



Body, emotions, and sexuality in the metaverse: A randomized control trial exploring the use of second life for an avatar-based intervention to support women with female orgasmic disorder

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1. Introduction

The present study analyzes the efficacy of an avatar-based intervention protocol for female orgasmic disorder (FOD). FOD is a broad problem with several existing, effective interventions. However, due to the sensitive nature of sexual disorders, many people in distress are reluctant to pursue treatment. An avatar-based intervention occurring in the metaverse may help these people overcome obstacles to treatment, so determining whether this approach would be effective could help more individuals receive the treatment they need.

Sexual dysfunctions represent a pervasive mental health concern affecting a substantial portion of the global population. Roughly 40% of women and 30–70% of men encounter some sexual problem at some point in their lives (Hendrickx et al., 2019; Sutherland et al., 2019). Of all sexual dysfunctions, one of the most prevalent is FOD. This disorder is characterized by the absence, recurrent delay, infrequency, and/or reduction of the intensity of an orgasm (American Psychiatric Association - APA, 2014). The prevalence of this condition varies due to inconsistencies in diagnostic criteria (Graham, 2010); the systematic review study by Shifren and colleagues (Shifren et al., 2008) identified orgasmic difficulties in 35% of the population, while the epidemiological study by Brody (2017) found FOD prevalence rates reaching values up to 50%. The increased frequency of sexual dysfunctions, along with the profound correlation between sexual, physiological, and

psychological well-being (Sutherland et al., 2019; Rider et al., 2016), highlights the escalating importance of prioritizing sexual health. Sexual satisfaction has been, in fact, associated with a lower risk of falling into depression and higher levels of perceived quality of life (Stepptoe et al., 2015; Pastuszak et al., 2013). FOD has been found to be related to distress, difficulties with personal relationships, and an increased probability of depressive symptomatology or anxiety (Alcoba Valls et al., 2004).

Existing psychosexual treatments to treat FOD are effective (Brody, 2017; Kingsberg et al., 2017). The approach with the most empirical evidence and best results is based on cognitive-behavioral therapy (CBT) (Kingsberg et al., 2017; McCabe, 2015). As sexual anxiety can inhibit sexual arousal and impede relaxation, which as a consequence can reduce or even eliminate the possibility of achieving an orgasm (Kingsberg et al., 2017; Shifren et al., 2008), CBT treatments aim to reduce inhibitory anxiety to maximize stimulation (i.e., increasing the focus of attention to sexual stimuli) (Kingsberg et al., 2017; McCabe, 2015). In more detail, interventions for FOD are based on three principles (MSD Manual, 2022): self-stimulation (e.g., a series of prescribed exercises along with educational protocols about sexual function), sex therapy (e.g., addressing concerns about sexual performance and feelings, with or without a partner), and psychological therapy (e.g., CBT to identify and manage fear of vulnerability and issues of trust with a partner, or mindfulness-based cognitive therapy [MBCT] to learn how to

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pay attention to sexual sensations without judging or monitoring them).

While treatments for FOD are effective, the current state of art presents some limitations. First, most existing studies on interventions for FOD focus exclusively on the presence or absence of the disorder, with the goal of removing its symptoms. But there are other relevant and related outcomes to consider that could help reveal both the specific mechanisms that lead to the reduction of FOD and additional or specific benefits of the types of intervention (Sánchez-Fuentes et al., 2014; Jayne et al., 2021). Additional outcomes to consider are sexual satisfaction (i.e., the feeling of pleasure that one has when the sexual desire has been fulfilled, sexual function (i.e., the capacity of having a satisfactory sexual life), and sexual initiative (i.e., the proactive and consensual expression of one's sexual desires, interests, and intentions within the context of a sexual relationship or encounter) (Dekker et al., 2020). Measuring other psychological factors (e.g., self-esteem or sex guilt) might also help identify the benefits and unpack potential mechanisms in FOD treatment to help focus future treatments. The second shortcoming of existing studies is the predominant use of in-person therapy to treat FOD. Patients with sexual problems rarely request psychological assistance (Alcoba Valls et al., 2004; Meston et al., 2004). This reluctance is due to a variety of factors, including shame, guilt (Meston et al., 2004; van Ameringen et al., 2017), limited privacy during consultations (Sarkadi & Rosenqvist, 2001), and especially perceived stigma about having a sexual problem. Stigma arises from the notion that certain sexual practices are considered unnatural, immoral, or sinful. Consequently, sexual stigma results in social isolation, discrimination, and mistreatment (Côté et al., 2020), causing individuals to conceal stigmatized aspects of their sexuality, including sexual dysfunctions. This discomfort is therefore a significant obstacle for potential patients seeking psychological treatment for sexual disorders, as they fear the embarrassment of visiting a hospital or clinic (Sarkadi & Rosenqvist, 2001; Vila et al., 2023a).

In addition to stigma making individuals reluctant to pursue psychological help for sexual problems, the specific tasks of psychological treatment can contribute to individuals avoiding treatment (Rodón-Benítez et al., 2009). For example, although exposure and systematic desensitization are proven techniques to treat sexual disorders (Mestre-Bach et al., 2022), patients may resist exposing themselves to their feared stimuli. The perceived difficulty of therapeutic techniques can lead individuals to dropping treatment (Botella et al., 2007).

Both the challenges of stigma and fear are particularly pronounced in the in-person therapies assessed in previous studies but might be avoided with a different approach. To address patients' sexual stigma and fear of exposure, one alternative treatment approach worth examining more fully is based on e-mental health and includes different technologies such as apps or virtual reality (VR). Therapeutic apps have been shown to help improve sexual health (Oldham, 2021; Vila et al., 2023a), but it is recommended that the apps should only supplement a broader intervention (Vila et al., 2023c), run for example using VR. This technology employs computer-generated, three-dimensional environments to simulate reality (Riva, 2022). VR has already revealed its efficacy in treating sexual problems (Loranger & Bouchard, 2017; Mozgai et al., 2020; Lafortune et al., 2022), but it does not sufficiently address the challenges posed by patients' sexual stigma and fear. To receive VR-based therapy, patients still need to commute to a clinic. The present-day limitation of individuals needing to physically relocate to the therapeutic environment to receive a VR intervention may be solved with the use of a metaverse.

A metaverse is a virtual shared space accessed via the internet, resembling the physical world but with added elements (Seidel et al., 2022). Contrary to VR, the metaverse presents the benefit of being accessible remotely without expensive equipment. Metaverses provide privacy, realistic simulations, and engagement for users.

Metaverse-based therapy uses avatars—virtual representations of the persona inside the digital environment—and is also known as avatar-based therapy (Kocur et al., 2021). Using an avatar provides

therapeutic benefits such as safety, flexibility, and access to virtual objects and activities that may be hard to obtain in real life (Rehm et al., 2016). Unlike other remote therapies, like online counseling or videoconferencing, metaverse-based therapy allows patients' avatars to confront anxiety-inducing stimuli, enabling the use of therapeutic techniques like exposure therapy, systematic desensitization, and behavioral skills training (Riva et al., 2021). The characteristics of metaverses contribute to reducing patient stigma and fear, offering a safe environment for exploring sexual identities. Moreover, engaging in specific exercises relevant to the treatment of sexual problems, such as practicing techniques related to masturbation, might push ethical boundaries when conducted in front of a psychologist. Within a metaverse, these exercises can be undertaken with fewer ethical constraints.

For all these reasons, the characteristics of the metaverse would make it conducive to being used to treat sexual problems. Despite its potential, we were unable to find any prior study testing the efficacy of an intervention delivered through a metaverse to treat FOD (or any other sexual disorder). The present study aims, therefore, at filling this gap. Specifically, we hypothesize that (1) a metaverse-based intervention would be effective in treating FOD, and that (2) it would also improve three primary outcomes related to FOD: sexual satisfaction, sexual function, and sexual initiative. Similarly, we hypothesize that (3) a metaverse-based therapy would improve three secondary outcomes that affect orgasm consecution: sexual self-esteem, sex guilt, and sexual anxiety. Finally, in the context of obstacles to traditional treatment, we hypothesize that (4) participants in the metaverse-based therapy would be subjectively satisfied with its implementation.

2. Method

2.1. Participants

A power analysis was conducted prior to the intervention to calculate the necessary sample size for the study (Suresh & Chandrashekar, 2012). This analysis used the G Power 3.1 software with the conventional effect size values suggested by Cohen and the *International Committee of Medical Journal(1997) Editors*, the subsequent literature on the topic (Kang, 2021), and previous sexual interventions (Pyke & Clayton, 2018) (effect size $f = 0.25$; moderate effect size) and yielded a required value of at least 30 participants.

A total of 31 participants finished the interventions: 16 women ($M=27.88$; $SD = 6.77$) took part in the avatar-based intervention group (IG), and 15 women ($M=31.27$; $SD = 8.34$) were part of the control group based on minimum therapeutic contact (CG). All participants attended the post-treatment and follow-up assessments.

