Research Article

Association Between Viewing Social Virtual Reality–Based Peer Dialogue and Perceived Public Stigma Toward Mental Illness Among University Students: A Longitudinal Observational Study of Viewers of a Television Program

Junichi Fujita[1], Masahiro Matsui[1], Mizuho Takayama[1], Satoru Shinoda[2], Tomoko Moroga[1], Yoshiko Aoki[1], Mio Ishii[1,3], Koji Hara[4], Tomoyuki Miyazaki[5]

1. Department of Child Psychiatry, Yokohama City University Hospital, Japan; 2. Department of Biostatistics, Graduate School of Medicine, Yokohama City University, Japan; 3. Department of Psychiatry, Yokohama City University, Japan; 4. School of Economics and Business Administration, Yokohama City University, Japan; 5. Center for Research and Industry-Academia-Government Collaboration, Yokohama City University, Japan

Aim: To examine whether viewing a social VR–based peer dialogue television program is associated with reductions in perceived public stigma toward mental illness among university students.

Design: Single-center longitudinal observational study.

Methods: University students viewed an episode of a Japanese public television program depicting peer dialogue among adolescents with psychiatric disorders in a social virtual reality environment. Participants completed self-administered questionnaires before viewing, immediately after viewing, and three months later. Perceived public stigma was assessed using the Perceived Devaluation and Discrimination scale. Depressive symptoms were assessed using the Patient Health Questionnaire-9. Changes over time were analyzed using linear mixed-effects models.

Results: Of 183 students initially approached, 127 completed the baseline assessment, 115 completed the post-viewing assessment, and 96 completed all three assessments. Perceived public stigma significantly decreased immediately after viewing and remained lower at the three-month follow-up, with effects sustained over three months. Reductions were greater among participants with higher

 doi.org/10.32388/AC4VYW.2

baseline stigma levels. The results remained consistent in sensitivity analyses. Depressive symptoms showed no immediate worsening, and levels remained low throughout the follow-up.
Conclusion: Viewing social VR–based peer dialogue was associated with reductions in perceived public stigma among university students, with effects sustained over three months. Implications for the profession and/or patient care: Social VR–based peer narratives may offer a scalable approach for reducing mental health stigma in educational settings, with potential implications for nursing practice and mental health promotion.

Corresponding author: Junichi Fujita, jun1182@yokohama-cu.ac.jp

Impact

What problem did the study address?

Perceived public stigma remains a barrier to mental health help-seeking among young adults.

What were the main findings?

Viewing VR-based peer dialogue was associated with sustained reductions in perceived stigma, particularly among those with higher initial stigma levels.

Where and on whom will the research have an impact?

These findings may inform stigma reduction interventions in university settings and among young adults without direct mental health experience.

Reporting Method

This study adhered to STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Patient or Public Contribution

No patient or public involvement: This study did not include patient or public involvement in its design, conduct, or reporting.

What does this paper contribute to the wider global clinical community?

- Viewing social VR–based peer dialogue was associated with sustained reductions in perceived public stigma toward mental illness among university students, with effects persisting over three months.
- Stigma reductions were concentrated among individuals with higher baseline stigma levels, suggesting that VR-based peer narrative programs may be particularly effective for audiences with limited prior exposure to mental health narratives.
- These findings support the potential use of broadcast VR peer dialogue as a scalable, low-burden approach to mental health stigma reduction in university and public health settings.

1. Introduction

Stigma toward people with mental illness remains a major public health concern across diverse settings, contributing to social exclusion, reduced help-seeking, and delayed access to care[1][2]. Stigma is commonly conceptualised as comprising three interrelated components: problems of knowledge (ignorance and misinformation), attitudes (prejudice), and behaviour (discrimination)[3]. Among these, perceived public stigma—individuals' beliefs about how most people in society view those with mental illness—occupies a particularly important role. Unlike personal stigma, which reflects one's own attitudes, perceived public stigma shapes the social environment in which people with mental illness live, influencing their expectations of rejection, their willingness to disclose their condition, and their decisions to seek help[4] (Corrigan & Watson, 2002). Elevated perceived public stigma has been associated with reduced treatment-seeking, social withdrawal, and diminished quality of life among people with mental illness (Corrigan & Watson, 2002). Because perceived public stigma is sustained through prevailing cultural narratives and widely endorsed stereotypes, it is difficult to modify through individual-level interventions alone, underscoring the need for scalable, population-level approaches that can shift broader social attitudes[3].

2. Background

Narrative-based media interventions have demonstrated efficacy in reducing mental health stigma. Grounded in intergroup contact theory and narrative persuasion frameworks, these interventions expose audiences to first-person accounts from people with mental health problems, increasing empathy, facilitating perspective-taking, and challenging negative stereotypes. A meta-analysis of 40 studies

found a small but consistent effect of narratives in reducing stigma, with first-person narratives demonstrating superior effectiveness[5]. Recent research on public disclosures identified specific factors associated with stigma reduction, including explicit diagnoses, emphasis on psychosocial causes, and audience empathy toward disclosers[6]. However, authentic disclosure faces a critical barrier: many individuals with mental illness prefer anonymity when sharing personal experiences, creating tension between genuine narratives and privacy protection. Intergroup contact theory suggests that positive exposure to members of stigmatised groups can reduce prejudice, with even indirect or mediated forms of contact demonstrating meaningful effects[7][8]. In this context, narrative-based media may function as a form of vicarious intergroup contact, in which observers are exposed to authentic personal accounts without direct face-to-face interaction[9].

Social virtual reality (VR) environments, in which users interact through avatars, may offer a promising solution to this tension. Emerging research suggests that VR-based interventions can reduce mental health stigma, particularly among student populations. A scoping review of AR/VR-based interventions found improvements in knowledge, attitudes, empathy, and stigma toward people with mental illness across the majority of included studies, with undergraduates comprising the largest participant group[10]. A systematic review and meta-analysis of technology-based interventions similarly demonstrated a medium effect on reducing public stigma, with the majority of included studies conducted among students[11]. Most existing approaches, however, require active participation in simulated scenarios or immersive VR environments. A distinct but underexplored possibility is whether broadcast viewing of content produced within VR environments—transmitted through conventional screen-based media—can produce comparable effects among general student audiences through a process of vicarious intergroup contact.

