

Feasibility and acceptability of Orygen Virtual Worlds: a virtual world platform for delivering youth mental health treatment

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Abstract

Background: Online virtual worlds are platforms that allow users, represented as avatars, to meet and interact with other users in real time within 3D virtual environments. These platforms have potential utility as vehicles to deliver/receive clinical services, especially as a preference to video-conferencing-based telehealth. However, commercial virtual worlds (e.g., "Second Life") are often deemed unsuitable due to privacy and safety concerns.

Objective: The aim of this study was therefore to co-develop and test a bespoke virtual world platform to deliver routine youth mental health services.

Methods: We undertook a participatory-design process to develop the platform (Orygen Virtual Worlds) involving 10 young people with lived experience of mental health difficulties, researchers, software designers and mental health clinicians. We then tested two types of clinic-led interventions delivered through the virtual world (a structured therapy group and an individual therapy) in a public youth mental health service setting in Australia. Participants were patients receiving treatment in the service. The main outcomes were acceptability and feasibility; we also measured symptom change, usability, presence and therapeutic alliance. We conducted qualitative interviews post-intervention with the participants and analysed these interviews using thematic analysis.

Results: 15 young people were recruited to the structured group (27% consented from referred) and 8 were recruited to the individual therapy (36% consented from referred). Drop out was higher in the individual therapy than the structured group therapy (38% versus 80%). Acceptability ratings were high for both therapy approaches and there were no significant safety events attributed to using the platform. There were no significant pre-post differences in the symptom outcome measures in either the structured group intervention or individual therapy. The platform was perceived as being comfortable and safe, enjoyable, fun and interactive, and was not confusing to navigate or difficult to use. The qualitative themes included the platform being fun and engaging, making treatment more accessible, providing a safe and inclusive place, fostering connections, positively impacting wellbeing and providing a catalyst for real life functional change. Young people perceived decreased barriers, increased comfort with help-seeking and reduced social stress facilitated by the avatar, communication options (emoji, text, voice) and accessibility from home.

Conclusions: Our findings indicate that online virtual world platforms, such as the one we have designed, hold considerable

promise for providing interventions for young people in clinical services. Virtual worlds can provide fun and engaging experiences of therapeutic interventions for young people with mental health difficulties which are safe and inclusive, especially for harder to reach groups.

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Original Manuscript

Feasibility and acceptability of Orygen Virtual Worlds: a virtual world platform for delivering youth mental health treatment

Thompson, A.^{1,2,*} Bell, I.H.^{1,2}, Tennant, M. ¹, Ellinghaus., C. ^{1,2}, Li, C. ^{1,2}, Lui, Y.¹, Ja, J.^{1,2}, Nicholas, J. ^{1,2}, Reinoso, M.¹, Thomas, N.³, D'Alfonso, S.⁴, Kolovos, D.¹, Einfeld, G.⁵, Louis, S.¹, Yung, A.R.⁶, Leicester, S.⁷, Wadley, G.⁴

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Abstract

Background:

Online virtual worlds are platforms that allow users, represented as avatars, to meet and interact with other users in real time within 3D virtual environments. These platforms have potential utility as vehicles to deliver/receive clinical services, especially as a preference to video-conferencing-based telehealth. However, commercial virtual worlds (e.g., "Second Life") are often deemed unsuitable due to privacy and safety concerns. Therefore, the aim of this study was to co-develop and test a bespoke virtual world platform to deliver routine youth mental health services.

Methods:

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therapeutic alliance. We conducted qualitative interviews post-intervention with the participants and analysed these interviews using thematic analysis.

Results:

15 young people were recruited to the structured group (27% consented from referred) and 8 were recruited to the individual therapy (36% consented from referred). Drop out was higher in the individual therapy than the structured group therapy (38% versus 80%). Acceptability ratings were high for both therapy approaches and there were no significant safety events attributed to using the platform. There were no significant pre-post differences in the symptom outcome measures in either the structured group intervention or individual therapy. The platform was perceived as being comfortable and safe, enjoyable, fun and interactive, and was not confusing to navigate or difficult to use. The qualitative themes included the platform being fun and engaging, making treatment more accessible, providing a safe and inclusive place, fostering connections, positively impacting wellbeing and providing a catalyst for real life functional change. Young people perceived decreased barriers, increased comfort with help-seeking and reduced social stress facilitated by the avatar, communication options (emoji, text, voice) and accessibility from home.

Conclusions:

Our findings indicate that online virtual world platforms, such as the one we have designed, hold considerable promise for providing interventions for young people in clinical services. Virtual worlds can provide fun and engaging experiences of therapeutic interventions for young people with mental health difficulties which are safe and inclusive, especially for harder to reach groups.

Trial Registration: Australian New Zealand Clinical Trials Registry ACTRN12622001017718; <https://www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=384278&isReview=true>

Keywords: virtual worlds; group therapy; individual therapy; youth mental health

Introduction

Mental ill health is one of the most important health issues facing young people worldwide today [1]. Accumulating evidence indicates rates of mental ill health among youth have been steadily increasing in many countries over the past two decades or more [2]. Emerging data shows further increases in rates of depression, anxiety, and psychological distress during and following the COVID-19 pandemic [3, 4]. Current estimates report that around one-third of all children aged 11 to 15 years and up to half of young people aged 16 to 24 years will experience a mental health disorder [5, 6].

The high rates of youth mental health difficulties are concerning given many life trajectories are set in place during adolescence and young adulthood. Over 75% of major mental disorders such as depression, psychosis and bipolar disorder manifest before the age of 25 years [7]. If not adequately addressed, mental health conditions can have enduring impacts on relationships, physical health, educational outcomes, and quality of life into adulthood and are also economically costly [8]. Consequently, global youth mental health reform has focused on the need for early intervention services [1]. However, despite the growing prevalence of mental disorders in youth, and to some extent the growing acknowledgement of the problem, around the globe access and engagement with treatment has remained low [9]. It is estimated that at least 50-60% of youth with mental health problems are not in contact with services or receiving the treatment they require [6, 10].

Even for those who are able to access services there are significant problems. Once seen, young people show variable engagement and a lack of ongoing support contributes to the very high relapse rates of 80% [11]. Sadly, young people most frequently endorse negative societal views and attitudes toward mental health problems and help-seeking as the main reasons for reluctance to attend appointments and adhere to recommended treatments [10].

New approaches to youth mental health care are therefore needed to address the treatment gap and growing demand from youth in need of mental health treatment. There is increasing prominence for the role of early intervention approaches, and it is critical to develop early interventions that are accessible, stigma-free and that resonate with young people to support help-seeking. In recent times, greater integration of digital health interventions into modern healthcare delivery has provided an alternative to traditional face to face care that might be more appealing for some young people. This was further accelerated by the rapid and widespread uptake of telemedicine during COVID-19 lockdown restrictions, which saw most young people attending sessions virtually during this period [12]. Studies indicate that this shift to remote care delivery was well received by some but not all young service users. In a study Australian service users, recipients perceived positive impacts on service quality, foremost on how supported and safe they felt, with fewer cancellations also recorded [12]. However, most perceived telemedicine use did not impact their willingness or motivation to attend services, and some found the medium challenging [12].

