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Feasibility and Perceptions of Telerehabilitation Using Serious Games for Children with Disabilities in War-Affected Ukraine

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Abstract

This study aimed to evaluate the feasibility of using serious games for the (tele)rehabilitation of children with disabilities affected by the Ukrainian war. Additionally, it provides requirements for technologies that can be used in war-affected areas. Structured interviews and Likert scale assessments were conducted on-site and remotely with patients of the tertiary care facility in Ukraine. All participants used the telerehabilitation platform for motor and cognitive training. Nine serious games were employed, involving trunk tilts, upper limb movements, and head control. By mid-September 2023, 186 positive user experiences were evident, with 89% expressing interest in continued engagement. The platform's accessibility, affordability, and therapeutic benefits were highlighted. The recommendations from user feedback informed potential enhancements, showcasing the platform's potential to provide uninterrupted rehabilitation care amid conflict-related challenges. This study suggests that serious games solutions that suit the sociopolitical and economic context offer a promising solution to rehabilitation challenges in conflict zones. The positive user experiences towards using the platform with serious games indicate its potential in emergency healthcare provision. The findings emphasize the role of technology, particularly serious gaming, in mitigating the impact of armed conflicts on children's well-being, thereby contributing valuable insights to healthcare strategies in conflict-affected regions. Requirements for technologies tailored to the context of challenging settings were defined.

Keywords: gamification; telerehabilitation; war exposure; disabled children

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1. Introduction

As of September 2023, it was estimated that due to the conflict, 6.2 million Ukrainian citizens had become internally displaced persons and 4.2 million people had become refugees, leaving the territory of Ukraine [1]. Approximately 23% of these individuals were persons with disabilities; the available evidence indicates that the rights of refugee children with disabilities are often disregarded and overlooked [2]. These children face severe risks in their lives, including the inability to access treatment and educational services, isolation, discrimination, and exposure to violence as they are forced to flee their homeland [3].

For youths with disabilities who remain in the country, the impact of the war is even more traumatic. Many of these children indeed lack access to regular education and care, putting them at risk of having their fundamental rights violated and being forcibly

separated from their families and institutions [4]. Furthermore, there have been reports of tragic cases where children have lost their lives—killed by the Russian army—due to starvation and exposure to cold conditions. With 20% of Ukrainian territory currently under Russian occupation, it is expected that more crimes will continue to be documented until the war comes to an end.

While the primary conflict zones are concentrated in the eastern and southern regions of Ukraine, no part of the country can be considered safe due to the ongoing risk of rocket attacks and kamikaze drone missiles. Additionally, the impact of the war extends beyond those children directly in harm's way, affecting those indirectly through the pervasive anxiety generated by the conflict in families, schools, and the mass media [5].

Elita Rehabilitation Center (ERC) is a tertiary care facility for children with neurological disabilities in Lviv, a central city in western Ukraine. ERC is not limited to a specific region; it provides treatment to children from all over Ukraine. Before the full-scale Russian invasion, ERC could offer rehabilitation care to one thousand children annually, with a medical staff consisting of more than 60 professionals, including physicians, physical and occupational therapists, and medical nurses. In 2022, however, only 537 children could access rehabilitation services, and the number of specialists working at ERC has reduced to 46. There are multiple reasons for this phenomenon: the high rate of people fleeing Ukraine and coming to safer countries, the decreased financial well-being that forces healthcare professionals to switch occupations, and the compulsory mobilization of the men liable for military service, including medical staff [6].

As the conflict persists and related risks, such as a humanitarian crisis, financial instability, and the threat of missile attacks in various parts of Ukraine, including Lviv, continue to exist, there remains a shortage of clinical staff, making it challenging for many families to access rehabilitation facilities; meanwhile, it is of paramount importance to ensure the continuity of care to preserve the progress achieved during rehabilitation, thereby maximizing the functioning of patients and, consequently, improving their quality of life [7,8].

Games designed for more than just fun, known as serious games (SG), have proven to help improve rehabilitation outcomes in wealthier countries [9]. These games use a mix of therapeutic exercises and engaging gameplay to offer a new way of approaching rehabilitation, which could be beneficial in addressing the challenges faced by the shortage of rehabilitation specialists [10].

Research has indicated that computer games have the potential to reduce the recurrence of intrusive traumatic memories in individuals who have post-traumatic stress disorder [11]. Furthermore, the affordability of SG tailored for motor and cognitive training presents an opportunity to address the health disparities faced by children with disabilities in Ukraine and other regions with poor access to healthcare professionals [12].

