

Virtual Reality-Based Skills Training for Risk Reduction in Offenders with Intellectual Disability

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Abstract

Purpose: The adaptive abilities of offenders with intellectual disability tend to be limited, emotional control is weak, and the recognition of risk situations is deficient, which makes re-offending more probable. The skills-based interventions that are traditionally based are very much based on verbal intervention and role plays, which might not prove effective with this population. The purpose of the study was to determine the effectiveness of a virtual reality (VR) based skills training program in decreasing the risk factors of dynamic type and enhancing adaptive coping skills among intellectually disabled offenders. Design: The quasi-experimental pre-post control group was adopted. Sixty mild and moderate intellectually disabled offenders were recruited in a forensic rehabilitation environment and assigned to an intervention group (n = 30) and an intervention-as-usual group (n = 30) using VR. The VR program involved simulated real-life risk conditions that involved emotional control, problem solving, refusal, and social decision making. Standardized measures of adaptive behavior and dynamic risk indicators were used in the assessment of outcomes at baseline, post-intervention, and three months follow-up. Interpretation of data was done through mixed-model repeated measures with the level of statistical significance of $p < 0.05$. Cohen d was used to calculate effect sizes. Findings: There was a statistically significant increase in adaptive skills of the participant who underwent VR training as compared to the control group ($F(2, 116) = 15.28, p < 0.001, d = 0.85$). There were also significant changes in risk-related behaviors ($F(2, 116) = 12.41, p = 0.001, d = 0.78$). The same was maintained at the three-month follow-up ($p < 0.01$). Conclusion: The study gives empirical evidence that VR-based skills training is an efficient and available intervention in risk reduction among intellectually disabled offenders, which can be added to the existing forensic rehabilitation programs and be seen as a practical addition to them.

Keywords Intellectual Disability, Virtual Reality, Risk Reduction, Offenders, Adaptive Behavior, Quasi-Experimental.

Introduction

Intellectually disabled offenders are a very vulnerable population in criminal justice/forensic rehabilitation systems. Intellectually disabled individuals are usually deficient in their cognitive functioning, emotional control, social awareness, and ability to solve problems. Such constraints expose a person to dynamic risks, including low impulse control, inability to perceive risky scenarios, low victim recognition, and inability to transfer the acquired skills to real-life situations. This means that offenders who have intellectual disability stand a greater chance of behavioral outbursts, breaches of the rules, and recidivism compared to the overall population of offenders [1][3]. Control of such risk factors using structured and available interventions is hence one of the priorities of forensic and rehabilitative services.

The existing risk-reduction and skills-training interventions with offenders with intellectual disability form, to a large extent, the verbal instruction, written resources, and group interventions involving role plays [2][5]. Although much utilized, these methods tend to require a lot of abstract thinking, memory, and verbal understanding, which might be beyond the learning capacity of people with intellectual disability [4][6]. Also, using traditional role-play techniques can not necessarily simulate the risk scenario of real life, thereby constraining skill generalization outside the therapeutic environment. In turn, a significant number of available interventions are not effective enough to generate sustained behavioral changes and quantifiable improvements in dynamic risk factors.

Research gap

Despite the evidence-based frameworks of offender rehabilitation stating the significance of experiential learning and training, there is a lack of empirical studies in the analysis of the implementation of technology-assisted interventions in offenders with intellectual disability [7]. Specifically, treatment using virtual reality (VR) in the training of structured skills among forensic ID populations is underutilized [14][17]. There are hardly any immersive, controlled, and repeatable simulations in existing programs that enable individuals to safely practice coping and decision-making skills in real-life risk situations. This gap shows that there is a need to explore whether VR-based training is able to result in better engagement, learning retention, and risk reduction outcomes in this population.

Objectives

The aim of the study is to determine how effective a virtual reality-based skills training programs is in the context of minimizing dynamic risk factors in offenders with intellectual disability. The specific objectives are

- To determine changes in adaptive coping and social decision-making skills after VR training.
- To test the differences in risk-related behaviors reductions relative to treatment-as-usual.
- & - To establish the long-term intervention effects.

This paper proposes a new VR-based intervention that is specifically tailored to offenders with intellectual disability, with simplified interfaces, prompts, and exposure to realistic risk situations graded. As opposed to conventional programs, the proposed approach allows for the performance of immersive, repetitive, and safe skills rehearsal with measurable behavioral outcomes. It also makes a contribution to the study as evidence of the risk reduction through standardized assessment tools in a quantitative manner, which offers a convenient model of implementation to the forensic rehabilitation setting.

