Advancing Suicide Prevention Through Immersive Technology

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Abstract: This study presents a novel translational method for suicide prevention research, employing customizable virtual reality (VR) simulations that mimic real-life situations. We aim to validate the usability of these VR scenarios as approximations of actual suicide and to rigorously assess their safety. By increasing the variety of simulated suicide methods and variables, this study enables researchers to effectively isolate the causes of suicide and thus provide key insights for suicide prevention.

1 INTRODUCTION

Each year, there are more than 700,000 people around the world who die from suicide (WHO, 2021), leaving devastating impacts on their families, friends, and communities long after. Suicide remains a major public health concern across different regions, with varying trends and risk factors influenced by cultural, economic, and social contexts. Despite major institutional and scientific efforts to reduce suicide rates, such as those outlined by Fox et al.(2020), the prevalence of suicidal thoughts and behaviors remains concerningly high in certain populations, including the United States (CDC, 2024a; Curtin et al., 2021).

An experimental method to investigate the direct cause of suicide is required to develop effective treatments targeting the specific cause. We know little about direct suicide cause since we cannot use suicide as an experimental outcome variable in real life, where manipulation may make its occurrence more likely. Suicide scenarios in VR allow us to investigate the causes of suicide by conducting experiments that manipulate purported causes of suicide and detect their effects on VR suicide rates. Previous research has validated shooting and jumping scenarios from existing VR games as safe approximations of real-life suicide (Franklin et al., 2019; Huang et al., 2021).

However, these scenarios were limited in the variety of suicide methods, lack of consistency, and restricted interactions. This limitation arises because these VR suicide scenarios were derived from separate, unrelated commercial games, each designed with different mechanics, environments, and objectives that were not originally intended for suicide research. As a result, their implementation varies across studies, making it difficult to systematically compare findings or establish a standardized research framework. In the current study, we designed a VR Suicide Scenarios project with a novel VR platform with various buildable suicide methods, allowing researchers to overcome previous limitations, test new hypotheses about specific causal factors of suicide, and design and deliver targeting interventions. This study focused on the following objectives: 1) Measure the validity of the VR suicide scenarios by comparing the new scenarios with actual suicide and previously validated VR scenarios; 2) Evaluate the safety of the proposed VR suicide scenarios.

2 LITERATURE REVIEW

Suicide research has historically struggled to identify strong predictive risk factors, with most identified factors offering weak predictions for suicidal behaviors (Franklin et al., 2019). Many identified risk factors for suicide, such as prior psychiatric hospitalization, are correlated with suicide but do not di-

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rectly cause it. As a result, interventions targeting these factors have shown limited efficacy (Fox et al., 2020). This highlights the need for a shift toward identifying causal factors with large effects, using experimental methodologies involving random assignment and controlled manipulation. One such factor is perceived entrapment — the feeling of being trapped in an unbearable situation with no escape (O'Connor and Kirtley, 2018). Unlike correlational risk factors, causal factors like this can directly influences suicidal behavior and can be experimentally tested. Empirical work supports its causal role: perceived entrapment predicts the first onset of suicidal thoughts in medical students (Wang et al., 2023) and exacerbates suicide risk in psychiatric populations (Taylor et al., 2010). Interventions targeting this mechanism, such as cognitive strategies to reduce entrapment perceptions, have demonstrated success in lowering suicidal ideation (O'Connor and Kirtley, 2018).

VR offers a safe, ethical, and controlled method to manipulate such factors, enabling researchers to explore suicide mechanisms beyond the limitations of observational studies. Franklin et al. (2019) developed a VR suicide approximation featuring scenarios like jumping from *Richie's Plank Experience* and shooting in *Arizona Sunshine*. Their findings indicate that these VR suicide scenarios are realistic and that factors such as gender, suicidal desire, and prior suicidality, which predict real-world suicide, also influence VR suicide rates. This effectively validates VR as a useful tool for suicide research. Regarding safety, Huang et al. (2021) conducted two longitudinal studies (one-month and two-year follow-ups) to assess the psychological safety of VR suicide scenarios. They measured suicidality, capability for suicide, and agitation post-exposure, finding no significant increases in distress or suicidal ideation. In some cases, suicide-related constructs showed small to moderate reductions, supporting the safety of VR-based suicide research. These findings align with utilitarian ethics, which prioritize maximizing benefits while minimizing harm. The study suggests that the potential research and intervention benefits of VR suicide scenarios outweigh minimal risks when ethical safeguards—such as participant screening, careful scenario design, and post-experiment debriefing—are implemented.