Amidst the challenges posed by the ongoing conflict, the implementation of an online gaming platform holds promise in alleviating barriers that impede the timely provision of comprehensive rehabilitation care for children with disabilities. Therefore, this study aims to assess the perception of Ukrainian children with disabilities and their families regarding telerehabilitation with serious games during the Ukrainian conflict as well as its feasibility. Additionally, requirements for technologies suitable for the war-affected regions were defined.

This study examines the feasibility of telerehabilitation using serious games (SG) for children with disabilities in a war-affected context, addressing two key research questions. First, it investigates whether SG-based telerehabilitation is a viable therapeutic intervention in such challenging environments. Second, it explores how children and their families perceive the platform in terms of usability, accessibility, and therapeutic effectiveness.

2. Materials and Methods

2.1. Approach

ERC has actively engaged in various international multidisciplinary projects aimed at the continual advancement of SG [13]. This collaborative effort has culminated in developing Stasism, a comprehensive cost-effective social online SG platform designed to benefit individuals with cerebral palsy and other movement disorders in different settings [14]. The Stasism platform strongly emphasizes inclusivity and accessibility, requiring only readily available and affordable commercial hardware for use. All games are developed in three dimensions (3D) using Unity, and MediaPipe framework is used to identify the body movements. They provide both visual and auditory feedback to the player.

Briefly, this system has been developed to support personalized telerehabilitation and telemonitoring for individuals requiring rehabilitation or continuous monitoring. The platform collects and assesses relevant physiological, kinematic, and environmental information by integrating diverse sensors and validated data analytic approaches. The platform's built-in diagnostic tools allow therapists to monitor patients' performance remotely. These tools include a static balance test using a balance board and performance analytics (e.g., percentage of completed tasks, speed, and precision). Daily assessments of patient progress are available to therapists and take 2–10 min to review.

It enables tailored rehabilitation activities according to individual requirements, permits remote monitoring of patient advancement (e.g., balance assessment), and delivers immediate feedback. In order to ensure the confidentiality of patient information and protect their privacy, the platform ensures the secure transmission and storage of data. Descriptions and objectives of the SG used in this study are presented in Table 1; screenshots of the SG are presented in Figure 1.