The rest of the paper is structured in the following way. Section 2 will include a literature review of the existing skills training, risk reduction, and VR intervention of persons with intellectual disability. Section 3 reports on the study design, participants, VR intervention, and methods of analysis. Section 4 includes findings of the intervention. Section 5 interprets the findings based on the available research and clinical practice. Lastly, Section 6 presents limitations, implications, and conclusions of the study.

Literature review

The skills training is an essential part of the rehabilitation programs of a personally intellectually disabled offender, and it usually aims at enhancing emotional regulation, social

understanding, problem solving, and decision making related to offenses. The usual strategies are group-based psychoeducation, modifications of cognitive-behavioral therapy, and procedures such as role-playing. These interventions will work to promote adaptive functioning and decrease offending risk behaviors. Nonetheless, intellectually disabled people usually have difficulties in dealing with abstract reasoning, verbal understanding, and the application of acquired skills to real-life contexts. Consequently, conventional skills training might not prove to be very effective unless it is tailored to suit the cognitive and learning requirements of this group. Organized rehabilitation models like the risk-need-responsivity (RNR) model tend to inform risk minimization in forensic intellectual disability settings [8][10]. This model focuses on addressing dynamic risk factors, meeting the individual criminogenic needs, and tailoring interventions to the learning ability and responsiveness of the individual. Impulsivity, emotional dysregulation, poor social judgment, and lack of awareness of consequences are dynamic risk factors of offenders with intellectual disability [9][11]. Despite a solid theoretical base that these frameworks present, these models are only as effective as the delivery of interventions is effective in practice. The problem is that many of the existing programs find it difficult to operationalize principles of responsivity in a manner that captures the attention of people with intellectual disability in a meaningful way [12].

