360° Video-based virtual-reality simulation: shaping knowledge, attitudes, and social distance towards mental illness in Malaysian contexts

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ABSTRACT

Background: Mental illness is a major global public health concern, and in Malaysia, about one in three individuals experience mental health challenges. Addressing this issue requires public education, stigma reduction, and greater societal acceptance. Objectives: We aimed to determine the effect of 360° video-based Virtual-Reality (VR) simulation on shaping the attitude, knowledge and social distance toward individuals with mental illness among Malaysians. Methods: A randomized controlled trial was conducted with 82 participants assigned to a VR simulation group or a text-based control group (41 per group). The VR group viewed 360° videos via smartphones mounted in VR headsets, while the control group read the same content in text form. Participants completed pre-test, immediate post-test, and one-week follow-up assessments on attitudes, knowledge, and social distance. Results: At baseline, the VR group had significantly lower mean scores in the affective (P=0.019) and cognitive (P=0.014) attitude domains than the control group. Repeated-measures ANOVA showed significant improvements across three time points for attitudes (P=0.024), knowledge (P<0.001), and social distance (P=0.003) in the VR group, but not in the control group. The VR group demonstrated significantly higher knowledge scores than the control group at both immediate post-intervention (P=0.008) and one-week follow-up (P=0.003). Conclusion: The VR-based simulation effectively enhanced participants' attitudes, knowledge, and social distance toward individuals with mental illness, supporting its potential as an engaging tool for mental health education and stigma reduction.

Keywords:

Virtual reality, Simulation, Mental Illness, Knowledge, Attitudes, Social distance, Malaysia

INTRODUCTION

There is an increasing recognition of the role of mental illness in the burden of poor health across the world. Mental and behavioral disorders affect more than one quarter of the global population at some point during their lifetime (Mahto et al., 2009). Like many other nations, Malaysia faces diverse public

health challenges, with mental health being a significant concern; approximately one in three Malaysians is affected by mental health issues (Economic Planning Unit, 2021). Financial constraints, unemployment, workplace stress, marital problems, parenting challenges, and other environmental factors have contributed to an increase in the prevalence of mental illness in Malaysia from 10.6% in 1996 to 29.2% in 2015 (Ministry of Health Malaysia, 2020). In addition, the limited awareness and inadequate coping mechanisms within communities, together with insufficient social support, further exacerbate the impact of mental illness. Misconceptions and preconceived judgments, often based on myths and insufficient information, contribute to stigma toward individuals with mental health conditions. These stigmas can become more ingrained and foster discrimination when more persons are affected with mental illness (Corrigan et al., 2003; Corrigan et al., 2006).

Social stigma manifests itself in negative attitudes, beliefs, and stereotypes of society in respect to the people with mental disorders. These negative features contribute to the creation of prejudice and discriminating conduct (Thornicroft et al., 2007). Over the years, society's attitude to mental health has changed dramatically. A growing number of people has come to the understanding of the importance of mental health alongside learning about the wide distribution and curability of mental diseases. However, the stereotype and the wrong idea about the issue remain, which complicates the access of patients to necessary help and support (Yeap and Low, 2009).

Virtual reality (VR) is an artificial reality that is interactive, commonly using 360° technology and head-mounted displays, and places the observer in a simulated world, thereby enhancing feelings of being there and perspective-taking (Delaney and Biocca, 1995; Hawkins, 1995). Unlike Augmented Reality (AR) and Mixed Reality (MR), which partially overlay the virtual world into the physical world, users are fully disconnected from the physical world within VR, and it has been widely adopted throughout diverse fields such as entertainment, education, healthcare, and mental health, especially since the COVID-19 pandemic (Rauschnabel et al., 2022; Ball et al., 2021; Kavanagh et al., 2017; Zyda, 2005). VR improves training, diagnosis, and therapy (e.g., exposure therapy for phobias, skill-building for autism, destigmatizing mental illness by inducing the lived experience of another in the field of medicine (Javaid and Haleem, 2020; Dixon et al., 2020; Baghaei et al., 2021; Marques et al., 2022). Its availability has spread with the development of new technological platforms, such as Google Cardboard, by which easy-to-use and non-immersive VR can be experienced through smartphones (Riva and Wiederhold, 2015).

