Evaluating the Effects of Experiencing Virtual Reality Simulation of Psychosis on Mental Illness Stigma, Empathy, and Knowledge in Medical Students

Majid Zare-Bidaki[1], Alireza Ehteshampour[1], Masoud Reisaliakbarighomi[2], Robabeh Mazinani[3], Mohammad Reza Khodaie Ardakani[3], Arash Mirabzadeh[2,3], Rosa Alikhani[3], Mehdi Noroozi[3], Fereshteh Momeni[3], Amir Dehghani Samani[1], Mohammad Mahdi Mehrabi Tavana[4], Aliakbar Esmaeili[5,6] and S. Bentolhoda Mousavi[2,3]

[1] Social Determinants of Health Research Center, Faculty of Paramedical Sciences, Birjand University of Medical Sciences, Birjand, Iran, [2] Psychiatry Department, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [3] Psychosis Research Center, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [4] Psychology Department, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran, [5] Clinical Research Development Unit of Imam Reza Hospital, Birjand University of Medical Sciences, Birjand, Iran, [6] Psychiatry and Behavioral Science Research Center, Birjand University of Medical Sciences, Birjand, Iran

Objectives: Applying technologies such as virtual reality (VR) in education has gained popularity especially in comprehending abstract and subjective phenomena. Previous studies have shown that applying a virtual reality simulation of psychosis (VRSP) is useful in increasing knowledge and empathy toward patients. Here, the efficacy of using VRSP in altering stigma, empathy and knowledge as well as side effects have been assessed in medical students in comparison with the routine education (visiting the patients).

Method: After attending one session of lecture about positive psychotic symptoms, medical students were allocated to two groups: experiencing one session of VRSP or visiting patients under supervision as routine practice in the ward. Before and after the first session and after the second one, questionnaires of knowledge, empathy and stigma were filled by students. Finally, the results were compared in two groups.

Results: Both interventions were effective in reducing stigma as well as increasing knowledge and empathy toward patients with psychotic experiences. VRSP could significantly reduce stigma and increase knowledge and empathy compared with the traditional visiting patients under supervision. The side effects were minimal and ameliorated right after the experience.

Conclusion: VRSP is an effective tool in decreasing stigma and increasing empathy and knowledge of the students and can be incorporated in psychiatric education with minimal side effects.

Keywords: psychosis, stigma, empathy, virtual reality, simulation, medical education, E-learning

INTRODUCTION

Psychiatric disorders are associated with an overwhelming stigma, not only among general population, but also within healthcare providers and students especially the novitiates (1–3). Stigma directly affects help-seeking behaviors (4–6). In case of mental health problems, holding negative attitudes toward psychiatric disorders and perceived negative social consequences related to them, leads to denial, which subsequently results in postponing the necessary treatment (4). Even the attitudes, manners, and speech of mental health professionals can nourish stigma, which is called the "Iatrogenic stigma" (7, 8).

Anti-stigma movements have proposed different interventions to overcome the stigma toward patients, among which social interaction in combination with education is the most effective one (2, 9). Different curricula applied in psychiatric education have been shown to decrease stigma toward patients with mental illness through education as well as direct contact with patients (10, 11).

Recent literature suggests that simulations of first-hand experiences in virtual environments can decrease implicit stereotypes and reduce stigma (9, 12). Utilizing compound contact-based interventions such as watching film and live contact can considerably improve outcomes of attitude and knowledge toward mental illness (2, 13). There are, however, concerns over a mere simulation of psychotic disorders without any education as such interventions may prove counterproductive (12). This is an important criticism that efforts of reducing stigma through focusing on first-hand experience simulation, might lead to an excessive focus on symptom experience without appreciation for the "whole person" that one might obtain from a contact experience.

Educational methods have improved dramatically in recent years and incorporating innovative technologies such as virtual reality (VR) into traditional pedagogic methods has gained popularity. Literature suggests that utilizing VR, as an immersive environment, can increase motivation, engagement, and the time spent for learning in students. Using VR in education promotes students' ability in cognitive tasks and indorses affective and psychomotor skills (14, 15). VR can also improve students' knowledge, empathy, and reduce stigma toward patients with mental health disorders (16, 17). The graphical quality and the sense of presence (immersion) have been proposed to be important factors affecting learning outcomes (14, 18).

