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Research Article

Virtual Zen Garden for Residents in Long-Term Care Home: A Feasibility Study

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Abstract

Aim: To examine the feasibility and acceptability of conducting a full-scale randomized controlled trial with virtual Zen garden compared to an activity control group. **Design:** This study was designed as a single blinded randomized controlled trial with repeated measure and convergent mixed methods design. **Methods:** Participants will be randomly allocated to receive virtual Zen garden intervention or activity control. Each participant will received bi-weekly session for 3 months. Quality of life and affect before, after and 3-month post-intervention will be measured. Semi-structured interview was conducted to supplement the findings. **Results:** Significant group-time-interaction effects were noted in QUALIDEM-C ($F = 4.085$, $p = 0.011$), care relationship ($F=3.647$, $p=0.037$), positive affect ($F=0.3875$, p 0.031), negative affect ($F=7.840$, $p=0.002$), social isolation ($F=4.255$, $p=0.023$), depression ($F=13.714$, $p < 0.001$) , anxiety ($F=6.222$, $p=0.005$) and pain ($F=10.383$, $p < 0.001$). There were only significant time effects found in social relations ($F=4.455$, $p=0.020$) and feeling at home ($F=3.949$, $p=0.029$). **Conclusion:** It is the first study to examine the feasibility of virtual Zen garden. The present mixed method approach on examining quality of life would also contribute to future studies in related field. **Impact:** This is the first study to test the feasibility of virtual Zen garden which would add value on current interventions for quality of life in long-term care home population. This study also contributes to evidences of quality of life in elders using mixed method approach. **Public contribution:** The study supports the feasibility of virtual Zen garden which transfers the therapeutic effect of garden intervention in a safe and efficacious way to long-term care home population.

Keywords: Quality of life; Long-term care home; Virtual reality; Garden; Mixed method

Introduction

Garden has been increasingly appreciated in providing suitable therapeutic environments and programmers for elders [1-4]. Studies showed small yet consistent effect of outdoor garden as a multisensory environment on improving affect and wellbeing in elders [5-8]. To achieve promising and optimal intervention effect of garden, Zen garden from Asian culture has been adopted as an indoor environment and found to be have positive influence on behavior and effect of elder residents in long-term care home [9]. However, problems on set up and reliability of implementation were still of concern in studies. It is worthy to develop a feasible way to transfer the effect of Zen garden to long-term care home.

Virtual Zen garden makes use of the characteristic of Zen garden being developed specifically to calm one's mind by viewing scenery [9], in combination with merit of virtual reality (VR) in conveniently and controllably transferring therapeutic effect [10]. VR has been used to combine different therapy including horticulture and viewing forest with noted improvement in physical and mental health [11-13]. However, study on virtual

Zen garden and overall QOL as outcome measurement has not yet been conducted.

The present study aimed to examine the feasibility and acceptability of conducting a full-scale randomized controlled trial with virtual Zen garden compared to an activity control group.

Methods

This study was designed as a single blinded randomized controlled trial with repeated measure and convergent mixed methods design. Participants were randomly allocated into intervention group (completing 60-minute virtual Zen garden sessions bi-weekly) or activity control group on top of usual care for 3 months. Quantitative measurements were conducted by trained assessors blinded to group allocation in periods of preintervention (T0), post-intervention (T1) and post 3-months follow up (T2). For semi-structure interview, trained interviewers were independent from facilitation of intervention period and quantitative measurements of the trial. This study was approved by the Chinese University of Hong Kong Survey and Behavioral Research Ethics Committee.

Intervention group - Virtual Zen garden

The aims of 24-session virtual Zen garden intervention are to foster soothing and sensorial environment to improve affect and quality of life of participants through viewing landscape of Zen garden together with nature sound. The structure of Zen garden emphasizes on the principles of naturalness, simplicity, and austerity. Components of Zen garden include arrangement of rocks, sand and gravel pattern. In each session, Zen garden was presented as a set of still photos in order of landscape as a whole, followed by components of landscape and then the repeated overall landscapes. There were 6 sets presented in total with each set lasted for 10 minutes.

Activity control group

The aims of 24-session activity control are to control the social effect on affect and quality of life of participants when compared with virtual Zen garden. Activity control was provided in each session with urban scenes together with traffic sound in comparable length. Components of urban scenes include city blocks, roads and traffic. In each session, the order of presentation of urban scenes was similar to that in intervention group.