Fig. 1 shows the flow of participants who were recruited and screened, along with information of those who started and completed the treatment. A total of 967 potential participants were recruited through university advertisements, social media, and personal communication apps (February–May 2022). Of these, 518 attended a pre-screening, telephonic interview conducted by trained psychologists. After the pre-screening process excluded 301 potential participants, 217 women participated in a videoconference psychological clinical evaluation to check if they matched the Diagnostic and Statistical Manual of Mental Disorders – DSM-5 – diagnostic criteria for female orgasm disorder. Inclusion criteria to be part of the study were: (a) to present the characteristics to diagnose FOD after a clinical assessment (considering natural characteristics of the women's sexual response cycle (Conn & Hodges, 2022), based on the DSM-5 criteria; (b) providing a medical check to prove the absence of physical factors that may be the cause of the orgasm dysfunction; (c) being at least 18 years old; and (d) having access to a computer with an internet connection and an operating system to access the metaverse (secondlife-requirements). Exclusion criteria were: (a) presenting a diagnosis of a physical condition that may be the cause of the orgasm dysfunction (e.g., genital lesions, systemic and hormonal factors, vulvovaginal atrophy); (b) presenting other

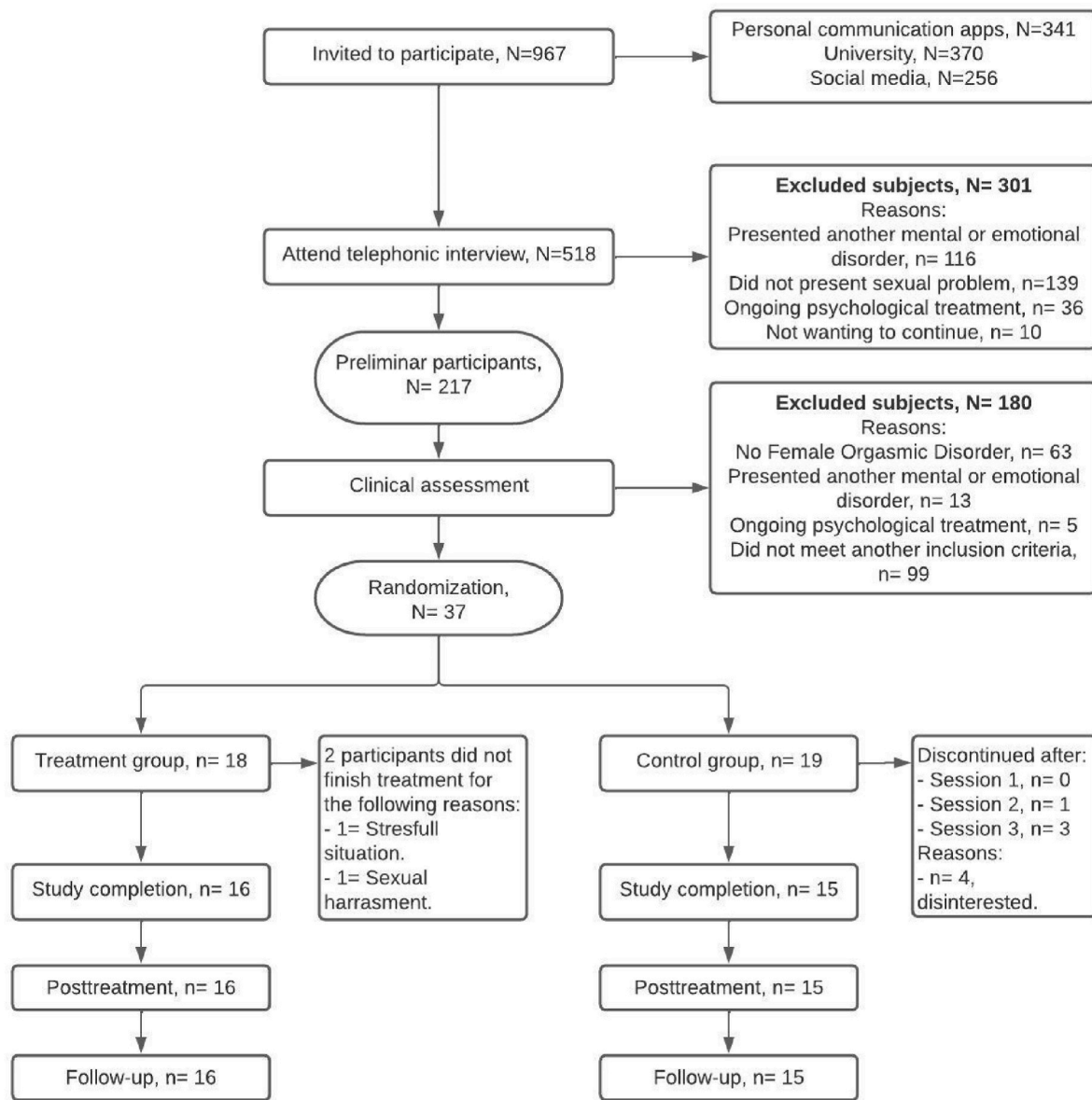


Fig. 1. The flow of participants throughout the study.

psychological condition that may be the cause of the orgasm dysfunction (e.g., depression, trauma); (c) having alcohol dependence (evaluated during the clinical assessment, according to the diagnostic criteria from the DSM-5, to determine if the individual meets the criteria for an alcohol use disorder diagnosis); (d) using drugs, including medication that is known to cause sexual difficulties (e.g., selective serotonin reuptake inhibitors (SSRIs), that commonly cause sexual dysfunction [American Psychiatric Association – APA, 2013]); and (e) having participated in a previous psychological intervention in the last year.

After the telephonic pre-screening and the videoconference clinical assessment, 37 women were identified who met the inclusion criteria and were enrolled in the study. Participants were randomly assigned to the avatar-based intervention group (IG) and the control group (CG). A total of 31 completed the treatment, as well as post-treatment and follow-up assessments. All individuals were informed of the intervention details, the possible risks (e.g., distress experienced due to increasing awareness of an emotional problem during the therapeutic process, possibility of increasing interpersonal difficulties with the partner, etc.), and their right to terminate the program without prejudice, and signed an informed consent, sent via Google Forms. The clinical trial was

retrospectively registered on [ClinicalTrials.gov](https://clinicaltrials.gov) and reports the trial identifier NCT06187246. The study was approved by the ethical committee of Rey Juan Carlos University (registration number: 2005202114121), which complies with the European Union Regulation 2016/679, of April 27, General Data Protection and Organic Law 3/2018, of December 5, Protection of Personal Data and Guarantee of Digital Rights.

2.2. Treatments

2.2.1. Avatar-based intervention group (IG)

The avatar-based intervention was aimed at providing a comprehensive metaverse-based treatment that covers all the important factors of FOD. The intervention was based on the CBT approach, as it represents the treatment with the most empirical evidence for sexual dysfunctions (Kingsberg et al., 2017) and FOD (Brody, 2017; McCabe, 2015). It included establishing and pursuing sexual goals aligned with one's personal values in the service of a meaningful life. The treatment aimed at improving sexual variables (i.e., sexual satisfaction, sexual function, and initiative and sexual communication), and variables that

are known to affect orgasm consecution (i.e., sexual self-esteem, sex-guilt, and sexual anxiety). To achieve this objective, the intervention focused on fostering participants' abilities to increase their levels of sexual stimulation, and engagement in personal values, along with identifying and modifying dysfunctional thoughts about sexuality. The techniques used included psychosexual education, cognitive restructuring, virtual exposure, sexual stimulation, and engagement in personal values from the acceptance and commitment therapy (ACT) perspective.

The program consisted of 12 weekly online individual sessions implemented in the metaverse Second Life (secondlife.com) over three months. Each session lasted about 60 min according to previous FOD literature (Marchand, 2021). A pilot study testing the feasibility of the intervention helped develop the program (Vila et al., 2022). The main content of each of the 12 sessions is shown in Table 1, and the detailed protocol is available upon request.

The therapists were clinical psychologists, trained in CBT and ACT principles and techniques, with experience in the field of sexuality, families, and couples. Therapists attended weekly supervision sessions with members of the study team and other therapists and received specialized training in the intervention conditions.

Having a partner was not part of the inclusion criteria for participating in the study, so the content and techniques of the intervention related to couples therapy were adapted to participants without partners. The exercises designed to take place with a partner were aimed at covering one important part of sexual well-being: sexual communication. This is a common, anxiety-evoking topic and, thus, people with sexual difficulties tend to avoid it. The communication activities presented two main purposes: improving the communication skills of the patient and reducing the anxiety induced by the communication itself. These same goals were achieved by patients without partners through speaking with friends, family, or casual sex companions.

2.2.2. Minimal support control group (CG)

Control group sessions consisted of individual informative talks, during which participants were provided with information about female orgasms, masturbatory techniques, and techniques to focus attention on one's body (i.e., an important factor to pleasure). The main content of each session is shown in Table 2.

Sessions were interactive (e.g., the participant was asked to solve puzzles, speak about personal inquiries, and practice some beneficial exercises) and implemented through video call, and no specific therapeutic techniques were applied toward this group. Participants received three individual monthly sessions lasting 1 h each, mirroring the duration of the IG sessions.

Neither the avatar-based treatment, nor the minimal support intervention, poses any permanent, significant risk for the participants, beyond that anytime that awareness of a problem is increased, there is a possibility for eliciting distress about it. If an individual demonstrated fatigue or distress due to the discussed topics, the person was suggested to conclude the session or the treatment, in the best interest of the patient's benefit. Additionally, should the experience become emotionally burdensome because of the inherent nature of the content, individuals were free to interrupt the intervention at any point.

2.3. Procedure

A parallel trial design with a 1:1 allocation ratio was employed. Both the study subjects and the therapists providing the treatment were blind to the intervention they received or provided. Participants were not informed of the existence of another type of intervention, and healthcare providers were not informed of the objectives of the study. Blocked randomization (block size = 10) was implemented to ensure adherence; to begin intervention before recruitment was complete, participants who met the criteria to be part of the study were provided with a personal number, grouped, and randomized between intervention types. The random allocation sequence was automatically generated using the

Table 1
Content of the avatar-based intervention received by the IG.