While VR suicide scenarios do not replicate real-life suicide, they provide valuable insights into the causes of suicide and are crucial in directing future strategies in suicide prevention. Research studies involving commercial games as VR suicide scenarios have shown that the anticipation of avoiding future psychological and physical pain significantly influ-

ences VR suicide decision rates (Huang et al., 2020; Park et al., 2023). These results emphasize the importance of anticipated consequences over experienced antecedents like stress, rejection, and physical pain in determining suicidal behavior. Furthermore, Ribeiro et al. (Ribeiro et al., 2021) showed that raising doubts about the desirable outcomes of suicide can effectively reduce VR suicide rates and alter perceptions regarding the lethality of suicide methods. These crucial findings further confirm the indispensable role of VR suicide scenarios; without them, exploring and experimentally manipulating suicide risk factors in real-life settings could be dangerous and unethical.

3 OUR CONTRIBUTION

Our VR experience is designed for healthcare professionals to study suicide-related decision-making in the general population. While participants in the VR scenarios come from the non-clinical population, the goal is to analyze their behaviors in a controlled environment, providing insights for suicide prevention and clinical interventions

Although previous studies using VR suicide scenarios have provided valuable insights, they also present significant limitations, which our project aims to address. First, the two existing scenarios in *Richie's Plank Experience* and *Arizona Sunshine*, though realistic, offer limited variety and fail to adequately represent the most common methods of suicide in the United States. For instance, jumping is not a common method of suicide in the United States. In contrast, commonly used methods such as suffocation and poisoning, as noted by the Centers for Disease Control and Prevention (CDC, 2024b), were not included. Second, both jumping and shooting are highly lethal methods, offering minimal chances for individuals to reconsider their actions. In reality, many individuals attempting suicide might opt for less lethal methods, and many may not complete the act. These discrepancies highlight the necessity for a wider range of VR suicide scenarios that more accurately mirror the methods commonly used in suicide attempts. Our study responds to this gap by introducing five VR suicide scenarios— gun shooting, jumping, overdosing, hanging, and cutting — aligning with the most prevalent methods of both suicide death and nonfatal self-harm according to the U.S. Centers for Disease Control and Prevention (CDC, 2022).

Furthermore, the existing VR scenarios were primarily designed for entertainment purposes and might not align with the nuanced requirements of psychological and behavioral research. These scenarios may

lack the complexity and specificity needed for a thorough exploration of intricate suicide-related phenomena. Our project goes beyond these enhancements by developing tailored VR suicide scenarios, created specifically for research purposes. These scenarios will include a private set of environments and situations, representative of the various contexts in which suicidal thoughts and behaviors occur. In the development of these scenarios, we are collaborating closely with mental health professionals. This partnership ensures that the scenarios accurately represent the psychological and behavioral aspects of suicide, while also providing researchers with essential, controllable variables for their studies. This approach is intended to enhance the generalizability of research findings using these scenarios across diverse populations.

4 METHODS

From the literature review and our previous investigation results using existing gaming scenes, we followed several key points in designing the current project. First of all, the VR application prioritized realism and immersion to closely approximate real-life situations involving suicide. Unlike some other VR games that use simple polygons to achieve engagement purposes, the suicide scenarios have to be as realistic as possible so that the proposed system can trigger the embodied feelings of the users. Furthermore, we implemented controlled behavior scenarios tailored to each potential method of suicide, such as the available options between shooting oneself and shooting other objects. Additionally, the system offers the flexibility to show or hide tools commonly associated with suicide, for example, by allowing a gun to be hidden in a drawer or disabling it through user choices. This level of detail not only enhances the realism of the simulation but also allows for a more comprehensive understanding and analysis of these critical situations.