Virtual environments have several applications in psychiatric education. Simulating a complex or nontangible condition for students to get involved in -as a first-person experience- is one of these applications (16, 17). Positive psychotic symptoms such as hallucinations and delusions are subjective and complicated experiences that are difficult to understand. Hallucinations are perceptions without any external source and delusions are misbeliefs without any factual evidence to support them (17, 19, 20). These symptoms present not only in psychiatric disorders but also in other medical conditions such as hearing loss or neurological conditions (20, 21). Despite the prevalence, students often complain of the difficulty of understanding the symptoms. On the other hand, holding negative attitudes towards patients experiencing psychotic symptoms (stigma) is common among students and health care providers (7, 17, 22, 23).

Limited studies have assessed the outcomes of incorporating VR in routine education in reducing stigma toward patients. Previous studies suggest that simulating first-person experiences in VR can effectively increase knowledge of the symptoms and empathy toward patients with minor side effects such as mild cybersickness (17, 24). For instance, Formosa et al. simulated positive psychosis symptoms in a VR setting; their study suggests that one session of experiencing it could increase students' knowledge, attitude, and improve empathy toward patients with psychosis (16). In their study, however, questionnaires only were applied before and after applying VR; where VR stands in comparison with the current methods of education is still under question.

In another study, Yellowlees et al. developed a VR psychosis simulation on an internet platform and showed the user-friendliness and feasibility of applying it as a practical method (24). In their study, participants filled a questionnaire only after experiencing the simulation so there was no comparison whether before or after or with other methods, and the study population was only limited to a certain group of internet users.

In this study, after simulating auditory hallucinations with persecutory content and reference delusion in a VR setting, we compared one session of virtual reality simulation of psychosis (VRSP) to the routine educational program- that is visiting patients under supervision as its counterpart in altering stigma, empathy, and knowledge about psychosis in medical students as well as evaluating potential side effects.

MATERIALS AND METHODS

In this project, we assessed the effects of experiencing one session of virtual reality simulation of psychosis (VRSP) on stigma, empathy, and knowledge in medical students in comparison with the traditional learning style; that is, visiting patients at the psychiatric ward. In the first phase of the study, we have developed a simulation of psychotic experience in a VR setting with a scenario based on the real experiences of the patients and the consensus of a psychiatrist team. After providing consent, 10 patients with schizophrenia in remission were interviewed by two different psychiatrists for their experiments during their last psychotic episode. The documents were assessed by a panel of four psychiatrists for extracting the most prevalent themes. Among those, the ones that could be reproduced in a simulated environment (such as auditory hallucinations and some form of delusions) were chosen to be the content of the experiment. The VR environment provided a three-dimensional, 360-degree video that was displayed by a VR headset mounted on the user's head (**Figure 1**). The basic graphical environment (patient's home) was designed by the objects needed for the scenario (modeled by 3D Max, Maya, and After Effect software). For the production of special effects (for example: displaying the other homeowner, broadcasting meteorological reports on television, etc.), we utilized 4K resolution filming technology. The sounds were recorded using the Qubis software; to maximize the clarity and orientation of the sounds, each one tailored to different

FIGURE 1 | The simulated environment used in this study.

positions to the user. After rendering, the final VR file was easily accessible through any mobile operating system (Android or iOS) and could be displayed by a VR headset for 4 and a half minutes.

In this scenario, the experiencer assumes herself/himself in a position of a person who hears voices with persecutory content and experiences the TV news host sending her/him messages (delusion of reference) which were the most prevalent experience based on our interviews and are some of the prevalent forms of delusions and hallucinations (20, 21, 25). At first, the person assumes that she/he is sitting on a couch in a living room of an apartment which has been designed with some elements of Iranian culture, such as red carpet, calligraphy on the wall, and some famous Persian books on the table and in the shelf that cause the experiencer feeling familiar with the environment. The atmosphere is as much as possible neutral (with no dark color that causes feelings of horror), so it can be similar to real life. There is an actor, sitting in the living room, talking and leading the experiencer through several occasions, such as turning on/off the TV or asking her/him to do some favors, such as moving into the kitchen where some hallucinations happen.