In the past 10 years, studies have investigated the impact of VR simulations on empathy, understanding, and stigma towards patients with a range of different mental illnesses. Specifically, to mental health education, VR has been employed to immerse students and the public into simulated mental illness experiences by others to promote empathy and perspective-taking. Previous studies have demonstrated varied outcomes regarding the effectiveness of VR-based interventions in reducing mental health stigma and enhancing empathy. Lam et al showed that in-class VR simulations on psychosis, mood, and anxiety disorders strengthened nursing students' empathy and positive attitudes towards patients (Lam et al., 2020). However, Yuen and Mak observed no significant difference in public stigma between immersive VR animation and first-person audio narration among Hong Kong university students (Yuen and Mak, 2021). Evidence related to schizophrenia remains inconsistent. Formosa et al and Lee et al found that VR-based training enhanced empathy, understanding, and engagement among participants, whereas Penn et al noted that empathy increased only when VR was coupled with perspective-taking activities, but occasional VR exposure alone was associated with greater social distance (Formosa et al., 2018; Lee et al., 2020; Penn et al., 2010). Similarly, Marques et al reported no significant differences in empathy or emotion recognition between VR simulation and control groups (Marques et al., 2022). Other investigations have highlighted that VR/AR education simulations can decrease stigma and boost empathy among medical students (Silva et al., 2017; Zare-Bidaki et al., 2022), although Stelzmann et al revealed that VR alone did not significantly reduce stigma and may have increased it compared to standard video (Stelzmann et al., 2021).

Beyond psychotic disorders, VR applications have also been applied in autism spectrum disorder, dementia, and depression, yielding positive outcomes. Koniou et al showed that a VR experience among adult Canadian participants had a significant effect on the knowledge, attitude and openness towards autism (Koniou et al., 2023). Regarding dementia, VR and mixed-reality simulations have yielded greater awareness and attitude in caregivers as well as health science students (Jütten et al., 2019; Gilmartin-Thomas et al., 2018; Campbell et al., 2021). Mood disorders, especially depression, have also been targeted using contact-based educational VR interventions. Lem et al revealed that VR simulation was effective in decreasing stigma towards depression and increasing empathy compared to traditional-viewing interventions (Lem et al., 2022). Overall, VR simulation has demonstrated its potential as an immersive and engaging tool for promoting knowledge about and changing attitudes toward mental illness when applied in different disorders. Its effectiveness varies depending on the type of disorder, the level of immersion, and how well the VR experience is integrated with educational components.

In Malaysia, secondary and tertiary education embrace the use of VR for immersive and interactive learning environments since both students and teachers are positive towards its integration (Wong et al., 2020; Azar and Tan, 2020; Sulaiman et al., 2020). In the field of mental health, most local interventions that aimed at reducing stigma and promoting positive attitudes towards individuals with mental illness have utilized conventional video-based formats (Ng et al., 2017; Fernandez et al., 2016; Ibrahim et al., 2020). Nevertheless, the use of VR as a tool to promote attitude change and reduce stigma toward mental illness remains relatively underutilized in Malaysia, having only limited applications for therapeutic purposes concerning autism spectrum disorder (ASD) (Mustapha et al., 2021). This represents a significant gap in the research, as VR can provide an alternative modality for promoting empathy and reshaping public perceptions rooted in common misconceptions which are often inadequately addressed by conventional educational interventions.

Introducing VR-based simulations to address attitudes toward mental illness in Malaysia holds substantial social and academic value. This approach may help reduce stigma, foster empathy, and promote community acceptance, thereby improving help-seeking behavior and mental health outcomes. Therefore, a randomized controlled trial was conducted to determine the effect of 360° video-based virtual-reality based simulation in reducing stigma towards mental illness among Malaysians. We hypothesized that participants exposed to the VR-based simulation would differ significantly in their attitudes, knowledge, and social distance toward individuals with mental illness compared with those in the text-based condition. The findings of our study are expected to contribute to the growing body of evidence supporting immersive technologies as impactful tools in mental health education and stigma reduction.

METHODS

We conducted a randomized controlled trial aimed at evaluating the effect of virtual reality simulation in changing attitudes towards mental illness among Malaysians. The research was conducted among the general population of Malaysia, comprising individuals aged 18 years and older. The study duration was six weeks, from February to March 2024.

Using OpenEpi (Version 3.01) (Dean Ag, 2013), we conducted a sample size calculation to compare the means of a continuous outcome between two independent groups such as control and intervention with an equal group size, a 95% confidence interval, and 80% power. Based on prior data, an estimated mean difference of 0.98 and a pooled standard deviation of 1.53 was used (Rodríguez-Rivas et al., 2024), yielding a minimum required sample size of 39 participants per group. To accommodate potential non-response or attrition, a 10% adjustment was applied, resulting in a final sample size of 44 participants per group.