Alternative digital solutions may be even more suitable or appealing for engaging young people in clinical interactions. Young people report feeling safe and comfortable discussing mental health online and already use this as their primary source of information and support [13]. In particular, virtual reality (VR) interventions have shown promise as a platform for engaging and helping young people with mental health difficulties.

One specific type of VR intervention are known as virtual worlds (VWs). These are commonly online social environments where users can interact via "avatars" or computer representations of themselves to participate in activities and communicate with one another. The users can interact with the digitally simulated world in real-time, creating a feeling of presence in that environment [14]. Crucially, social norms and the way people interact in

these environments can mirror real-world social behaviour, giving VWs an advantage over telehealth where such social interactions are not possible [15-17]. Although relatively limited studies have been conducted to date, VWs have been used to treat social anxiety and have been found to be feasible and acceptable with effect sizes potentially comparable to face-to-face cognitive behaviour therapy (CBT), for seasonal affective disorder [18] and in treating social cognition problems in autism [19] and first episode psychosis [20].

Previous studies [18, 21] including our own pilot trial (the VEEP project [22, 23], have adopted an existing VW platforms (e.g. Second Life©) which have not been designed to provide mental health care and can be both overwhelming and unsafe as clinical environments [24]. In our own VEEP study there were also concerns expressed by participants about data storage and privacy [22]. Furthermore, whilst co-production of the VW environment was a key part of the VEEP trial, the virtual environment was constrained by the broader second life platform and as such we had no ability to prioritise aspects that young people find most appealing or conducive to therapeutic interactions [22].

Building on the experience of this previous pilot work to address a gap in care, enhancing safety of the therapeutic experience and provide a scalable codesigned healthcare solution, we aimed to co-design with young people the world's first 'bespoke' VW platform designed specifically to deliver care and evidence-based treatments to youth with mental ill-health. Our objective was to test the feasibility of delivering this platform and the acceptability of the platform to the end users (young people with moderate to severe mental health disorders and clinicians delivering the care).

Method

Study Design

A single arm, nonrandomized, feasibility and acceptability trial of two interventions delivered through the bespoke Orygen Virtual World (OVW) platform: 1) a group-based psychosocial depression intervention, named 'OVW-Connect', and 2) a one-to-one distress tolerance skill building intervention, named 'OVW-DT', delivered one to one with a therapist.

The study was approved by Royal Melbourne Hospital Human Research Ethics Committee (approval number: HREC81589) and was prospectively registered (ACTRN12622001017718).

Orygen Virtual Worlds (OVW)

OVW is a purpose-built, online virtual world that was designed to support mental health service delivery with young people with various mental health conditions. OVW was co-produced with 10 youth advisors with lived experience of mental ill-health, six experienced youth mental health clinicians and two developers alongside the study team over a 6-month period. Figure 1 displays screenshots of the environment.

Co-production and Lived Experience Involvement

Following user-centred design methods [25], youth and clinician advisors participated in 6 – 10 workshops and individual user testing sessions to design and develop the OVW platform. Young people and clinicians were consulted regarding key aspects of the virtual environment (i.e., avatar creation, aesthetic, functionality, safety), the treatments delivered (e.g., interactive experiences, learning and engagement tools) and to ensure the platform was fit for purpose (i.e., clinical service use). Young people and clinicians were also consulted on the research design and the choice of outcome measures, recruitment procedures, and populations in which to test the platform.



Figure 1. Images of Orygen Virtual Worlds (OVW) Setting, Recruitment and Eligibility Criteria

Participants were recruited from a tertiary, early intervention public youth mental health service (Orygen Specialist Program) in Melbourne, Australia. This service provides a 2-year period of care to over 700 young people experiencing severe mental health difficulties, including mood and anxiety disorders, personality disorders and first episode psychosis, across four specialist clinics. All young people aged between 15-25 registered with the service, with sufficient English language to participate meaningfully and not in an acute phase of treatment (i.e., not acutely psychotic, not in hospital/in contact with crisis teams at recruitment) were eligible. Exclusion criteria included inability to provide informed consent as judged by treating clinician.

Intervention Design

The focus of this trial was to evaluate the feasibility and acceptability of using OVW to deliver routine youth mental health care in this setting. The group and individual treatments selected were based on consultation with youth and clinician advisors during workshops and with clinical service managers working within the service to compliment current treatments offered and address young people's mental health needs at the time. The two specific interventions were:

Group intervention (OVW-Connect): Two rounds of structured and manualised group therapy 'OVW-Connect' were delivered between Sept 2022 - May 2023. Each round had 8 sessions, running twice weekly for 4 weeks, with up to 8 youth participants and facilitated by two clinicians and a peer worker as is standard practice at Orygen clinical services. In the first group round session length was 1.5 hours per session. This was increased to 2 hours per session for the second group round based on participant feedback that longer sessions would improve the group experience. The content and structure of OVW-Connect was adapted from an existing manualised intervention currently being delivered face-to-face through our service's Psychosocial Group Program, called 'Relate', which aims to address mood, anxiety and social challenges to improve the quality of relationships utilizing an interpersonal psychotherapy (IPT) framework [26], while also providing a positive relational experience and group exposure. The relate group used also used social skills training. Adaptations were based on consultation with the original Relate program designers and translatability of activities to the virtual world and specifically aimed to complement but not replace the face-to-face Relate groups delivered by the service by offering a bridging service to face to face therapy, particularly socially isolated youth.

Individual intervention: 8 sessions (1-hour per session) of individually tailored psychological treatment delivered by a registered psychologist, focusing specifically on improving emotion regulation skills and distress tolerance. The intervention approach was based on therapeutic methods derived from cognitive behavioural therapies, including Acceptance and Commitment Therapy, Dialectical Behaviour Therapy and Behavioural Activation. This is in line with the intervention approaches commonly employed within Orygen Specialist Programs, based on psychological intervention evidence in youth populations e.g. [27, 28], and endorsement during user-centred design by both clinicians and young people as being the most suitable individual intervention approaches for the current research and relevant to young people's mental health needs. The clinicians viewed these approaches as essential skills to be delivered by the clinical program.

Measures

A mixed methods approach was taken to evaluate the platform, combining both quantitative and qualitative measures. Measures used for the quantitative evaluation are listed and described in Table 1, including which intervention groups completed them.