Participants

Residents were recruited from two long-term care homes in Hong Kong. Inclusion criteria were age 65 or above, length of residence of more than 3 months and informed consent obtained. The exclusion criteria included blindness, severe hearing impairment that could not be resolved by hearing aid, recent change in psychoactive medication and medical emergency. The estimated sample size was 20 participants, leading to 10 participants per group with consideration of pilot randomized trial with medium effect size expected and the sample size of main study [14].

Feasibility outcomes

Feasibility outcomes included the number of recruitment and retention using logs [15]. Acceptability of outcome measures was examined by assessing the completion rates, and the acceptability of Virtual Zen garden was examined by assessing attendance rate and rate of set-up completion. To consider the trial is feasible, at least 75% of rating in intervention group was expected [16].

Clinical outcomes

Clinical outcomes included quality of life using the Chinese version of QUALIDEM (QUALIDEM-C) validated with Cronbach's alpha of 0.895, anxiety using Rating anxiety in dementia scale (RAID) [17], depression using Cornell scale for depression in dementia (CSDD) [18], behavioral disturbances using Neuropsychiatric Inventory, Nursing Home version (NPI-NH) [19], pain using Abbey pain scale (APS) [20, 21], physiological responses include blood pressure and heart rate, functional abilities using Modified Barthel Index [22], cognitive functioning using Mini-Mental State Examination [23] and Global Deterioration Scale [24].

Post-trial interview

Four participants were invited for semi-structured interview upon completion of the study. The purpose of interview was to obtain information of virtual Zen garden in terms of its layout and content, experience of participant, and practicalities of its use in long-term care home. The interview lasted up to 30 minutes. The data were audio-recorded and transcribed verbatim.

Informed consent

Informed consent was obtained from residents without dementia and guardian of residents with dementia before data collection started. Participants were given appropriate explanation of the purpose and procedure of the study, confidentiality and anonymity, and the right to withdraw from the study. Sufficient time was given to reach a decision to ensure all the participants joined this study on voluntary basis. Consent forms were signed and dated by the participant and the witness before they entered the study. All the data were kept confidential and locked in cabinet for access restricted to researcher only.

Statistical analysis

Descriptive statistics of feasibility outcomes among the intervention and control group were compared. Clinical outcomes were analyzed with same procedure in main study using two-way repeated measures multivariate analysis of variance with post-hoc analysis to estimate effect of virtual Zen garden. Analysis were performed by SPSS. A 2-tailed P value <.05 was considered statistically significant. Data from semi-structured interview were summarized and grouped by topic without coding nor thematic analysis due to consideration of small sample size and difficulty in reaching data saturation [25].

The quantitative and qualitative data were analyzed separately before an integration process of merging the result

through compare and contrast. In the mixed analysis and merging, there was greater weighting placed on quantitative data with qualitative data as support.

Validity, reliability and rigour

Quantitative data were double entered for validation purposes. All outcome measures were examined with very good reliability and validity. The Cronbach's alpha of measure was examined in this study, using a cut-off score of greater than 0.7 to verify its use [26].

As for the qualitative data analysis, the transcribed verbatim was verified against the taped interview by principal investigator and corresponding interviewer. Data credibility was maintained by conducting an audit trail and monthly debriefing of the qualitative study team. The categories that emerge were reviewed for resonance with the quantitative outcomes.

Results

Feasibility and acceptability

Thirty residents were identified and screened for eligibility from two long-term care homes in Hong Kong. After informed consent, 20 eligible participants were recruited and completed the study. Full attendance rate was noted except 87% (21 out of 24 sessions) in one participant from intervention group and 83% (20 out 24 sessions) in one participant from control group. The completion rate of set-up and outcome measures were all 100%. There was 10% of participants (2 participants in total, each from intervention and control group) missed follow-up (T2) due to home leave. No adverse event was reported within period of pilot study.

Characteristics of samples

The 20 participants in this study were randomized into either intervention group (IG) or control group (CG), with 10 participants per each group. The participants had mean age of 85.78 ± 6.07 years and length of residence of 6.83 ± 2.64 years. There were 12 (60%) females and 8 (40%) males. The means of modified barthel index, mini-mental state examination, number of medications and body mass index were 46.67 ± 20.36, 14.28 ± 7.57, 11.00 ± 3.05 and 25.43 ± 5.61 respectively. Half of the total participants had received education for less than 3 years. There were 6 (30%) participants still married, 5 (25%) participants in normal diet. For global deterioration scale, there were 5 (25%) participants at stage 1 – 3, 12 (60%) participants at stage 4 – 5 and 3 (15%) participants at stage 6 – 7. Tests of homogeneity showed no difference in distributions on any of the characteristics between IG and CG. (Table 1) presented the baseline demographic and clinical characteristics of the samples.