4.1 VR Scenario Design

This application is developed as a fully immersive VR experience, utilizing narrative and interactive elements, unlike conventional VR 360 videos or simulated intervention sessions. The Unity game engine was used for the development of the VR scenarios. The primary platform targeted for this application is Oculus Quest 2 or 3. It features a scenario-based narrative, presented from a first-person perspective, and integrates comprehensive user interactions including head and hand movements, as well as body tracking,

to ensure a realistic simulation. Users can navigate the virtual environment – an apartment setting – using VR control inputs, allowing them to teleport, walk, interact with various objects, and perform specific gestures. Additionally, they can engage with objects in multiple ways, such as picking them up or jumping. The application includes a voiceover feature that suggests acts of self-harm; however, users retain autonomy over their actions and can choose to ignore these suggestions. There are two distinct modes within the game: a 'free exploration' mode intended for experimental sessions in a laboratory setting, where a research assistant provides live directions without in-game voice guidance, and 'guided scenes' mode, where the in-game voice offers navigational cues and instructions. All scenarios in the application were intended to provide valuable insights into human behavior and decision-making under extreme virtual circumstances, while maintaining a controlled and safe environment for the player. Researchers outside of the virtual environment initiate the sequence and choose different scenes according to the experimental plan, playing a crucial role in guiding and monitoring the experience.

4.1.1 Level Design

The main hub is an apartment in a high-rise building. It has a living room, an open kitchen, a bedroom, a bathroom, and a balcony linked to the living room, all fully furnished and filled with furniture. The balcony offers a view of other apartment buildings and the street below. The user is the main character in the game, who resides in the apartment. The voice is a non-player character who provides guidance and instructions to the player throughout the game. A flowchart of the scenarios is shown in Figure 1, screenshots of essential scenarios are shown in Figure 2 and the following paragraphs describe them in detail.

Tutorial (Main Hub) - Figure 2a. The player is introduced to the game mechanics in an immersive and instructive manner. Upon spawn, the player finds themselves in the living room (which serves as the main hub) of their virtual apartment, where they are immediately greeted by a voiceover. This voiceover explains the basic controls and mechanics of the game, effectively orienting the player to the VR environment. It provides detailed instructions on how to move the player character, interact with various objects within the environment, and access the different features available in the game. Such hands-on experience in the tutorial phase is designed to enhance the player's comfort and dexterity with the game's
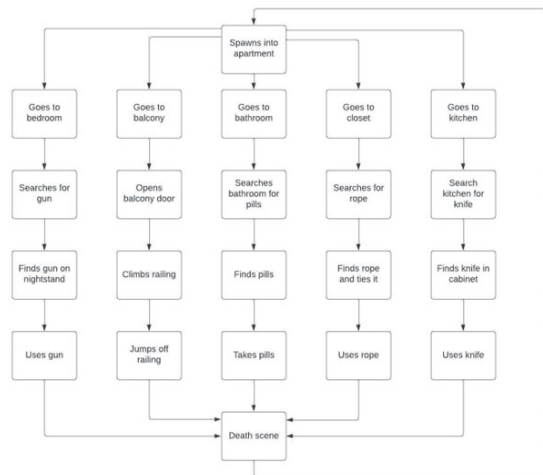
Figure 1: Flowchart of the scenarios.

(a) Main hub.

(b) Shooting scene.

(c) Jumping scene.

(d) Overdosing scene.

(e) Hanging scene.

(f) Cutting scene.

Figure 2: Screenshots of the scenarios.

interactive elements, setting a solid foundation for their subsequent VR experience. All scenarios have a timer; if the user chooses not to do self-harm, they will be sent back to the main hub scene after a certain amount of time.

Shooting - Figure 2b. The player receives instruction, which instructs them to go to the bedroom and retrieve a handgun. This is followed by instructions to shoot at a neutral object in the environment, serving as an introduction to the use of the firearm within the virtual space. Subsequently, the voice presents the player with a critical decision: to either "point

the gun between your eyes and pull the trigger, effectively shooting yourself in the face," or to opt for shooting another neutral object. This decision point is central to the scenario, testing the player's response to extreme virtual situations. Should the player choose the suicide option, the game is programmed to display a death scene before automatically resetting the player back to the living room. This reset serves both as a narrative conclusion to the chosen path and as a mechanism to allow the player to re-engage with the scenario or explore other aspects of the VR experience. This scenario is carefully crafted to provide insights into player decision-making and responses within high-stress environments.