Non-probability convenience sampling method was employed to recruit the participants. The inclusion criteria for this study were individuals aged 18 years and above, of Malaysian nationality, who provided written informed consent. The exclusion criteria included individuals with a diagnosed mental illness, underlying mental health conditions, or medical contraindications to the use of virtual reality (VR). Of the 88 participants initially assessed for eligibility, six were excluded based on the study's exclusion criteria. The remaining 82 participants provided informed consent and were randomly allocated into two groups using block randomization, with 41 assigned to the intervention group and 41 to the control group.

Initially, all participants were screened using the 12-item General Health Questionnaire (GHQ-12) to exclude individuals with known mental or physical health conditions that resulted in ineligibility for participation (Goldberg, 1978). After providing informed consent, participants completed a pre-test questionnaire assessing their knowledge, attitude, and social distance towards individuals with mental illness. Participants then received an educational poster titled "Understanding Mental Illness: Mind Matters" and a briefing from the investigators.

Participants in the experimental group were instructed to wear VR headsets and view 360-degree immersive videos with a total duration of approximately seven minutes, depicting scenarios related to dementia, schizophrenia, and autism (Alzheimer's Research UK, 2016; 360immersive, 2023; National Autistic Society, 2016). Each video was preceded by a brief textual scenario to enhance participants' understanding. The VR simulation videos were sourced from publicly available educational content on YouTube, used with appropriate permission, and depicted real-life experiences of individuals with mental illness. The 360° videos were selected based on the inclusion criteria such as (i) relevance to mental health awareness and stigma reduction, (ii) accurate and realistic portrayal of mental illness, (iii) high audiovisual quality suitable for VR viewing, and (iv) English narration easily understood by Malaysians. The second video, which focused on schizophrenia, was shortened to a two-minute segment to align with the objectives of the study. Three content experts including one psychiatrist and two public health specialists reviewed and validated the videos for accuracy and educational appropriateness. The videos were played using the investigator's smartphone. In contrast, participants in the control group were provided with detailed text-based scenarios which were corresponding to the content of the videos, in either English or Malay language. No virtual reality equipment or video material was utilized in the control group.

After the intervention, both groups completed a post-test questionnaire, while only the experimental group responded to a VR satisfaction survey. A follow-up questionnaire was administered one week after the intervention to assess the retention of knowledge, attitude, and social distance towards individuals with mental illness. Moreover, eligible participants completed a sociodemographic questionnaire which included age, gender, ethnicity, religion, occupation, education level, income, marital status, and personal experience with mental illness. The pre-test and post-test questionnaires were adapted from validated questionnaires in previous studies and translated to both English and Malay, with expert validation. The attitude questionnaire was developed by modifying items from the Perception and Attitudes Toward People with Mental Illness (PWMI) questionnaire (Abolfotouh et al., 2019) and the Community Attitudes towards Mental Illness (CAMI) scale (Taylor and Dear, 1981). The knowledge questionnaire was adapted from two previous studies (Abolfotouh et al., 2019; Al Omari et al., 2020). While the social distance questionnaire was a modified version of the 7-item Social Distance Scale (Bogardus, 1925). Additionally, participants in the intervention group completed a satisfaction survey about the VR-based intervention which was adapted from previous studies (Lam et al., 2020; Penn et al., 2010).

We used Microsoft Excel for data entry, and data were analyzed using IBM SPSS Statistics (Version 29.0 trial) (IBM, 2022). Frequencies and percentages were calculated for demographic data and VR satisfaction survey items, while means and standard deviations were used for attitude, knowledge, and

social distance scores. Between-group comparisons (intervention vs. control) were performed using independent t-test. Changes within groups across the three time points (pre-intervention, immediate post-intervention, and one-week post-intervention) were analyzed using repeated measures ANOVA, with Bonferroni adjustment applied for pairwise comparisons. P value of <0.05 was considered statistically significant.

We emphasized the importance of voluntary participation, making sure that participants had the full right to decide whether to take part in the study. Written informed consent was obtained from all participants after clearly explaining the study's purpose, procedures, potential risks, and benefits. Confidentiality and privacy were prioritized by anonymizing all collected data and storing it securely. Ethical approval for the study was obtained from the Research Ethics Committee of Manipal University College Malaysia (MUCM/ Research Ethics Committee – 009/2024).