Session	Content	Techniques
1	<ol style="list-style-type: none"> 1. Learning about FOD: characteristics, orgasms, prevalence rates of difficulties in getting orgasms, prevalence rates of FOD, and causal factors. 2. Learning about female sexuality: sexual cycle phases, desire, psychological variables, the reproductive system, genitalia, pleasure areas, facts and fallacies. 3. Working with irrational beliefs: learning about irrational beliefs and being aware of the patient's irrational beliefs regarding their sexuality. 4. Clarifying personal values: understanding what are the goals that motivate the participant's actions and serve as guiding principles in their lives. 5. Learning breathing and relaxation techniques that the participant should practice from this session onwards. 	Psychoeducation, cognitive restructuring, values-based and ACT techniques, relaxation techniques training.
2	<ol style="list-style-type: none"> 1. Psychoeducation about guilt and other emotions (e.g., embarrassment): learning about the role of emotions in achieving orgasm and understanding the part that they play in the participant's life. 2. Restructuring irrational beliefs and exploring a values-focused life (i.e., focus personal efforts on actions with meaning). 	Psychoeducation, cognitive restructuring, values-based and ACT techniques.
3	<ol style="list-style-type: none"> 1. Systematic desensitization: the participant exposes herself to the anxiety-evoking stimuli of visually examining her body, excluding genitalia and breasts. 2. Restructuring the irrational beliefs that appear and work as a barrier for sexual well-being. 3. Definition of values-based goals and commitment to values-based action. 4. At-home task: the participant exposes herself to the anxiety-evoking stimuli that she has practiced during the SL session. 	Individual sexual therapy, cognitive restructuring, systematic desensitization, exposure therapy, values-based and ACT techniques.
4	<ol style="list-style-type: none"> 1. Systematic desensitization: the participant exposes herself to the anxiety-evoking stimuli of tactilely examining her body, excluding genitalia and breasts. 2. Restructuring the irrational beliefs that appear and work as a barrier for sexual well-being. 3. At-home task: the participant exposes herself to the anxiety-evoking stimuli that she has practiced during the SL session. 	Individual sexual therapy, cognitive restructuring, systematic desensitization, and exposure therapy.
5	<ol style="list-style-type: none"> 1. Systematic desensitization: the participant exposes herself to the anxiety-evoking stimuli of visually examining her genitalia and breasts. 2. Restructuring the irrational beliefs that appear and work as a barrier for sexual well-being. 3. At-home task: the participant exposes herself to the anxiety- 	Individual sexual therapy, cognitive restructuring, systematic desensitization, and exposure therapy.

(continued on next page)

Table 1 (continued)

Session	Content	Techniques
6	<p>evoking stimuli that she has practiced during the SL session.</p> <ol style="list-style-type: none"> 1. Systematic desensitization: the participant exposes herself to the anxiety-evoking stimuli of tactile examining her genitalia and breasts. 2. Restructuring the irrational beliefs that appear and work as a barrier for sexual well-being. 3. At-home task: the participant exposes herself to the anxiety-evoking stimuli that she has practiced during the SL session. 	Individual sexual therapy, cognitive restructuring, systematic desensitization, and exposure therapy.
7	<ol style="list-style-type: none"> 1. Working with pleasure areas: reviewing what has been learned in the past sessions, providing information on the best ways of stimulating them, exposure to the anxiety that the topic evokes. 2. Commitment to values-based action check and restructuring of barriers. 3. Communication with partner: conversation planning and restructuring of the associated dysfunctional thoughts or beliefs. The participant shall indicate that she is going to therapy and ask for his cooperation. 4. Kegel exercises. 	Psychoeducation, cognitive restructuring, values-based and ACT techniques.
8	<ol style="list-style-type: none"> 1. Communication with partner: checking the conversation's outcome (the participant should have engaged in the conversation planned) and restructuring of the associated thoughts or beliefs. Conversation planning about communicating pleasure areas list. 2. Elaborating a pleasure areas list based on what has been learned. 3. Stimulation-discomfort desensitization. 	Psychoeducation, cognitive restructuring, systematic desensitization, and exposure therapy.
9	<ol style="list-style-type: none"> 1. Checking the conversation's outcome and restructuring the related irrational beliefs. 2. Emotional management training. 3. Systematic desensitization reminder of every step achieved: the participant exposes herself to the stimuli that no longer produce high levels of anxiety. 4. Working with the barriers that emerge when implementing therapy improvements in real life. 	Couple sexual therapy, cognitive restructuring, systematic desensitization, and exposure therapy.
10	<ol style="list-style-type: none"> 1. Working with emotions, barriers, and irrational beliefs. 2. Preparation for the next step. 3. Planning of at-home task: creating a sketch of items for couple's desensitization. 	Psychoeducation, emotion management training, couple sexual therapy and cognitive restructuring.
11	<ol style="list-style-type: none"> 1. Checking the at-home task and restructuring of related beliefs. 2. Systematic desensitization: exploration with the couple in the following order (1) visual examination excluding genitalia and breasts, (2) visual examination of the genitalia, (3) tactile examination excluding genitalia and breasts, (4) tactile examination of the genitalia. 	Cognitive restructuring, systematic desensitization, exposure therapy, psychoeducation, and couple sexual therapy.

Table 1 (continued)

Session	Content	Techniques
12	<ol style="list-style-type: none"> 3. Debriefing. 4. Psychoeducation on sexual positions that guarantee clitoral stimulation. 5. Planning of the at-home task: what do I want my partner to learn? (Based on what has been discovered from past sessions). <ol style="list-style-type: none"> 1. Checking the at-home task and restructuring of related beliefs. 2. Systematic desensitization: stimulation with couple- self-stimulation while partner looks, partner stimulates pleasure areas as he has learned. 3. Sexual communication skills. 4. Debriefing. 5. Therapy end. 	Couple sexual therapy, cognitive restructuring, systematic desensitization, and exposure therapy.

SL=Second Life.

Table 2

Content of the minimal support intervention received by the CG.

Session	Main topic	Content
1	Female orgasms	<p>Information about:</p> <ul style="list-style-type: none"> • What an orgasm is. • Neuronal orgasm. • Factors that may influence consecution. • Ways to achieve an orgasm. • Sexual response. • Differences between genders. • Contraindications. • Desire and age.
2	Masturbatory techniques	<p>Information about:</p> <ul style="list-style-type: none"> • Key elements to achieve pleasure. • Anatomy of the female genitalia. • Pleasure areas. • Benefits of self-pleasure. • Techniques.
3	Attention on one's body	<p>Information about:</p> <ul style="list-style-type: none"> • Attention and consciousness. • Dos and don'ts. • How stress affects sexuality. • Techniques.

random sampling method in Python.

The complete intervention program for the IG was conducted online in the metaverse Second Life (i.e., participants and therapists never met in person). Second Life was selected over other possible metaverses because (1) within this virtual realm any sexual fantasy can be virtually brought to life; (2) it allows users to design avatars with genitalia and various sexual attributes, granting the freedom to utilize a wide range of sexual accessories as well; and (3) creating specialized environments does not require technical expertise. Before the intervention began, participants needed to download and install Second Life, as well as learn the basic commands for avatars: walk/run, take and release objects, sit and stand up, camera control, chat/call, and take pictures. In instances when a participant needed assistance with these tasks, the clinician would help, thereby starting to build a therapeutic relationship. For the intervention, a virtual room was adapted for the therapist and the participant to meet (see Fig. 2). The room was designed to mimic a comfortable clinic office which resembled a living room to increase calmness, and included different elements such as two couches, some lamps, or a rug. While viewing their avatars on their computer screens (see Fig. 3), the patient and therapist communicated via audio. Avatars were personalized for each patient to look like the person they were representing.



Fig. 2. The room prepared for the intervention.



Fig. 3. The avatar's perspective during the sessions.

Note: photos were taken as an example, and are not part of the intervention sessions, in order to guarantee participants' privacy.

2.4. Measures

Variables were measured before and after the intervention, and two follow-ups were conducted once the program ended (i.e., 1 and 3 months after the end of the intervention). In addition to obtaining sociodemographic information (i.e., age, marital status, sexual orientation, education level, and profession), the following variables were measured.

2.4.1. Presence/absence of female orgasmic disorder

Following DSM-5 criteria, a semi-structured, clinical psychosocial interview based on the sexual history for Assessment of Female Sexual Dysfunction (Conn & Hodges, 2022) was used to determine if FOD was present before and after the intervention. The main objective of this clinical interview was to determine if the participant presented a delayed, infrequent, or absent orgasm after a normal sexual arousal phase and despite high levels of subjective arousal, happening on all or almost all occasions for at least 6 months and causing some amount of distress or interpersonal problems (APA, 2013). To make this assessment, the interview covered several areas: 1) past and current medical history (e.g., general health, pregnancies, contraception, use of safe sex

practices, gynecologic and obstetric procedures), 2) relationship with the partner (e.g., attraction, emotional intimacy, communication, trust), 3) current sexual context (e.g., adequacy of sexual stimulation, timing, degree of privacy), 4) triggers of desire and arousal (e.g., setting, activities and types of stimulation), 5) inhibitors of arousal (e.g., fears about outcome, sleep deprivation, anxiety), 6) emotional and physical satisfaction or dissatisfaction, 7) self-image (e.g., feelings about desirability, sexual competence), 8) developmental history (e.g., traumas, abuse, cultural or religious restrictions), 9) past sexual experiences, and 10) personality factors (e.g., need to feel in control, ability to trust, comfort level with being vulnerable). It is important to address that women's sexual response cycle is strongly influenced by subjective factors, such as perceived mental health or the quality of the connection with the partner (Conn & Hodges, 2022). Due to these subjective factors, it takes women longer than men to reach sexual fulfillment, as it typically builds as sexual activity and intimacy progresses. Women can access sexual desire once sexual stimulation causes (1) excitement and pleasure (subjective arousal) and (2) genital congestion (physical, genital arousal) (Conn & Hodges, 2022). Based on the interview, the clinician determined whether or not the participant met the DSM-5 criteria for FOD.