Beyond its potential as an intervention context, avatar representation in social VR environments may reduce social evaluative threat and enhance psychological safety, enabling individuals with mental illness to communicate about sensitive topics without revealing their physical appearance or identity. This quality may be especially valuable for people with mental illness, for whom disclosure carries significant social risk, and may facilitate the authentic emotional expression that renders such narratives persuasive to observers. When transmitted through broadcast media, such VR-produced narratives may function as a form of technology-mediated vicarious intergroup contact[9], in which viewers are exposed to authentic peer dialogue without direct participation. Previous research found that participation in avatar-mediated peer dialogue within a VR-based television program was associated with improvements in resilience and

depressive symptoms among adolescents with psychiatric disorders ([Author et al., 2025]). The avatar-mediated format appeared to facilitate authentic emotional disclosure that participants indicated would have been difficult in face-to-face settings.

These findings raise an important question: can the authentic narratives generated within VR environments—when transmitted through broadcast media—influence viewers who observe but do not directly participate? This question has both theoretical and practical significance. Theoretically, it addresses whether peer dialogue enabled by VR can reduce perceived public stigma among observers, extending the impact beyond direct participants. Practically, if effective, VR-based programs could serve dual roles as therapeutic interventions for participants and public health tools for broader audiences. These potential benefits warrant further empirical investigation.

3. The Study

Aim

This study examined whether university students who viewed an episode of Project Aliens—a social VR–based peer dialogue television program produced by NHK (NIPPON HOSO KYOKAI; Japan Broadcasting Corporation)—showed reductions in perceived public stigma toward mental illness. University students (aged 18–25) were selected as the target population because the college years represent a developmentally sensitive period for psychiatric disorder onset[12], with epidemiological evidence indicating that nearly half of all lifetime mental disorders emerge by age 18 and approximately two-thirds by age 25[13], making stigma reduction particularly relevant for this group.

Research Question

Is viewing social VR–based peer dialogue associated with changes in perceived public stigma toward mental illness among university students? Does baseline stigma level moderate this association?

Primary Objective

To examine changes in perceived public stigma (Perceived Devaluation and Discrimination scale) from baseline to immediately after viewing and at three-month follow-up.

Secondary Objective

To assess whether exposure to the program was associated with worsening of depressive symptoms (Patient Health Questionnaire-9) as a safety outcome, and to explore whether baseline stigma level moderated the primary outcome.

4. Methods/Methodology

Design

This was a single-center, longitudinal observational study examining changes in perceived public stigma toward mental illness among university students who viewed an episode of Project Aliens, a social VR–based television program broadcast on Japanese public television.

Study Setting and Sampling

Participants were recruited during a university lecture at [University], on October 27, 2025. The study was conducted in a School of Economics and Business Administration, selected for two reasons: first, a faculty member of this school (KH) is a participating member of the research consortium under which this study was conducted, which facilitated access and enabled careful procedural arrangements; second, students enrolled in an economics and business administration program represent a general student population unlikely to have received systematic professional training in mental health, making them appropriate for examining stigma in a non-specialist sample. The study was introduced during a regularly scheduled lecture session, and interested students received detailed information via an online platform (Microsoft Forms). Participation was entirely voluntary, and students were explicitly informed that their decision to participate would not affect their academic standing. No incentives were offered for participation at any time point. Prior to recruitment, the principal investigator and the course instructor coordinated in advance to ensure that no implicit pressure was placed on students to participate. Electronic informed consent was obtained prior to participation. To ensure confidentiality and minimize response bias, the course instructor had no access to individual response data.

The sample size was determined using a precision-based approach. Assuming a standard deviation of 5 points on the Perceived Devaluation and Discrimination scale and accounting for an estimated 10% attrition rate, a sample of approximately 80 participants was targeted to provide an 80% probability that

the 95% confidence interval for the mean change would be within ±1.25 points of the true population mean.

Inclusion and Exclusion Criteria

Eligible participants were undergraduate students enrolled at [University] who met the following inclusion criteria: (1) aged 18–25 years, and (2) able to provide informed consent. Exclusion criteria included: (1) severe cognitive impairment precluding completion of self-report questionnaires, (2) difficulty understanding Japanese, and (3) current or planned employment in mental health professions such as psychiatrists, psychiatric nurses, psychiatric social workers, clinical psychologists, certified psychologists, occupational therapists, or related professions, as professional training may systematically influence stigma-related attitudes.

Television Program

Participants viewed Episode 10 ("Difficulties in Interpersonal Relationships") of Project Aliens, a VR-based peer dialogue television program produced by NHK, during a lecture on October 27, 2025. The episode had been broadcast on September 14, 2025. Episode 10 followed the program's standard format, featuring four adolescent participants. The episode included brief self-disclosure videos in which participants shared their mental health experiences, followed by avatar-mediated dialogue within a space journey narrative framework facilitated by Moon Rabbit, a virtual character portrayed by a professional performer. Over the course of the 45-minute episode, the dialogue unfolded across four virtual scenes—Cityscape (Shibuya), Spaceship, Spaceport, and the Moon (Figure 1)—designed to support progressively deeper emotional disclosure and peer interaction. Participants discussed their mental health experiences, including diagnoses, symptoms, treatment, and daily challenges, with considerable emotional depth and authenticity. The program concluded with three segments: follow-up interviews showing participants' ongoing challenges, encouraging comments from the facilitator, and clinical commentary by a child psychiatrist discussing the therapeutic value of peer dialogue and shared emotional experiences.



Figure 1. The four virtual scenes of Project Aliens Episode 10 ("Difficulties in Interpersonal Relationships"). The episode unfolded across (A) Cityscape (Shibuya), (B) Spaceship, (C) Spaceport, and (D) Moon, designed to support progressively deeper emotional disclosure and peer interaction among adolescent participants with psychiatric disorders. Images reproduced with permission from NHK©.