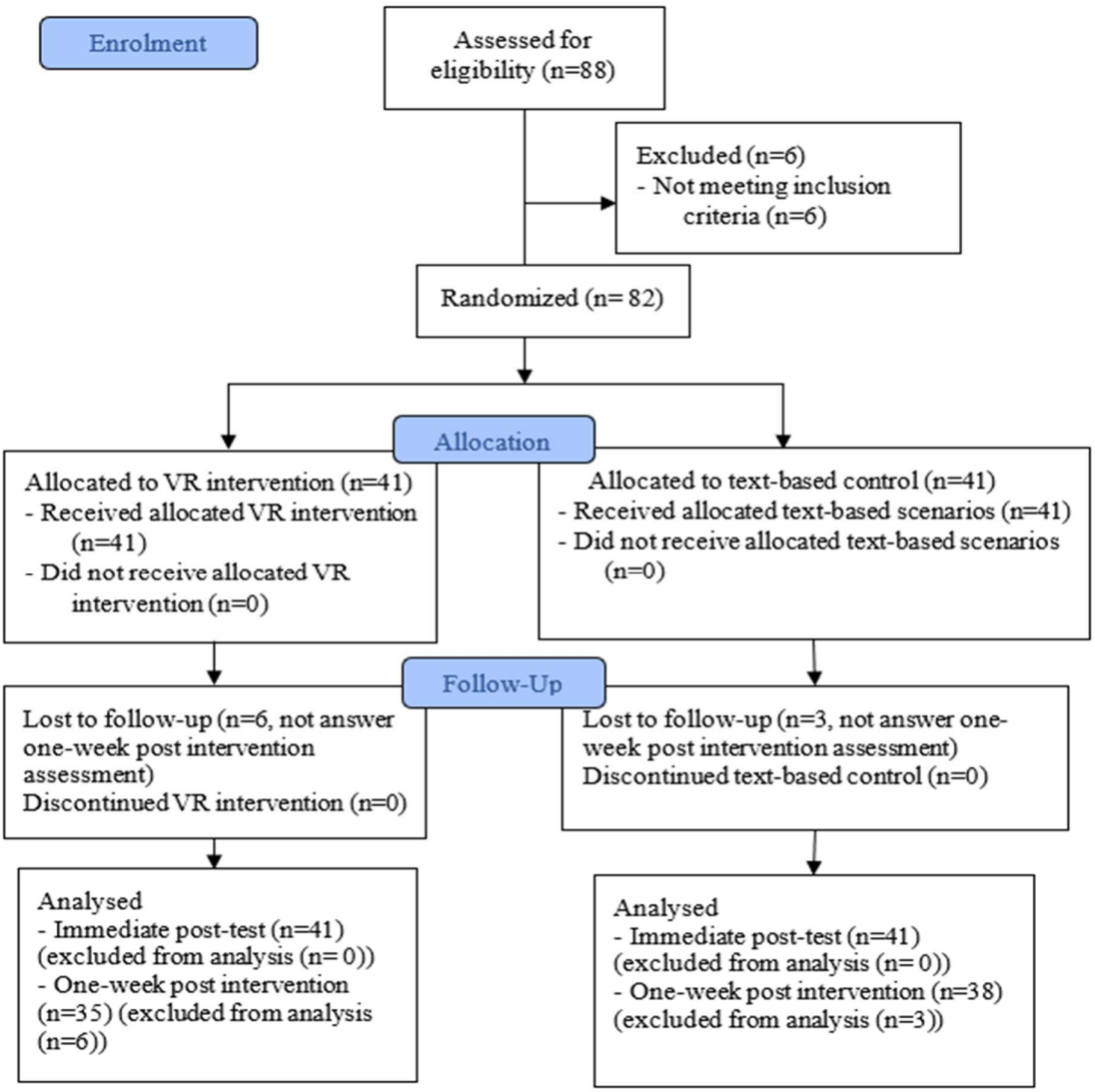

Figure 1: Consort flow diagram

RESULTS

Table 1 presents the baseline characteristics of participants in virtual reality (VR) intervention and text-based control groups. No statistically significant differences were observed between the groups in terms of age, gender, ethnicity, religion, occupation, education, field of work or study, household income, marital status, personal experience with mental illness (including having ever talked to, met, or worked with a person with mental illness), experience as a caregiver to a person with mental illness, or having a family member with current or past mental illness. [Table 1]