2.4.2. Primary outcomes

In addition to the ultimate goal of reducing the symptoms of FOD, as determined by a clinician, other variables have been identified as primary outcomes related to FOD: sexual satisfaction, sexual function, and sexual initiative (Dekker et al., 2020).

Sexual Satisfaction. Sexual satisfaction was evaluated with the Golombok Rust Inventory of Sexual Satisfaction (GRISS) (Rust & Golombok, 1986). This self-reported measure consists of a 28-item (e.g., “Is sex interesting for you?”) that assesses desire, pleasure, and sexual gratification within sex acts by using a Likert-type response format ranging from 0 = “never” to 4 = “always”. Specifically, scores equal to or above 60 indicate the existence of a sexual problem (cut-off point = 60). Higher scores indicate a greater severity of sexual problems. Previous studies showed a Cronbach’s alpha for this scale of 0.94 (Rust & Golombok, 1986).

Sexual Function. Sexual function was assessed using the Female Sexual Function Index (FSFI) (Rosen et al., 2000). This self-reported questionnaire provides scores on 6 domains based on the previous four weeks: sexual arousal, vaginal lubrication, orgasm, pleasure/desire, satisfaction, and pain. The sum of these domains provides a total score on sexual function, where higher scores indicate better sexual function. The scale consists of 19 items (e.g., “During the last four weeks, how frequently did you experience desire or interest in sexual behavior?”) with Likert-type responses with 5 degrees of frequency (from 1 = “never” to 5 = “always”), intensity (from 1 = “really hard or almost impossible” to 5 = “no difficulties”) and satisfaction (from 1 = “not at all satisfied” to 5 = “really satisfied”). The cut-off for determining significant levels of this variable is 55 (scores equal to or below 55 indicate poor Sexual Function). Previous studies showed a Cronbach’s alpha for this scale of 0.91 (Meston, 2011).

Initiative and Sexual Communication. Initiative and sexual communication were analyzed using the Female Sexual Function Questionnaire (FSFQ) (Borrás Valls et al., 2004). This self-reported questionnaire assesses how the sexual response cycle, initiative, and sexual communication took place in the previous four weeks through 14 items (e.g., “During the last four weeks, have you felt confident to tell your partner what you like or dislike during sexual intercourse?”). The measure employs Likert-type responses ranging from 1 = “never” to 5 = “always”. The cut-off for determining significant levels of this variable is equal to or lower than 25. The internal consistency obtained for this scale was 0.90 (Cronbach’s alpha) (Borrás Valls et al., 2004).

2.4.3. Secondary outcomes

In addition to the above, three other variables that affect orgasm consecution were measured: sexual self-esteem, sex guilt, and sexual anxiety.

Sexual self-esteem. Sexual self-esteem was measured adapting the Rosenberg Self-Esteem Scale (RSE) (Rosenberg, 1979). This self-reported questionnaire assesses the appreciation that one has of oneself through 10 items (e.g., “I am sure I have good qualities”) with Likert-type responses ranging from 1 = “strongly agree” to 4 = “strongly disagree”. The minor adaptation that was implemented concerned the instructions, which were modified as follows to assess sexual self-esteem: “Below is a list of statements dealing with your general feelings about yourself – regarding sexual behaviors. Please indicate how strongly you agree or disagree with each statement”. The cut-off for clinical low self-esteem is a score equal to or lower than 25 (Rosenberg, 1979). Previous studies showed a Cronbach’s alpha for this scale of 0.91 (Sinclair, Holloway, Riley, & Auret, 2013).

Sex-Guilt. Sex guilt was evaluated using the Brief Mosher Sex-Guilt Scale (BMSGs) (Janda & Bazemore, 2011). This self-reported questionnaire assesses cognitions, affects, and behaviors, related to a generalized expectancy for self-mediated punishment (i.e., guilt) (Mosher, 1965) through 10 items (e.g., “Sex relations before marriage help people adjust”). Responses were provided employing a Likert-type scale ranging from 1 = “not at all true” to 6 = “extremely true”, with

higher scores indicating greater levels of guilt. The internal consistency of this scale (Cronbach’s alpha) was 0.85.

Sexual Anxiety. The Sexual Anxiety scale of the Expanded Sexual Arousal Inventory (SAI-E) (Chambless & Lifshitz, 1984) assesses levels of nervousness, worry, restlessness, concern, or fear about sexual behaviors through 28 items (e.g., “How do you feel when a loved one undresses you?”) with Likert-type responses from 0 = “relaxing” to 6 = “extremely anxiety-provoking”. Previous studies showed a Cronbach’s alpha for this scale of 0.97 (Aluja et al., 1990).

2.4.4. Treatment implementation measures

Treatment implementation was measured in various ways. First, *intrasession assessments* were conducted through two items which evaluated the patients’: 1) perceived sexual anxiety (“On a scale of 1–10, how much anxiety does this topic make you feel?”), and 2) perceived sexual satisfaction (“Of all sexual behaviors you had this week, how many of them were satisfactory?” – given as a percentage). These two questions were created ad hoc and represented subjective variables monitored during each session.

Second, after the treatment, participants were asked to rate their *satisfaction with the intervention*, the therapists, and the content and exercises. Responses options ranged from 0 (not satisfied at all) to 10 (totally satisfied). Women were also asked whether they would recommend the intervention to other potential users. Responses options ranged from 0 (would not recommend at all) to 10 (totally would recommend).

The *benefits of the avatar-based intervention* over other forms of therapy were assessed by asking about the patient’s subjective experience. For this purpose, the research team developed a series of items, rated on a scale of low (0) to high (10), based on the previous literature (Vila et al., 2022). Participants were asked: 1) Did you feel comfortable with the at-home therapy? 2) Did this therapy help you avoid the embarrassment of going to a clinic? Do you think this kind of therapy helped you to avoid embarrassment of any kind? 3) Would you have sought other kinds of psychological help? 4) Did the therapy help with family/work? 5) From a scale of 0–10, where “0” means “not at all convenient and flexible” and “10” means “very convenient and flexible”, how would you rate the intervention? and 6) Did the treatment help reduce your anxiety before practicing sexual acts in real life?

2.4.5. The Participant’s experience within the virtual world

The Independent Television Commission Sense of Presence Inventory (ITC-SOPI) (Lessiter et al., 2001) was used to measure participants’ sense of presence (the feeling of “being there” in a virtual environment, as if it were real) in SL. This inventory is a 44-item survey with four subscales: (1) the Spatial Presence subscale, which evaluates the sense of physical placement in the environment, assessing the extent to which the player felt as if they were actually in the virtual space; (2) the Engagement subscale, which evaluates the participant’s enjoyment of the game and their level of psychological involvement; (3) the Ecological Validity subscale, that assesses whether the user’s tendency to perceive the virtual environment to be like real life; and (4) Negative Effects subscale, to address the participant’s tendency to have adverse physiological reactions to the experience. The Inventory provides an overall score of the subjective feeling of presence of the respondents. It uses Likert-type responses going from 1 = “strongly disagree” to 5 = “strongly agree”. Internal consistency coefficients ranged from 0.94 (Spatial Presence) to 0.76 (Naturalness) (Lessiter et al., 2001).

2.5. Data analysis

IBM SPSS Version 22 (IBM Corp., 2013) software with a significance level of $p < 0.05$ (two-tailed) was used for all analyses. To identify bias in the data, the presence of univariate and multivariate outliers, as well

as the normality of the data, were evaluated using the criteria established by [Tabachnick and Fidell \(2001\)](#). Tests to analyze baseline differences in the assessed variables between participants who completed the study and those who dropped out were also conducted. In addition, differences between intervention conditions at pretreatment in the assessed variables were tested. In both cases, mean differences tests (t-tests) for continuous variables, and independence tests (chi-square χ^2) for categorical variables were conducted, to identify significant differences in the baseline characteristics of participants and intervention conditions.

Changes over time in the assessed variables, including both primary, sexual variables (i.e., sexual satisfaction, sexual function, initiative, and sexual communication) and secondary variables (i.e., self-esteem, sex-guilt, sexual anxiety) were analyzed using linear mixed models with random intercepts and restricted maximum likelihood estimation (REML). The factors considered in the model were treatment group (IG vs. CG), measurement time point (pretreatment, posttreatment, 1-month follow-up and 3-month follow-up), and group-by-time interactions as fixed effects. Subjects were treated as random effects in the analyses. To assess changes from baseline to posttreatment and to follow-ups, planned contrasts were carried out. Furthermore, to examine differences in the assessed variable means between pretreatment and posttreatment, as well as the two follow-up assessments within each condition group, the researchers conducted t-tests. These additional tests provided insights into specific changes at different time points within each treatment group. Both completers and non-completers were included in the analysis following previous literature ([Adam et al., 2019](#)).

Three effect sizes were computed for the primary outcomes of the study. The first was Cohen's d effect size. To calculate Cohen's d effect sizes, [Feingold's \(2009\)](#) formula was used. Ranges for Cohen's d are: 0.21–0.49 = small; 0.50–0.70 = moderate; >0.80 = large ([Caycho et al., 2016](#)). To assess clinical significance, the number of participants who needed to be treated to achieve one additional favorable outcome (number needed to treat; NNT) was determined. The NNT was calculated with Newcombe-Wilson 95% confidence intervals based on the criteria outlined by [Bender \(2001\)](#) and [Newcombe \(1998\)](#). The third effect size, the reliable change index (RCI), was also calculated following the method introduced by [Jacobson and Truax \(1991\)](#) adapted by [Morley and Dowzer \(2014\)](#). These effect size measurements provided information about the magnitude of treatment effects and the clinical significance of the interventions used in the study.