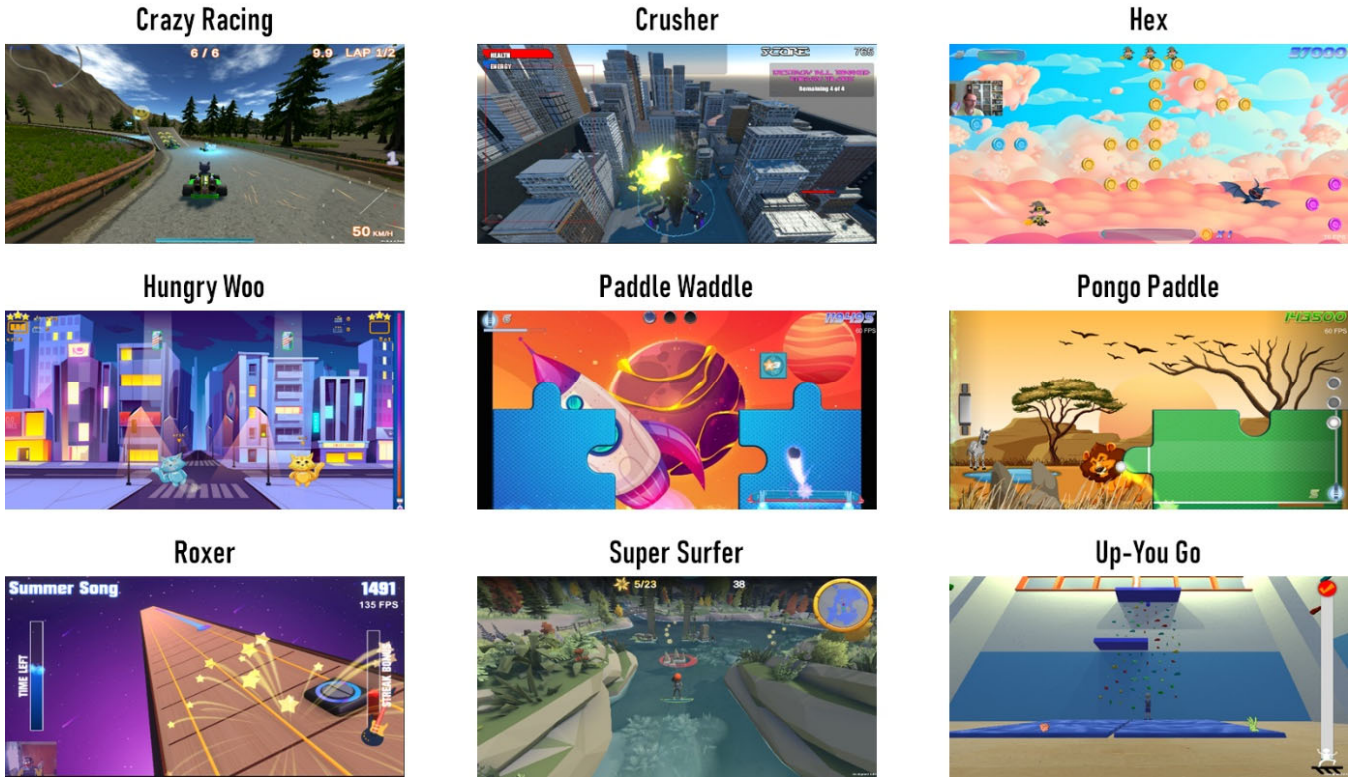

Figure 1. Screenshots of the serious games used in this study.

Table 1. Descriptions and therapeutic targets of the specific SG used during the study.

Serious Games	Description	Motion to Control the Games	Therapeutic Targets
Crazy Racing [ab]	In this racing game, each level assigns a specific task to the player. The character is required to capture designated objects, engage in races against other cars, and navigate through diverse road networks.	• Trunk tilts • Wrist flexion • Elbow flexion • Elbow supination • Shoulder flexion • Shoulder abduction • Shoulder external rotation • Head tilts	• Balance • Proprioception • Visual–spatial ability • Navigation skills • Attention
Crusher [b]	A dynamic action game that incorporates diverse bodily movements for the purpose of demolishing structures and transporting objects, all within the context of controlling a monstrous character.	• Movements of upper extremities, trunk, and head	• Coordination • Proprioception • Gross motor skills • Dexterity • Stress relief
Hex [b]	Players assume control of a witch navigating the skies on her broom through intuitive body movements. As the levels progress, the character's speed increases, presenting players with the opportunity to explore diverse environments and confront an array of challenges.	• Wrist flexion • Elbow flexion • Elbow supination • Shoulder flexion • Shoulder abduction • Shoulder external rotation • Head tilts	• Gross motor function • Dexterity • Voluntary motor control • Attention
Hungry Woo [a]	In this game, the central theme revolves around the player's mission to nourish a cat. The primary objective involves skillfully capturing food items while skillfully evading non-edible objects. As the game advances, the pace intensifies, and the nature of encountered objects undergoes dynamic transformations at each successive level.	• Trunk tilts	• Balance • Proprioception • Visual–spatial ability • Decision-making • Object recognition • Impulse control

Table 1. *Cont.*

Serious Games	Description	Motion to Control the Games	Therapeutic Targets
Paddle Waddle [ab]	In this action-packed game, the primary objective is to sustain the perpetual motion of balls through adept rebounding using a paddle. Along the journey, players have the opportunity to accumulate stars, enhancing their point tally and unlocking access to more advanced levels. As players progress, the velocity of the balls escalates, accompanied by the revelation of new puzzle pictures. In addition to striving for individual accomplishments, participants can engage in global competition, vying for the highest score and earning rewards for surpassing existing records.	• Trunk tilts • Wrist flexion • Elbow flexion • Elbow supination • Shoulder flexion • Shoulder abduction • Shoulder external rotation • Head tilts	• Balance • Proprioception • Visual–spatial ability • Gross motor function • Dexterity • Voluntary motor control • Attention • Decision-making
Pongo Paddle [ab]	An iteration of the Paddle Waddle game, this action-packed variant centers around the core objective of maintaining the perpetual motion of balls through adept rebounding with a paddle. Along the gaming journey, players can gather stars to amass points and advance to more challenging levels. As young participants progress, the ball speed escalates, unveiling new puzzle pictures for added intrigue. In addition to pursuing personal achievements, players have the opportunity to engage in global competition, vying for the top spot on the leader board. By striving to achieve the highest score, participants can earn coveted rewards for surpassing existing records, enhancing the competitive and rewarding aspects of this thrilling gaming experience.	• Trunk tilts • Wrist flexion • Elbow flexion • Elbow supination • Shoulder flexion • Shoulder abduction • Shoulder external rotation • Head tilts	• Balance • Proprioception • Visual–spatial ability • Gross motor function • Dexterity • Voluntary motor control • Attention • Decision-making
Roxer [ab]	In this melodic gaming experience, players engage in a musical journey where their task is to synchronize with the rhythm to craft enchanting melodies. The game offers the flexibility of using pre-existing songs or composing original tunes, allowing for a personalized and creative musical expression. Players must follow the beat meticulously, whether it be to the harmonies of established tracks or the unique compositions they create themselves, resulting in a harmonious and immersive gameplay experience	• Trunk tilts • Wrist flexion • Elbow flexion • Elbow supination • Shoulder flexion • Shoulder abduction • Shoulder external rotation	• Balance • Proprioception • Visual–spatial ability • Gross motor function • Dexterity • Attention
Super Surfer [ab]	Players take command of their surfboard, embarking on an exciting journey to explore novel environments while strategically collecting stars. These accumulated stars contribute to the overall point tally, enhancing the player's score. As participants skillfully navigate the waves, the dynamic interaction with the environment adds an element of discovery and adventure to the gaming experience, making "Super Surfer" an exhilarating pursuit of points and exploration.	• Trunk tilts • Head tilts	• Balance • Proprioception • Visual–spatial ability • Navigation skills • Attention

