the organization of each data set, (c) the creation of general themes with direct quotes, (d) the generation and articulation of

themes and subthemes with direct quotes, and (e) data interpretation. Our research team read each raw data set to gain a broad overview of the Jigsawdio activity experience of people living with dementia, caregivers, and facility staff. While reading each data set, investigators generated and clustered general themes and subthemes with direct quotes. When consensus was reached on the interpretation of all data sets, we produced the final set of themes and subthemes. During this process, we compared the main themes and subthemes with those that emerged using contextual analysis (Iversen, 2011), which strengthened our consensus on data saturation and data interpretations.

RESULTS

Quantitative findings assessing pre-post differences in cognition and depression

The age of the participants ranged from 66 to 86 ($M = 74.66$, $SD = 8.13$), of which 33.3% ($n = 3$) were male and 66.7% ($n = 6$) were female (Table 1). Table 2 summarizes MoCA test score descriptive statistics at the baseline and exit assessments. The MoCA score was improved at the exit assessment ($M = 20.89$, $SD = 6.09$) compared to the baseline ($M = 16.66$, $SD = 8.17$). The CSDD-SF score was increased at the exit measurement ($M = 1.77$, $SD = 2.16$) from the baseline ($M = 2.77$, $SD = 2.43$). A paired t-test (Table 3) described the matched group mean differences in the MoCA test score and CSDD-SF score. Significant differences were found in the MoCA and CSDD-SF scores between the pre and post intervention assessments (post – pre) ($M = 4.55$, $SD = 2.92$, $t = 4.68$, 95% CI: 2.31 – 6.80, $p < .05$; $M = -1.00$, $SD = 1.00$, $t = -3.00$, 95% CI: -1.76 – -0.23, $p < .05$). The effect size of the result is presented in Table 4. The group mean difference between the MoCA scores was 1.56 Cohen's d (95% CI: 0.54 – 2.53), and the CSDD-SF score was -1.00 Cohen's d (95% CI: -1.79 -0.16).

Qualitative findings

Based on participant statements about their Jigsawdio experience and the caregiver and trained staff observations, two major themes were reported as health outcomes by participants, as further described below: (a) enhanced cognitive function and (b) improved emotional health. This finding suggests that the Jigsawdio program can be beneficial for the cognitive and emotional functioning of participants. However, some participants also reported experiencing difficulties in solving the puzzles that led to a sense of frustration and emotional attachment to past experiences that should be considered by researchers of future clinical trials for people living with dementia.

Enhancing cognitive function

Enhancing cognitive function is the most significant theme identified as a benefit of using the Jigsawdio program. All people living with dementia participants indicated that they recalled and reflected upon their past meaningful events when using the Jigsawdio program and engaged with their past experiences. They mentioned that they were able to reconnect with important events through the Jigsawdio activity and had meaningful experiences while doing it. For example, one participant said,

"I still have more cherished memories that I hold dear. These puzzles have become a valuable tool for me to reminisce and reconnect with those moments." (Female, M, 84)

"Not that I obviously enjoyed it, but it got me thinking, and it's very important for a man like me to do things that keep them thinking and organizing things, and that's what the puzzles do, keep them thinking." (Male, D, 84)

In a similar manner, some participants stated that the Jigsawdio activity provided them with an opportunity to refocus on their lives and initiate reminiscence. They also mentioned that the Jigsawdio activity helped them increase their ability to remember their past and reconnect with family members and friends. For example, one participant stated,

"There were eleven of us. So, I'm really happy to get this because a lot of them died. Having this puzzle with my family photos brings back so many memories. It's a precious reminder of the eleven of us who were once together. I cherish it even more now, especially since many of them are no longer with us." (Female, M, 84)

In addition, some participants reported that they experienced increased concentration skills while engaging in the Jigsawdio activity. They indicated that engaging in the Jigsawdio activity had a positive impact on their ability to concentrate and immerse themselves in the task at hand. They emphasized that the puzzle encouraged them to channel their full attention and draw it towards the activity, resulting in a heightened sense of focus. According to the participants,

"I did my best with what I had, carefully arranging all the pictures like this." (Female, R, 71)
She focused on her puzzle activity to accomplish her goal.