Auditory hallucinations (three-dimensional sounds) start with the voice of knocking on the door several times and some voices (both adult male and female with real-life tone), asking the participant not to open the door as there might be some neighbors trying to hurt her/him. Voices also talk about the actor and tell the participants that he might have some intentions to hurt her/him (persecutory content). When the actor turns on the TV to watch some news, the host of the news keeps addressing the participant and trying to undervalue her/him with her words (simulating the process of delusions of reference). After the scenario leads the participant to the kitchen, the voices comment on her/his actions in the kitchen as the third person (running commentary).

Medical students in Iran train psychiatry during their clerkship by attending to the visits by an attending psychiatrist (a Faculty) or psychiatry residents as passive observers. That is, the attending or the psychiatry resident visits the patients and the trainees observe the process of interviewing and examining mental status. After several sessions of observation, they can interview one or more patients to gain psychiatry history for their final project. The first stage (passive observation) has been compared to VRSP in the current study.

Data Gathering and Sample Size Calculation

The study population was all the 2nd and 3rd year medical students in the Birjand University of Medical Sciences, who haven't passed any psychiatry course or training before. The inclusion criteria were: having no previous history of severe psychiatric disorders themselves or in their first degree families. No previous history of chronic types of headaches, vertigo or seizures. The exclusion criteria were developing any side effects during the experience. This study was approved by the Research Ethics boards of Birjand University of Medical Sciences (IR.BUMS.REC.1397.174).

Using Cohen standardized effect sizes, sample size was calculated 64 in each group and considering 10% attrition rate, the total of 72 students participated in each group [alpha = 0.05, power = 0.80, and Cohen's d = 0.5 (a medium effect)]. After providing written informed consent, all participants who enrolled in the study with the convenient method of sampling took part in one session of a lecture on theoretical concepts targeting positive psychotic symptoms. The students were cluster-randomized and allocated to two groups: experiencing one session of VR Simulated Psychosis (VRSP) or visiting patients under supervision as the routine practice in the ward. Before and after the first session and after the second one, questionnaires of knowledge, stigma, empathy, and side effects were filled by students. Finally, the results were compared in two groups. We

also conducted a telephone follow up after 1 week and 1 month to record the participants' experience of any long-lasting side effects, as stressors can be related to the psychiatric symptoms if there is a reasonable temporal relationship to it, which according to The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) is considered 1 month (26).

As knowledge of basic psychological facts can be measured quantitatively (16, 24), participants completed a pen and paper educational achievement test, designed to assess knowledge of definitions and examples of delusions and hallucinations based on DSM-5 criteria. Two independent research assistants scored students' answers by using a scoring guide to reduce the potential of subjective interpretation. In case of any discrepancy, the third rater would score the items independently. Inter-rater reliability analysis was done, and the average amount was counted for each student as the score of knowledge. The Persian version of the "Mental illness stigma by world psychiatric association" was used to assess positive and negative attitudes towards patients with psychotic symptoms. Its validity and reliability in Farsi have been documented by Nojomi et al. (27, 28). Also, the Persian version of the Jefferson Scale of Physician Empathy- students (S-version) was applied, which was validated by Shariat et al. (29, 30). For side effects, seven items were assessed by a 7-point Likert scale anchored between "1" indicating "none" and "7" signifying "extremely high". Blurry vision, headaches, nausea, and dizziness were assessed as general side effects (Cybersickness) and difficulty in accepting reality, paranoia, and any change in auditory perception as psychological side effects. Researchers were trained to monitor participants in the VR group for distress and participants were told that they can discontinue anytime they felt distressed. The telephone follow-up was conducted according to the same checklist 1 week and 1 month after the study; if any of the participants reported any symptoms that has bothered them, could get a free visit by a psychiatrist or neurologist for further evaluations.