Jumping - Figure 2c. The scenario begins with instructions guiding the player to move out onto the balcony of the virtual apartment. The player is confronted with a significant choice: to either "step forward and fall to their death" or to retreat safely back into the apartment. In the event that the player opts for the suicide option, the VR application is designed to depict a death scene, providing a stark visual conclusion to the choice made. Following this, the player is automatically reset to the living room, allowing for a reevaluation of their decision or the opportunity to explore other scenarios within the VR environment.

Overdosing - Figure 2d. The scenario begins with an in-game voice guiding the player to locate the medicine cabinet in the kitchen of the virtual environment. Once found, the player is directed to pour two pills into their hand. The player is confronted with a significant choice: to either "take the whole bottle of medicine," implying an act of self-harm, or to adhere to the prescribed dosage of just two pills. If the player opts for the overdose, the VR system allows for an important safety mechanism: the player can abort the scenario at any time by calling an ambulance. This feature adds a layer of realism and choice, reflecting real-world emergency responses. If the player does not call an ambulance after choosing the overdose option, the game is programmed to display a death scene, followed by a reset of the player back to the main hub. If the player calls an ambulance, the screen transitions to white, and the player "wakes up" on the couch in the apartment, simulating a rescue and recovery.

Hanging - Figure 2e. The scenario begins with a voice directing the player to locate a noose hidden within a cabinet. The player is then instructed to place a stool under a ceiling fixture and attach the

noose to it. The player is confronted with a significant choice: placing the noose around their neck and stepping off the stool, implying a simulated act of suicide, or deciding against it and simply walking away from the stool. If the player chooses to simulate suicide, the VR application is programmed to display a death scene. This is followed by a reset of the player back to the living room.

Cutting - Figure 2f. The scenario begins with an in-game voice instructing the player to locate a sharp knife in the kitchen of the virtual environment. This introduction to the tool is immediately followed by a directive to cut an orange on a chopping board, establishing a mundane and safe use for the knife. The player then faces a significant choice: either simulate self-harm by cutting their wrist or engage in a harmless activity by cutting a loaf of bread on the counter. Moreover, the player can choose to abort this scenario at any time by calling an ambulance. Should the player opt for the simulated self-harm option and not call an ambulance, the VR application is designed to depict a death scene, followed by an automatic reset of the player back to the living room.

Death Scene. All scenarios either end with exceeding the time limit or a death scene. In the death scene, when a user triggers a death scene, the immersive experience takes a poignant turn. As the participant's virtual perspective slowly darkens, the environment fades away, symbolizing the retreat of life itself. Concurrently, a heartbeat sound underscores this transition—starting with a strong, rhythmic pulse that gradually shifts to a heavy, dissonant beat before finally dwindling into a weak echo. This orchestrated blend of visual and auditory cues is designed to deeply engage users, allowing them to viscerally experience the final moments in a controlled, virtual setting.

4.2 Experimental Design

For this study, we will recruit undergraduate college students from a non-clinical sample, primarily from psychology courses at Florida State University. These students will participate in the study in exchange for course credit. Students will receive course credits for their participation. We will implement a within-subjects approach, meaning each participant will be exposed to all five VR suicide scenarios. The order of these scenarios will be counterbalanced using a balanced Latin square method to ensure no order effects bias the results.

For each scenario, participants will be faced with a decision: to follow through with the simulated suicide option or to choose a safer alternative action. This study has no manipulation to encourage participants to choose one option over the other, assessing the suicide completion rate at a neutral condition.

Our primary objective is to assess the readiness of the newly developed VR suicide scenarios by examining their fidelity in replicating real-life suicide situations and comparing them to previously validated VR suicide scenarios using commercial games. This study is designed to validate the system's effectiveness as a research tool for suicide-related experiments, not to investigate the underlying causes of suicide. Once the system is validated, it will serve as a foundation for future research to explore how specific variables might influence participants' likelihood of choosing the suicide option.

4.2.1 Hypotheses

First, we hypothesize that participants will perceive the scenarios as realistic and directly relevant to actual suicide contexts. To test this, participants will be asked to provide realism and suicide-relevance ratings for each scenario after completion.