Table 1. Outcomes measures used in the interventions

	Group intervention	Individual intervention	Measure description
Sample characteristic			
Demographics	X	X	Measured at baseline
Technology Use and Access	X	X	Measured at baseline
Feasibility			
Trial uptake and retention	X	X	Measured throughout the trial
Session attendance	X	X	Measured throughout the trial
Acceptability			
Post intervention satisfaction questionnaire	X	X	10-item self-report scale developed for the current study capturing themes of acceptability, engagement, safety and usability. Items are rated from 1 (Strongly disagree) to 5 (Strongly agree) with higher scores indicating greater satisfaction. Completed at the post intervention assessment.
Post session satisfaction questionnaire	X	X	4-item self-report scale developed for the current study, capturing themes of acceptability, safety and engagement. Completed at the end of each therapy session
Working Alliance Inventory - Short Revised (WAI-SR) [29]	X	X	12-item self-report measure used to assess the therapeutic alliance between client and therapist [29]. Items are rated on a 5-point Likert scale from 1 (rarely) to 5 (always) and cover three subscales: Bond, Tasks, and Goals. Higher scores indicate a stronger working alliance. Completed at the post intervention assessment.
ITC-Sense of Presence Inventory (ITC-SOPI) [30]	X	X	A reliable and valid cross-media self-report presence measure that is one of the most commonly used [30]. Items are rated from 1 (Strongly disagree) to 5 (Strongly agree). Completed at the post intervention assessment.
System Usability Scale (SUS) [31]	X	X	A reliable and valid self-report measure for assessing user satisfaction and usability performance [31]. It consists of 10 items rated from 1 (Strongly disagree) to 5 (Strongly agree). The SUS total score is computed as the sum of the adjusted scores, then multiplied by 2.5 to get a range between 0 and 100

			(higher scores indicating better system usability). Completed at the post intervention assessment.
Safety			
Adverse events	X	X	Measured by the number of adverse events and serious adverse events recorded coded according to the NHMRC Guidelines on Safety monitoring and reporting in clinical trials involving therapeutic goods. Adverse events were coded by a study doctor following a review of details collected during assessments with determination as to whether they were intervention related, trial related, or unrelated. Completed throughout the trial.
Level of comfort or distress during intervention	X	X	Single items within the post session and post intervention acceptability questionnaires. Completed at the end of each therapy session
Clinical measures			
Kessler Psychological Distress Scale (K10) [32]	X	X	A 10 item measure of psychological distress validated in youth populations [33] rated 0 to 50.
Patient Health Questionnaire (PHQ-8) [34]	X	X	8 item self-report measure of depressive symptoms which has been validated in youth populations [35, 36]. Items are rated on a four-point-Likert scale from 0 (Not at all) to 3 (Nearly every day), with total scores ranging from 0 to 27 and higher scores indicating greater depression severity. Completed at the baseline and post intervention assessment.
Generalized Anxiety Disorder (GAD-7) [37]	X	X	7 item self-report measure of anxiety symptoms which has been validated in youth populations [38]. Items are rated on a four-point Likert Scale Items are rated from 0 (Not at all) to 3 (Nearly every day), with total scores ranging from 0 to 21 and higher scores indicating greater anxiety severity. Completed at the baseline and post intervention assessment.
Warwick-Edinburgh Mental Well-being Scale (WEMWBS) [39]	X	X	14 item self-report measure of general mental wellbeing which has been validated in youth populations [40]. Items are rated from 1 (None of the time) to 5 (All of the time), with total scores ranging from 14 to 70 and higher scores indicating greater positive mental wellbeing. Completed at the baseline and post intervention assessment.
Social Connectedness Scale (SCS) [41]		X	8 item self-report measure of social connectedness which has been used in youth populations [41]. Items are rated from 1 (Strongly disagree) to 6 (Strongly agree), with total scores ranging from 8 to 48 and higher scores indicating a stronger sense of social connectedness. Completed at the baseline and post intervention assessment.
UCLA Loneliness Scale (ULS-8) [42]		X	8 item self-report measure of loneliness which has been found to be reliable and valid in youth populations [42]. Items are rated from 1 (Never) to 4 (Always), with total scores ranging from 8 to 32 and higher scores indicating a higher degree of loneliness. Completed at the baseline and post intervention assessment.
Distress Tolerance Scale (DTS) [43]	X		15 item self-report measure of ability to endure emotional distress which has been validated in a

			youth population [44]. Items are rated from 1 (Strongly disagree) to 5 (Strongly agree), with higher scores indicating greater levels of distress tolerance. Completed at the baseline and post intervention assessment.
Qualitative interview	X	X	One-on-one interview focusing on intervention experiences, including perceived benefits, challenges, and areas for improvement and barriers and enablers for use in youth mental health services. Completed at the post intervention assessment.

Procedure

The two interventions were delivered in parallel due to therapist availability, with the group intervention being offered twice over an 8-month period, and the individual intervention running alongside this. The lead VR clinician (MT) and group program clinician (GE) presented to clinicians within each specialist service to explain the study and consulted with the treating teams to identify potentially eligible clients from case lists. Clinicians made direct referrals to the study, with group intake supported by Orygen's psychosocial recovery group program in which OVW-Connect was embedded. The study team then reached out to screen participants for eligibility. Eligible and interested participants were then sent a participant information consent form to consider their enrollment in the study and encouraged to discuss this with their case manager and carers. Those who were interested in participating then completed the informed consent and baseline procedure before being onboarded onto the OVW platform and commencing the intervention. We included one initial 30-60 minute session (Session 0) where the OVW clinician helped the participant to set up, create an avatar and familiarise themselves with the world in order to take part. Consent was received from a parent or guardian in cases where participants were under the age of 18 years with assent obtained from the young person.

Analysis

Quantitative analysis: Sample characteristics, attendance, consent and engagement rates, and acceptability ratings, were summarised descriptively (i.e. means/median, standard deviations/percentiles). Pre to post changes in outcome measures were analysed using paired sample t-tests and associated effect sizes (Cohen's d) and confidence intervals. All analyses were conducted using SPSS statistical software (version 27.0). All young people were invited to complete the outcome assessment and interview regardless of whether they dropped out of treatment (intention-to-treat analysis).

Qualitative analysis: Qualitative data collected from interviews with participants were analysed using thematic analysis [45]. Three authors (MT, GE, JJ) separately read and coded all interviews using open coding. The resulting codes were then compared, discussed, and combined into a final set of themes that accurately represented the participants' experiences.

Results

Sample characteristics

The demographic characteristics of participating young people are presented in Table 2. Participants in both the group intervention and individual intervention had a mean age between 18 and 19 years of age, with relatively equal numbers of males and females and a small proportion of transgender- or non-binary-identifying individuals. The majority spoke English as their primary language and were born in Australia, with none identifying as Aboriginal or Torres Strait Islander. The predominant living situation was with family or renting independently. In terms of service origin, the majority were receiving care for early

psychosis or a mood disorder. Most of the sample were frequent users of technology, with the majority using a smartphone several times an hour. Mean scores on clinical measures indicated that the sample was likely to be experiencing mild to moderate psychological distress according to the K10, with moderate to severe depression according to the PHQ-8, and moderate anxiety according to the GAD-7.