Table 1. *Cont.*

Serious Games	Description	Motion to Control the Games	Therapeutic Targets
Up-You Go [b]	In this dynamic action game designed for comprehensive engagement, players utilize both hands and arms to control a determined character striving to ascend to the summit. The gameplay involves skillfully navigating through challenges, including the act of shoving falling rocks out of the way, incapacitating mobile adversaries, and unraveling intricate puzzles. The dual-handed interaction not only adds a physical dimension to the gaming experience but also demands strategic coordination for the successful progression of the character towards the pinnacle.	• Climbing movements	• Balance • Proprioception • Visual–spatial ability • Gross motor function • Dexterity • Attention

[a] balance board is a controller; [b] camera is a game controller.

For technical requirements, users need (i) a PC or laptop with Windows 10 or a later version and, depending on the goals of their rehabilitation program, (ii) a standard web camera, (iii) a balance board, and (iv) an internet connection. A minimum of 8 GB RAM is required for proper functioning of the games. Game sessions should be organized in a quiet room with enough space to make movements in a full range. Some games can be controlled through swaying movements when the player uses a balance board in standing, sitting, or kneeling positions. In contrast, other SG require movements of the trunk, head, or upper extremities to capture objects (see Table 1). All SGs are designed to be played independently, without assistance. The body parts and movements chosen to control the character were based on the therapeutic goals established collaboratively with the child, family, and physical therapist.

2.2. Patients

Children undergoing medical rehabilitation at ERC from May 2022 to September 2023 were invited to participate in testing the SG platform. Inclusion criteria encompassed a history of developmental disability, motor or balance impairment, ability to maintain independent sitting, an age range of 5 to 18 years, and residency in Ukraine at the onset of the conflict on 24 February 2022. Exclusion criteria included uncontrolled seizures, non-compliance with instructions, and technical incapability to utilize the platform for home users.

2.3. Ethics

The use of the platform, including its testing and gathering of feedback, was approved by the Local ethical commission in Truskavets, Ukraine. Families signed informed consent forms and children verbally consented before any activities after the aims and procedure of the study were explained. All the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and the Helsinki Declaration of the World Medical Association.

2.4. Procedure

All families with children at ERC eligible to use the Stasism platform were informed about it through various channels, including email, social media, and in-person communication. Access to the platform's games was free of charge to the families associated with the center. For two weeks, participants had ten game sessions lasting 15 min.

The platform offered two usage modes:

(i) It could be utilized during standard rehabilitation sessions at ERC, with guidance and supervision of the medical staff (Figure 2). The content of the session was a serious game depending on the abilities, preferences, or therapeutic aim of the child. This usage mode was suitable for families who currently lived in Ukraine and came for rehabilitation in ERC.

(ii) Alternatively, physical therapists could use it with remote supervision; the therapist created the training program in this option, and the child tried it remotely at their home or institution (Figure 2). Remote supervision served families who fled away from Ukraine and lived abroad.