Second, we anticipate that the rates of virtual suicide completion will be low, reflecting the low prevalence of suicidal behaviors observed in the general population. We expect the completion rates to be similar to those observed in neutral conditions of previously validated VR suicide scenarios (around 5%) (Franklin et al., 2019). This will be tested by calculating the percentages of participants who opt for each behavioral outcome within the scenarios.

Third, we expect that factors commonly associated with real-life suicide will predict participants' decisions to complete the VR suicide scenarios. Specifically, we will examine male sex, suicidal desire, agitation, prior suicidality, and other psychological risk factors. These variables will be assessed using pre-experiment self-report questionnaires and validated psychometric measures.

Fourth, we predict that the justifications provided by participants for choosing the safe alternative or for aborting the virtual suicide attempt will parallel the reasons often cited in actual suicide cases. To examine this, we will collect the reasons that participants follow through with the simulated suicide option or choose the safe alternative. This aspect of the study aims to deepen our understanding of the cognitive and emotional processes underlying such critical decisions.

Finally, we hypothesize the responses elicited by the newly developed scenarios to closely align with those from previously established ones. We will draw comparisons of all the above metrics among the sce-

narios. This will help us determine the similarity in how participants react and make decisions across different VR suicide scenarios.

Finally, we hypothesize that the responses elicited by the newly developed VR suicide scenarios will align with those from previously established scenarios. To evaluate this, we will compare key behavioral (e.g., VR suicide completion rates) and psychological (e.g., distress levels, realism ratings) metrics within our study conditions and against data from previous VR suicide studies where available (Franklin et al., 2019; Huang et al., 2021).

4.3 Measures and Assessments

Participants will complete a series of validated psychometric measures at baseline, after each VR scenario, and at the end of the study. Baseline assessments include demographics, suicidal ideation (Beck and Steer, 1991), depressive symptoms (Beck et al., 1996), agitation (Ribeiro et al., 2011), risk-taking tendencies (Blais and Weber, 2006), fearlessness about death (Ribeiro et al., 2014), moral reasoning (Fleischmann et al., 2019), self-injurious behaviors (Nock et al., 2007), interpersonal needs (Bryan, 2010), substance use (WHO ASSIST Working Group, 2002), and current suicidal desire. After each VR scenario, participants will rate realism and suicide relevance and provide responses on the reasons for engaging, not engaging, or aborting VR Suicide Scales (Franklin et al., 2019). At the end of the study, suicidal desire and BSS will be re-administered. Participants meeting suicide risk criteria (e.g., $BSS \geq 5$, history of multiple attempts, or increased suicidal desire) will undergo a clinical risk assessment (Chu et al., 2017) by a trained doctoral student, following established VR suicide research protocols (Franklin et al., 2019; Park et al., 2023). All study team members will receive IRB-approved risk management training before conducting assessments.

4.4 Data Analysis

To evaluate differences across the five VR suicide scenarios, we will use repeated-measures ANOVA to test for significant variations in behavioral (e.g., VR suicide completion rates) and psychological (e.g., distress, realism ratings) metrics. If significant effects are detected, post hoc Bonferroni corrections will be applied to control for multiple comparisons.

For comparisons with previous studies (Franklin et al., 2019; Huang et al., 2021), we will use independent t-tests for direct mean comparisons and mixed-effects models to account for individual differences across studies. Effect sizes, such as Cohen's d for between-group comparisons and partial eta squared for within-subject effects, will be reported to contextualize findings.

All statistical analyses will be conducted in R, with an alpha threshold of 0.05 for significance testing.

4.5 Safety Evaluation

This study was reviewed and approved by the Florida State University Institutional Review Board (STUDY00004909).

To ensure the safety of participants exposed to the new VR suicide scenarios, our safety evaluation plan involves a combination of immediate, short-term, and long-term assessments.