Instrument with Validity and Reliability

Perceived Public Stigma

Public stigma toward mental illness was assessed using the Japanese version of the Perceived Devaluation and Discrimination (PDD) scale[14]. The PDD consists of 12 items measuring the extent to which respondents believe that most people devalue and discriminate against individuals with mental illness. Items are rated on a 4-point Likert scale (1 = strongly disagree to 4 = strongly agree), and total scores range from 12 to 48, with higher scores indicating greater perceived public stigma. The scale has demonstrated adequate reliability and validity in Japanese populations. In the current sample, internal consistency was good (Cronbach's α = 0.85). The PDD assesses perceived public stigma—respondents' perceptions of how most people in society view individuals with mental illness—rather than respondents' own personal stigmatizing attitudes or discriminatory behaviors[4]. This distinction is

important because perceived public stigma reflects individuals' beliefs about societal attitudes and may differ from their personal views.

Depressive Symptoms

Depressive symptoms were assessed using the Japanese version of the 9-item Patient Health Questionnaire (PHQ-9)[15]. The PHQ-9 assesses the presence and severity of depressive symptoms over the past two weeks, with total scores ranging from 0 to 27; higher scores indicate more severe symptoms. Severity categories are 0–4 (minimal or none), 5–9 (mild), 10–14 (moderate), 15–19 (moderately severe), and 20–27 (severe). The PHQ-9 has demonstrated good reliability and diagnostic validity in Japanese populations[15], and has shown favorable psychometric properties compared with other depression scales in Japanese university student samples[16]. In the present study, it was included as a safety outcome to evaluate whether exposure to emotionally salient mental health narratives resulted in worsening depressive symptoms among viewers. The PHQ-9 was selected because it is widely used as a monitoring tool for depressive symptoms in Japanese university student mental health settings, including student counseling services. Although anxiety disorders are also highly prevalent among university students, the PHQ-9 was prioritized as the most ecologically appropriate brief screening instrument for this population in the Japanese university context.

Demographic Information

At baseline, participants self-reported age and sex.

Data Collection

Data were collected at three time points: (1) immediately before viewing the program (baseline), (2) immediately after viewing (within 10 minutes of program completion), and (3) three months after viewing. All assessments were administered online via Microsoft Forms. Prior to participation, all students confirmed that they had not previously viewed the episode used in the study. No participants reported prior exposure to Episode 10 of Project Aliens, which had been broadcast on September 14, 2025, approximately six weeks before the study session. At each time point, the questionnaire link was distributed exclusively through the course-specific Microsoft Teams channel managed by the course instructor, which was accessible only to students enrolled in the course, ensuring that only registered students could submit responses. At baseline, the questionnaire was available only during the interval

between the study explanation and the start of program viewing. The program was viewed during a lecture session on October 27, 2025. All participants viewed the program simultaneously in a university lecture hall under standardized conditions. The program was presented on a standard 2D projection screen; participants did not use VR headsets or any immersive VR hardware, and thus experienced the VR-based content as a conventional screen-based broadcast rather than as an immersive virtual reality environment. Baseline and immediate post-viewing assessments were completed during the same session. The 3-month follow-up assessment was conducted during a subsequent lecture session on January 26, 2026. The Microsoft Forms questionnaire was made available to students at the start of this session and was automatically set to close approximately 10 minutes after session commencement, after which no further responses could be submitted. Only after the form had closed did the course instructor introduce the principal investigator, who delivered a supplementary lecture on the aims of Project Aliens and related topics in child and adolescent psychiatry. This procedural sequencing—enforced in part through the automatic form closure—ensured that questionnaire responses were completed before any lecture content was presented and that participation remained entirely voluntary regardless of the subsequent lecture. Students who arrived late to the 3-month follow-up session were excluded from that assessment, as they had already been exposed to the lecture content before completing the questionnaire; this exclusion criterion applied only at the 3-month time point and not at baseline or immediate post-viewing, as no supplementary lecture was delivered at those earlier sessions.

Data Analysis

The analysis sets were the Full Analysis Set (FAS; all participants with a baseline PDD assessment, n = 127), the Per-Protocol Set (PPS; n = 96 with complete data at all time points), and the Safety Analysis Set (SAS; n = 127 with baseline data).

Primary Analysis

A linear mixed model (LMM) was used to examine changes in PDD scores (primary outcome) and PHQ-9 scores (secondary outcome) across three time points (pre-viewing, immediate post-viewing, 3-month follow-up). The LMM was selected to optimally use all available data and handle missing data under the missing at random assumption. The models included time as a fixed effect (pre-viewing as the reference) and random intercepts for participants. Parameters were estimated via restricted maximum likelihood with the Satterthwaite approximation for degrees of freedom. Post hoc pairwise comparisons were conducted using the Bonferroni adjustment.

Exploratory Analysis

To explore whether baseline stigma moderated program effects, participants were stratified into lower and higher groups using a median split of baseline PDD scores (median = 29.0). An LMM including a Group × Time interaction was fitted to examine differential effects across baseline stigma levels.

Sensitivity Analysis

To assess robustness to missing data assumptions, we compared baseline characteristics (age, sex, PDD score, PHQ-9 score) between completers (n = 96) and non-completers (n = 31) using independent samples t-tests for continuous variables and chi-square tests for categorical variables. Additionally, we conducted sensitivity analyses using the same LMM approach with the PPS to verify consistency with the primary analysis results.

Effect sizes were calculated as Cohen's d using baseline pooled standard deviations. All analyses were conducted using IBM SPSS Statistics version 31 (IBM Japan, Tokyo). Statistical significance was set at $p < 0.05$ with Bonferroni correction for multiple comparisons.