Table 2. Sample characteristics.

	Group intervention (n=15)	Individual intervention (n=8)
Age Mean (SD)	19.87 (2.90)	18.38 (2.83)
Gender n (%)		
Male	7 (47)	3 (37.5)
Female	5 (33)	3 (37.5)
Transgender / non-binary	1 (7)	2 (25)
Undisclosed	2 (13)	0 (0)
Place of birth n (%)		
Australia or New Zealand	12 (79)	7 (88)
Africa	1 (7)	0 (0)
Asia	1 (7)	0 (0)
Europe	1 (7)	1 (12)
Aboriginal or Torres Strait Islander n (%)		
Yes	0 (0)	0 (0)
No	15 (100)	8 (100)
Primary language		
English	14 (93)	7 (88)
Other	1 (7)	1 (12)
Living situation		
Living with family	9 (60)	6 (75)
Renting independently	5 (33)	2 (25)
Boarding/hostel	1 (7)	0 (0)
Service of origin		
Specialist – UHR ^a /early psychosis	5 (33)	6 (38)
Specialist - mood	5 (33)	4 (50)
Specialist - personality	1 (7)	0 (0)
Specialist – youth access	1 (7)	1 (12)
Not disclosed	3 (20)	0 (0)
Frequency of internet use		
Several times an hour	11 (73)	5 (64)
Once an hour	3 (20)	1 (12)
Once to several times per week	0 (0)	1 (12)
Not disclosed	1 (7)	0 (0)
Baseline clinical measures		
K-10	24.80 (8.83)	32.5 (6.31)
PHQ-8	15.73 (6.66)	9.38 (4.81)
GAD-7	13.40 (7.60)	6.75 (4.43)
WEMWBS	31.00 (10.27)	44.75 (10.77)
SCS ^b	20.67 (10.52)	-
ULS-8 ^b	24.40 (5.42)	-

Confidence managing MH ^c	3.29 (2.27)	5.38 (2.20)
Skills and resources MH ^d	4.33 (2.35)	5.50 (1.60)
Understanding MH ^e	5.07 (2.52)	5.25 (2.12)
DTS ^f	-	53.00 (13.82)

^aUHR: ultra-high risk; ^bMeasure completed for group intervention only; ; ^cSingle item 1: I feel confident in my ability to manage my mental health; ^dSingle item 2: I feel I have the skills and resources needed to manage my mental; ^eSingle item 3: I feel I have an understanding of how to manage my mental health; ^fmeasure completed for individual intervention only
 PHQ-8 = Patient Health Questionnaire; DTS = Distress Tolerance Scale; UCLA-8 UCLA Loneliness Scale; SCS = Social Connectedness Scale; WEMWBS = Warwick-Edinburgh Mental Well-being Scale; GAD = Generalized Anxiety Disorder; Kessler Psychological Distress Scale = K-10; MH= Mental Health.

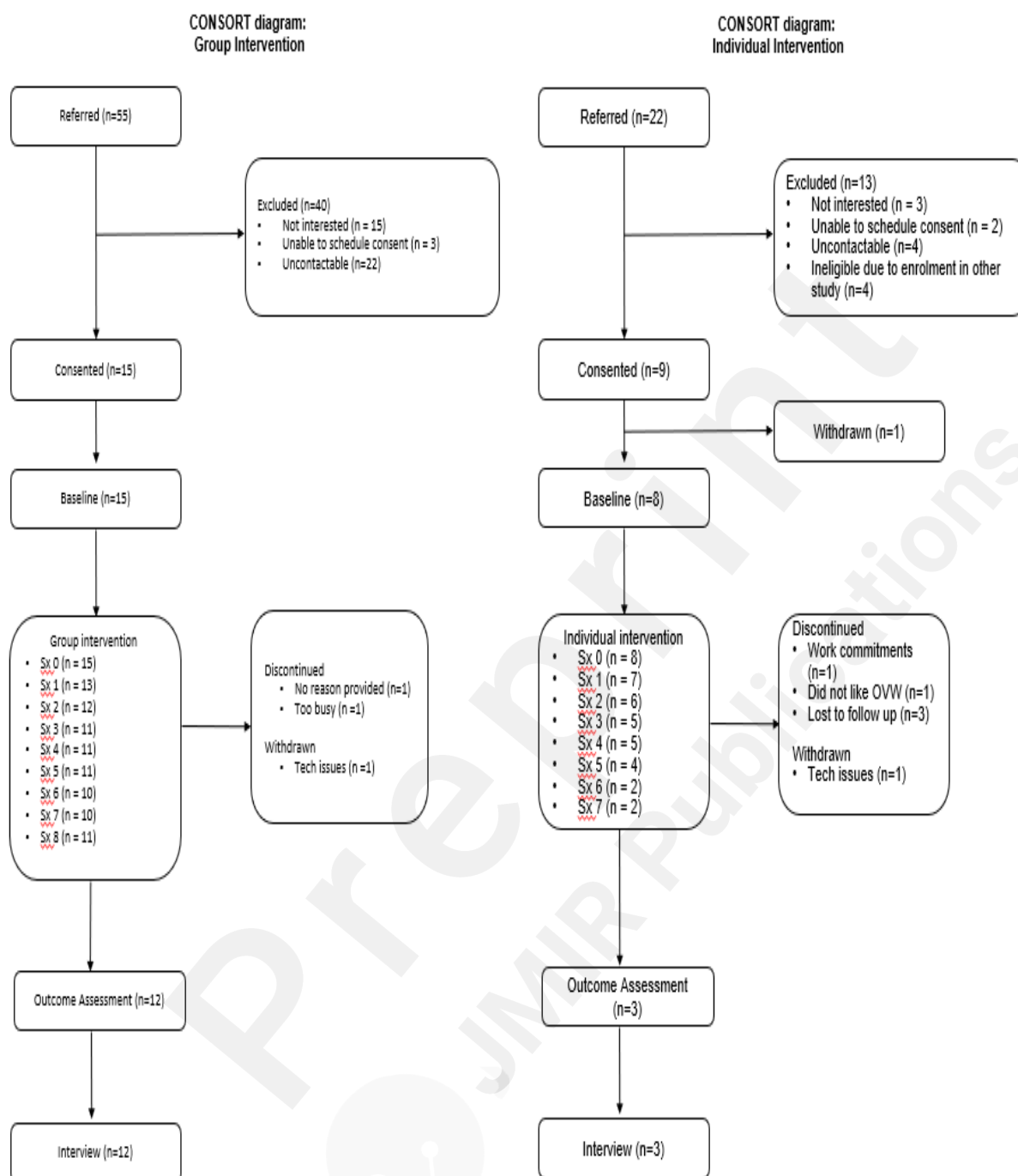
Quantitative results

Feasibility:

Group intervention. Of the 55 young people referred to the group intervention (two groups), 15 went on to consent (27% consent rate), complete the baseline assessment and commence treatment, none of the 55 were ineligible. Three of the 15 participants who consented discontinued the therapy (20% drop out rate), with 12 completing the outcome assessment (80% outcome completion rate). Session attendance rates were good for the group intervention, with 11 out of 15 (73%) consistently attending all sessions (see figure 1: CONSORT diagram).