3. Results

3.1. Outliers and normality

No univariate nor multivariate outliers were detected in the data, and the skewness and kurtosis values were within the normal range.

3.2. Differences between groups at pretreatment in the assessed variables

[Table 3](#) provides descriptive statistics about the sample, highlighting differences between the IG and CG in the assessed variables at the pre-treatment stage. These variables, along with others later described (e.g., participant's experience within the virtual world), could potentially act as confounding variables. Therefore, their distribution has been considered, and differences have been analyzed. As can be seen, there were no significant differences between the intervention and control groups in terms of sociodemographic characteristics (such as age, education, or marital status) or outcome variables (i.e., sexual satisfaction, sexual function, initiative and sexual communication, sexual self-esteem, sex-guilt, sexual anxiety).

3.4. Changes in the presence of female orgasmic disorder

[Table 4](#) shows the percentage of participants diagnosed with FOD

Table 3
Sample characteristics by treatment condition.

Variable (ranges- cut-off points)	IG (n = 18)	CG (n = 19)	t/ χ^2	p
Participant age in years; Mean (SD)	27.39 (6.57)	30.37 (7.76)	-1.26	0.952
Age range	18–39	21–52		
Marital status			0.974	0.808
Married	1 (5.56%)	2 (10.53%)		
With a partner	7 (38.89%)	5 (26.32%)		
Single	5 (27.78%)	7 (36.84%)		
Having casual sex	5 (27.78%)	5 (26.32%)		
Heterosexual relationship	16 (88.89%)	14 (73.68%)	1.39	0.238
Education			0.717	0.699
Low educational level	6 (33.33%)	7 (36.84%)		
Mean educational level	5 (27.78%)	7 (36.84%)		
High educational level	7 (38.89%)	5 (26.32%)		
Profession			0.222	0.638
Employed	10 (55.56%)	12 (63.16%)		
Unemployed	8 (44.44%)	7 (36.84%)		
Levels of sexual satisfaction (0–112, 60)	75.94 (6.66)	76.95 (7.83)	-0.418	0.874
Levels of sexual function (19–95, 55)	39 (13.11)	37.68 (13.23)	0.304	0.749
Levels of initiative and sexual communication (14–70, 25)	22.33 (2.87)	22.95 (1.96)	-0.764	0.547
Levels of sexual self-esteem (10–40, 25)	19.39 (3.43)	19.95 (3.27)	-0.507	0.869
Levels of sex guilt (10–60)	31.67 (10.40)	31.21 (10.37)	0.134	0.857
Levels of sexual anxiety (0–168)	72.72 (14.37)	68.74 (16.22)	0.790	0.882

Table 4
Participants with FOD at pretreatment, posttreatment, and both follow-ups.

Time	Variable	IG (n = 16)	CG (n = 15)	χ^2	P
Baseline	FOD Presence	16 (100%)	15 (100%)	-	-
	FOD Absence	0 (0%)	0 (0%)		
Posttreatment	FOD Presence	0 (0%)	15 (100%)	31	0.001 ^a
	FOD Absence	16 (100%)	0 (0%)		
1 month follow-up	FOD Presence	0 (0%)	15 (100%)	31	0.001 ^a
	FOD Absence	16 (100%)	0 (0%)		
3 months follow-up	FOD Presence	0 (0%)	15 (100%)	31	0.001 ^a
	FOD Absence	16 (100%)	0 (0%)		

^a Statistically significant (p ≤ .01).

who finished the intervention at the four measurement points (pre-treatment/baseline, posttreatment, and both follow-ups). At baseline, every participant met the criteria for FOD. At posttreatment, no participant in the IG met the criteria for FOD, while all the participants from the CG still presented the disorder. As can be expected from this stark difference between IG and CG participants, statistically significant between-group differences were identified in the presence of the disorder between treatment conditions ($\chi^2 = 31$; p < 0.001) at posttreatment. This finding was maintained in both the 1- and 3-month follow-up assessments: 100% of the IG participants (n = 16) fully recovered of FOD and did not meet the DSM-5 criteria anymore, while 0% of the CG participants (n = 15) recovered ($\chi^2 = 31$; p < 0.001). Results support the first hypothesis and suggest that a metaverse-based intervention can be effective in treating FOD.

3.5. Changes in primary outcomes

[Table 5](#) presents the mean values for primary and secondary

Table 5
Estimated means across time by treatment condition.

Measure (ranges, cut-off points)	Condition	Time			
		Baseline Mean (SE)	Posttreatment Mean (SE)	1 Follow-up Mean (SE)	2 Follow-up Mean (SE)
Primary outcomes					
Sexual satisfaction (0–112, 60)	IG (n = 18)	75.95 (2.0)	38.66 (2.1)	38.91 (2.1)	38.91 (2.05)
	CG (n = 19)	76.95 (1.94)	75.65 (2.15)	73.72 (2.15)	73.72 (2.01)
Sexual function (19–95, 55)	IG (n = 18)	39 (2.91)	62.23 (3.02)	61.86 (3.05)	61.86 (3.05)
	CG (n = 19)	37.68 (2.84)	39.59 (3.05)	40.99 (3.02)	40.99 (3.08)
Initiative and communication (14–70, 25)	IG (n = 18)	22.33 (0.8)	46.39 (0.85)	45.08 (0.85)	45.07 (0.9)
	CG (n = 19)	22.95 (0.78)	23.24 (0.87)	23.64 (0.87)	23.65 (0.92)
Secondary outcomes					
Sexual self-esteem (10–40, 25)	IG (n = 18)	19.39 (0.74)	33.69 (0.77)	33.37 (0.77)	33.39 (0.75)
	CG (n = 19)	19.95 (0.72)	20.64 (0.78)	20.77 (0.78)	20.77 (0.76)
Sex-guilt (10–60)	IG (n = 18)	31.67 (1.98)	12.48 (2.03)	12.8 (2.03)	12.8 (2.02)
	CG (n = 19)	31.21 (1.93)	30.55 (2.02)	30.55 (2.02)	30.55 (2.01)
Sexual anxiety (0–168)	IG (n = 18)	72.72 (3.42)	29.51 (3.46)	30.26 (3.46)	30.26 (3.45)
	CG (n = 19)	68.74 (3.33)	68.1 (3.42)	67.57 (3.42)	67.57 (3.4)

outcomes at all time points for both the IG and CG. Fig. 4 displays these values as a series of line graphs, highlighting the consistency of the control group and the change in all outcome variables for the IG after treatment. Results displayed in Table 5 and Fig. 4, and reviewed below, support the second hypothesis that the metaverse-based intervention would improve three primary outcomes related to FOD: sexual satisfaction, sexual function, and sexual initiative.

3.5.1. Changes in sexual satisfaction

Table 5 and Fig. 4 show the average GRISS scores for sexual satisfaction for the IG and CG over time. Lower scores represent greater sexual satisfaction, and scores over 60 indicate a sexual problem. Both IG and CG averaged scores above 60 before treatment (75.95 and 76.95, respectively), indicating the presence of a sexual problem on average. The CG scores were consistent from before treatment to posttreatment to both 1- and 3-month follow-ups and did not change in a statistically significant way. But IG scores dropped to 38.66 posttreatment, representing an increase in sexual satisfaction and elimination (on average) of sexual problems. This was a large and statistically significant change (estimate = 37.03; t = 16.52; dg = 58; p < .001; Cohen’s d = 4.52) that was maintained at both the 1- and 3-month follow-up assessments. Comparisons of sexual satisfaction from baseline to posttreatment showed that participants in the IG presented greater increases in sexual satisfaction than participants in the CG (time by treatment effect

estimate = -33.80; t = -10.57; dg = 58; p < 0.001; Cohen’s d = 3.93). Again, these results were maintained at both follow-up periods.

3.5.2. Changes in sexual function

Table 5 and Fig. 4 also reveal the mean FSFI scores for sexual function for the intervention (IG) and control (CG) groups over time. Lower scores represent lower sexual function, with scores of 55 or lower indicating poor sexual function. Both IG and CG groups averaged poor sexual function scores before treatment (39 and 37.68, respectively). Once again, the CG scores were consistent and did not change in a statistically significant way across all time periods. Average IG scores, though, increased to 62.23 posttreatment, representing an increase in sexual function to a level that would no longer be considered “poor”, and thus problematic for the individual. This was a large and statistically significant change (estimate = -22.86; t = -8.74; dg = 58; p < .001; Cohen’s d = 2.08) that was maintained at both follow-up periods. Comparisons of sexual function from baseline to posttreatment displayed that participants in the IG presented a greater increase in sexual function than participants in the CG (time by treatment effect estimate = 19.56; t = 5.23; dg = 58; p < 0.001; Cohen’s d = 2.08). This comparison led to similar results in both follow-ups.