Table 2 illustrates a comparative analysis of attitudes toward individuals with mental illness between the VR intervention group and the control group. Before the intervention, the VR intervention group demonstrated lower mean scores across all three attitude domains such as affective, cognitive, and behavior. These differences were deemed significant in the affective (P=0.019) and cognitive (P=0.014) domains but not in the behavioral domain (P=0.707). The overall mean attitude score was lower in the VR intervention group compared to the control group with a significant result indicated by a P value of 0.027. The immediate post-intervention assessment revealed slightly higher mean score in the VR intervention group regarding affective (P=0.968), behavioral (P=0.092) as well as total attitude score (P=0.671) than the control group, but the differences were not statistically significant. At 1-week post-intervention, the VR intervention group demonstrated a higher mean score in the behavioural domain (P=0.090) and overall attitude score (P=0.830) compared to the control group. In contrast, the mean scores for the affective (P=0.781) and cognitive (P=0.475) domains were slightly lower in the VR intervention group. However, none of these differences were statistically significant. [Table 2]

Regarding knowledge about mental illness, Table 3 shows that the VR intervention group had a slightly higher mean pre-intervention score compared to the control group; however, this difference was not statistically significant. At both immediate post-intervention (P=0.008) and 1-week post-intervention (P=0.003), the VR intervention group demonstrated significantly higher mean knowledge scores than the control group. [Table 3]

Table 4 shows the results for social distancing towards mental illness between the VR intervention group and text-based control group. The VR intervention group had a lower pre-intervention mean score compared to the control group (P=0.261). Immediately post-intervention (P=0.438) and 1-week post-intervention (P=0.959), the VR intervention group displayed a slightly higher mean score compared to the control group indicating lesser social distance towards individuals with mental illness. However, these differences were not statistically significant. [Table 4]

Table 5 presents the comparison of attitudes, knowledge and social distancing towards mental illness between three time points among VR intervention and text-based control groups. In the intervention group, there was significant difference of attitudes between three time points (P=0.024), but not significant in the control group (P=0.070). In the intervention group, the mean attitude score increased significantly immediately after the intervention compared to the pre-intervention score (P=0.016). In terms of knowledge, there was significant difference between three time points in the intervention group (P<0.001), but not in the control group (P=0.430). In the intervention group, the mean knowledge score was significantly higher both immediately post-intervention (P=0.001) and at 1-week follow-up (P=0.013) compared to the pre-intervention score. Similarly, for social distancing, there was significant difference between three time points in the intervention group (P=0.003), but not significant in the control group (P=0.205). In the intervention group, the mean score improved significantly immediately after intervention (P=0.006) compared to the baseline. [Table 5]

Participants reported high levels of satisfaction and perceived effectiveness of the VR simulation. A majority strongly agreed or agreed that the simulation was interesting (95.1%), effective in increasing awareness (95.1%), and enhanced their understanding (95.1%) and attitude (87.8%) towards mental illness. Overall, 95.1% expressed satisfaction with the VR simulation, indicating its acceptability and perceived impact. [Table 6].

Table 1: Baseline characteristics of participants among Virtual Reality (VR) Simulation intervention and Text-based control group

Variable	N (%)		p value
	VR intervention (n=41)	Text-based control (n=41)	
Age			
18-25	30 (73.2)	35 (85.4)	0.054[a]
26-35	6 (14.6)	0 (0.0)	
36-45	1 (2.4)	2 (4.9)	
46-55	4 (9.8)	3 (7.3)	
56-65	0 (0.0)	1 (2.4)	
Gender			
Male	19 (46.3)	15 (36.6)	0.370[b]
Female	22 (53.7)	26 (63.4)	
Ethnicity			
Malay	1 (2.4)	3 (7.3)	0.293[a]
Chinese	16 (39.0)	11 (26.8)	
Indian	24 (58.5)	25 (61.0)	
Others	0 (0.0)	2 (4.9)	
Religion			
Islam	1 (2.4)	4 (9.8)	0.264[a]
Buddhist	10 (24.4)	10 (24.4)	
Hinduism	21 (51.2)	24 (58.5)	
Christianity	7 (17.1)	3 (7.3)	
Others	2 (4.9)	0 (0.0)	
Occupation			
Employer	2 (4.9)	0 (0.0)	0.071[a]
Government employee	0 (0.0)	1 (2.4)	
Private employee	8 (19.5)	4 (9.8)	
Self-employed	2 (4.9)	0 (0.0)	
Unemployed	0 (0.0)	2 (4.9)	
Student	29 (70.7)	34 (82.9)	
Education			
Primary	1 (2.4)	0 (0.0)	0.482[b]
Secondary	3 (7.3)	6 (14.6)	
Tertiary	37 (90.2)	35 (85.4)	
Field of work/study			
Healthcare	24 (58.5)	23 (56.1)	0.823[b]
Non-healthcare	17 (41.5)	18 (43.9)	
Household income			
B40 (≤ RM5250)	14 (34.1)	11 (26.8)	0.173[b]
M40 (RM5,251 - RM11,819)	17 (41.5)	12 (29.3)	
T20 (≥ RM11,820)	10 (24.4)	18 (43.9)	