Individual intervention. Of the 22 young people referred to the individual intervention, 4 were ineligible and 9 went on to consent (41% consent rate) and complete the baseline assessment and 8 went on to commence treatment. Six of the 9 discontinued (25% retention rate), with 3 completing the outcome assessment (75% dropout rate). Session attendance rates were lower in the individual intervention, with 5 out of 8 participants (62%) attending the fifth therapy session and 2 completing the final session (25%) (figure 1).

Figure 1: CONSORT diagram flow diagrams for each intervention group.



Acceptability: Participants feedback on the post session and post intervention satisfaction questionnaire are shown in Table 3. Patterns of responses to individual items suggest that OVW was perceived as being a highly satisfactory way of receiving care which helped young people to deal with their problems. The platform was perceived as being comfortable and safe, enjoyable, fun and interactive, and was not confusing to navigate or difficult to use. Post session ratings indicated that therapy occurring in OVW was acceptable. Satisfaction scores were slightly higher for those in the group intervention as opposed to

those in the individual therapy intervention although the numbers were relatively low. All three participants (100%) who completed the post assessment for the individual intervention, and 10 out of the 12 group intervention participants (83%), said they were likely to recommend OVW to other young people with similar experiences. The average total and subscale scores on the working alliance scale - WAI-SR - are displayed in Table 4; they are in the mid-level range for both groups [29], indicating moderate emotional connection, agreement on therapy tasks and alignment of goals between the participants and therapists.

Table 3. Means and standard deviations for the participants in the group and individual interventions on the post session and post intervention satisfaction questionnaires

	Group intervention (n=12)	Individual intervention (n=3)
	Mean (SD)	Mean (SD)
Post intervention satisfaction questionnaire (scores 1-5*)		
I found OVW to be a satisfactory way of receiving mental health care	4.17 (1.12)	3.00 (1.73)
I found that receiving mental health care through OVW helped me deal with my problems better	3.58 (1.31)	4.00 (1.00)
I felt comfortable and safe receiving care in OVW	4.33 (1.16)	4.33 (.58)
I found OVW to be enjoyable to use	4.17 (1.27)	4.00 (1.00)
I found OVW to be fun and interactive	4.55 (.93)	4.00 (1.00)
I found OVW to be engaging	4.08 (1.24)	4.33 (7.78)
I am satisfied with OVW overall	4.08 (1.24)	4.00 (1.00)
I found using OVW to be confusing	1.50 (.67)	1.67 (1.16)
I found participating in OVW difficult	1.75 (.62)	1.33 (.58)
I found OVW complicated to use	1.42 (.67)	1.33 (.58)
How likely is it that you would recommend OVW to someone with similar experiences to you? ^a	7.67 (2.96)	7.00 (1.00)
Post session satisfaction questionnaire (scores 1-5* averaged over sessions)		
I found this session helpful	3.89 (.79)	4.09 (.95)
I found OVW helped me engage with this session	3.97 (.80)	4.12 (.86)
I found OVW was suitable for this session	3.92 (.79)	4.06 (.83)
I felt safe and comfortable during this session	3.97 (.84)	4.42 (.83)

*Scale range from 1 (strongly disagree) to 5 (strongly agree); ^ascore ranged from 0 (not at all likely) to 10 (extremely likely)

Table 4. Subscale scores of the Working Alliance Inventory – Short Revised (WAI-SR)

	Group intervention (n=12)	Individual intervention (n=3)
	Mean (SD)	Mean (SD)
Bonds	11.36 (2.46)	13.33 (1.53)
Tasks	12.45 (1.21)	11.00 (1.0)

Goals	11.82 (1.33)	9.33 (0.58)
Total	35.63 (3.12)	33.67 (2.08)

*Note: The range of the subscale scores is from 4 to 20, and the total score from 12 to 60. Higher scores indicate greater alliance

User experience

Ratings on the System Usability Scale (SUS) are shown in supplementary table 1. The mean total SUS score of 82.92 (group intervention) and 72.50 (individual intervention) exceeds the average benchmark of 68 out of 100 [46], suggesting that users perceive OVW to have above average usability compared to industry standards. See supplementary table 1 for individual item scores for each intervention group.

Presence

Spatial presence received a value of 58% of the maximum possible score with an average of 2.9 out of 5, indicating general neutrality with regard to presence. The group intervention showed a slightly higher score compared to the individual intervention, indicating a slightly stronger sense of "being there." Engagement received a value of 70% of the maximum possible score with an average of 3.5 out of 5, indicating a mixture of neutrality and agreement. Scores were similar between groups, reflecting moderate involvement in the virtual experience for both. Ecological validity/naturalness received a value of 61% of the maximum possible score with an average of 3 out of 5, indicating general neutrality. Scores were nearly identical across groups, suggesting the virtual world environment was somewhat convincing but could be more natural. Negative effects were 19% of their possible total, with an average of 1.8 out of 5, indicating disagreement regarding any negative effects. Both groups showed low scores, indicating minimal discomfort or adverse effects and that both interventions appeared to be well-tolerated (Table 5). The following items did particularly well across group and individual interventions (4/5 average): I enjoyed myself; It felt like the content was 'live'; I felt involved (in the displayed environment); I'd recommend the experience to my friends.

Table 5. Means and standard deviations of for the group and individual interventions on the post assessment for the ITC-Sense of Presence Inventory (ITC-SOPI)

Factor (min possible score, max possible score)	Group intervention (n=12)	Individual intervention (n=3)
	<i>Mean (SD)</i>	<i>Mean (SD)</i>
Spatial presence (19, 95)	55 (18.44)	60.67 (10.79)
Engagement (13, 65)	45.33 (14.08)	46.67 (0.58)
Ecological validity/naturalness (5, 25)	15.25 (3.72)	15.33 (2.08)
Negative effects (6, 30)	10.67 (3.39)	12.33 (3.06)

*Note: higher scores on the first three factors are ideal whereas lower scores on the fourth factor (negative effects) are ideal.