3.5.3. Changes in initiative and sexual communication

Results are similar for the final primary outcome, initiative, and

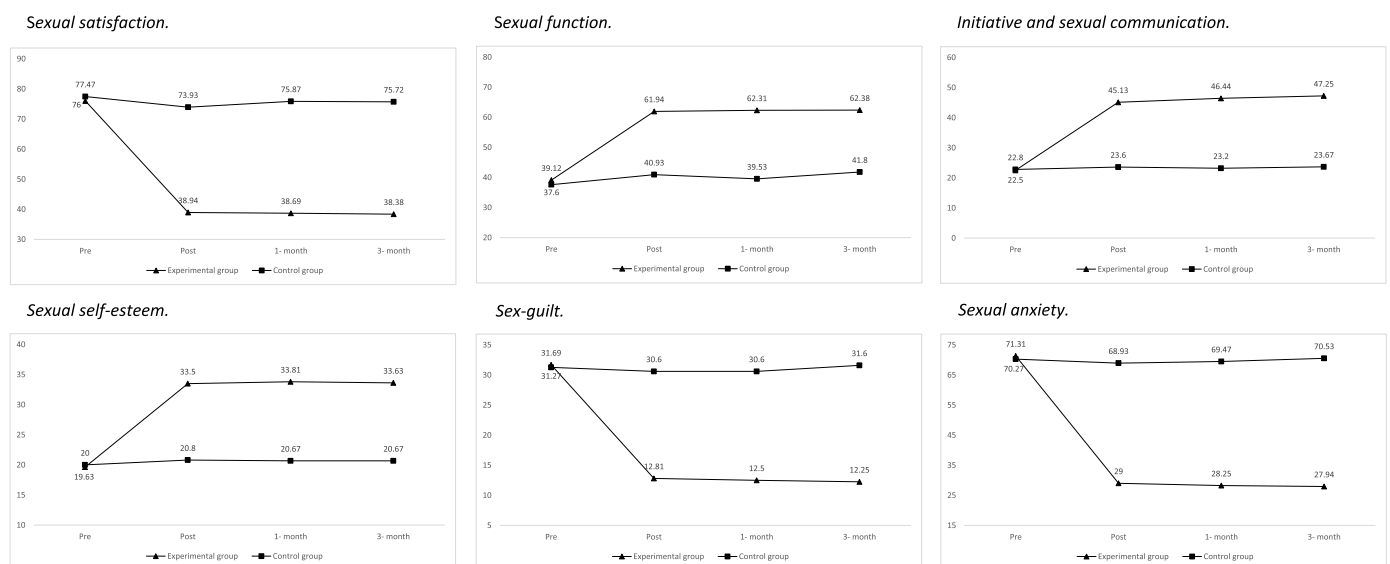


Fig. 4. Outcome variable means for the intervention and control group over time.

sexual communication. For this variable, Table 5 and Fig. 4 show the average FSFQ totals, where a score of 25 or lower represents a problem. Before treatment, IG and CG averaged scores below this cutoff (22.33 and 22.95, respectively), representing commonly held problems with initiative and sexual communication. CG scores again were consistent at all measurement points and did not change in a statistically significant way. IG scores increased to 46.39 posttreatment, representing an increase in initiative and sexual communication to a level at which it was no longer considered a problem on average. This increase was large and statistically significant (estimate = -22.74; $t = -22.82$; $dg = 58$; $p < .001$; Cohen's $d = 5.05$), and the change was maintained at the 1- and 3-month follow-up assessments. Comparisons of initiative and sexual communication from baseline to posttreatment depicted that participants in the IG presented a greater increase in this variable than participants in the CG (time by treatment effect estimate = 22.05; $t = 15.54$; $dg = 58$; $p < 0.001$; Cohen's $d = 5.1$). This difference between IG and CG held across time.

3.6. Changes in secondary outcomes

Secondary outcomes displayed patterns similar to the primary outcomes. These results provide support for the third hypothesis that the metaverse-based therapy would improve three secondary outcomes that affect orgasm consecution: sexual self-esteem, sex guilt, and sexual anxiety.

3.6.1. Changes in sexual self-esteem

Table 5 and Fig. 4 show RSE scores as a measure of sexual self-esteem, with a score of 25 or lower indicating low self-esteem. The IG had an average baseline score of 19.39, and the CG had an average baseline score of 19.95, indicating both groups had low self-esteem on average. The CG scores did not statistically significantly change from baseline to any following time period. However, the IG scores increased to 33.69 posttreatment, representing an average improvement that overcame the cutoff for low self-esteem. This large and statistically significant change (estimate = -13.99; $t = -18.73$; $dg = 58$; $p < .001$; Cohen's $d = 4.51$) was maintained from posttreatment to both follow-up periods. Comparisons of sexual self-esteem from baseline to posttreatment revealed that participants in the IG presented a greater increase in sexual self-esteem than participants in the CG (time by treatment effect estimate = 13.16; $t = 12.37$; $dg = 58$; $p < .001$; Cohen's $d = 4.15$). These results were maintained at 1- and 3-month follow-up assessments.

3.6.2. Changes in sex-guilt

Table 5 and Fig. 4 show the average BMSGs scores for sex-guilt for both groups over time. Higher scores represent higher sex-guilt, but there is no cut-off indicating high or low levels of sex-guilt. Both the IG and CG had high levels of sex-guilt at baseline, reporting scores of 31.67 and 31.21, respectively. The CG average sex-guilt scores did not change in a statistically significant way over the study. The IG sex-guilt scores, on the contrary, decreased to 12.48 posttreatment, representing a large and statistically significant improvement (estimate = 18.87; $t = 14.53$; $dg = 58$; $p < .001$; Cohen's $d = 2.57$). Again, this change was maintained at 1- and 3-month assessments. Comparisons of sex-guilt from baseline to posttreatment showed that participants in the IG presented a greater decrease in sex-guilt than participants in the CG (time by treatment effect estimate = -18.22; $t = -9.78$; $dg = 58$; $p < .001$; Cohen's $d = 2.67$). This contrast between groups was consistent over time.

3.3. Adherence to treatment and attrition

The earlier Fig. 1 shows that 31 participants completed the intervention and were assessed at postintervention, out of the 37 women who started the intervention. The intervention group had a completion rate of 88.89% (16 out of 18), and the control group's completion rate was 78.95% (15 out of 19). No significant differences were found between

completers and non-completers at pretreatment assessment in most sociodemographic variables, including age ($t(35) = 1.14$, $p = 0.21$), sexual orientation ($\chi^2 = 0.97$, $p = 0.32$), education ($\chi^2 = 1.38$, $p = 0.50$), and profession ($\chi^2 = 0.15$, $p = 0.53$), but non-completers were more likely than completers to be engaging in casual sex ($\chi^2 = 14.32$, $p < 0.05$). No significant differences were found between completers and non-completers in any of the primary or secondary outcome variables at baseline: sexual satisfaction ($t(35) = 0.48$, $p = 0.12$), sexual function ($t(35) = 0.07$, $p = 0.06$), initiative and sexual communication ($t(35) = -0.20$, $p = 0.41$), sexual self-esteem ($t(35) = 0.54$, $p = 0.13$), sex-guilt ($t(35) = 0.07$, $p = 0.55$), and sexual anxiety ($t(35) = 0.17$, $p = 0.95$).

Reasons to discontinue treatment differed between the two groups. Non-completers from the IG terminated the treatment due to external factors unrelated to the intervention, impeding their ability to continue; CG non-completers discontinued treatment due to a lack of interest. No harm was caused. Every participant who completed the posttreatment assessment also took part in the follow-up assessments, so no differences between the intervention and control group regarding attrition after treatment could be found.

3.6.3. Changes in sexual anxiety

The final outcome shown in Table 5 and Fig. 4 is sexual anxiety. There is no cutoff point indicating high or low SAI-E results of sexual anxiety, but lower scores represent lower sexual anxiety. The IG and CG presented high sexual anxiety scores at baseline (72.72 and 68.74, respectively). The CG scores were consistent across all measurement periods and did not change in a statistically significant way. The IG scores dropped to 29.51 posttreatment, representing a large and statistically significant improvement in sexual anxiety (estimate = 42.46; $t = 25.36$; $dg = 58$; $p < .001$; Cohen's $d = 3.46$). This change was maintained at both follow-ups. Comparisons of sexual anxiety from baseline to posttreatment revealed that participants in the IG presented a greater decrease in sexual anxiety than participants in the CG (time by treatment effect estimate = -41.29; $t = -17.18$; $dg = 58$; $p < 0.001$; Cohen's $d = 2.94$). Once again, this difference was maintained over the time periods analyzed.

3.7. Clinical effect sizes

Calculating clinical effect sizes through NNT and RCI provided additional support for the second hypothesis on primary outcomes (for sexual satisfaction, sexual function, and initiative and sexual communication), as well as partial support for the third hypothesis on secondary outcomes (for sexual self-esteem).

For sexual satisfaction, we computed the number needed to treat (NNT) at posttreatment and follow-up by defining treatment success as scoring < 60 (the cutoff for sexual problems being a score above 60) on the GRIS at the three postintervention assessment time points. Success rates at posttreatment were 0/15 participants (0%) in the CG condition and 16/16 participants (100%) in the IG condition (NNT = 1). Similarly, success rates at both follow-ups were 0/15 participants (0%) in the CG condition and 16/16 participants (100%) in the IG condition (NNT = 1). In other words, one additional participant in the IG would have resulted in one additional favorable outcome. For sexual function, we computed NNT at posttreatment and follow-up by defining treatment success as scoring > 55 (the cutoff for poor sexual function is a score of 55 or lower) on the FSFI at the postintervention assessment time points. Again, NNT suggests one additional participant in the IG would have resulted in a favorable outcome for that participant. Success rates at posttreatment were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1). Success rates at both follow-ups were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1).

For the final primary outcome, initiative, and sexual communication, we computed NNT at posttreatment and follow-up by defining treatment success as scoring > 25 (scores of 25 or lower representing a problem) on

the FSFQ at the postintervention assessment time points. Success rates at posttreatment were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1). Success rates at both follow-ups were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1). This means that in addition to sexual satisfaction and sexual function, one additional participant in the IG would have resulted in an additional favorable outcome in terms of improvement/success for initiative and sexual communication.