Marital status			
Single	35 (85.4)	35 (85.4)	0.572[b]
Married	5 (12.2)	5 (12.2)	
Divorced	0 (0.0)	1 (2.4)	
Widowed	1 (2.4)	0 (0.0)	
Have you ever talked to a person with mental illness?			
Yes	33 (80.5)	30 (73.2)	0.432[b]
No	8 (19.5)	11 (26.8%)	
Have you ever met a person with mental illness?			
Yes	33 (80.5)	33 (80.5)	0.999[b]
No	8 (19.5)	8 (19.5)	
Have you ever worked with a person with mental illness?			
Yes	13 (31.7)	8 (19.5)	0.206[b]
No	28 (68.3)	33 (80.5)	
Are you a caregiver to someone who is mentally ill?			
Yes	9 (22.0)	5 (12.2)	0.240[b]
No	32 (78.0)	36 (87.8)	
Do you have a family member who is mentally ill or who has recovered from mental illness?			
Yes	11 (26.8)	11 (26.8)	0.999[b]
No	30 (73.2)	30 (73.2)	

[a]Fisher Exact test, [b]Chi-square test, $p<0.05$ is statistically significant

Table 2: Attitudes toward people with mental illness between Virtual Reality (VR) Simulation intervention group and Text-based control group

Variable	**Mean (SD)**		**Mean difference (95% CI)**	**p value**
Attitudes toward people with mental illness	**VR intervention (n = 41)**	**Text-based control (n = 41)**		
Pre-intervention				
Affective domain score (5-20)	15.05 (3.02)	16.61 (2.89)	-1.57 (-2.86, -0.26)	0.019[c]
Cognitive domain score (5-20)	13.66 (2.56)	15.29 (3.30)	-1.63 (-2.93, -0.34)	0.014[c]
Behavioural domain score (5-20)	15.61 (2.35)	15.80 (2.33)	-0.20 (-1.22, 0.83)	0.707[c]
Attitude total score (15-60)	44.31 (6.45)	47.71 (7.15)	-3.39 (-6.38, -0.40)	0.027[c]
Immediate post-intervention	**VR intervention (n = 41)**	**Text-based control (n = 41)**		
Affective domain score (5-20)	16.02 (2.70)	16.00 (2.78)	0.02 (-1.18, 1.23)	0.968[c]
Cognitive domain score (5-20)	14.32 (2.15)	14.61 (3.14)	-0.29 (-1.48, 0.89)	0.624[c]
Behavioural domain score (5-20)	16.32 (2.44)	15.44 (2.23)	0.88 (-0.15, 1.90)	0.092[c]
Attitude total score (Immediate after) (15-60)	46.66 (5.76)	46.05 (7.13)	0.61 (-2.24, 3.46)	0.671[c]
1-week post-intervention	**VR intervention (n = 35)**	**Text-based control (n = 38)**		
Affective domain score (5-20)	15.69 (2.74)	15.87 (2.84)	-0.18 (-1.49, 1.12)	0.781[c]
Cognitive domain score (5-20)	13.77 (1.96)	14.21 (3.16)	-0.44 (-1.66, 0.78)	0.475[c]
Behavioural domain score (5-20)	16.03 (2.43)	15.08 (2.29)	0.94 (-0.15, 2.05)	0.090[c]
Attitude total score (15-60)	45.49 (5.85)	45.16 (7.04)	0.33 (-2.70, 3.36)	0.830[c]

[l]ndependent t-test, $p<0.05$ is statistically significant

Table 3: Knowledge towards mental illness between Virtual Reality (VR) Simulation intervention group and Text-based control group