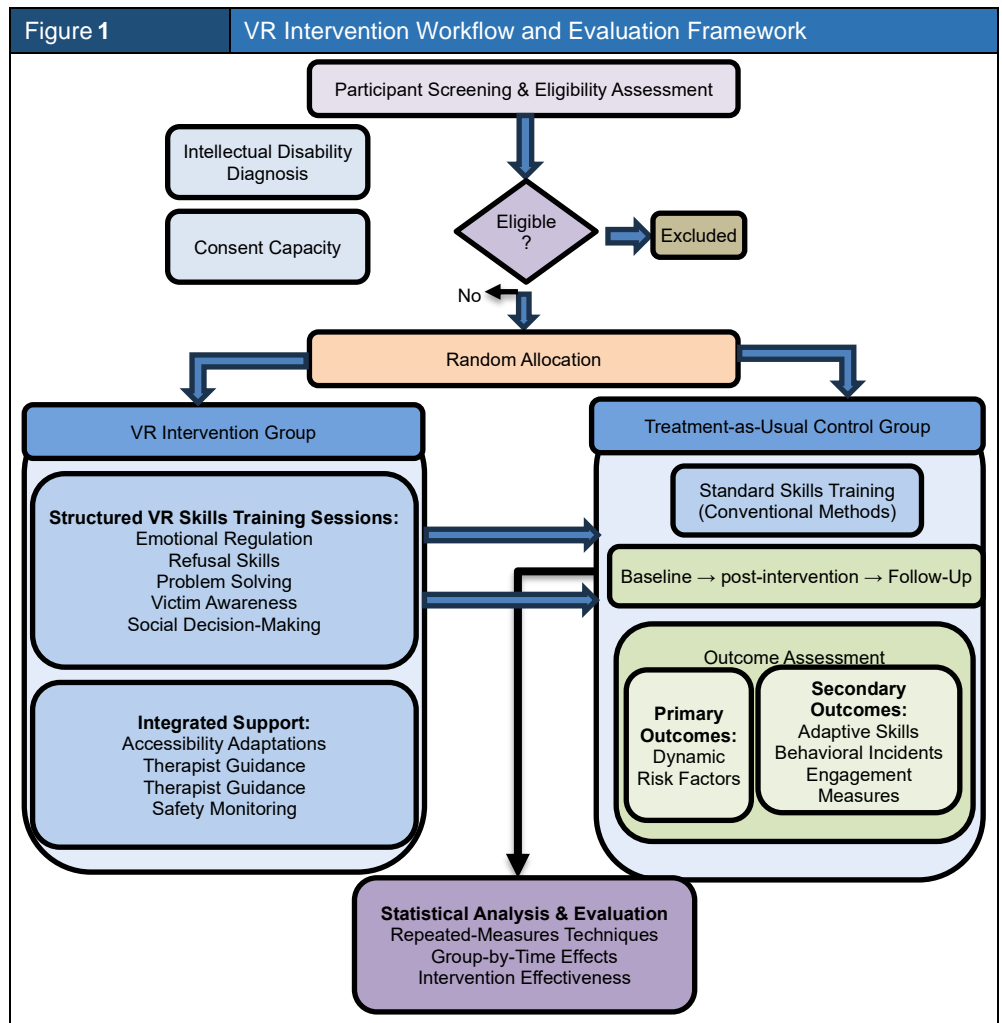
The VR has been receiving growing interest in rehabilitation and behavior change interventions owing to its capability to offer immersive, interactive, and controlled learning environments. Studies in the healthcare sector, mental health, and offender rehabilitation indicate that VR can improve engagement, motivation, and learning retention. The VR enables people to train on skills through realistic yet harmless simulation repeatedly, thereby decreasing the risks involved in learning the same in the real world. Notably, interventions based on VR assist in experiential learning, which has been proven to enhance generalization of skills outside the training environment. These characteristics render VR especially appropriate to the groups of people who have an advantage in visual learning and systematic repetition. Accessibility and usability need to be considered when the VR is used by people with intellectual disability [13]. Research underscores the significance of simplified instructions, interfaces that are easy to use, step-wise instructions, and the use of sensory stimulation that is controlled in order to prevent the issue of cognitive overload. With proper adaptation, VR has been demonstrated to assist in the process of skill learning, confidence development, and behavioral training among people with intellectual disability. The constant exposure to guided situations allows the learners to rehearse the decision-making and coping techniques at their own speed. Regardless of these benefits, the application of VR in offender forensics when dealing with intellectually disabled persons is still minimal, especially in interventions that focus on risk minimization and offending behavior. Overall, although skills training and a structured risk reduction model have become common in forensic intellectual disability services, the current interventions do not commonly offer immersive, realistic, and repeatable learning experiences. Virtual reality is the potential solution to these constraints because it will allow practicing adaptive skills in a safe and experiential way according to personal learning requirements [15][16]. Nonetheless, there is a lack of empirical evidence to estimate the effectiveness of VR-based skills training in reducing risks in offenders with intellectual disabilities. This gap specifically informs the current study, which is to explore whether a VR intervention specifically designed is capable of positively impacting adaptive skills and dynamic risk factors in such a population.

Methods

The research took a quasi-experimental pre-post controls group design and a follow-up outcome measure to investigate the efficacy of virtual reality (VR) based skills training intervention on offenders with intellectual disability. The participants were divided into a VR intervention group and a treatment-as-usual control group. Measurements of outcomes were done at three follow-up timing points, which were baseline before the intervention, the end of the programs, and three months later. The design has been chosen based on the need to maintain a balanced approach to methodological rigor and feasibility approaches in a forensic rehabilitation setting (Figure 1).

The research was carried out within an Indian forensic intellectual disability rehabilitation service that includes a secure inpatient unit and a planned reintegration programs in the community. The service offers psychological interventions, behavioral monitoring, and risk management to individuals with intellectual disability who have a history of offending or risk-related behaviors. All interventions and evaluations were conducted in the service in specific

therapy areas. The subjects were adults who had a confirmed clinical diagnosis of mild to moderate intellectual disability, aged 18-55 years, and were defined using standardized tests and multidisciplinary clinical histories. All respondents were those with a recorded offending behavior history or those with dynamic risk factors who were all considered able to make informed consent, with necessary support given where necessary. People who had a severe sensory impairment, acute psychiatric instability, a history of epilepsy, or any other negative experience with immersive technology were not included. The appropriate sample size was 60 participants who were divided into 30 individuals each. This was deemed adequate as a pilot study on effectiveness and was able to identify a medium to large effect of the interventions through repeated measures analysis.