Ethical Considerations

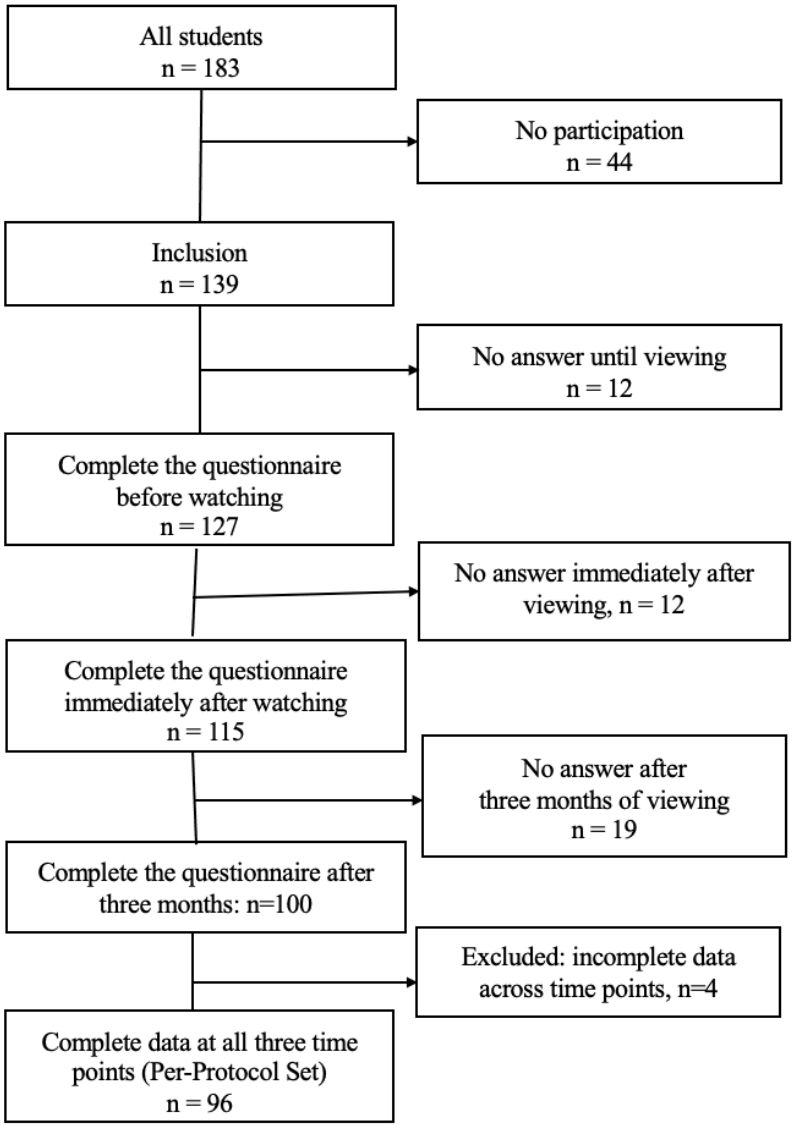
The study was conducted in accordance with the Declaration of Helsinki and the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan and approved by the Ethics Committee of [University] (approval number: [blinded for review]). Data were collected anonymously, with no personally identifiable information linked to questionnaire responses. Participants were informed that they could withdraw at any time without penalty. Because the program included emotionally sensitive content, information about available mental health support resources was provided at each assessment point, with contact information for the university counseling center included in all questionnaires. No adverse events were reported.

5. Results

Characteristics of the Sample

Of 183 students enrolled in the course, 127 completed baseline assessments and viewed the program (Figure 2). Among these participants (n = 127), 115 (90.6%) completed the immediate post-viewing assessment, and 100 (78.7%) completed the 3-month follow-up assessment. Complete PDD data across all

three time points were available for 96 participants (75.6%), who constituted the Per-Protocol Set; the remaining 4 participants who completed the 3-month follow-up had not completed the immediate post-viewing assessment and were therefore excluded from the Per-Protocol Set. Participants had a mean age of 20.0 ± 1.1 years (n = 125), and 44.9% were female. The mean baseline PDD score was 28.5 ± 6.1, and the mean baseline PHQ-9 score was 4.1 ± 3.9, indicating minimal depressive symptoms. No significant differences were observed between completers (n = 96) and non-completers (n = 31) in age, sex, baseline PDD, or baseline PHQ-9 scores (all $p > .05$).



Footnote： Of 183 students approached, 127 completed baseline (Full Analysis Set), 115 completed immediate post-viewing, and 96 completed three time points (Per-Protocol Set). Primary analysis used Full Analysis Set; sensitivity analysis used Per-Protocol Set.

Figure 2. Participant Flow Diagram. Of 183 students approached, 127 completed baseline assessments (Full Analysis Set), 115 completed the immediate post-viewing assessment, and 100 completed the 3-month follow-up assessment. Of these, 96 participants had complete data at all three time points and constituted the Per-Protocol Set. The primary analysis used the Full Analysis Set; the sensitivity analysis used the Per-Protocol Set.

Primary Outcome: Perceived Public Stigma (PDD)

Main Analysis (Full Sample)

There was a significant main effect of time on PDD scores ($F(2, 220) = 5.93$, $p = .003$, $\eta p^2 = 0.051$; Figure 3A). Post hoc pairwise comparisons with Bonferroni adjustment indicated significant reductions in perceived public stigma from baseline to immediate post-viewing ($p = .005$, Cohen's $d = 0.26$) and from baseline to 3-month follow-up ($p = .028$, Cohen's $d = 0.23$). The difference between immediate post-viewing and 3-month follow-up was not significant.

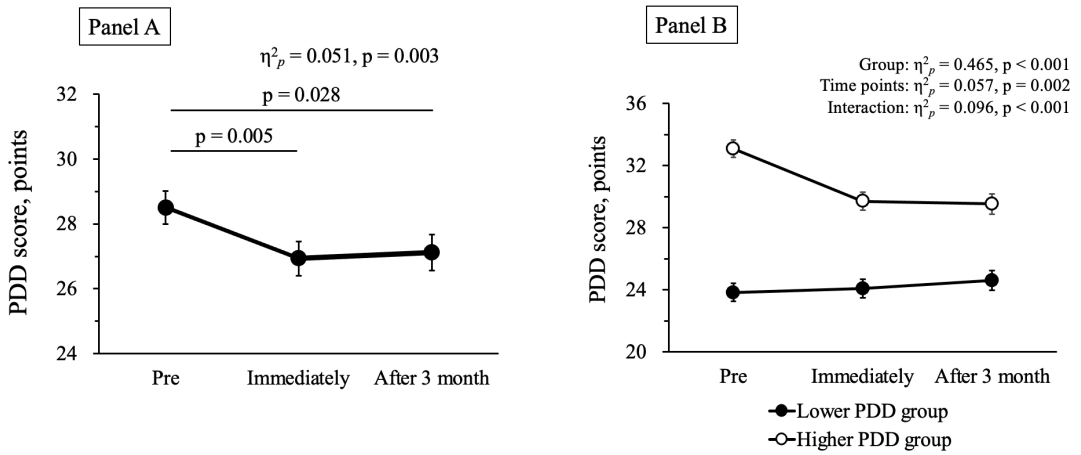
Sensitivity Analysis

To assess robustness to missing data assumptions, we repeated the analysis restricted to participants with complete data at all three time points ($n = 96$). The results remained consistent with the primary analysis (baseline: 28.2 ± 6.5; immediate: 26.8 ± 5.7; 3-month: 26.9 ± 5.5; $F(2, 190) = 3.85$, $p = .023$, $\eta p^2 = 0.039$).