Variable	Mean (SD)		Mean difference (95% CI)	p value
Knowledge (0-11)	**VR intervention (n=41)**	**Text-based control (n=41)**		
Knowledge score (Pre-intervention)	6.85 (1.90)	6.22 (2.07)	0.63 (-0.24, 1.51)	0.153[c]
Knowledge score (Immediate post-intervention)	7.61 (1.16)	6.63 (1.97)	0.98 (0.26, 1.69)	0.008[c]
	VR intervention (n=35)	**Text-based control (n=38)**		
Knowledge score (1-week post-intervention)	7.60 (1.51)	6.37 (1.85)	1.23 (0.44, 2.03)	0.003[c]

[c]Independent t-test, $p<0.05$ is statistically significant

Table 4: Social distancing towards mental illness between Virtual Reality Simulation intervention group and Text-based control group

Variable	Mean (SD)		Mean difference (95%CI)	p value
Social Distancing (7-28)	**VR intervention (n=41)**	**Text-based control (n=41)**		
Social Distancing (Pre-intervention)	16.02 (4.38)	17.10 (4.21)	-1.07 (-2.96, 0.82)	0.261[c]
Social Distancing (Immediate post-intervention)	18.10 (4.64)	17.29 (4.72)	0.80 (-1.25, 2.86)	0.438[c]
	VR intervention (n=35)	**Text-based control (n=38)**		
Social Distancing (1-week post-intervention)	17.60 (4.58)	17.66 (4.98)	-0.06 (-2.30, 2.18)	0.959[c]

[c]Independent t-test, $p<0.05$ is statistically significant.

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Table 5: Comparison of Attitudes toward people with mental illness, Knowledge towards mental illness and Social distancing between Three time points among Virtual Reality Simulation intervention and Text-based control groups

Variable	VR intervention		Text-based control	
	N	p value	N	p value
Attitudes toward people with mental illness				
Pre- vs Immediate post-intervention	41	0.007[d]	41	0.041[d]
Pre- vs 1-week post-intervention	35	0.218[d]	38	0.039[d]
Immediate vs 1-week post-intervention	35	0.069[d]	38	0.418[d]
Knowledge towards mental illness				
Pre- vs Immediate post-intervention	41	0.004[d]	41	0.210[d]
Pre- vs 1-week post-intervention	35	0.004[d]	38	0.569[d]
Immediate vs 1-week post-intervention	35	0.900[d]	38	0.385[d]
Social distancing				
Pre- vs Immediate post-intervention	41	<0.001[d]	41	0.667[d]
Pre- vs 1-week post-intervention	35	0.025[d]	38	0.099[d]
Immediate vs 1-week post-intervention	35	0.363[d]	38	0.313[d]

[d]Dependent t-test, $p<0.05$ is statistically significant

Table 6: Satisfaction towards Virtual Reality (VR) Simulation intervention (n = 41)

Item	Frequency (%)				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The VR simulation was interesting.	25 (61.0%)	14 (34.1%)	2 (4.9%)	0 (0.0%)	0 (0.0%)
The VR simulation is an effective way of increasing awareness of mental illness.	31 (75.6%)	8 (19.5%)	2 (4.9%)	0 (0.0%)	0 (0.0%)
After the VR simulation, I have an increased understanding about mental illness.	29 (70.7%)	10 (24.4%)	2 (4.9%)	0 (0.0%)	0 (0.0%)
After the VR simulation, I have a more positive attitude about mental illness.	25 (61.0%)	11 (26.8%)	4 (9.8%)	1 (2.4%)	0 (0.0%)
I am satisfied with this VR simulation.	29 (70.7%)	10 (24.4%)	1 (2.4%)	0 (0.0%)	1 (2.4%)