The VR intervention constituted the main part of the study and was presented in the form of a standalone head-mounted display with software designed by a therapist that was specially designed for skills training. Participants were held in sessions, sitting at all times and watched over by their superiors to provide safety. The intervention was 12 sessions that were structured and occurred over six weeks, that is, two sessions weekly. The session duration ranged between 30 and 40 minutes per session and had a regular structure consisting of an orientation, the process of working with VR scenarios with the help of the therapist, and a short reflection. The VR programs involved scenario-driven modules, which were aimed at dealing with important dynamic risk factors that are usually exhibited by the intellectually disabled offenders. These modules were on emotional regulation and anger provocation, refusal and assertiveness skills, victim awareness and consequence recognition, problem solving and decision-making, and interpretation of social cues and boundaries. All the scenarios were developed to reflect realistic but controlled scenarios that are applicable to real-life risk situations. To be user-friendly, the intervention consisted of simplified language, visual icons, step-by-step instructions, repeated practice time, step-graded difficulty of the work, and low-level sensory stimulation to avoid cognitive overload.

Members of the control group were treated in the usual manner that involved normal group-based skills training and psychoeducational classes that regularly occurred at the service. Similar thematic areas were covered in these sessions as in the VR programs, but these sessions were mainly based on verbal teaching, workbook activities, and role-play exercises without immersive technology. Primary outcome measures were related to the changes in dynamic risk factors and were measured by the structured professional judgement tools, which were regularly used in the service. These instruments examined emotional regulation, impulsivity, social judgment, and risk awareness. Secondary outcomes were adaptive behavior and functional skills measurements, institutional record of incidents and misconducts, therapist-reported ratings of engagement and participation, and ratings of confidence and skill generalization by the participants. The assessment of the baseline was done before the intervention started. The post-intervention assessments were done one week after the completion of the programs, and the follow-up assessments were done after three months. Trained clinicians who were not part of the intervention delivery process were used to collect the data to minimize the possibility of bias. To test the effects of group by time interaction, quantitative data were analyzed by means of mixed-model repeated measures analysis of variance. The p-value was determined as 3.84. Cohen's d was used to determine the effect sizes, and confidence intervals were reported where necessary. Repeated-measures analytical procedures, which are appropriate in longitudinal designs, were used to address missing data.

The research received ethical approval from the institutional ethics committee. All the subjects were given simplified information sheets, and informed consent was given after a formal capacity assessment by a qualified clinician. Various safety measures were provided during the research process, such as constant observation of the VR exposure and proper guidelines on how to address distress or unfavorable occurrences. The participants were informed that they could withdraw at any time without any consequence on their current care.

Experimental Design

The study used a quasi-experimental pre- post control group design to determine the effectiveness of a virtual reality (VR) based skills training programs for offenders with intellectual disability. A total of sixty adults with mild to moderate intellectual disability were selected out of a forensic rehabilitation service and divided into VR intervention (n = 30) and treatment-as-usual control group (n = 30). The VR intervention involved 12 therapist-guided sessions that were spread over six weeks with the help of a standalone head-mounted display and specially developed software. What was incorporated in the programs was the structured, scenario-based modules that focused on emotional regulation, refusal skills, victim awareness, problem solving, and social decision-making, and accessibility adaptations were simplified language, visual prompts, repetition, and graded difficulty. The control participants were provided with normal skills training in groups through verbal and workbook training. Structured professional judgement tools of the dynamic risk factors were used to evaluate outcomes at baseline, post-intervention, and three-month follow-up, together with adaptive behavior measure and institutional incident records. Mixed-model repeated measures ANOVA was performed to analyses the data with $p < 0.05$ statistical significance, and d was calculated with Cohen. The ethical approval was received, informed consent was justified with the help of the capacity assessment, and all the sessions in question were provided within the framework of the existing safeguarding measures.

Evaluation metrics

The changes in dynamic risk scores and adaptive skills outcomes at different points in time were used as the measure of intervention effectiveness. The major measure was the risk reduction, which was calculated as the difference between the baseline and post-intervention (and follow-up) scores in equation (1):

$$\Delta R = R_{baseline} - R_t \tag{1}$$

Repeated-measures analysis of variance was used to evaluate group-level effects in the longitudinal analysis in equation (2).