Baseline characteristics	Total (n =20)	IG (n=10)	CG (n=10)	Test for homogeneity - p value
Age (in years)[a]	85.78 (6.07)	86.89 (5.73)	84.67 (6.54)	0.407
Sex[b] Female Male	 12 (60%) 8 (40%)	 4 (40%) 6 (60%)	 8 (80%) 2 (20%)	0.170*
length of residence (in years)[a]	6.83 (2.64)	6.00 (2.65)	7.67 (2.50)	0.079
number of medications [a]	11.00 (3.05)	10.78 (2.77)	11.22 (3.46)	0.672
Body Mass Index (in kg/m^2)[a]	25.43 (5.61)	23.92 (4.10)	26.93 (6.71)	0.260
Education level[b] Less than 3 years 3 years or above	 10 (50%) 10 (50%)	 5 (50%) 5 (50%)	 5 (50%) 5 (50%)	1.000
Marital status[b] Divorced/widowed/single Married	 14 (70%) 6 (30%)	 7 (70%) 3 (30%)	 7 (70%) 3 (30%)	1.000*
Diet[b] Soft/puree/tube feeding Normal	 15 (75%) 5 (25%)	 6 (60%) 4 (40%)	 9 (90%) 1 (10%)	0.303*
Modified Barthel Index[a]	46.67 (20.36)	53.89(21.47)	39.44 (17.40)	0.121
Mini-Mental State Examination[a]	14.28 (7.57)	12.67 (8.28)	15.89 (6.88)	0.625
Global Deterioration Scale a Stage 1-3 Stage 4-5 Stage 6-7	 5 (25%) 12 (60%) 3 (15%)	 3 (30%) 6 (60%) 1 (10%)	 2 (20%) 6 (60%) 2 (20%)	0.766
[a]mean (standard deviation); [b]frequency (percentage); *fisher's exact test				

Table 1: Baseline demographic and clinical characteristics of the samples

Layout

Participants found virtual Zen garden as a comfortable environment with minimal distraction. When asking of the experience in virtual Zen garden, one participant commented:

'The setting looked quite simplistic and cozy.' (Interview 1)

The background sound was similar to that in nature. One participant had comment related to the degree of immersion in virtual Zen garden:

'It sounded like cicadas were making the noise. I felt like I was in nature as I listened to it.' (Interview 2)

Content

Participants were positive about the content of Zen garden including stone, sand and pattern of gravel. They found the speed of slideshow is suitable. One participant commended on the content of slideshow with appreciation:

'The pacing was not too fast for me to appreciate the sand and stone. When I paid attention, I could see different patterns on them.' (Interview 1)

Participants expressed that the content was fruitful for exploration within the session. One participant commended on the experience in virtual Zen garden:

'I was so absorbed by how and where they (the stones) were placed that I didn't realize the time passed by until the session finished.' (Interview 2)

Potential benefits

Participants reflected on their experience in calming environment of virtual Zen garden which potentially improves their mood. One participant expressed feeling of tranquility in virtual Zen garden:

'I forgot about my worries at that moment and I was filled with calmness and peace.' (Interview 1)

Virtual Zen garden potentially creates a safe environment to foster readiness for connection with others. One participant mentioned how readiness for connection developed in virtual Zen garden:

'I felt relaxed and open to connect with others and the environment.' (Interview 2)

Clinical outcomes

The results of repeated measures multivariate analysis of variance were presented in (Table 2). Significant group-time-interaction effects were noted in QUALIDEM-C (F=4.085, p=0.011), care relationship (F=3.647, p=0.037), positive affect (F=0.3875, p 0.031), negative affect (F=7.840, p=0.002), social isolation (F=4.255, p=0.023), depression (F=13.714, $p < 0.001$) , anxiety (F=6.222, p=0.005) and pain (F=10.383, $p < 0.001$). There were only significant time effects found in social relations (F=4.455, p=0.020) and feeling at home (F=3.949, p=0.029).