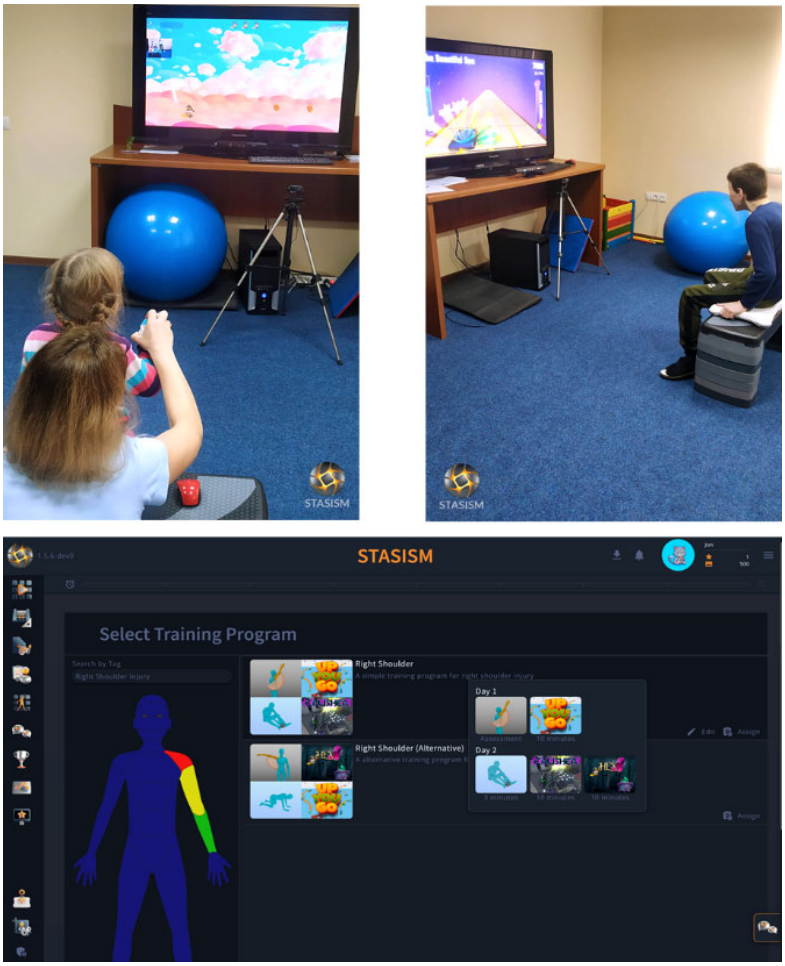

Figure 2. Sessions with the SG platform and example of home training program.

2.5. Metrics and Instruments

In order to gather comprehensive user feedback, we used questionnaires which were given to the caregivers (i.e., parents and legal representatives) of the children who used the SG platform. Assessment incorporated Likert scale (1–5 scale) responses to elucidate insights regarding specific game experiences and overall impressions of the platform. Families filled out the questionnaire in the presence and agreement of children. The person who did not work with the family introduced the questionnaire to reduce social desirability bias.

Semi-structured one-on-one interviews were conducted to further explore perceptions, barriers, and facilitators associated with SG engagement. The interviews were carried out by a seasoned researcher experienced in qualitative research and were audio-recorded. A designated interview instructor guided the discussions; the main parts of the interview were based on the survey lines. Every part started with the question the same as in the survey, but the instructor initiated an open answer instead of a multiple-choice answer.

Following the Braun guidelines, thematic analysis was applied to the audio-recorded interviews [15]. The data underwent description, summarization, and interpretation to uncover broader implications.

Descriptive codes, derived from patterns within the data, were organized, with a primary emphasis on identifying key themes emerging from the questionnaire responses. These themes underwent discussion, revision, and validation by a second researcher, ultimately receiving input and validation from the entire research team.

3. Results

3.1. Patients' Characteristics

A total of 320 children met the inclusion criteria, of whom 186 (58%) completed the 2-week intervention and provided survey responses (Figure 3). Participants were predominantly female (65%), with a mean age of 11 ± 2.2 years, and most resided in Ukraine (89%), primarily in western regions (Table 2). The majority had spastic cerebral palsy (65%) or developmental coordination disorders (24%).