(RM-ANOVA) to test the interaction of group x time:

$$Y_{ijt} = \mu + G_i + T_t + (G \times T)_{it} + \varepsilon_{ijt} \tag{2}$$

Effect magnitude was quantified using Cohen's d in equation (3)

$$d = \frac{\bar{X}_{VR} - \bar{X}_{Control}}{S_p}, S_p = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}} \quad (3)$$

Secondary outcomes included adaptive skill improvement, calculated in equation (4) as:

$$\Delta A = A_t - A_{baseline} \quad (4)$$

Behavioral outcomes were evaluated using incident reduction rate in equation (5):

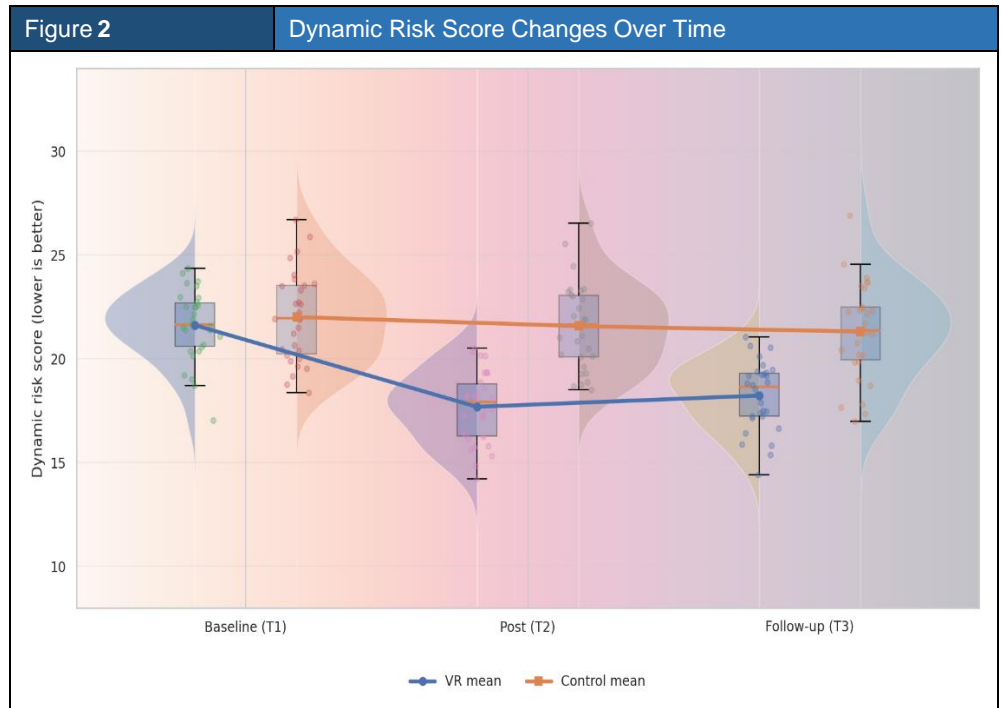
$$IRR = \frac{I_{baseline} - I_{follow-up}}{I_{baseline}} \quad (5)$$

Statistical significance was determined at $p < 0.05$, and 95% confidence intervals were reported for all primary comparisons.

Results

The study enrolled 60 participants, including 30 in virtual reality (VR) and 30 in treatment-as-usual control arms of the study. Table 1 provides an overview of the flow of participants by summarizing participant flow and baseline characteristics. There is no statistically significant difference between groups at baseline in terms of age, level of intellectual disability, offense history, or baseline risk and adaptive behavior scores ($p > 0.05$) hence comparability of the groups before the intervention.