Caregivers and facility staff also reported similar experiences of people living with dementia participants sharing their personal stories after participating in the Jigsawdio activity and recol-

The evaluation of the Jigsawdio program

Table 1. Demographic characteristics

Characteristics	n	%
Age		
66 to 86 years old (Mean = 74.66, SD = 8.13)	9	100
Gender		
Male	3	33.3
Female	6	66.7
Marital status		
Married	3	33.3
Widowed	4	44.4
Never married	2	22.2
Education		
High school graduate	1	11.1
Some college	1	11.1
College graduate	4	44.4
Graduate school	3	33.3
Type of Residency		
Memory care unit	5	55.5
Community-dwelling	4	45.5
Total n = 9		

lecting previous events and activities. They believed that the Jigsawdio activity stimulated the cognitive ability of people living with dementia participants and helped them reminisce about their past. They used expressions like “he talked a lot about his past experience after the program,” “he was able to remember a lot about his wedding,” and “he doesn’t remember the words to a lot of stuff, but he does definitely remember the Cubs.” Musical elements that evoked unique experiences and events for participants contributed to the development of memory skills. One participant who was an avid fan of the Chicago Cubs had been reluctant to engage in any social conversation with others, but when he participated in the Jigsawdio activity and finished his puzzle with the Cub’s team picture and its victory song, he actively shared his experience with others as identified by his caregiver. In addition, one caregiver said,

Put together the puzzle and press the button and listen to the voice and listen to the stories. I could see that bringing back somebody like that... to listening any and hearing. And then they could talk about the pictures that they see, and they can ask questions from the pictures and the stories.

Based on her observation, she valued this Jigsawdio activity as it allowed her client to recollect her memory and share it with her.

Table 2. Descriptive statistics

Variables	Mean	SD
MoCA baseline	16.33	7.38
MoCA exit	20.88	5.44
CSDD baseline	2.77	2.43
CSDD exit	1.77	2.16
Total n = 9		

These statements show that people living with dementia participants gained cognitive benefits through the Jigsawdio activity by engaging with and later sharing memorable events and stories with others. It appears that the Jigsawdio activity can be beneficial for cognitive function among people living with dementia participants.

Improving emotional health

Improving emotional health was identified as a second significant theme reported by participants related to participating in the Jigsawdio activity. They mentioned that they experienced renewed emotional attachment to their family members by recalling special moments spent with them. By reengaging with meaningful life events, they shared similar experiences of enjoying this activity. They mentioned that they were emotionally attached to the photos, memories, music, and sounds. They expressed gratitude and enjoyment for being able to participate in the Jigsawdio activities. For example,

“This makes me miss my dad. We would play games like pinning the tail on my cousin’s nose and seeing if we got it right. Those were such joyous and carefree times filled with endless laughter and amusement. We just had a lot of fun.” (Female, L, 79)

“Looking at pictures often brings laughter and amusement to my loved one’s face, as they recall cherished moments.” (Female, L, 79)

“(When I listened to Amazing Grace) I cried my heart out. Yeah. I don’t know maybe because it reminded me of going to church with my mom.” (Female, R, 71)

Participants had enjoyable experiences participating in the activity. They believed that the technology-based puzzle activity provided both enjoyment and fun. Compared to traditional puzzle activities, they reported that putting pieces of their memorable photos together and listening to stories from their family members gave them a sense of happiness and enjoyment. They used expressions such as “This is so much fun to do,” “I really enjoyed it (Jigsawdio),” “hearing my family voices talk about the photos is really appreciated,” and “listening to my favorite music with puzzles is so much fun.” Participants valued customized puzzles as an important and fun factor,

“However, amidst the laughter, there’s always a profound recognition of someone very dear to them—their daughter. The love shared between them is a source of strength and connection.” (Male, B, 86)

The evaluation of the Jigsawdio program

Table 3. Paired t-test

Variable	95% Confidence interval					
	Mean	SD	t	Sig.	Lower	Upper
MoCA (Exit – Baseline)	4.55	2.92	4.68	.00*	2.31	6.80
CSDD (Exit – Baseline)	-1.00	1.00	-3.00	.02*	-1.76	-0.23