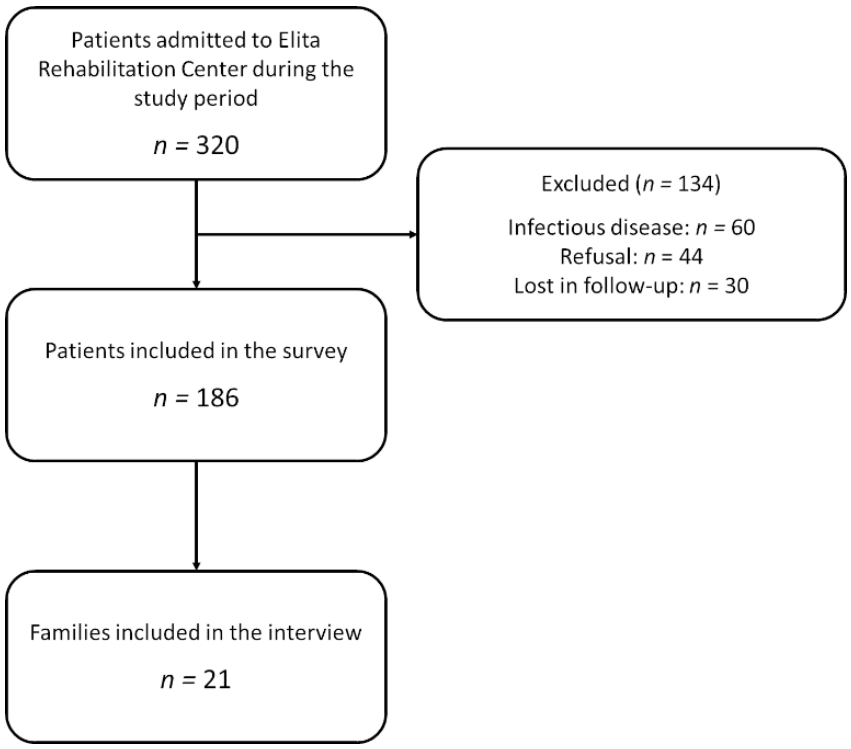

Figure 3. Patients' inclusion flowchart.

Table 2. Socio-demographic and clinical characteristics of the patients (SD—standard deviation).

Variables	Values
Age, mean ± SD	11 ± 2.2 years
Gender, female	120, 65%
Place of residence	
Ukraine (SG platform used on-site)	166, 89%
Western regions	76, 46%
Central and Northern regions	34, 20%
Eastern and Southern regions	56, 34%
Outside Ukraine (SG platform used online)	20, 11%
Diagnosis	
Cerebral Palsy	121, 65%
Spastic Type	107, 88%
Ataxic Type	6, 5%
Dyskinetic Type	8, 7%
Developmental Coordination Disorders	45, 24%
Other Developmental Disabilities	20, 11%

Participation in the in-depth interview was voluntary, and 21 families (11%) expressed their willingness to participate. The complete characteristics of the patients are presented in Table 2, and the flowchart of patients' inclusion is shown in Figure 3.

3.2. Quantitative Analysis

The survey results demonstrated strong participant engagement and generally positive perceptions of the serious games platform across multiple dimensions (Figure 4). Caregivers reported overall high satisfaction with platform usability, with 89% (n = 166) rating it as "easy" or "very easy" to use (Likert score $\geq$ 4). Importantly, 78% of respondents (n = 145) noted that their children maintained high motivation to use the games throughout the two-week intervention period, suggesting good engagement potential for sustained rehabilitation.

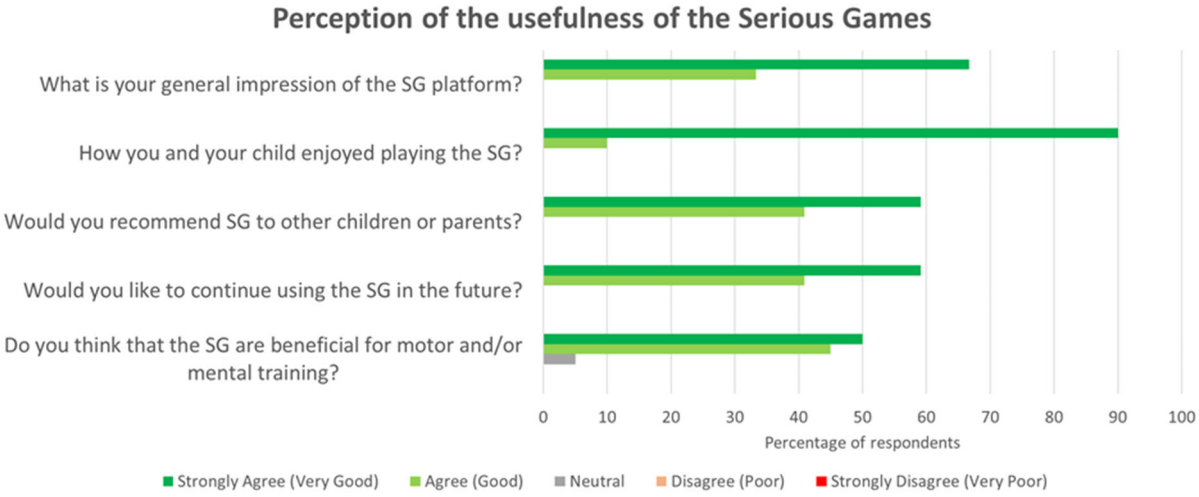

Figure 4. Results of users' experience on the use of serious games rehabilitation platform.