Statistical Analysis

Analyses were performed by Statistical Package for Social Sciences (SPSS version 21.0). The independent t-test was performed to compare means in each stage. To consider the role of potential confounders, a univariate analysis of covariates was performed to compare means at the final assessment and the effect size was calculated. The descriptive statistics were

TABLE 1 | Demographic characteristics of participants.

		Group 1: visiting patients	Group2: VRSP	Total	p-value
N		72	72	150	
Age		20.38 (± 1.04)	19.90 (± 1.47)		0.843
Gender	Male	N = 30 (20.8%)	N = 35 (24.3%)	N = 65 (45.1%)	0.402
	Female	N = 42 (29.2%)	N = 37 (25.7%)	N = 79 (54.9%)	

VRSP, Virtual Reality Simulation of Psychosis.

TABLE 2 | Means and standard deviations of scores in two groups in 3 stages of assessment.

		Group	N	Mean	Std. Deviation	Std. Error Mean
Knowledge	Level 1	Visiting patients	72	2.0833	2.47665	0.29188
		VRSP	72	2.3750	2.76006	0.32528
	Level 2	Visiting patients	72	14.1944	2.98182	0.35141
		VRSP	72	14.2778	2.87888	0.33928
	Level 3	Visiting patients	72	14.8889	2.96722	0.34969
		VRSP	72	16.5139	2.63237	0.31023
Stigma	Level 1	Visiting patients	72	4.5694	1.30898	0.15426
		VRSP	72	4.3889	1.54332	0.18188
	Level 2	Visiting patients	72	4.3056	1.29614	0.15275
		VRSP	72	3.9583	1.52387	0.17959
	Level 3	Visiting patients	72	3.8194	1.69777	0.20008
		VRSP	72	3.5972	1.21794	0.14354
Empathy[†]	Level 1	Visiting patients	72	115.7500	13.48943	1.58974
		VRSP	72	118.8056	12.49973	1.47311
	Level 2	Visiting patients	72	119.2500	14.09600	1.66123
		VRSP	72	122.1667	13.52619	1.59408
	Level 3	Visiting patients	72	121.9861	12.38751	1.45988
		VRSP	72	128.7639	9.39657	1.10740

VRSP, Virtual Reality Simulation of Psychosis.
Level 1: Pretest.
Level 2: Assessment after one session of theory education.
Level 3: Post interventions test.
[†]Based on the Jefferson Scale of Physician Empathy- students (S-version).

also reported as means and standard deviations. In all analyses P-value < 0.05 was considered statistically significant.

RESULTS

Table 1 shows the demographic characteristics of participants in each group. The mean age of the two groups that visited patients and experienced VRSP were 20.38 ± 1.04 and 19.90 ± 1.47 respectively and had no significant difference ($p = 0.843$). 65 males and 79 females participated in the study and the analysis of the distribution between groups showed no significant difference between groups ($P = 0.402$) (**Table 1**). The mean scores and standard deviations of knowledge, empathy, and stigma in different stages of assessment have been shown in **Table 2**. There were 3 levels of assessment and for convenience, we showed them as level 1 indicating pretest, level 2 indicating assessment after one session of theory education, and level 3 as post interventions test. There was no significant difference between the scores of the two groups at baseline in variables of knowledge ($p = 0.506$), empathy ($p = 0.161$), and stigma

TABLE 3 | Univariate analysis of covariates for the assessments.