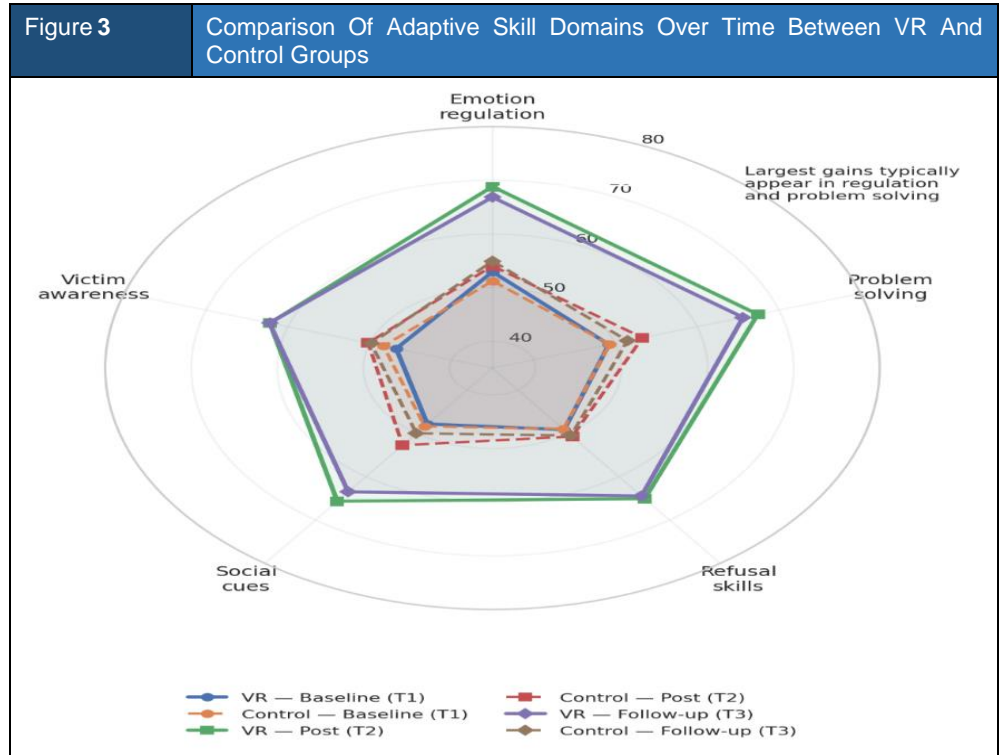
| Table 1 | | Baseline Participant Characteristics | | |
|------------------------------------|-------------------|--------------------------------------|---------|--|
| Characteristic | VR group (n = 30) | Control group (n = 30) | p-value | |
| Age (years), mean ± SD | 31.4 ± 7.2 | 32.1 ± 6.9 | 0.68 | |
| Male, n (%) | 26 (86.7) | 25 (83.3) | 0.72 | |
| Mild / Moderate ID, n | 18 / 12 | 17 / 13 | 0.79 | |
| Baseline risk score, mean ± SD | 21.6 ± 4.3 | 22.1 ± 4.1 | 0.64 | |
| Adaptive behavior score, mean ± SD | 58.2 ± 7.5 | 57.6 ± 7.9 | 0.73 | |



The VR group reported high intervention adherence with 27 (90%) out of the 12 sessions being attended. Three respondents dropped out of the study because of scheduling reasons as opposed to intervention concerns. The mean session attendance in the VR group was

11.3 (SD = 1.1). There were no reported adverse events of VR exposure and none of the participants dropped out because of discomfort or cybersickness, which is evidence of good feasibility and tolerability of the intervention.

Primary outcome analysis indicated that there was a strong group by time interaction effect of dynamic risk factors. The VR group participants showed a statistically significant change in overall risk scores between baseline and post-intervention, which was sustained at three-month follow-up ($F(2,116) = 12.41, p < 0.001$). Conversely, the control group did not experience significant change in assessment points. The post-intervention and follow-up between-group comparisons showed that risk scores were significantly lower in the VR group than controls ($p < 0.01$). Figure 2 demonstrates these findings.



The presence of significant positive changes in adaptive behavior and functional skills among participants with VR training as secondary outcome measures indicated the success of this intervention. VR group had a higher increase in emotional regulation, problem-solving and social decision-making skills than the control group ($F(2,116) = 15.28, p < 0.001$). The institutional incident records also showed that the behavioral incidents decreased in the VR group but there were no significant changes in the incident rates in the control group during the follow-up period. There were also higher ratings of therapist ratings that showed increased engagement and enhanced skill generalization of VR participants. Figure 3 shows comparative changes on adaptive skills.

Finding on user experience and acceptability were found to be good. The respondents indicated that VR sessions were simple to follow, interactive and useful in terms of training such skills in real world scenario. Employee feedback has also shown an increased participant motivation and attention of VR sessions as opposed to the conventional group work. The adaptations of the accessibility such as simplified instructions and repetition were found to be the most influential factors facilitating the interaction of the participants and no particular usability-related issues were raised.