Game-specific analysis revealed notable variations in user ratings (Table 3). The racing-themed game Crazy Racing emerged as the clear favorite, receiving the highest scores for both enjoyment (4.6 $\pm$ 0.3) and perceived therapeutic benefit (4.2 $\pm$ 0.5). Qualitative comments associated these high ratings with the game's intuitive controls ("He understood immediately how to steer by leaning"), rewarding progression system, and immediate visual feedback. In contrast, Up-You Go received significantly lower ratings (enjoyment: 3.3 $\pm$ 0.8; benefit: 3.0 $\pm$ 0.9), with 18% of respondents (n = 34) specifically citing technical issues like input lag as primary detractors.

Table 3. Serious game ratings for enjoyment and perceived therapeutic benefit.

Serious Games	Enjoyment (Mean $\pm$ SD)	Therapeutic Benefit (Mean $\pm$ SD)
Crazy Racing	4.6 $\pm$ 0.3	4.2 $\pm$ 0.5
Hungry Woo	4.2 $\pm$ 0.6	3.9 $\pm$ 0.7
Super Surfer	4.1 $\pm$ 0.4	4.0 $\pm$ 0.6
Hex	4.0 $\pm$ 0.5	3.8 $\pm$ 0.8
Roxer	3.8 $\pm$ 0.7	3.7 $\pm$ 0.8
Crusher	3.7 $\pm$ 0.7	3.6 $\pm$ 0.7
Paddle Waddle	3.5 $\pm$ 0.8	3.2 $\pm$ 0.9
Pongo Paddle	3.4 $\pm$ 0.9	3.1 $\pm$ 0.8
Up-You Go	3.3 $\pm$ 0.8	3.0 $\pm$ 0.9

We then conducted a Spearman correlation analysis which showed a moderate positive correlation (ρ = 0.51, $p < 0.01$) between game enjoyment and perceived therapeutic benefit. Feedback was analyzed per game; "Crazy Racing" and "Hungry Woo" were favorites, with high ratings in enjoyment and improvement in balance and motor function.

3.3. Qualitative Analysis

Participants shared a range of experiences regarding the diagnostic tools, the benefits of the games, and their overall impressions. For qualitative interviews, six main themes have been identified (see Table 4).

Table 4. Qualitative themes from interviews (n = 21).

Theme	Frequency	Illustrative Quote	Implications
Engagement	100%	"She asks to play every day—it's her favorite therapy now."	High intrinsic motivation for sustained use.
Recommendations	81%	"Add more games like Crazy Racing—my child loves the races."	Preference for action-based, reward-driven SG.
Therapeutic Perceptions	71%	"His balance improved after 5 days with the board."	Games perceived as adjunct therapy.
Emotional Impact	62%	"She laughed more after playing; it distracted her from war stress."	Potential psychosocial benefits beyond motor gains.
Technical Barriers	57%	"Power cuts interrupted sessions; we needed offline options."	Critical need for offline functionality.
Diagnostic Tools	33%	"The balance test was useful but hard to calibrate at home."	Demand for simplified remote assessments.

For some, the diagnostic tools offered an effective starting point for engagement, with one parent noting, "For us, it was useful because the child performed this remote kind of testing firstly". Many participants also highlighted the positive impact of the games on their child's mood and enjoyment. Parents appreciated the games as a source of joy, with comments like, "Nice and funny game that cheers the kid up", and expressed satisfaction with the games' therapeutic effect, with one parent observing, "Mood and balance of my kid is improving because of the game".

The games were also praised for their role in enhancing therapy enjoyment. One parent shared that it had become their child's "favorite therapy", emphasizing the need for such engaging interventions: "She needed something like that". Another parent echoed this sentiment, focusing on the games' dual benefits of entertainment and relaxation, which aligned with their goals for their child: "Games entertain and relax my child, and it's my main goal for him nowadays".

Suggestions for improvement also emerged, with some participants calling for greater variety to maintain engagement, such as one parent's recommendation to "Add new games for the camera, my child needs more". These responses reflect an overall positive reception, with diagnostic tools and games valued for their accessibility, emotional benefits, and therapeutic potential, while also identifying areas for continued development. The subsequent theme analysis, conducted under Braun's standards, of the in depth-interview provided a framework for interpreting the depth and complexity of these interactions.

Upon examining the evaluation tools and the direct feedback provided by the platform, it became evident that all participants shared the same opinion regarding the usefulness of these tools. This finding led to a demand for the development of more diagnostic instruments based on SG.

The ease and effectiveness of the tool to assess static balance were praised, while the problem of the dynamic balance tool was acknowledged, with some individuals expressing a preference for a more direct calibration process for the balance board. Participants expressed a need for website assistance to efficiently navigate and utilize these resources at home.