Exploratory Analysis: Moderation by Baseline Stigma

To explore whether baseline stigma level moderated program effects, participants were stratified into lower and higher PDD groups using a median split of baseline scores (median = 29). A linear mixed model analysis revealed a significant Group × Time interaction ($F(2, 222) = 11.71$, $p < .001$, $\eta p^2 = 0.096$), suggesting that changes in perceived public stigma differed by baseline stigma level (Figure 3B).

Participants in the higher baseline stigma group showed significant reductions in PDD scores from baseline to immediate post-viewing ($p < .001$, Cohen's $d = 0.55$) that were sustained at the 3-month follow-up ($p < .001$, Cohen's $d = 0.59$)



Footnote: Mean PDD scores (± SE) at baseline, immediately after viewing, and three-month follow-up. Panel A shows overall changes across all participants (n = 127). Panel B demonstrates differential effects based on baseline stigma level, showing that reductions were concentrated among participants with higher initial stigma. Abbreviations: PDD, Perceived Devaluation and Discrimination scale; SE, standard error.

Figure 3. Changes in Perceived Public Stigma Over Time. Panel A: Full sample trajectory (n = 127). Panel B: Moderation by baseline stigma (Higher vs. Lower groups). Mean Perceived Devaluation and Discrimination (PDD) scores (±SE) at baseline, immediately after viewing, and at the three-month follow-up. Panel A shows overall changes across all participants. Panel B demonstrates differential effects based on baseline stigma level, showing that reductions were concentrated among participants with higher initial stigma. Abbreviations: PDD, Perceived Devaluation and Discrimination scale; SE, standard error.

Secondary Outcome: Depressive Symptoms (PHQ-9)

A linear mixed model analysis revealed a statistically significant but small time effect on PHQ-9 scores ($F(2, 214) = 3.76$, $p = .025$, $\eta p^2 = 0.034$). However, mean scores remained within the minimal to mild range throughout the study (baseline: 4.1 ± 3.9; immediate: 3.6±4.2; 3-month: 4.6 ± 4.5). No participants showed clinically significant worsening from baseline to immediate post-viewing. At 3-month follow-up, 7 participants showed PHQ-9 increases ≥5 points from baseline. No adverse events directly related to program viewing were reported.

6. Discussion

This longitudinal observational study examined whether viewing social virtual reality (VR)–based peer dialogue was associated with changes in perceived public stigma toward mental illness among university students. We observed that perceived public stigma significantly decreased immediately after viewing and remained lower at the three-month follow-up. These findings suggest that broadcast viewing of VR-

produced peer dialogue may be associated with reductions in stigma among observers, operating through a process consistent with technology-mediated vicarious intergroup contact. Exploratory analyses revealed that stigma reduction was not uniform across participants but was concentrated among individuals with higher baseline levels of stigma. This moderation pattern suggests that viewers holding stronger initial stigmatizing attitudes may be more responsive to such narratives, though controlled studies are needed to confirm this interpretation.

The observed effects extend beyond direct participants in the VR environment. In a previous participant-focused study, adolescents engaging in avatar-mediated peer dialogue showed improvements in psychological outcomes[17]. The current findings suggest that viewing such dialogues may also reduce stigma among observers who did not directly participate. While these two studies examined different populations and outcomes, taken together, they suggest that VR-based peer dialogue programs may have value for both direct participants and audiences. Further research, particularly controlled studies with comparison conditions, is needed to determine whether these associations reflect causal effects and whether such programs might contribute to broader mental health promotion efforts.

Perceived public stigma—the belief that others devalue people with mental illness—is often elevated among individuals without personal experience of mental illness. Research has shown that people with lived experience of mental illness report significantly lower stigma toward mental illness compared to those without such experience[18]. While direct interaction with people who have mental illness can reduce stigma, such encounters are not always feasible and may create psychological demands for both parties. A meta-analysis of mediated intergroup contact demonstrated that positive exposure through media can reduce prejudicial attitudes, though effects are typically smaller than those of direct contact[9]. Complementing this, a broader meta-analysis of real-world contact interventions showed that both direct and indirect forms of contact are effective in reducing prejudice, with effects that persist over time[8]. In this study, university students observed authentic peer dialogue—produced within a social VR environment and transmitted via broadcast media on a standard 2D screen. This viewing experience is best conceptualised as a form of technology-mediated vicarious intergroup contact[9], which may have facilitated perspective-taking and empathy without the psychological demands of face-to-face interaction. Importantly, the stigma-reducing effects observed here are likely attributable to the narrative content and authenticity of the peer dialogue rather than to immersive VR-specific features such as embodiment or active participation in a virtual environment.

In this study, the pattern of change in stigma appeared to vary by baseline stigma level. This pattern is consistent with theoretical frameworks in stigma reduction research. Intergroup contact theory suggests that exposure to counter-stereotypical exemplars can reduce prejudice, with effects potentially being stronger among those with more limited prior contact[7]. Research on narrative persuasion has demonstrated that argument strength has a greater impact on individuals who are initially more skeptical toward the story's message[19]. The present findings align with this perspective: viewers with elevated baseline stigma appeared more responsive to exposure to authentic peer dialogue grounded in lived experience.

The observed effect sizes were small, consistent with prior research on contact-based interventions conducted in real-world settings, which typically yield modest but reliable effects[8]. Importantly, such interventions have been shown to produce changes that persist over time and generalize beyond the specific individuals involved. While the magnitude of change was modest, the sustained reduction over three months and the larger effects observed among participants with higher baseline stigma suggest potential practical significance. Small but sustained changes in perceived public stigma at a population level may contribute meaningfully to broader shifts in social attitudes toward mental health disclosure.