Pre-post intervention changes in clinical measures

Due to the small sample size in both groups, and substantial drop out in the individual intervention, clinical measures should be interpreted with caution as this study was not sufficiently powered to detect statistical changes in outcome measures and does not have a control group. As shown in Table 6, effect sizes were in the small range for all outcomes for the group intervention, with larger effects for the individual intervention particularly for single

item measures capturing management and understanding of mental health. The results of the two-tailed paired samples t-test showed no statistically significant changes in any of the outcome measures for either group



Table 5. Statistical results and associated means, standard deviations and effect sizes for all outcome measures pre and post intervention for participants in the individual and group intervention

	Pre mean (SD)	Post mean (SD)	t test (df)	P value	Cohen's d ^a (95% CI)
<i>Group intervention (n=12)</i>					
K-10	24.75 (9.92)	25.58 (10.28)	-.501 (11)	.63	-.15 (-.71, .43)
PHQ-8	15.58 (7.10)	15.50 (6.43)	.05 (11)	.96	.01 (-.55, .58)
GAD-7	13.58 (7.69)	12.17 (7.32)	1.24 (11)	.24	.36 (-.24, .94)
WEMWBS	30.33 (11.40)	31.42 (11.03)	.51 (11)	.62	.15 (-.71, .43)
SCS	20.58 (11.37)	21.83 (11.51)	-.39 (11)	.71	.11 (-.46, .68)
ULS-8	24.25 (5.86)	22.75 (5.31)	1.53 (11)	.15	.44 (-.16, 1.03)
Confidence managing MH ^b	3.18 (2.40)	3.45 (2.81)	-.35 (10)	.73	.11 (-.49, .70)
Skills and resources MH ^c	4.58 (2.58)	5.17 (2.89)	-.85 (11)	.42	.24 (-.34, .81)
Understanding MH ^d	4.67 (2.67)	4.92 (2.81)	-.43 (11)	.67	.13 (-.45, .69)
<i>Individual intervention (n=3)</i>					
K-10	33.33 (10.21)	34.33 (9.24)	-1.00 (2)	.42	-.58 (-1.78, .72)
PHQ-8	9.00 (6.08)	8.33 (6.43)	.76 (2)	.53	.44 (-.81, 1.59)
GAD-7	7.67 (5.77)	7.33 (5.51)	1.00 (2)	.42	.58 (-.72, 1.78)
WEMWBS	42.67 (6.03)	44.33 (4.93)	-1.39 (2)	.30	.80 (-.60, 2.09)
DTS	48.33 (19.50)	50.66 (18.56)	-2.65 (2)	.12	-1.53 (-3.27, .30)
Confidence managing MH ^a	5.33 (2.52)	7.00 (1.73)	-1.90 (2)	.20	1.09 (-.47, 1.09)
Skills and resources MH ^b	4.67 (.58)	6.67 (2.08)	-1.73 (2)	.23	1.00 (-.51, 2.39)
Understanding MH ^c	5.67 (1.52)	8.00 (2.65)	-1.94 (2)	.19	1.12 (-.46, 2.59)

^aPositive Cohen's d scores reflect an improvement for all measures; ^bSingle item 1: I feel confident in my ability to manage my mental health (MH); ^cSingle item 2: I feel I have the skills and resources needed to manage my mental health; ^dSingle item 3: I feel I have an understanding of how to manage my mental health. Footnote: PHQ-8 = Patient Health Questionnaire; DTS = Distress Tolerance Scale; UCLA-8 UCLA Loneliness Scale; SCS = Social Connectedness Scale; WEMWBS = Warwick-Edinburgh Mental Well-being Scale; GAD = Generalized Anxiety Disorder; Kessler Psychological Distress Scale = K-10; MH=Mental Health

Safety

There was one adverse event recorded in the group intervention (increased suicidal ideation) however this was not deemed related to the trial or treatment. As shown in Table 3, there were high levels of comfort with OVW with all three participants from the individual intervention who completed the post assessment (100%), and 11 out of 12 from the group intervention (92%), reporting that they agreed or strongly agreed that OVW was safe and comfortable. Session measures suggested no safety issues. In both group and individual interventions the overall rating of the question “I felt comfortable and safe receiving care in OVW” was 4.33 out of 5.

Qualitative results

Five specific themes were derived from the interviews with the participants and are shown in table 6. The themes related to the interaction and engagement of the therapy, the accessibility, the safety, the therapeutic connection and the real-world applicability. The feedback was invariably positive in all the themes.

Table 6. Themes, subthemes and illustrative quotes identified from qualitative feedback interviews with young people on their experiences of OVW.

Main theme 1: OVW is fun, interactive and a highly engaging way to experience therapy		
<i>Subthemes</i>	<i>Description</i>	<i>Illustrative Quote</i>
Fun and enjoyable	<i>Young people reported high levels enjoyment in therapy on the platform, describing their experience as overall engaging and fun.</i>	<i>“I just want to say that it was awesome. I really enjoyed it, and I wish it went for longer because it was really great.”</i>
Interactive and engaging	<i>Young people described enjoyment and amazement with the interactive features on the platform and perceived this supported attention and involvement in therapeutic activities and learning.</i>	<i>“The ways you can interact with things and all that. I feel like that was pretty amazing. I guess it just surprised me about how much I learned from it as well. Feel like I learned a lot more participating in that than if I just, I don't know, did my own research into emotions or whatever.”</i> <i>“I can interact with certain things. That was cool... I believe there was a dog in there. I believe you could pat the dog. You can even go up to the horse and pat it with one of the sessions. The five senses. That session, that was really cool. It's like a little scavenger hunt.”</i>
A motivating environment	<i>Young people described feeling motivated and looking forward to attending sessions and expressed a desire for more sessions.</i>	<i>“What surprised me? I guess I didn't expect to be so engaged in it and when it ended to be so emotional about it ending...it's not the first group work, but the first group work that I</i>

		probably stuck with the whole way.” “Yeah, I wish I could do it more. It was just so easy and comfortable to be in.”
Main theme 2: OVW removed barriers and made treatment more accessible		
<i>Subthemes</i>	<i>Description</i>	<i>Illustrative Quote</i>
Easy to access	<i>Young people perceived OVW as highly accessible, convenient, simple and easy to access.</i>	“I think most people are very unlikely to go out into a clinic to get care, so this makes it a lot easier. And I'm pretty sure everyone at least owns a laptop or something, so it's very accessible to most people nowadays.”
Removed barriers to care	<i>Young people described reduced burden and obstacles accessing care in OVW and was often linked to removal of physical barriers and illness-barriers, especially for people that struggle to leave the house or be face-to-face with people.</i>	“I wanted to participate in a group without leaving the house and having to worry about Uber fares and financial costs, but also not having to be face-to-face with people.” “The online aspect really helped because I don't really like leaving my house or going out, so I guess that helped.”
Lowered threshold to engagement	<i>Young people described feeling safe, familiar and comfortable online, supporting engagement in OVW and felt it was able to provide access to care when they needed it most.</i>	“I found it most helpful because it helped me, or because of the fact that it was online, helped me engage with the group.” “I found it most helpful by providing a space for me to be able to access, which I wouldn't normally be able to access when I'm feeling too unwell to leave my apartment. So, I found that quite helpful that I was able to do it from home.” “Because it's an easy thing to do. You get to stay home, in your comfortable space, and you don't have to speak if you don't want to. It's cozy, and easy.”
Main theme 3: OVW is a safe, welcoming and inclusive space		
<i>Subthemes</i>	<i>Description</i>	<i>Illustrative Quote</i>
Comfortable and safe	<i>All young people strongly endorsed OVW as a confidential, comfortable,</i>	“I think the spaces they created were very welcoming, like the hub, the campfire, like I said, it was one of my