Total n = 9

* $p < .05$

“Yeah, well, it was it was fun to put together. And so, it's there so then I can scramble it up and then put it together and take apart it together.” (Male, S, 65)

“Oh, sure. Love it. Love it. (the songs that played from the puzzle)” (Female, M, 87)

In addition, participants experienced a sense of achievement by participating in the Jigsawdio activity, and they felt that they gained confidence and personal satisfaction. While a few participants challenged themselves to complete the puzzles, they mentioned that their puzzling skills improved as they attempted to engage with more complicated puzzles made of their individualized photos. They also indicated that using their own photos and music motivated them to complete the Jigsawdio activity. For example, one participant stated,

“I learned a lot from doing the puzzle, and as you can tell, I did it much better after we’ve done it a few times.” (Male, D, 84)

“That’s true, at the beginning, when I started doing the puzzles, it was not so easy for me. But after a while, it got much easier, and I did it more quickly.” (Male, D, 84)

Some caregivers and facility staff shared their perspectives on how this activity was emotionally and mentally beneficial for their clients. They mentioned that their clients enjoyed the activity and that the emotional engagement with the photos, family voices, songs, and music gave them a sense of happiness and enjoyment. For example,

“But yeah, he really likes it. He carries a puzzle all over the place, and sometimes I played puzzle with Butch and especially for the Cubs, and we sang along, and he started crying.” (Female, L, 28)

“When she pushes that button that tells her who's kind of in that picture.” (Female, J, 75)

Table 4. Effect size (Cohen's d)

Variables	95% Confidence interval		
	Cohen's d	Lower	Upper
MoCA (Exit – Baseline)	1.56	0.54	2.53
CSDD (Exit – Baseline)	-1.00	-1.79	-0.16

Total n = 9

Based on these statements and experiences, it appears that people living with dementia participants enjoyed the activity, gained a sense of achievement, and experienced happiness. Not only

did they have fun, but they also connected with photos, narratives, and music through the activity and experienced enhanced emotional wellbeing.

DISCUSSION

This mixed-methods pilot study investigated the pre- and post-intervention changes in cognitive function and depression of people living with dementia who participated in the Jigsawdio program. This study also collected qualitative evidence describing the possible effects of engagement with the Jigsawdio program on the mental and emotional health of people living with dementia, caregivers, and facility staff. The findings provide promising evidence of mental and emotional health benefits, offering a foundation for future research to expand upon. The study showed significant improvements in participants’ MoCA and CSDD-SF scores between baseline and post-intervention measurements. These results indicate that the Jigsawdio activity can be instrumental in enhancing cognitive function and reducing depression among people living with dementia.

The qualitative findings also support the utility of the Jigsawdio program in helping people living with dementia experience improved cognitive function and emotional health. Prior studies have demonstrated that traditional jigsaw puzzles and reminiscence therapy contribute to improved cognitive and mental health in older adults and people living with dementia (Fissler et al., 2018; Lazar et al., 2014; Stallings, 2010). Similarly, studies that examined the effects of technology-based reminiscence programs have shown their efficacy in improving cognitive function and overall health among people living with dementia (Lazar et al., 2014; Martínez-Alcalá et al., 2016; Smith & Mountain, 2012). The findings of this study indicate that using the Jigsawdio program can have similar positive effects on the cognitive function and emotional health of people living with dementia and suggest that these factors can be used as additional key health outcome measures for future studies.

There is increasing recognition that innovative technology-based interventions can play an important role in promoting improvements in the cognitive health and emotional well-being of people living with dementia (García-Betances et al., 2015; Ge et al., 2018; Irazoki et al., 2020).

The evaluation of the Jigsawdio program

Prior research has stressed the importance of customized and individualized technology-based programs for maximizing health benefits (Davison et al., 2016; Lancioni et al., 2021; Moon et al., 2020; Subramaniam et al., 2016). As demonstrated, Jigsawdio, an innovative audiovisual jigsaw puzzle application, creates meaningful moments for people living with dementia using individualized puzzles.