Several design features of the program may have contributed to the observed effects. Previous research has identified specific message characteristics associated with stigma reduction, including explicit disclosure of diagnoses and emphasis on psychosocial causes of mental ill health[6]. In the current program, the structured progression through VR environments facilitated gradually deepening emotional disclosure, culminating in an explicit discussion of diagnoses, symptoms, and recovery experiences. The use of avatars may have reduced visual markers associated with diagnostic labeling, potentially shifting viewers′ attention from categorical differences to shared human concerns. These narrative elements may have been particularly impactful for viewers initially holding stronger stigmatizing beliefs.

An important interpretive question concerns the extent to which observed effects were attributable to the VR-mediated context of production versus the content of the peer dialogue itself. Research has shown that avatar-mediated communication can facilitate emotional self-disclosure[17], which may have enabled participants to share richer emotional experiences and more authentic personal narratives than would have been possible in face-to-face settings. Patient narratives have been shown to enhance empathy and understanding while reducing prejudice toward mental illness[20]. However, because participants in the current study viewed the program on a standard 2D screen without immersive VR hardware, any stigma

reduction observed cannot be attributed to embodiment or active social VR participation. Rather, the findings suggest that the authenticity of disclosure facilitated by the VR context of production—combined with the narrative content and facilitation structure of the program—may be sufficient to produce stigma-reducing effects when transmitted through conventional broadcast media. This distinction has practical significance: it suggests that the benefits of VR-facilitated peer dialogue may be scalable through broadcast without requiring viewers to access VR technology.

Regarding safety, depressive symptoms did not worsen immediately following program viewing. Although PHQ-9 scores showed a small increase at the three-month follow-up, mean values remained within the minimal to mild range throughout the study, and no participant required clinical intervention. It should be noted that the follow-up assessment coincided with the end-of-term examination period; although it was scheduled after the conclusion of examinations to minimize acute stress, residual post-examination fatigue may have contributed to the modest PHQ-9 increase independently of program effects. As no measure of academic stress was collected and no control group was included, this contextual factor cannot be fully excluded. Future studies should consider incorporating stress measures as covariates or scheduling follow-up assessments at periods further removed from the examination cycle. While these findings provide some reassurance regarding short-term safety, longer-term monitoring in diverse populations would strengthen the evidence for broader implementation.

Strengths and Limitations of the Work

Strengths

This study has several strengths. First, the longitudinal design with three assessment points enabled examination of both immediate and sustained effects of program viewing. Second, the use of a linear mixed model optimally used all available data while appropriately handling missing data. Third, the study was conducted under standardized conditions with a clearly defined and consistent intervention. Fourth, procedural safeguards—including channel-based questionnaire distribution and automatic form closure—ensured the integrity of the data collection process. Finally, the inclusion of a safety outcome (PHQ-9) addressed potential risks associated with exposure to emotionally sensitive content.

Limitations

Several limitations should be acknowledged. First, the observational design without a control group limits causal inference, and changes in stigma cannot be definitively attributed to program viewing.

Second, participants were university students from a single institution, which may limit generalizability. Third, the exploratory subgroup analysis was based on a median split of baseline stigma, which may have reduced statistical precision and should therefore be interpreted cautiously. In addition, because subgrouping was based on baseline values of the same outcome, the observed differential change may partly reflect regression to the mean rather than true effect modification. Fourth, public stigma was assessed using self-report measures and may have been influenced by social desirability bias—the tendency for respondents to answer in ways that present themselves favourably rather than reflecting their true attitudes[21]—particularly given the group setting of a university lecture. It is worth noting that the PDD scale assesses perceived societal attitudes rather than personal prejudice, which partially mitigates this concern[4], and that anonymous online data collection has been shown to reduce social desirability effects compared with face-to-face methods[21]. Nonetheless, future studies would benefit from incorporating a validated social desirability measure as a covariate. Fifth, exposure consisted of a single episode, and the durability and cumulative impact of repeated exposure remain unknown. Finally, as participants viewed the program on a standard 2D screen rather than using immersive VR hardware, the study cannot isolate the effects of VR as a production context from the effects of the narrative content itself. Although previous research suggests that VR may facilitate authentic disclosure among direct participants, the present study did not compare VR-produced content with equivalent content produced through conventional formats. Therefore, the relative contributions of the VR production context and the narrative content it enables remain unclear and warrant further investigation. Additionally, the program included multiple elements beyond the peer dialogue itself, including follow-up interviews with participants and clinical commentary on their experiences. While these additional elements may have contributed to the observed stigma reduction, the current design cannot determine their relative contributions to the overall effects.

Recommendations for Further Research

Future research should employ controlled designs to clarify causal mechanisms underlying selective stigma reduction. Randomized comparisons with conventional educational materials would help isolate the specific contribution of avatar-mediated peer dialogue. Examination of dose–response relationships and repeated exposure paradigms is warranted. Further investigation is needed to identify which narrative elements most strongly influence higher-stigma viewers, including diagnostic disclosure, emotional intensity, narrative coherence, and facilitation style. Expanding outcome measures beyond

self-reported attitudes to include behavioral indicators and longitudinal follow-up would strengthen ecological validity. Finally, future studies could explore psychological mechanisms underlying these effects through additional outcome measures such as empathic response or perspective-taking.

Implications for Policy and Practice

The findings suggest that social VR–based peer dialogue programs may offer a scalable, low-burden approach to reducing perceived public stigma toward mental illness in university settings. Unlike face-to-face contact interventions, broadcast-based viewing requires no direct interaction between viewers and individuals with mental illness, reducing barriers to implementation. The observed effects were particularly pronounced among students with higher baseline stigma, suggesting that such programs may be especially valuable for audiences with limited prior exposure to mental health narratives. For nursing practice and mental health promotion, these findings support the integration of media-based stigma reduction strategies into educational curricula, particularly for student populations at a developmentally sensitive period for psychiatric disorder onset. Policymakers and educators may consider incorporating evidence-based VR narrative programs into broader mental health literacy initiatives targeting young adults.