	Source	Mean square	F	P-value	Effect size	Observed power
Knowledge 3	Corrected model	301.390	137.000	0.000*	0.746	1.000
	Intercept	101.537	46.155	0.000	0.248	1.000
	Knowledge 1	5.113	2.324	0.130	0.016	0.328
	Knowledge 2	730.640	332.120	0.000	0.703	1.000
	Group	84.772	38.534	0.000	0.216	1.000
	Error	2.200				
Stigma 3	Corrected model	28.455	17.597	0.000*	0.274	1.000
	Intercept	16.721	10.341	0.002	0.069	0.891
	Stigma 1	8.814	5.451	0.021	0.037	0.640
	Stigma 2	20.274	12.538	0.001	0.082	0.940
	Group	0.112	0.069	0.793	0.000	0.058
	Error	1.617		0.000		
Empathy 3†	Corrected model	3071.704	44.783	0.000*	0.490	1.000
	Intercept	4990.712	72.761	0.000	0.342	1.000
	Empathy 1	264.938	3.863	0.051	0.027	0.497
	Empathy 2	2365.912	34.493	0.000	0.198	1.000
	Group	922.239	13.446	0.000	0.088	0.954
	Error	68.590	44.783	0.000	0.490	1.000

VRSP, Virtual Reality Simulation of Psychosis.
Level 1: Pretest.
Level 2: Assessment after one session of theory education.
Level 3: Post interventions test.
*Significant.
†Based on the Jefferson Scale of Physician Empathy- students (S-version).

($p = 0.450$) based on the t-test analysis. The univariate analysis of covariates (ANCOVA) showed that VRSP could significantly increase knowledge ($p < 0.000$), decrease stigma ($p < 0.000$), and improve empathy ($p < 0.000$) toward patients in comparison with one session of visiting patients under supervision (**Table 3**). **Table 4** shows the side effects of one session of experiencing VRSP. Most of the participants experienced no side effects and the minor side effects were reported by a few participants, which subsided quickly. No signs of distress were reported by research assistants and none of the participants withdrew from the study due to personal distress. In the follow-up study, neither after 1 week nor after 1 month, none of the participants

in the VRSP group reported any problem asked according to the checklist, so there was no need for an in-person visit by specialists.

DISCUSSION

The aim of this study was to assess the effects of experiencing one session of virtual reality simulation of psychosis (VRSP) on the stigma, empathy, and knowledge of medical students towards patients with psychosis in comparison with the routine training - that is visiting the patients in wards under supervision- as well as assessing any side effects. Highlighting the prominence of this study, to the best of our research, this is among the few head-to-head studies, examining the efficacy of incorporating virtual simulation in training, compared with routine educational program. There is minimal research regarding head-to-head studies comparing the two modalities (21).

In line with previous studies, the findings of the current study suggest that applying one session of VRSP can increase knowledge about psychosis (16, 17, 24), and this increase is significantly more than one session of visiting patients under supervision. Students, in this study, had no previous knowledge of the psychotic symptoms and this could reduce the potential bias in assessing the knowledge. VR has usages such as learning and training based on the constructivism theory of learning. VR can increase users' knowledge about some concepts that are complicated and difficult to understand. In mental health disorders, subjective symptoms such as delusions and hallucinations are tough to perceive (16, 31). The constructivist perspective that VR fundament on, emphasizes building the knowledge based on the real-life experiences and VR can provide a semi-real-life environment for students to experience symptoms first hand.

To further explain the findings on knowledge, simulation in VR was consistent, that is all students experienced all the simulated symptoms in one session. Visiting patients under the supervision, on the other hand, has some limitations such as patients might have different mental status in each visit, leading to presentation of different symptomatology in each session (32). Moreover, patients might not be willing to or feel safe enough to reveal their inner experiences in a crowded setting, resulting in non-cooperativeness. Patients experience variety of symptoms and students have to observe and/or visit a number of patients in order to get familiar with a complete picture of the disorder

TABLE 4 | Assessing side effects of one session of experiencing Virtual Reality Simulation of Psychosis.