Discussion

The ultimate purpose of the study was to investigate the ability of a virtual reality (VR) based skills training programs to minimize dynamic risk factors in intellectually disabled offenders [18]. The results show that the VR-trained participants had large scale risk-related behaviors reduction and significant increase in adaptive skills relative to the respondents who could only have treatment as usual. These gains were even sustained at follow-up and this implies

that the intervention was not a one-off event but continued after the completion of the programs. These findings are therefore in line with the purpose of the study and can indicate that VR-simulated skills training is able to improve risk minimization in forensic intellectual disability contexts [20]. The current results point towards the previous studies that identified the weakness of the traditional skills training methods in terms of the person with intellectual disability who depends on the verbal instruction and abstract learning. Rehabilitation and behavioral intervention settings have reported enhancement of the engagement and acquisition of skills when experiential and technology-assisted means are applied. The obtained findings add to this literature by delivering empirical data in a forensic group of intellectual disability individuals and make it clear that VR-based interventions may result in quantifiable changes in the risk-related outcomes and adaptive functioning, as reported in the literature reviewed in Section 2.

The virtual reality could be especially useful in offenders with intellectual disability because of the ability to facilitate the safe, immersive, and repetitive training of the skills [19]. VR enables people to rehearse coping and decision making in the simulated risk situation with no real-life effects, which minimizes anxiety and improves learning. Prompts and instant feedback help to comprehend and remember, and repeated exposure helps to sustain emotional regulation and behavioral control. Such processes are consistent with the principles of responsivity in the rehabilitation of offenders and could be the reason to consider the improvements in the risk and adaptive behavior outcomes. Clinically, the result indicates that the use of VR skills training can be a useful complement to other forensic rehabilitation programs available to intellectually disabled people. The intervention provides a systematic and interactive approach of dealing with dynamic risk factors that tend to be difficult to change using traditional methods. Introducing VR into a clinical routine can increase motivation of the participant, better generalization of the skills and the achievement of safer behavioral outcomes, which can result in the reduced institutional incidents and the enhanced community reintegration. However, despite all these positive aspects, to implement the VR-based interventions successfully, it is crucial to consider practical factors. Employees should be trained in order to facilitate sessions and control the reaction of participants. Early financial expenditures incurred in equipment's and software development must be weighed with the long-term gains, which are the low incidence rates and a better recovery. Physical space, unambiguous safety measures, flexible work hours, and encouragement of different degrees of digital literacy should also be allowed to guarantee accessibility and sustainability of VR programs to forensic intellectual disability services.

Policy Recommendations

Policy frameworks that control the forensic and correctional services of individuals with intellectual disability should formally acknowledge the use of virtual reality-based skills training as an evidence-based supplement to regular rehabilitation programs. The policymakers are advised to facilitate the implementation of VR interventions into the standard risk management and rehabilitation pathways, and ethical usage, accessibility criteria, and protection measures are to be defined. It is suggested to invest in employee education, infrastructure, and online accessibility to provide equal implementation. Moreover, the promotion of outcome monitoring and standardized assessment of the reduction of risks should be promoted by the policies to serve as the source of information related to service planning, cost-effectiveness analysis and long-term community safety results.

Conclusion

The current study compared the efficacy of a skills training programs, developed based on virtual reality, in decreasing the risk factors in a dynamic setting in a group of offenders with the intellectual disability in a forensic rehabilitation setting. In a quasi-experimental pre post control group design, the intervention was determined by using structured professional judgement-based risk measures and adaptive outcomes in the form of risk. The mixed model repeated measures of analysis of variance have statistically shown a significant group by time interaction, which proves that the participants in the virtual reality group experienced more reductions in the overall scores on risk than those who received treatment as usual ($p < 0.001$). This effect was considerable, and the values of d of Cohen were over 0.75, which means that its impact is clinically significant. Besides the main risk outcomes, the secondary analysis demonstrated that there were significant improvements in adaptive skills regarding emotional regulation, problem solving as well as social decision making in the virtual reality group ($p < 0.001$). These were sustained at three month follow up with follow up

comparisons significant ($p < 0.01$) which indicated permanent behavior change. Further evidence of intervention effectiveness was increased with decreased incidents of institutional behavior and increased therapist rated engagement. On the whole, the evidence shows that the use of virtual reality training based on immersion into VR can apply the principles of responsiveness in forensic intellectual disability service more efficiently than the traditional method. The intervention aims at changing the risk factors involved in offending behavior by facilitating safe rehearsal, immediate feedback, and repetition. The statistically sound decreases in dynamic risk factors reflect the positive impact on long term risk management, recovery outcome and safer reintegration of the intellectually disabled offenders. The results indicate its applicability to regular forensic practice.

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