	Group effect		Time effect		Group-time-interaction effect	
	F	**P value**	**F**	**P value**	**F**	**P value**
QUALIDEM-C	1.848	0.193	8.308	0.001*	4.085	0.011*
Care relationship	2.177	0.160	1.529	0.232	3.647	0.037*
Positive affect	0.315	0.583	7.125	0.003*	3.875	0.031*
Negative affect	0.530	0.477	10.720	< 0.001**	7.840	0.002*
Restless tense behavior	1.821	0.196	5.134	0.012*	2.507	0.097
Positive self-image	0.241	0.630	2.595	0.090	0.865	0.431
Social relations	1.052	0.320	4.455	0.020*	2.455	0.102
Social isolations	2.420	0.139	10.383	< 0.001**	4.255	0.023*
Feeling at home	0.135	0.718	3.949	0.029*	1.924	0.163
Having something to do	0.000	1.000	0.941	0.401	0.000	1.000
NPI-NH	1.673	0.214	1.547	0.228	1.015	0.374
CSDD	0.579	0.458	8.490	0.001*	13.714	<0.001**
RAID	1.653	0.217	6.222	0.005*	6.222	0.005*
APS	0.741	0.402	10.383	<0.001**	10.383	<0.001**
Heart rate	2.221	0.156	0.320	0.728	0.960	0.394
Systolic blood pressure	0.040	0.844	0.320	0.728	0.960	0.394

Diastolic blood pressure	2.666	0.122	0.715	0.497	0.443	0.646
*p<0.05, **p<0.001						

Table 2: Results of repeated measures multivariate analysis of variance.

Post-hoc analyses were conducted for outcome variables with significant group-time-interaction effect as shown in (Table 3). When comparing T1 to T0, IG showed significant improvement in QUALIDEM-C (mean change=5.20, standard deviation(SD)=2.66), care relationship (mean change=0.60, SD=0.52), positive affect (mean change=0.80, SD=0.42), negative affect (mean change=0.90, SD=0.32), social isolation (mean change=0.70, SD=0.48), depression (mean change=0.90, SD=0.57), anxiety (mean change=0.90, SD=0.57) and pain (mean change=0.90, SD=0.57). These improvements maintained in QUALIDEM-C (mean change=3.89, SD=3.37), positive affect (mean change=0.67, SD=0.50), negative affect (mean change=0.78, SD=0.44), social isolation (mean change=0.56, SD=0.53) and depression (mean change=0.78, SD=0.44) at T2 when compared with T0. There was no significant change found in CG at both T1 and T2.

	Mean change (SD)		**P value**	
	CG	**IG**	**CG**	**IG**
QUALIDEM-C				
T1 vs T0	-1.10 (4.15)	5.20 (2.66)	0.423	< 0.001**
T2 vs T0	0.56 (3.61)	3.89 (3.37)	0.657	0.004*
Care relationship				
T1 vs T0	-0.10 (0.57)	0.60 (0.52)	0.591	0.005*
T2 vs T0	0.11 (0.33)	0.22 (0.83)	0.347	0.447
Positive affect				
T1 vs T0	0.10 (0.57)	0.80 (0.42)	0.591	< 0.001**
T2 vs T0	0.11 (0.60)	0.67 (0.50)	0.594	0.004*
Negative affect				
T1 vs T0	0.20 (0.63)	0.90 (0.32)	0.343	< 0.001**
T2 vs T0	0.00 (0.50)	0.78 (0.44)	1.000	< 0.001**
Social isolation				
T1 vs T0	0.20 (0.42)	0.70 (0.48)	0.168	0.001*
T2 vs T0	0.00 (0.50)	0.56 (0.53)	1.000	0.013*
Depression				
T1 vs T0	0.00 (0.67)	0.90 (0.57)	1.000	< 0.001**
T2 vs T0	0.11 (0.60)	0.78 (0.44)	0.594	< 0.001**
Anxiety				
T1 vs T0	0.10 (0.57)	0.90 (0.57)	0.591	< 0.001**
T2 vs T0	0.00 (0.50)	0.67 (1.00)	1.000	0.081
Pain				
T1 vs T0	0.10 (0.57)	0.90 (0.57)	0.591	< 0.001**
T2 vs T0	0.00 (0.50)	0.44 (0.53)	1.000	0.035
*p < 0.05, **p < 0.001				

Table 3: Results of post-hoc analyses of outcome variables with significant group-time-interaction effect

The results of t-tests for physiological parameters within session were presented in (Table 4 and Table 5). The difference between IG and CG in terms of minimum and maximum heart rate did not reach significance. There was no significant difference in average heart rate before session between IG and CG. For within group comparison, only IG showed significant decrease in average heart rate after session (mean change=4.30, SD=1.25).