Likert Scale Side effects	1	2	3	4	5	6	7
Blurry Vision	59 (81.9%)	6 (8.3%)	4 (5.6%)	3 (4.2%)	0	0	0
Headache	61 (84.7%)	10 (13.9%)	1 (1.4%)	0	0	0	0
Nausea	68 (94.4%)	4 (5.6%)	0	0	0	0	0
Dizziness	60 (83.3%)	9 (12.5%)	3 (4.2%)	0	0	0	0
Difficulty in accepting reality	60 (83.3%)	8 (11.1%)	4 (5.6%)	0	0	0	0
Paranoia	67 (93.1%)	3 (4.2%)	2 (2.8%)	0	0	0	0
Any change in auditory perception	68 (94.4%)	4 (5.6%)	0	0	0	0	0

manifestation. Immersive experiences in VR, can add to the benefits of the visits by providing the facility to experience more symptoms and removing distractions (14, 18, 33). The key point here is that VRSP cannot and should not assumed to replace visiting patients, but can be seen as an effective pedagogical tool that is used alongside visiting patients to address the limitations that students might face in wards.

In this study, both groups showed a reduction in stigma score after one session of visiting patients and after VRSP. In VRSP, however, the stigma scores decreased significantly compared with visiting patients. Whether and to what extent the direct contact with the patients affects stigma reduction is still controversial. On one hand, some literature suggest that direct contact with patients- whether it is a real in-person contact or a virtual one-can decrease stigma (2); anti-stigma movements propose different forms of interventions, among which social interaction in combination with education is the most effective one (2, 9). Also, curriculums applied in psychiatric education have decreased stigma toward patients with mental illness through education as well as direct contact with patients (10, 11). On the other hand, some literature suggest that mental health care givers that work in inpatient settings, are prone to have more stigmatizing attitudes toward patients due to several reasons such as burnout and associative stigma (3). Clinicians who work in inpatient settings often tend to work with patients with long-term conditions and worse prognosis which enhances the phenomena of "the clinician's illusion." (34), which might explain the mentioned stigma to some extent (3). In this study, the sample consisted of medical students without any history of psychiatric conditions themselves or in their first degree family members, therefore the mentioned mechanism of familiarity that might lead to increase stigma, was eliminated in this study.

There are lack of evidence to explain the mechanism of associative stigma- that is the phenomena of increased stigma in the first degree families of patients with severe psychiatric conditions and care givers. the proposed mechanisms consist of the burden of these disorders to families as well as burnout in care givers (3). The mediating role of empathy in theses process has not been explored yet. In this study the empathy scores increased in both interventions and whether the increase in empathy can be a mediating factor for decreasing stigma should be explored in future studies.

Some qualitative studies has extracted important themes mirroring associative stigma among mental health care providers: devaluating the occupation, media representation, and assumptions/expectations about the job. Publicly, psychiatry practice is frequently perceived as unproductive or even destructive (3). Moreover, medical students might see psychiatry as low status and non-priority (35). Applying technologies, such as VR, has shown to increase the motivation of students. However, assessing whether incorporating such technologies in psychiatric education would modify such attitudes needs more in depth studies.

Recent literature suggest that simulations of first hand experiences in virtual environments can decrease implicit stereotypes and reduce stigma (9, 12). Utilizing compound contact-based interventions such as watching film and live contact can considerably improve outcomes of attitude and knowledge toward mental illness (2, 13). This is consistent with our findings, confirming our hypothesis that using simulations incorporated into routine medical education can improve knowledge and attitudes towards stigmatizing others. There are, however, concerns over mere simulation of psychotic disorders without any education (12); in a study on the effects of a virtual reality simulator on perceptions of schizophrenia, Kalyanaraman et al., argued that using simulations of hallucination, without any education to participants might increase negative attitudes toward patients with schizophrenia (12). Efforts of reducing stigma through focusing on merely simulating the symptoms, might lead to an excessive focus on symptom experience without appreciation for the "whole person" that one might obtain from a contact based-experience. Therefore, we believe that education must be an important component in such interventions.

It is argued that simulations that portrays psychosis as a terrifying experience with dramatic environmental features in a dark or horrifying setting- in contrast with using neutral environmental cues-, might have negative effects on participants attitude towards patients (12). These are important ethical concerns; increasing literature suggest that interventions that seek to enhance empathy are required to represent the symptoms in an unbiased way and according to the real experiences of the subjects with whom empathy is to be enhanced. Using more realistic environmental features is more similar to the real experiences of people with psychotic disorders. In a study of simulating symptoms in an augmented reality (AR) environment, where the hallucinations are experienced in the actual environment (9), in line with our findings, simulation showed to be a promising approach in reducing stigma.