7. Conclusion

Viewing social VR–based peer dialogue was associated with reductions in perceived public stigma toward mental illness among university students, particularly among individuals with higher baseline stigma, without evidence of adverse psychological effects. Effect sizes were small but consistent with prior research on mediated contact interventions. Together with prior participant-focused findings, these results suggest that social VR–based peer dialogue programs may have value both for direct participants and for audiences who view the interactions, though controlled studies are needed to establish causal effects and clarify mechanisms.

Statements and Declarations

Funding

This study was funded by the Japan Science and Technology Agency (JST) under the Co-creation Opportunity Formation Support Program (COI-NEXT), FY2022–2031.

Potential Competing Interests

JF received a supervision fee from NHK for clinical consultation during program development and appeared in the program to provide expert commentary. The current study was conceived, designed, and conducted independently after program broadcast. To ensure objectivity, data collection and statistical analysis were performed by independent research staff (MT, MM) who had no financial relationship with NHK. NHK was not involved in study design, data collection, analysis, or interpretation of results. All other authors declare no conflicts of interest.

Statistics Statement

- There are statisticians on the author team: Satoru Shinoda, PhD (SS), Department of Biostatistics, Graduate School of Medicine, Yokohama City University, & Masahiro Matsui, PhD (MM), Department of Child Psychiatry, Yokohama City University Hospital.
- The author(s) affirm that the methods used in the data analyses are suitably applied to their data within their study design and context, and the statistical findings have been implemented and interpreted correctly.
- The author(s) agree to take responsibility for ensuring that the choice of statistical approach is appropriate and is conducted and interpreted correctly as a condition to submit to the Journal.

Author Contributions

- JF (Junichi Fujita): Conceptualization, Methodology, Investigation, Writing – Original Draft, Writing – Review & Editing, Supervision, Project Administration
- MM (Masahiro Matsui): Formal Analysis, Writing – Review & Editing
- MT (Mizuho Takayama): Investigation, Writing – Review & Editing
- SS (Satoru Shinoda): Formal Analysis (supervision), Methodology
- YA (Yoshiko Aoki): Resources, Writing – Review & Editing
- ToM (Tomoko Moroga), MI (Mio Ishii): Data Curation, Project Administration
- KH (Koji Hara): Resources, Investigation (participant recruitment)
- TMi (Tomoyuki Miyazaki): Resources, Funding Acquisition, Supervision

All authors have read and approved the final manuscript.

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to privacy protection and the scope of the research plan but are available from the corresponding author on reasonable request.

Nagoya Protocol

This study did not involve genetic resources or associated traditional knowledge; therefore, the Nagoya Protocol on Access to Genetic Resources does not apply.

Acknowledgments

The authors used Claude (Anthropic) and ChatGPT (OpenAI) to assist with English language editing, translation between Japanese and English, and preliminary literature review. All AI-generated content was carefully reviewed, edited, and verified by the authors. The authors take full responsibility for the content of this manuscript. The television program viewed in this study was independently produced and broadcast by NHK. We thank NHK for their collaboration in developing the program format. All editorial decisions regarding program content and final participant selection for broadcast were made independently by NHK production staff. The current viewer study was designed and conducted independently following broadcast, with no involvement from NHK in study design, data collection, or analysis.

References

1. ^*Evans-Lacko S, Courtin E, Fiorillo A, Knapp M, Luciano M, Park A-L, Brunn M, Byford S, Chevreul K, Forsman AK, Gulacsi L, Haro JM, Kennelly B, Knappe S, Lai T, Lasalvia A, Miret M, O'Sullivan C, Obradors-Tarragó C, Rüsch N, Sartorius N, Švab V, van Weeghel J, Van Audenhove C, Wahlbeck K, Zlati A, McDaid D, Thornicroft G (2014). "The State of the Art in European Research on Reducing Social Exclusion and Stigma Related to Mental Health: A Systematic Mapping of the Literature." Eur Psychiatry. **29**(6):381–389.*
2. ^*Gronholm PC, Thornicroft G, Laurens KR, Evans-Lacko S (2017). "Mental Health-Related Stigma and Pathways to Care for People at Risk of Psychotic Disorders or Experiencing First-Episode Psychosis: A Systematic Review." Psychol Med. **47**(11):1867–1879. doi:10.1017/S0033291717000344.*