Incorporating recorded family voices, meaningful narratives, and familiar music provides opportunities for reminiscence, emotional connection, and cognitive stimulation, enhancing experience beyond visual and tactile engagement. Compared to other digital and technological approaches that have been used to engage users socially and emotionally, Jigsawdio does not require an internet connection or technical knowledge. This system is relatively low-cost and easily approachable for users with cognitive impairments. Narrations, photos, and music are used to allow people living with dementia to increase cognitive function and emotional health. Also, there has been substantial interest in older adults generally in enhancing their digital skills post-COVID-19. Thus, the findings of this study suggest that Jigsawdio can serve as an effective intervention to enhance the cognitive function and emotional health of people living with dementia. By enabling participants to engage with personally meaningful events and activities, the program provides a valuable tool for improving quality of life and fostering emotional and cognitive resilience.

While a statistical relationship between Jigsawdio and depression was found, the magnitude of the difference was minimal. Our qualitative findings have provided additional evidence that people living with dementia who engaged with Jigsawdio experienced enjoyment and a sense of achievement, positive experiences that can be effective in reducing depression levels. Also, caregivers and facility staff provided evidence of the impact of Jigsawdio on emotional health, indicating that Jigsawdio improved the enjoyment of people living with dementia participants based on their observations. This preliminary evidence provides implications for future researchers who wish to investigate the effect of Jigsawdio program use on the emotional health of people living with dementia. Thus, the findings of this study suggest the utility of the Jigsawdio activity as a facilitator of improved emotional well-being in people living with dementia.

Despite its benefits, facilitators should be mindful of potential negative emotions that may arise during the activity. Participants might feel frus-

trated if they struggle to complete the puzzle frame or fail to recall certain family members or friends, which could lead to distress. Furthermore, engaging with puzzles linked to past memories may have significant implications for individuals with a history of dysfunctional relationships or traumatic experiences, potentially hindering their engagement. We will recommend that puzzle instructions note the possibility of, but rare occurrence of, emotional distress. This study is subject to the limitations inherent to pilot studies. The primary objective of this study was to assess pre-post intervention cognitive function and gather the perspectives of a very small sample of participants, caregivers, and facility staff of a narrowly defined population, not to demonstrate the broader effectiveness of the Jigsawdio intervention. Future research is needed in which a large sample is recruited to conduct an experimental study with both treatment and control groups that can more precisely assess the effects of the program on the cognitive and emotional health of people living with dementia by controlling for potential confounding factors. Additionally, it is important to acknowledge that the presence of facilitators, caregivers, or peers may have contributed to improvements in mood or cognitive outcomes. These interactions likely provided participants with a sense of companionship and support, which could have positively influenced the results. Finally, future research should investigate the long-term effects of the intervention and its adaptability across diverse cultural and institutional contexts.

Despite this limitation, the results of this study provide valuable implications for the dementia care community. The preliminary evidence suggests that the Jigsawdio program, a technology-based multisensory jigsaw puzzle intervention, holds promise as an innovative tool for improving cognitive health and emotional well-being of people living with dementia. These findings emphasize the importance of technology-based jigsaw puzzles that integrate narrations, photos, and music to provide novel and enjoyable experiences for the target population. In addition, the findings of this study underscore the importance of incorporating enjoyable, personalized interventions like Jigsawdio into therapeutic practices. Future researchers can build on this work by designing experimental studies to further investigate the program's effectiveness across diverse sociodemographic groups, baseline cognitive abilities, and emotional states. Such research would expand the understanding of how Jigsawdio can be tailored to meet the unique needs of people living with dementia.

The evaluation of the Jigsawdio program

Therapists and healthcare professionals can use these findings to integrate Jigsawdio into cognitive and emotional health interventions, enhancing care strategies for people living with dementia. By leveraging this innovative tool, professionals can provide more effective and

personalized therapies that promote improved quality of life and foster meaningful connections with personal memories.

Conflict of interest

The authors declare that there is no conflict of interest in this research.

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