In recent years, VR studies have focused on promoting some concepts that are essential in human relationship such as empathy. The ability to empathize is a crucial skill for all mental health professionals and affects all aspects of psychiatric and psychological interventions (36, 37). In this study, both groups showed increase in empathic abilities-assessed by the Jefferson Scale of Physician Empathy- students (S-version). The VRSP group had significantly more empathy toward patients than students who visited patients under supervision. This confirms previous findings that suggests application of simulation of psychosis can increase empathy among students (16, 17) and general population (24).

Empathy has been defined as having non-judgmental attitude and understanding patients' viewpoints and emotions. It is a dynamic interpersonal process, depending on the relationship. It is also a multidimensional construct containing cognitive and affective components (38, 39). When arguing about training empathic abilities, it is essential to make a vivid discrimination between potential and actual skills. Empathy must be cultivated in a proper environment with required elements and support (31, 40). Studies suggest that the empathy increases with the years of experience. That is the more you have the firsthand experience with patients, the more you have the opportunity to develop empathy (41).

VR is a proper method for empathy training (42). VR technology can help student feel patient mental situation as if

it's their own and provide a judgmental free environment to learn through exploring one experience as many times as it is needed to be learned. As it is retrieved from constructivist theory, VR has elements that the person can reshape his inner world according the new and unique experience he passed in VR. Experiences of embodiment in an immersive VR environment (EVR) allow users to literally step into the shoes of others and see the world from their perspective. Research on EVR has explored how manipulations of the senses can be used to modulate empathic responses. Experiences of stepping into the shoes of outgroup members have shown significant plasticity of empathic abilities (43).

For training empathy there are some abilities that need to be developed such as (perspective taking between group empathy, compassion, self-regulation) and some that need to be evaded such as subjective distress (31). While the aforementioned skills can improve empathy toward patients, personal distress might even cause stigma through increasing avoidant responses. Developing a sense of familiarity with others experiences can increase the feeling of affiliation to that group which make it easier to empathize with that group (31).

Empathic responses are crucial for a productive doctor-patient relationship. However, unhealthy empathic reactions might induce personal distress that cause burnout and stigmatizing attitudes that cause avoidant responses (39, 44, 45). Reasonable amount of distress, however, is needed for feeling empathy toward others (31, 46). Therefore, it is crucial to assess whether experiencing a simulation of psychosis has any side effects such as personal distress or other psychiatric conditions. In this study none of the participants in the VRSP was withdrawn from the study due to personal distress and no personal distress was reported by observers.

Consistent with previous studies, the participants only reported mild general side effects (Cybersickness) which ameliorated quickly after several minutes (16, 47). None of the participants reported any psychosis-like symptoms, neither right after the experience, nor after 1 week and 1 month of follow-up. This is one of the first studies addressing psychiatric side effects and despite the rigorous inclusion criteria, the results are promising.

There are some limitations in this study that should be addressed in future studies. First of all, the VRSP in this study was only a passive experience and the participants couldn't actively explore all the components of the environment. It was done because we wanted to compare the experience with the passive observation during the clerkship and the future studies can make the comparison with more interaction between the participants and the virtual environment. With regard to the definition of stigma, in this study only attitudes and knowledge of students were measured. The behavioral component of stigma such as intended social distance or micro-aggressions needs to be addressed in future studies. Also, these results were only obtained in a population with no previous knowledge or contact with patients with severe mental health problems. The replicability in other populations is under question and whether such relationship would show different result must be explored.

In conclusion, applying simulation of psychosis can be an effective tool in reducing stigma, increase knowledge, and empathy in medical students and it seems to be a good choice to be incorporated in routine educational practice.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics boards of Birjand University of Medical Sciences (IR.BUMS.REC.1397.174). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FUNDING

ACKNOWLEDGMENTS

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2022.880331/full#supplementary-material

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