3. ^ a, b *Thornicroft G, Mehta N, Clement S, Evans-Lacko S, Doherty M, Rose D, Koschorke M, Shidhaye R, O'Reilly C, Henderson C (2016). "Evidence for Effective Interventions to Reduce Mental-Health-Related Stigma and Discrimination." Lancet.* ***387****(10023):1123–1132. doi:10.1016/S0140-6736(15)00298-6.*
4. ^ a, b, c *Link BG (1987). "Understanding Labeling Effects in the Area of Mental Disorders: An Assessment of the Effects of Expectations of Rejection." Am Sociol Rev.* ***52****(1):96–112.*
5. ^ *Zhuang J, Guidry A (2022). "Does Storytelling Reduce Stigma? A Meta-Analytic View of Narrative Persuasi on on Stigma Reduction." Basic Appl Soc Psychol.* ***44****(1):25–37. doi:10.1080/01973533.2022.2039657.*
6. ^ a, b *Zhang Z, Reavley N, Armstrong G, Morgan A (2025). "Public Disclosures of Mental Health Problems on S ocial Media and Audiences' Self-Reported Anti-Stigma Effects." Health Promot Int.* ***40****(1):daae204. doi:10.10 93/heapro/daae204.*
7. ^ a, b *Pettigrew TF, Tropp LR, Wagner U, Christ O (2011). "Recent Advances in Intergroup Contact Theory." Int J Intercult Relat.* ***35****(3):271–280. doi:10.1016/j.ijintrel.2011.03.001.*
8. ^ a, b, c *Lemmer G, Wagner U (2015). "Can We Really Reduce Ethnic Prejudice Outside the Lab? A Meta-Analysi s of Direct and Indirect Contact Interventions." Eur J Soc Psychol.* ***45****(2):152–168. doi:10.1002/ejsp.2079.*
9. ^ a, b, c, d *Banas JA, Bessarabova E, Massey ZB (2020). "Meta-Analysis on Mediated Contact and Prejudice." H um Commun Res.* ***46****(2–3):120–160. doi:10.1093/hcr/hqaa004.*
10. ^ *Tay JL, Xie H, Sim K (2023). "Effectiveness of Augmented and Virtual Reality-Based Interventions in Impro ving Knowledge, Attitudes, Empathy and Stigma Regarding People With Mental Illnesses—A Scoping Revie w." J Pers Med.* ***13****:112. doi:10.3390/jpm13010112.*
11. ^ *Rodríguez-Rivas ME, Cangas AJ, Cariola LA, Varela JJ, Valdebenito S (2022). "Innovative Technology–Base d Interventions to Reduce Stigma Toward People With Mental Illness: Systematic Review and Meta-Analysi s." JMIR Serious Games.* ***10****(2):e35099. doi:10.2196/35099.*
12. ^ *Mason A, Rapsey C, Sampson N, Lee S, Albor Y, Al-Hadi AN, Alonso J, Al-Saud N, Altwaijri Y, Andersson C, A twoli L, Auerbach RP, Ayuya C, Báez-Mansur PM, Ballester L, Bantjes J, Baumeister H, Bendtsen M, Benjet C, Berman AH, Bootsma E, Chan SCN, Cohut I, Covarrubias Díaz Couder MA, Cuijpers P, David O, Dong D, Eber t DD, Felez Nobrega M, Gaete J, García Forero M, Gili M, Gutiérrez-García R, Haro JM, Hasking P, Hudec K, Hu nt X, Hurks P, Husky M, Jaguga F, Jansen L, Kählke F, Klinkenberg E, Küchler A-M, Langer ÁI, Léniz I, Liu Y, M ac-Ginty S, Martínez V, Mathai M, McLafferty M, Miranda-Mendizabal A, Murray E, Musyoka CM, Nedelcea C, Ngai CH, Núñez D, O'Neill S, Piqueras JA, Popescu CA, Robinson K, Rodriguez-Jimenez T, Scarf D, Siu OL, St ein DJ, Struijs SY, Tomoiaga C, Valdés-García KP, van Luenen S, Vigo DV, Wang AY, Wiers R, Wong SYS, Kessle r RC, Bruffaerts R, Lima RA, Breet E, Garnefski N, Jacobs K, Kraaij V, Munro L, Munthali RJ, Prescivalli AP, Re*

*bagliato M, Roca M, Salemink E, van der Heijde C (2025). "Prevalence, Age-of-Onset, and Course of Mental Disorders Among 72,288 First-Year University Students From 18 Countries in the World Mental Health International College Student (WMH-ICS) Initiative." J Psychiatr Res. **183**:225–236. doi:10.1016/j.jpsychires.2025.02.016.*

13. ^*Solmi M, Radua J, Olivola M, Croce E, Soardo L, Salazar de Pablo G, Shin JI, Kirkbride JB, Jones P, Kim JH, Kim JY, Carvalho AF, Seeman MV, Correll CU, Fusar-Poli P (2022). "Age at Onset of Mental Disorders Worldwide: Large-Scale Meta-Analysis of 192 Epidemiological Studies." Mol Psychiatry. **27**(1):281–295. doi:10.1038/s41380-021-01161-7.*
14. ^*Shimotsu S, Sakamoto S (2020). "Psychiatric Disability, Attitudes, Prejudice, and the Link Stigma Scale." Jpn J Clin Psychiatry [Japanese Journal of Clinical Psychiatry]. **49**(8):1011–1017.*
15. a, b*Muramatsu K, Miyaoka H, Kamijima K, Muramatsu Y, Tanaka Y, Hosaka M, Miwa Y, Fuse K, Yoshimine F, Mashima I, Shimizu N, Ito H, Shimizu E (2018). "Performance of the Japanese Version of the Patient Health Questionnaire-9 (J-PHQ-9) for Depression in Primary Care." Gen Hosp Psychiatry. **52**:64–69. doi:10.1016/j.genhosppsych.2018.03.007.*
16. ^*Umegaki Y, Todo N (2017). "Psychometric Properties of the Japanese CES–D, SDS, and PHQ–9 Depression Scales in University Students." Psychol Assess. **29**(3):354–359. doi:10.1037/pas0000351.*
17. a, b*Ichino J, Ide M, Yokoyama H, Asano H, Miyachi H, Okabe D (2025). "Effects of New Communication Media and Gender on Self-Disclosure." Behav Inf Technol. doi:10.1080/0144929X.2025.2507690.*
18. ^*Trani JF, Yen BJ, Canares T, Bakhshi P, Deshpande S, Mishra NN, Kumar N (2023). "People With Mental Illness Stigmatize Mental Illness Less: A Comparison Study Between a Hospital-Based Sample of People With Mental Illness and a Non-Clinical General Population Sample in Urban India." Transcult Psychiatry. **60**(6):979–993. doi:10.1177/13364615231179265.*
19. ^*Schreiner C, Appel M, Isberner MB, Richter T (2018). "Argument Strength and the Persuasiveness of Stories." Discourse Process. **55**(4):371–386. doi:10.1080/0163853X.2016.1257406.*
20. ^*Cho MK, Kim MY (2024). "Effects of an Empathy Enhancement Program Using Patient Stories on Attitudes and Stigma Toward Mental Illness Among Nursing Students." Front Psychiatry. **14**:1304947. doi:10.3389/fpsyt.2023.1304947.*
21. a, b*Henderson C, Evans-Lacko S, Flach C, Thornicroft G (2012). "Responses to Mental Health Stigma Questions: The Importance of Social Desirability and Data Collection Method." Can J Psychiatry. **57**(3):152–160.*

Declarations

Funding: This study was funded by the Japan Science and Technology Agency (JST) under the Co-creation Opportunity Formation Support Program (COI-NEXT), FY2022–2031.

Potential competing interests: JF received a supervision fee from NHK for clinical consultation during program development and appeared in the program to provide expert commentary. The current study was conceived, designed, and conducted independently after program broadcast. To ensure objectivity, data collection and statistical analysis were performed by independent research staff (MT, MM) who had no financial relationship with NHK. NHK was not involved in study design, data collection, analysis, or interpretation of results. All other authors declare no conflicts of interest.