Of the three secondary outcomes affecting orgasm consecution, two of the measurement scales—sex-guilt and sexual anxiety—did not include cutoff points to identify success. But NNT could be calculated for sexual self-esteem, where scoring >25 (scores of 25 or lower representing low self-esteem) on the sexual-RSE at posttreatment and follow-up was defined as success. Success rates at posttreatment were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1). Success rates at both follow-ups were 0/15 participants (0%) in the CG and 16/16 participants (100%) in the IG (NNT = 1).

In addition to NNT, clinically significant change was also evaluated using the Reliable Change Index (RCI). Clinically significant change, as defined by Jacobson and Truax (1991), involves (a) falling above/below a specific cutoff score, indicating they are within the range of normal functioning (e.g., GRISS <60; FSFI >55; FSFQ >25; RSE >25), and (b) showing statistically significant change according to the Reliable Change Index (RCI). If individuals meet both criteria, they are classified as “recovered”, whereas those who meet RCI criteria alone without crossing the diagnostic threshold of a cutoff score are classified as “improved”. In this context, every participant in the intervention group (16/16) met both criteria and could be classified as recovered. In contrast, no participant in the control group (0/15) met either criteria, so they were neither improved nor recovered.

3.8. Treatment implementation

Asking participants about their experiences with the treatment on a variety of factors revealed support for the fourth hypothesis that participants in the metaverse-based therapy would be subjectively satisfied with its implementation.

3.8.1. Satisfaction with the intervention

After treatment, participants were asked to rate their satisfaction with the treatment, the therapists, and the content and exercises on a scale of 0–10. The intervention group reported high levels of satisfaction (mean = 9.25; SD = 0.77) while the control group was not that satisfied (mean = 5.4; SD = 0.91). This was a statistically significant difference ($t = 12.71$; $p < .01$). When asked if they would recommend the treatment to others, participants from the intervention group expressed they would very likely recommend the treatment (mean = 9.88; SD = 0.34) while the control group was not as sure (mean = 4.93; SD = 1.1). Again, this difference between groups was statistically significant ($t = 17.13$; $p < .01$).

3.8.2. Intrasession assessments

3.8.2.1. Perceived sexual anxiety throughout the treatment. In addition to measuring the outcome variables at baseline, posttreatment, and the two follow-up periods, perceived sexual anxiety (1–100) and perceived sexual satisfaction, presented as a percentage, were monitored at each treatment session. As shown in Fig. 5, average perceived sexual anxiety levels stayed relatively high for the CG but decreased over the sessions for the IG. These subjective anxiety levels were maintained posttreatment and at the 1- and 3-month follow-up assessments.

Perceived sexual satisfaction throughout the treatment.

Levels of perceived sexual satisfaction displayed a similar pattern. Fig. 6 displays the average percentage of sexual behaviors the participants found satisfactory from the prior week. The CG numbers increased

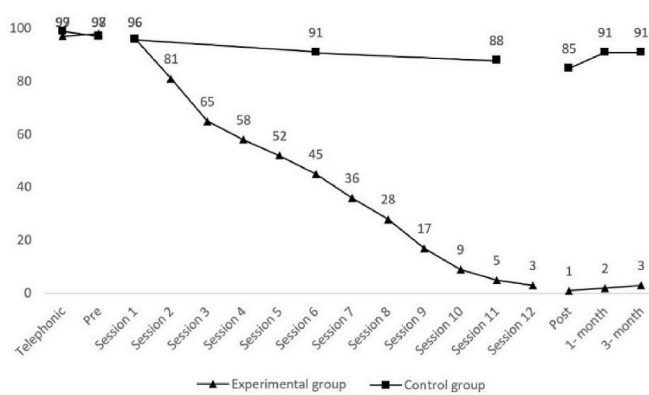


Fig. 5. Subjective sexual anxiety levels throughout conditions.

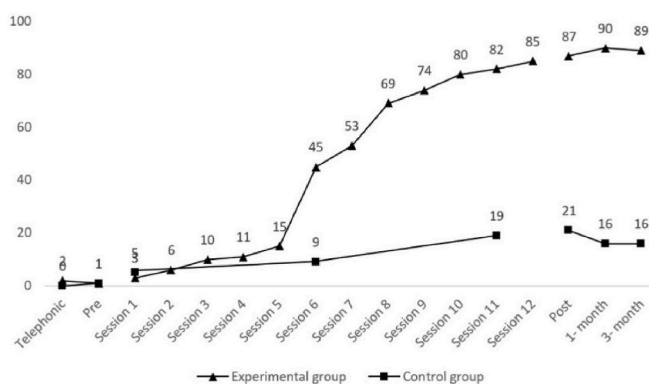


Fig. 6. Subjective sexual satisfaction levels throughout conditions.

slightly for their third, and final session. The IG numbers, on the other hand, exhibited a steady and large increase over their twelve sessions. Again, 1- and 3-month assessments had similar results to the posttreatment assessment.

3.8.3. Benefits of the intervention and Participant’s experience within the virtual world

Finally, in addition to examining the effectiveness of metaverse therapy for treating FOD, this study collected responses of participants in the IG condition on several variables representing possible additional benefits. Overall, participants were very comfortable with the at-home therapy (mean = 9.20; SD = 0.76). The implementation of the intervention helped avoid the embarrassment of going to a clinic (mean = 9.20; SD = 0.76). IG participants unanimously expressed that if not for the intervention, they would not have sought out other forms of therapy to address their disorder (mean = 10; SD = 0). Similarly, participants unanimously agreed that the metaverse intervention helped them balance therapy with their other duties (mean = 10; SD = 0). The modality of the treatment was rated as very convenient and flexible (mean = 9.71; SD = 0.49). And, importantly, participants thought the treatment helped them reduce their anxiety before practicing sexual acts in real life (mean = 10; SD = 0).

One reason the metaverse therapy could have been effective for participants is due to their subjective feeling of presence in Second Life. Measured using the ITC-SOPI, participants’ experience within the virtual world, their avatars, and the metaverse was consistently high in the intervention group (mean = 3.44; SD = 0.078).

4. Discussion

This study was aimed at designing and analyzing the efficacy of an avatar-based sexual therapy program for women with FOD, with the

final goal of promoting a wider access to therapy. By comparing an avatar-based intervention with a minimal therapeutic contact control group, all the proposed hypotheses have been supported. The novel, metaverse-based intervention was effective at (1) treating FOD; (2) improving primary, sexual outcomes related to FOD; (3) improving secondary outcomes related to orgasm consecution; and (4) leaving participants satisfied with treatment.

In terms of FOD treatment, this study is unique in its combination of CBT and ACT approaches to intervention, as well as in its implementation of therapy through the metaverse. Previous CBT intervention studies for treating FOD have been effective (Adam et al., 2019). From ACT, this treatment protocol included different sections and sessions focused on training women to clarify and foster decisions congruent with their personal values, ultimately leading to a more meaningful life experience (McCarter et al., 2016; Zettle, 2015). Values-based work facilitates the alignment of individuals' behaviors with their deeply held principles and beliefs, fostering a sense of purpose and fulfillment (Reilly et al., 2019). Combining CBT with ACT approaches led to an effective intervention for treating FOD. Also, in their design, most of the intervention studies for FOD treatment to date combine both psychologic and physiologic treatments (Heiman, 2002). However, this study suggests that a psychological intervention alone may be able to treat FOD. In addition, this is the first FOD treatment study using an avatar-based intervention, revealing new pathways to successful treatment, especially in a population generally reluctant to seek help (Alcoba Valls et al., 2004; Meston et al., 2004; van Ameringen et al., 2017).

Regarding the target of this treatment, tailoring the intervention on primary outcome variables associated with FOD (Dekker et al., 2020) seemed an effective strategy for supporting women to recover from FOD. While in the control group, participants did not change throughout the study, every participant in the intervention group improved sexual function, sexual satisfaction, and sexual initiative scores to the point of recovery at a statistically and clinically significant level after treatment. These results were maintained at 1- and 3-month follow-up assessments. These findings contribute to existing literature in a variety of ways and add a new delivery method that shortens the distance between women and psychological treatment. First, previous studies have found that psychological interventions improved sexual function over the short term (Schulster et al., 2017). This study, however, adds the potential for these improvements to be maintained over time (Gittens et al., 2011). Secondly, sexual function has been found to be strongly related to the sexual relationship between two people (Moors et al., 2019). For this reason, including patients' partners in couples' sexual therapy (a novel aspect for the avatar-based intervention featured here) may have played a role in the resiliency of results. In terms of sexual satisfaction, this study reinforces previous findings that psychological intervention (e.g., sexual skills training) does not necessarily need to be combined with medication in order to improve sexual satisfaction (Frühauf et al., 2013). Finally, it is known that sexual communication plays a crucial role in enhancing sexual health and improving overall sexual well-being (Widman et al., 2006), allowing patients to have meaningful sexual relationships (Rogers, 2017). However, most previous sexual intervention studies have overlooked communication and not focused on the relationships of patients with their partners (Vila et al., 2023c). This study incorporates communication and includes couple's therapy to achieve individual improvement and could represent an avenue for future interventions (Sansoni et al., 2023).

Similarly to the primary outcomes described above, also the secondary ones – known to affect orgasm consecution (Leeners et al., 2014) – displayed analogue patterns. Only participants in the intervention group, in fact, experienced greater sexual self-esteem, along with lower sex-guilt and sexual anxiety immediately and three months after. Results of this study suggest that these variables could serve as potential mechanisms through which this intervention operates and lead to an improvement of FOD. Previous interventions have overlooked this aspect (Abdo, 2016). Therefore, this study contributes to the current

state of research by exploring the potential effectiveness of mechanisms facilitating orgasm attainment (Barkham & Lambert, 2021; Lambert et al., 2019).