Immediately after the study, we will adhere to the safety protocols established in previous VR suicide scenario studies (Franklin et al., 2019; Huang et al., 2020; Ribeiro et al., 2021). All participants will undergo a positive mood induction by watching a VR animation *The Rose and I*. Then, all participants will receive a suicide risk assessment conducted by a trained clinical psychology graduate student under the supervision of the study's faculty advisor, a licensed clinical psychologist. The assessment will utilize an empirically informed risk assessment methodology, based on guidelines by Chu et al. (2015) and Joiner et al. (1999). Corresponding steps will be taken to mitigate risk based on their risk levels. These measures will be applied irrespective of the participant's decision to engage in VR suicide scenarios or their assigned study conditions. Following this, our plan includes a short-term follow-up survey within a week of participation that repeats the same questions as at baseline about the presence or absence of suicidal thoughts and behaviors. This will help us detect any delayed psychological effects, focusing on changes in mood, mental health, and any occurrence of suicidal thoughts or behaviors since their experience with the VR scenarios. We will also repeat the survey at long-term follow-ups at one month and three months post-participation to monitor any sustained or late-emerging effects on participants' mental health. A trained clinical psychology graduate student will conduct a suicide risk assessment for participants with elevated suicide risk and take corresponding steps to mitigate their risk levels.

In addition to these follow-ups, we will compare the data obtained from the new scenarios with that from the established VR suicide scenarios. This comparative analysis will help us determine if the new scenarios pose additional risks or have different psy-

chological impacts on participants.

Throughout the study, we will provide participants with access to mental health support and resources to address any distress or heightened suicidal ideation following the VR experience. The safety evaluation plan, including follow-up protocols and support mechanisms, will undergo ethical review and approval by our institutional review board.

By implementing this comprehensive plan, we aim to ensure the safety of the new VR suicide scenarios, maintaining them at a standard comparable to the established ones. This approach is integral to responsibly exploring participant responses to intense suicide stimuli in a virtual environment.

5 DISCUSSION

In order to get feedback for the proposed VR applications, we conducted a preliminary playtesting, in which seven college students from different majors without any mental conditions participated. They provided valuable insights into the VR experience. We summarized a few key points of the feedback.

First of all, users generally found the VR application to be realistic and immersive. They felt as if they were actually present within the scene. This suggests the VR environment and scenarios are effectively designed to create a convincing and engaging experience.

Secondly, the project's portrayal of suicide scenarios, such as the shooting and jumping options, was found to be emotionally impactful. Users reported feeling genuinely scared in these scenarios, suggesting a strong emotional engagement with the content as we expected.

All testers have reported that the death scene leaves a profound and lasting impression, prompting them to reexamine their own perceptions of life despite the actions occurring in a virtual environment. The carefully designed interplay of visual darkness and the diminishing heartbeat sound creates an emotionally charged experience that resonates deeply. This immersive encounter not only underscores the gravity of loss but also challenges participants to confront the reality of mortality, blurring the lines between virtual simulation and real-life introspection.

As an important note, users suggested the inclusion of in-game surveys to avoid breaking immersion by removing the headset, indicating a preference for a seamless experience. This aligns with our original plan that has not yet been implemented into the prototype. Furthermore, improvements such as character customization and enhanced interactivity within the

environment were also suggested. We will integrate the feedback into the upcoming development and enhance the user experiences for better study results.

6 CONCLUSION AND FUTURE WORK

In conclusion, our proposed VR experience will support the development of a translational approach to studying suicide, validate its reasonableness with actual suicide, and examine its safety. The developed VR suicide scenarios will increase the variety of suicide methods and manipulating variables researchers can use to design studies to isolate the causes of suicide. Only after the causes of suicide, rather than correlates, are identified, can researchers develop effective treatments targeting the causes.

For instance, prior research using VR scenarios highlighted that the anticipation of avoiding future psychological and physical pain influenced participants' choice of the suicide option. With our new VR scenarios, future research could examine how different suicide methods influence completion rates. Specifically, we hypothesize that methods perceived as more distressing (e.g., shooting, hanging) may have lower completion rates due to increased aversion, while methods that allow for aborted attempts (e.g., overdose) may result in more hesitancy and lower final completion rates compared to irreversible methods (e.g., jumping, shooting). Studying these differences in a controlled VR environment could provide valuable insights into the decision-making processes behind suicidal behavior, ultimately informing prevention strategies.

We will keep improving the prototype and conduct the proposed study and evaluation. Future development of the platform can even incorporate treatment strategies and test their effectiveness in laboratories.

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APPENDIX

A link to the game trailer can be found below. https://youtu.be/GtSm41xPKxQ