	<i>safe and inclusive space.</i>	favourites.” “I never really had a question of my safety using the platform.” “I felt safe, comfortable. I didn't have any problems with privacy”
Anonymous, de-stigmatising and judgement free	<i>Young people perceived greater safety and comfort with the avatar and not having to show their own face, particularly in the group environment. Young people described decreased stress by removing the pressure of social cues (e.g., maintaining eye contact while speaking), while others reported feeling less judged, less vulnerable and more able to be open and expressive.</i>	“It was a nice space to talk to other young people without having to share our faces, just with the avatar.” “You don't feel everything's out there to be judged or you don't feel as vulnerable.” “I was able to be more open about myself and speak about what's going with me.”
Inclusive, graded participation	<i>Young people described OVV as inclusive and accommodating, with the choice of various forms of communication a positive means to grade participation at the young person's pace, promoting overall perceptions of safety on the platform.</i>	“I found it quite nice. I thought that it was very inclusive and accommodating in the sense that it really catered to everybody's needs and preferences. So if you weren't comfortable using your voice, you could just use the chat and there wasn't any pressure to answer. You could always just pass. The facilitators were very accommodating with stuff like that. So yeah, I guess I just thought that it was all very welcoming and I didn't feel pressured in any way to do anything. I think I enjoyed it because as the saying goes, time flies by when you're having fun, and I felt like the sessions blew by quite quickly.”
Main theme 4: OVV fostered genuine therapeutic connections and a sense of belonging		
<i>Subthemes</i>	<i>Description</i>	<i>Illustrative Quote</i>
Social connection and belonging	<i>Young people perceived the</i>	“Overall, it was a good experience. It

	<i>opportunity to talk and form connections with other young people as the most valuable part of their experience in OVW and was often linked to lost opportunities, isolation and lost confidence in the real world.</i>	helped me socialize and just connect with other people, and it was just easier to do.” “I think it was really great being able to talk with people again and just get to know people.” “It's a good way of connecting with other people, especially if you are struggling to go the extra way and present yourself physically somewhere.”
Peer support and improved social confidence	<i>Young people felt they developed real relationships and gained peer support in OVW. Most described OVW as helpful to feel a bit more comfortable in socialising and beneficial for improving confidence in social situations.</i>	“I guess it was more helpful as...It's good to know that there's other people that also have these problems.” “I guess the most memorable one was when I shared a bit of my trauma and how I did share it. For me, it's really hard talking about that, and people's responses to it was really nice. And I was really acknowledged for that.” “I had something to do, and feel listened to, and become a little bit more confident.”
Therapeutic alliance	<i>All young people described a safe, supportive and therapeutic relationship with the OVW therapists. Young people reported feeling present with the therapists and made positive comparisons to OVW therapy as similar and as good as real life and expressed they would definitely recommend it to others.</i>	“The clinicians were very supportive and letting people just typed their answers and stuff instead of have to get them to talk. Very patient.” “They made you feel so comfortable to open up and they were really good with breaking the ice too, making it not feel awkward and sharing their own feelings and experiences. It just felt really welcoming.” “I'd tell them to do it because it's pretty enjoyable and the quality of care doesn't go down even though it's online. So I think some people will be

		worried about that, but I didn't feel that it went down."
Main theme 5: OVW positively enhanced wellbeing and provided a catalyst for real-life change		
Subthemes	Description	Illustrative Quote
Reconnection to social identity, and enhanced social and communication skills	<i>Among group participants, young people described an effect of OVW in facilitating reconnection to the social self and social identity, social and communication skills, leading participants to endorse OVW for young people with social anxiety and neurodiversity.</i>	"I'd say it's impacted positively. Like I said, finding out that I still had these really strong social skills and I guess this confidence I didn't know I had." "Just feeling like I am somebody that can hold a conversation. I am somebody that's kind of interesting enough to be worth something to other people." "I feel like it built my confidence back up a bit with my social skills." "For people that have social anxiety and stuff like that. It definitely helps."
Improved mood, self-esteem and functioning	<i>Young people perceived positive impacts of OVW on their life wellbeing and described an effect of improved mood and self-esteem and functioning, leading participants to endorse OVW for young people experiencing depression and isolation.</i>	"I think it works best, it works really well when you're depressed because it lifts up your mood. " "I know for me just, because I'm withdrawn from life, it just helped me...It was part of my routine. I always would be looking forward to attending these meetings and I would always feel better afterwards." "I'm a person that really struggles with committing to things. And it made me feel like every time I went and I did the session, I felt I'd achieved something and that was really great, having that sense of achievement. I went through the group and I either said something or that someone laughed at something I said or reacted positively. So that's really great."

A training ground for real life	<i>Many participants perceived OVW as a safe space to learn, practice new skills and grow confidence and described generalising effects of skills translation and growth in social confidence in the real world.</i>	"I think being in the virtual world provides training for real world scenarios, and I think the instructors showed us different skills that we can employ in real world situations." "I went out to this birthday, I don't know, maybe a week ago, and I suppose it helped me have conversations with other people." "Tomorrow I'm going to Relate, which you might have heard of, it's a group therapy at Orygen and it's in person and I met someone on the OVW platform who is also going to that one. So I sort of made a new friend, sort of because I only know the avatar."
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Discussion

Summary of findings

The aim of this study was to investigate the feasibility and acceptability of using a new co-produced virtual world platform to deliver care to a youth mental health population. The therapy was delivered in methods: 1) a structured group therapy and 2) a one to one therapy. Results for the group therapy indicated it was feasible to recruit, consent, and retain participants. Recruitment to the one-to-one therapy was good but retention was relatively poor, so feasibility was less clear. Both the group participants and the one-to-one therapy participants found therapy through the virtual world acceptable as measured by post therapy and post session. This level of acceptability was higher in the group therapy. Therapeutic alliance was relatively good in both therapies. The system usability was above average compared to industry standard again favouring the group setting. There were no changes in the outcome rating scales pre and post in either group or one to one settings. There were no specific safety issues reported. The levels of presence in the VW (ITC-SOPI) were average. Post therapy interviews were positive for both group and one to one settings and identified 5 themes relating to engagement, safety, accessibility, therapeutic connections and real-world applicability.