DISCUSSION

This randomized controlled trial evaluated the effectiveness of a 360° video-based virtual reality (VR) simulation in reducing stigma toward mental illness among Malaysians, specifically by comparing knowledge, attitudes, and social distance between participants exposed to the VR-based simulation and those receiving a text-based intervention. We found that the VR intervention group exhibited significantly lower baseline scores in the affective and cognitive domains of attitude compared to the control group. However, these differences were no longer significant at immediate post-intervention and 1-week follow-up. While between-group differences were not statistically significant at follow-up, the VR group exhibited internal improvements in attitude from a lower baseline, whereas the control group showed a decline over time. The observed baseline differences in cognitive and attitude domain scores between the VR intervention and control groups could be attributed to random variation despite randomization, as small group sizes may not have fully balanced participant's characteristics. Additionally, participants in the control group received only a text-based scenarios, which may have offered limited engagement and emotional connection compared to the immersive VR experience. The lack of interactive or experiential learning elements in the control condition could have contributed to lower motivation and attention, possibly explaining the decline in their scores over time. Conversely, the VR simulation provided a more vivid and empathic understanding of mental illness, which may have helped sustain or improve positive attitudes among participants despite initial lower baseline scores. Our findings suggest that the VR intervention may have contributed to positive changes in attitudes among participants with initially less favourable views, highlighting its potential to mitigate pre-existing disparities in stigma-related attitudes. This aligns with emerging evidence demonstrating VR's effectiveness in enhancing healthcare trainees' attitudes toward mental illness and dementia. Studies among nursing and health students found that VR-based simulations significantly improved attitudes, empathy, and understanding of patients' experiences compared to no intervention or 2D video alternatives (Lam et al., 2020; Marques et al., 2022). Similarly, randomized and non-randomized controlled trials showed that immersive VR experiences enhanced knowledge, attitudes, and empathy toward individuals with psychosis and dementia among medical, nursing, and pharmacy students, with superior outcomes compared to standard curriculum training (Famosa et al., 2018; Gilmartin-Thomas et al., 2018).

Both the VR and text-based control groups in our study were provided with an online poster detailing the causes of mental illness, treatment options, and common misconceptions. Our study demonstrated that the VR intervention significantly enhanced knowledge about mental illness compared to the control group. Additionally, within the VR group, significant improvements were noted in knowledge at both post-intervention time points. In contrast, no significant changes in knowledge were observed within the control group over time. Our findings align with previous evidence demonstrating the effectiveness of VR-based mental health education. Randomized and quasi-experimental studies across diverse populations, including students in Canada, Japan, and Australia, have consistently shown that VR interventions enhance knowledge, empathy, and attitudes toward mental illness compared with traditional or video-based methods (Koniou et al., 2023; Lem et al., 2022; Campbell et al., 2021)

In our study, social distance was assessed across three timelines. We found no statistically significant differences between the VR intervention and control groups at post-intervention assessments, despite a trend toward improvement that was observed in the VR group. However, the control group showed no significant changes in social distancing over time. Hence, our findings portrayed a possible effect of VR simulation in reducing social distancing towards mental illness. The observed reduction in social distancing in the VR group in our study may be attributed to reduced stigmatization towards mental illness. These findings are consistent with previous quasi-experimental study who reported that VR interventions reduced stigma toward mental illness among Brazilian medical students (Silva et al., 2017). However, other studies have shown mixed outcomes, as VR exposure alone, without adequate

contextual information, could increase social distance or reduce social proximity toward individuals with schizophrenia, suggesting that the effectiveness of VR may depend on prior knowledge and framing of mental illness (Penn et al., 2010; Stelzmann et al., 2021).

Participants of our study expressed high levels of satisfaction and perceived the VR simulation as effective in increasing awareness, understanding, and improving attitudes towards mental illness, highlighting its acceptability and potential as an engaging educational tool. Additionally, the VR simulation was found to enhance participants' understanding of the patient's inner world. Similar findings have been documented in previous studies, where VR-based simulations improved empathy, professional values, and attitudes toward mental illness, autism, and depression, and were consistently rated as enjoyable and effective learning experiences (Yuen and Mak, 2021; Lem et al., 2022). Notably, immersive 360-degree VR experiences simulating patients' perspectives with mood disorders, psychosis, and anxiety disorders were rated as interesting, enjoyable learning experiences that facilitated understanding of patients' difficulties (Lam et al., 2020)

We acknowledge several limitations in this study. The use of a cost-effective VR tool may have limited immersive experience compared to higher-end systems, and the short follow-up period restricted our ability to assess the long-term sustainability of the intervention's impact. Moreover, the predominance of participants aged 18–25 may limit the generalizability of our findings. The VR simulation was not produced in the local language or tailored to Malaysian cultural contexts due to resource and time constraints. Future research should address these limitations by recruiting more diverse participants, employing higher-quality VR systems, developing culturally adapted simulations in local languages, and extending follow-up durations to assess sustained impact. Furthermore, public engagement through culturally relevant digital education initiatives could help strengthen awareness and reduce mental health stigma.

In conclusion, this study demonstrates that VR-based simulations can positively influence attitudes, knowledge, and social distance related to mental illness among participants. The integration of 360-degree VR simulations into mental health education and community awareness initiatives is encouraged to promote empathy, reduce stigma, and foster a more informed and inclusive understanding of mental illness.

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