However, even though these results contribute to improve the existing treatments for FOD, the primary focus of this study was not merely to overcome the limitations of prior interventions, but to showcase the effectiveness of sexual therapy within the metaverse, as this delivery modality may surpass traditional in-person therapy. Results from the intrasession analyses reveal, in fact, decreases in perceived sexual anxiety and increases in perceived sexual satisfaction over the course of the intervention. Sexual anxiety seemed to decline sharply after the first two sessions; this could be hypothetically associated to the content of those sessions focusing on sexuality, guilt, and personal values which could help to normalize sexuality. Sexual satisfaction rose consistently after sessions five through seven, in which participants visually and tactilely examined their genitalia and breasts, as well as reviewed pleasure areas. The seemingly strong effect of examining genitalia and breasts on participants may point to one of the advantages of an avatar-based intervention, as these actions are more ethically delicate or impossible for in-person interventions. Additionally, the potential to modify the perception of the body while supporting cognitive change is an advantage that the use of metaverse shares with VR-based technologies. In line with previous studies, the metaverse could have generated an embodied simulation of the body in the virtual world, the same way the brain generates embodied simulations of the body in the real world to effectively regulate and control the body's actions, concepts, and emotions, according to neuroscience (Riva et al., 2019). This study also adds to the literature as it is the first to assess, to our knowledge, subjective variables associated with treatment improvement in sexuality, as most studies tend to focus on improving only the objective ones (Wheeler & Guntupalli, 2020), such as symptom reduction, behavior change, or the acquisition of specific skills. Results here suggest that both sexual anxiety and sexual satisfaction may play an important role in recovering from FOD (Sakuraya et al., 2020).

In addition to the mechanisms through which FOD treatment can be targeted, this study highlights a number of advantages of metaverse-based therapy over traditional therapy. As mentioned above regarding the examination of breasts and genitalia, a metaverse-based therapy allows patients to experiment in front of the psychologist what, in real life, would possibly surpass ethical boundaries and could lead to further sexual anxiety or embarrassment (e.g., masturbation techniques). Therapy inside a metaverse allows for patients and psychologists to work side by side in learning techniques, both at the psychoeducational level and intervention techniques (e.g., breathing techniques). This is interesting for two reasons; first, as shown in previous literature (Maddox et al., 2024), the use of a metaverse may activate four learning systems (i.e., learning and retention, presence and context, habit formation, and motivation [Squire & Wixted, 2011; Ashby & Maddox, 2005]) in synchrony. When this happens, learning is optimized, leading to better results. Second, the use of the metaverse can help reduce the large number of patients who abandon treatment, or avoid facing exposure therapy, systematic desensitization, and other therapeutic techniques in real life (Botella et al., 2007; Rodón-Benítez et al., 2009). The ability of the metaverse to preview real-life sexual activities is a characteristic that can aid treatment. The findings of this research indicate that the virtual environment may have the potential to trigger anxiety responses in sexual patients when they are exposed to sexual content and activities. This feature is a fundamental condition in utilizing the metaverse as a therapeutic tool. Review studies on the topic have found other VR-based technologies to be an effective method to introduce subjects into a state of activation (e.g., Sansoni et al., 2022), with the aim of reducing anxiety reactions, both at the level of the central and peripheral nervous system (Kosonogov et al., 2023).

Additionally, an avatar-based intervention allows patients to receive psychological treatment at home, inside a perceived safe space, and with the therapist-patient interaction occurring between avatars (i.e., the

metaverse provides patients with a heightened sense of privacy and security). This additional privacy provides a means of treatment for individuals who might otherwise be unwilling to seek psychological assistance. Research conducted on other health conditions linked to social stigma and difficulties in discussing sensitive topics (e.g., Human Immunodeficiency Virus) has shown that users experienced a sense of privacy and comfort while exploring these matters remotely (Vila et al., 2023b). In a similar way, avatar-based therapies may be able to overcome many of the barriers associated with face-to-face interventions for sexual disorders.

Together with the sense of privacy and security, metaverse-based therapy had other facilitators that led participants to be highly satisfied with the treatment. Participants identified it as convenient because it did not require travel to sessions, and the scheduling could be more flexible (Pierce et al., 2022). Many individuals have difficulties reaching in-person therapy sessions: the convenience provided by avatar-based therapies is to help people living in cities (i.e., where reaching session locations may be difficult due to distances or traffic) or rural areas (i.e., where they may not have the ad-hoc services) overcome barriers to treatment adherence (Vila et al., 2022). In addition to tangible benefits, the intervention displays also other types of advantages, consistent with those found in prior technology internet-based intervention studies. Similarly to the intervention proposed by Sansoni, Malighetti, and Riva (2022), this metaverse-based therapy also allows to address barriers related to knowledge and perceptions (e.g., improving their understanding of sexuality), beliefs and expectancies (e.g., restructuring the person's predictions about their sexual performance), affects (e.g., reducing the anxiety generated by sexual stimuli), values and goals (e.g., buffering the self-stigma associated to FOD) and self-regulatory skills (e.g., encouraging the development of effective coping mechanisms to manage the distress related to intimacy). All the above-mentioned features of the avatar-based therapy guided participants to universally acknowledge that, in the absence of the metaverse, they would not have pursued alternative therapeutic modalities to mitigate their orgasmic issues. This benefit elucidates a distinct avenue towards the effective implementation of treatment utilizing the metaverse.

While this study adds valuable insights to the existing literature, it has some limitations. The primary constraint is the sample size, which is relatively small even when the number of participants reached the required value from the power analysis. Also, participants consisted of volunteer women with FOD, who were a small proportion of those screened in the pre-assessments, and who had access to a computer with the characteristics to run Second Life. This limits the generalizability of the results, underscoring the necessity for future studies to replicate the findings with larger cohorts. Moreover, future research could explore the application of a metaverse approach to address other sexual disorders, aiming to confirm whether the metaverse is an optimal delivery modality for treating such clinical conditions. This study focuses on FOD, a sexual dysfunction with an overall positive prognosis (Frühaufer et al., 2013; Graziottin et al., 2009). However, it would be useful to extend the treatment to address other sexual disorders with more challenging prognoses, such as female sexual interest/arousal disorder (Cabello Santamaría, 2007), erectile disorder (Ismail & El-Sakka, 2017), or premature ejaculation (Waldinger, 2018). Confirming the efficacy of avatar-based interventions with these patients could therefore be particularly enlightening.

Another limitation of the study is the comparison between the 12-session intervention program and the three-session control group program. This was chosen instead of using a control group on a waiting list format due to the advantages it offered and in line with the recommendations of the American Psychiatric Association (APA, 2013). Control participants not only received three sessions but were in contact with therapists during the same three-month period that the avatar-based intervention was taking place. However, both interventions are not comparable in terms of intensity, and this constitutes a limitation of the present investigation. It is recommended that future

studies address the issue and design intervention studies that include a control group with a greater number of sessions, and even compare the experimental group with other types of interventions, including in-person CBT programs, and other technology-based treatments.

Furthermore, some of the variables related to treatment implementation (i.e., satisfaction with the intervention, and benefits of the intervention) were only assessed postintervention, and hence, the results only include the data from the participants who finished the treatment. In this sense, relevant information about the motives of dropouts is missing, as no post-hoc analysis has been conducted to check whether there was a significant difference in the responses of completers and non-completers in the perceived burden due to the intensity of the intervention. Regarding the burden of the visits, previous studies have found dropout rates for in-person therapy for women suffering from sexual difficulties to be around 50% (McCabe, 2001). We hypothesize that the treatment format may have influenced the finding that only two participants withdrew from this study. This number is in line with previous sexual interventions featuring technology (Adam et al., 2019). The results may support the feasibility of the metaverse-based intervention, but further investigation is needed. If results were replicated, this would be a remarkable breakthrough, also for male sexual disorders, which present higher numbers of dropouts (McCabe & Price, 2009), and may also benefit from an avatar-based intervention. Additionally, therapeutic alliance in the metaverse remains uncertain. The physical distance between patient and therapist (i.e., broad) may indeed not be fully bridged by the virtual distance of their avatars (i.e., short), potentially compromising therapy effectiveness. In psychotherapy, the significance of an environment is rooted in personal meaning rather than the tangible attributes of the environment itself, as argued in the cognitive person-focused model (Takac et al., 2023). Given the variability of personal meaning and the generic nature of most VR environments, therapists must actively manage situational plausibility. The cognitive person-focused model offers a valuable psychological framework to address the limitations of existing presence-emotion concepts, providing guidance for researchers and therapists alike. Consequently, further investigation is warranted to assess this aspect, potentially including a control condition where the dyad undergoes supplementary sessions to bolster the alliance and evaluate potential enhancements in outcomes.

Beyond sexual dysfunctions, future studies employing metaverses could explore their application to other psychological disorders, such as autism spectrum disorders or anxiety. These environments would indeed provide a secure space for social skills training and practice, among other applications.

More research is however necessary to examine facilitators and barriers to both in-person and metaverse-based interventions, as well as assess their relative effectiveness. Furthermore, additional investigations should explore variables influencing therapeutic success in avatar-based interventions, such as presence, digital literacy, or technical specifications of specific metaverses. Finally, as a result of the significant enhancement in clinical features achieved via VR (e.g., Brizzi et al., 2023; Sansoni et al., 2024), the use of an immersive metaverse employing this technology could also be considered to test the potential of immersive environments in enhancing treatment outcomes.

CRediT authorship contribution statement

Ariana Vila: Writing – review & editing, Writing – original draft, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Juan Ardoy-Cuadros:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **Rosa Romero-Moreno:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Celia Nogales-Gonzalez:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Andrew J. Ritchey:** Writing – review & editing, Supervision. **Maria Sansoni:** Writing – review & editing, Supervision, Resources. **Giuseppe Riva:** Writing – review &

editing, Supervision, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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