Results in context of prior research

current results suggest that whilst there are no clear safety issues and from the interviews, no clear contraindications for the use of the platform, some population groups might provide a more suitable target. Overall, it appears that the group approach might be more feasible and acceptable based on the reduced level of retention and the higher scores on acceptability. However, this could be due to the different clinical populations that were offered these different therapeutic approaches. Referrals for the

different interventions tended to prioritise young people with experiences and clinical profiles more suitable for the different approaches. Referrals to the group approach prioritized young people with depression whereas the individual therapy was prioritised those with emotional dysregulation that may be more prominent in those with personality disorders. This meant that the different interventions were not directly comparable, potentially explaining the difference in uptake and effects beyond the platform itself. Whilst not captured in the data directly, it appeared that more young people with social anxiety and autistic spectrum disorders were referred to the group approach. There is some evidence that groups might be more of an obvious approach for these youth cohorts [47]. One other difference that was highlighted by the young people in the interviews was that those agreeing to the individual therapy had to add another individual worker to their care team (one to one) as opposed to a group The approach where the anxiety of working with another therapist was perhaps proportionately less as diluted by the rest of the group. We also speculate that the use of the environment might have been different in the group and one to one therapy where there was more potentially more ability in the group setting to make use of the codesigned features and have a more “playful” and exploratory experience alongside others potentially making better use of the affordances of the environment.

There has been limited research into the use of virtual worlds especially in young people with moderate to severe mental health difficulties. There are more trials using virtual worlds for targeted specific mental health population groups who might be predicted to engage better with this form of technology such as those with social anxiety and autistic spectrum disorders where face to face communications may be especially challenging [18, 48, 49]. Most research has been done on approaches using groups than to deliver one to one therapy [18]. Very few studies have looked at a broader group in tertiary mental health services. Our previous VEEP trial is one of the few trials in a moderate to severe mental health population (first episode psychosis). The trial suggested it was feasible and acceptable to deliver structured group therapy the existing virtual world platform second life [23]. Whilst we are unable to demonstrate a preference for a specific clinical presentation in this trial, we note that the group intervention that appeared to be acceptable was aimed at a group with anxiety and depression and we had a number of young people with agoraphobia (either pre or post COVID lockdowns) who attended and were subsequently able to then attend face to face groups offered by the clinical program. One particular focus in these clinical settings could also be the use of virtual world interventions as a “stepping stone” for further face to face group therapy. Fewer previous trials have attempted to use virtual worlds to deliver one to one therapy [18] and it is of interest that this approach appeared less feasible and acceptable. Anecdotally, clinicians and young people were concerned about adding a further therapist to the current treating team. This appeared to be less of a problem in the group approach with groups being standardly offered to anyone receiving care in the service.

Interestingly other previous trials have found their approaches to using virtual worlds were successful in targeting groups of younger people with social anxiety and autistic spectrum disorders. The VR adapted Social Effectiveness Therapy for Children with social anxiety disorder and found that this was acceptable and effective [50], Similarly for children and adults with autistic spectrum disorder there have been small trials or

case studies examining feasibility, acceptability and effectiveness. None of these interventions to our knowledge were trialed in young people in tertiary mental health services where the level of need and complexity is possibly likely to be higher. With regards to depression most interventions have either been more immersive virtual reality approaches or gaming approaches [51]. More immersive social VR experiences such as VRchat have similarities with web based virtual world environments and whilst there have been enthusiasm for the therapeutic use of VRchat [52] the potential disadvantage of needing to use VR headsets likely to be harder to implement in a standard clinical setting.

More recently, renewed interest has focused in on the use of the metaverse as a form of virtual world experience, regarding impact on mental health but also as a therapeutic environment. The metaverse is defined as “persistent virtual worlds that exist in virtual or augmented reality, the metaverse proposes to afford a range of activities of daily life, from socializing and relaxing to gaming, shopping, and working” [53]. There are clearly some considerations both for using virtual worlds and the meta-verse more broadly for therapeutic approaches such as generalisable outcomes in real world settings and the risk of further worsening gaming addictions or social isolation.

Strengths and limitations

To our knowledge, this is the first virtual world purpose built to deliver mental health care for young people with mental health difficulties. The platform had a strong co-production approach with young people with mental health difficulties. We also attempted to trial the platform in the two standard therapy approaches, both group and individual (one to one) settings.

Limitations of the trial were the relatively small numbers of young people who participated in the trial, especially for the individual therapy. We are also aware that minimal interpretation can be drawn with respect to the outcome measure data post intervention in general given that these small numbers in the trial and the absence of a control group. The effect sizes only give us an indication for possible effects if planning for a larger definitive trial. Further, acceptability data should be interpreted with some caution, particularly for the individual group, as those who completed fewer sessions were lost to follow-up, although this follow-up was acceptable in the group intervention. We also acknowledge that the results are specific to a moderate to severe tertiary mental health group, although it might be reasonable to assume that it would also be appropriate for a less severe youth mental health group.

Implications

A virtual world designed for a mental health setting is feasible and acceptable especially for the delivering group therapy approaches to young people with moderate to severe mental health difficulties. Importantly, the public mental health clinical services where the trial was delivered and embedded were eager to continue delivering therapy using the platform as they could see the potential benefits to clients (the clinical service has continued to run the relate OVW group as part of their standard clinical service group program and now run another 4 groups). This was a pleasing outcome of embedding the trial within the existing clinical service structure. We feel that the results give us some confidence that this approach would be a beneficial addition to services such as these and also potentially has applicability to wider mental health populations.

Future directions

Based on the feedback from the trial it is necessary to refine the virtual world to make it ready for deployment in clinical services. The most significant refinements appear to be related to the technology needed to run the platform on multiple devices with lower broadband speeds and stable internet connections. There is a balance between the simplicity of the platform versus the ability to have the technological components and features to engage young people as might be expected in other mediums they are used to using such as online games. Further work is needed to fully understand which groups of young people may derive the greatest benefits from the platform and also to determine how this approach compares to standard telehealth services. Anecdotally the participants who took part in the trials were those young people who did not engage fully (e.g. kept their camera off) in the telehealth services offered and struggled with social anxiety and social communication. As clinicians are the second key user of the platform, we need to further understand the enablers and barriers to clinicians adopting the platform to use in their clinical toolbox. We have proof of concept of clinicians using this successfully in our clinical program, but these are likely to be early adopters within the setting.

Conclusions

We were able to co-produce a bespoke virtual world for use in mental health therapeutic settings with young people and clinicians which appears to be feasible and acceptable to deliver therapy to a population with significant mental health difficulties. In its present form and delivery, the virtual world appears to be better suited to a group intervention. We believe the trial provides a proof of concept, but both the virtual environment and the structure/content of the therapeutic interactions still need further refining with regard to technology and features but also the target population and the ability to implement widely within clinical services. The results suggest there is an opportunity to consider how this could be an important therapeutic technology for young people with mental health difficulties in the future.

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Authors' Contributions

AT obtained the funding and originated the study. IB participated in study design and analysis and interpretation of the results. MT led the development of the content and delivery of the interventions and conducted the qualitative analysis. SL and DK led the co-production of the virtual world. All other authors contributed to the project and the production of the manuscript.

Conflicts of Interest

None reported

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