Outcomes	Descriptive statistic		t-tests	95% CI	
	CG	IG		lower	upper
Minimum heart rate	67.00 (5.83)	68.10 (6.72)	p=0.701	-7.013	4.813
Maximum heart rate	69.70 (5.89)	73.30 (7.13)	p=0.234	-9.746	2.546
Average heart rate before session	68.10 (5.76)	73.30 (7.13)	p=0.090	-11.293	0. 893

Table 4: Results of independent t-tests between intervention group and control for physiological parameters within session

Outcome	**CG**			**IG**		
	before	**after**	**t-test**	**before**	**after**	**t-test**
Average heart rate	68.10 (5.76)	68.10 (5.76)	p=1.000 (-0. 584, 0. 584)	73.30 (7.13)	69.00 (6.77)	p < 0.001 (3.405, 5.195)

Table 5: Results of paired t-tests of intervention group and control group for physiological parameters within session

Discussion

This study evaluated the feasibility and acceptability of conducting a full-scale randomized controlled trial with virtual Zen garden compared to activity control. It informed appropriateness for a larger scale study in terms of screening, recruitment, randomization, and retention, feasibility of virtual Zen garden and outcome measures. It also supported data collection through convergent mixed methods design where both quantitative and qualitative data at the same time point (T1).

Screening, recruitment, randomization and retention rates

A total of 30 participants were identified from two long-term care homes. There were only 20 eligible participants recruited mainly due to guardian not reachable timely for having informed consent before the study started. This suggests more time needed for guardians' response to improve recruitment rate. The outcome of randomization was acceptable for the study with comparable baseline demographic and clinical variables. The allocation outcome was acceptable to participants as there were no dropout as a consequence of having been randomized to either of the two groups. The attrition rate (10%) was low for the study as only 2 out of 20 participants missed follow-up (T2) for reasons unrelated to the intervention.

Feasibility of virtual Zen garden and outcome measures

Full attendance rate was noted in overall except one participant from IG and CG with 87% and 83% attendance rate respectively. There were 100% completion rate of set-up and outcome measures. No adverse event was reported within trial period. The trial is feasible and acceptable for participants and implementation as the 75% rating has been met.

Outcome data

Considering the small sample size of the study and therefore lack of statistical power to detect effectiveness, no definite conclusions can be drawn from the results which should be interpreted with caution. However, potential signs of improvements in quality of life, depression, anxiety and pain can be identified which can be relevant for future research. Besides, the effect of virtual Zen garden sustained for 3 months after intervention in quality of life, in overall and some domains, and depression. This suggests that virtual Zen garden potentially leads to long-term improvement in quality of life.

The results of interview indicate that participant accepted the degree of immersion in virtual Zen garden without common side effects shown in fully immersive virtual reality such as dizziness, headache and motion sickness [27]. This suggests that virtual Zen garden is a safe intervention modality taking the advantage of virtual reality in simulation of nature. The content and time frame of virtual Zen garden were acceptable to participants in long-term care home. Moreover, experience of participants indicated feeling of tranquility and readiness for connection fostered in virtual Zen garden, which is similar to environmentally-induced psychological effect in other study on virtual nature intervention [28]. These complement the quantitative findings and suggest that virtual Zen garden as a feasible, safe and effective intervention.

Limitations

Despite encouraging findings of pilot study, there were several limitations. First, the sample size of this study is small that the results should be interpreted with caution. Second, qualitative data were not thematically analyzed due to difficulty in reaching data saturation. Third, integration of quantitative and qualitative data was not feasible in this study. However, this study fulfills its aim to examine feasibility and acceptability of the research protocol on virtual Zen garden. Besides, this study indicates possible effects of virtual Zen garden on quality of life and affect. These suggest virtual Zen garden is worthy and fit for a full-scale randomized controlled trial.

Conclusion

This study gave insights in feasibility of conducting a full scale randomized controlled trial of virtual Zen garden. In aspects of the study process, recruitment rate might be improved by allowing more time for guardians' response; randomization was adequate; attrition was low; outcome measures were feasible. In

aspects of intervention, attendance rate, completion rate of set-up and outcome measures were acceptable. The layout and content of virtual Zen garden were also acceptable by participants without adverse event reported within trial period. Lastly, there are some encouraging findings in terms of benefits for quality of life and affect from virtual Zen garden. It is recommended to conduct a full-scale randomized controlled trial with an increase in capacity to better support a larger sample size and recruitment rate. These modifications strengthen the design of a full-scale randomized controlled trial to better understand the effectiveness and impact of virtual Zen garden.

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