Exploring the preferences and complaints of the SG platform's games revealed a clear division. The extensive selection of games, characterized by varied visuals and scenarios, received acclaim. However, the frequent technological malfunctions resulting in delays and disruptions became a regular issue of worry. Despite the difficulties faced, the mutual pleasure experienced by parents and children when gaming emerged as a notable positive aspect.

Children responded favorably to certain Stasism games, including Crazy Racing, Super Surfer, and Hungry Woo, expressing general approval of the gaming experience. Parents reported positive improvements in motor function, namely enhanced balance and walking, which they attributed to using the balance board and camera input.

The participants expressed their enthusiasm to explore game worlds further and connect socially, affirming their strong support for continued employment of the SG platform. When deciding on a fair fee for using the Stasism platform, participants preferred paying for the service while receiving strong assistance rather than dealing with unwanted adverts.

Overall, the prevailing feeling towards the Stasism platform was positive in the larger context of perceptions. The respondents rated their experience as highly positive, involving, and advantageous, with youngsters displaying enthusiasm and notable improvements in motor function.

During the analysis, recommendations and guidance for future enhancements became apparent. Technical malfunctions necessitated immediate response, prompting requests for user manuals, instructional films, and online assistance. Suggestions additionally encompassed the elongation of training durations and the integration of trendy gaming concepts.

4. Discussion

This study demonstrates the strong feasibility and acceptability of a serious game-based telerehabilitation platform for children with disabilities in conflict-affected Ukraine, with quantitative and qualitative findings highlighting high engagement, usability, and perceived therapeutic benefits. Below, we contextualize our results and propose recommendations for future implementation.

4.1. Main Results and Contributions of the Study

The research successfully validated the feasibility of serious game-based telerehabilitation for children with disabilities in active conflict zones, as evidenced by 186 active users and a 58% adherence rate despite logistical constraints. Beyond implementation success, qualitative feedback highlighted strong user acceptance, with families and children reporting positive experiences regarding enjoyment, accessibility, and therapeutic value—underscoring the platform's suitability for high-stress environments.

This aligns with emerging evidence that digital health interventions can bridge service gaps during emergencies, while extending these findings specifically to pediatric neurorehabilitation. First, the study provides empirical proof that low-resource digital rehabilitation tools can remain operational and effective amid instability while addressing real-world barriers to care. Second, it enriches the literature with user-centered perspectives from vulnerable populations, offering critical insights into engagement drivers and perceived efficacy. Lastly, the work advances actionable design and technical guidelines to enhance adaptability and scalability in conflict-affected regions, informing future innovations in equitable healthcare delivery.

The quantitative results revealed substantial variability in user experience across different game types, which carries important design lessons. Specifically, action-oriented

games featuring clear goals and progression systems—particularly Crazy Racing and Super Surfer—consistently scored highest for both enjoyment (mean ratings 4.1–4.6/5) and perceived therapeutic benefit (3.9–4.2/5). In contrast, more repetitive or precision-demanding games like Paddle Waddle and Up-You Go received markedly lower ratings (3.3–3.5 for enjoyment). This pattern suggests that rehabilitation games for conflict zones should prioritize intuitive, reward-driven mechanics that provide immediate positive feedback, while minimizing complex motor demands that may frustrate unsupervised users. The significant moderate correlation between enjoyment and perceived therapeutic benefit ($\rho = 0.51$, $p < 0.01$) further reinforces established motor learning principles about the importance of intrinsic motivation for adherence and outcomes.

4.2. Requirements for the Technologies in a War Conflict Setting

Before the war, the COVID-19 pandemic had already highlighted the necessity of improving patient access to essential healthcare services for their well-being. The pandemic expedited the swift growth of telemedicine on a global scale, transcending various cultures and societies [16].

Concerning the military situation in Ukraine, the use of telemedicine has the potential to provide cost-effective and accessible healthcare for a vulnerable population spread across different locations having difficulties to reach rehabilitation facilities [17].

In light of the conflict and crisis, numerous additional factors must be considered to ensure the delivery of high-quality telerehabilitation care:

(i) The equipment must be lightweight and not restrict the children's movements, as it is crucial for them to reach shelter quickly in the event of an air alarm.
(ii) The hardware and software should be energy-efficient, considering the possible shortages caused by attacks on the infrastructure. Every family needs to use energy prudently.
(iii) Technologies must be tailored for children with disabilities, and the context must be considered, as many children are sensitive to loud, unexpected noises and bright lights commonly found in commercial video games and services.
(iv) The hardware and software should be affordable for most families in a low- or middle-income country affected by the war.
(v) Technologies should not be overly complex and should not require extensive clinical and technical support, given the shortage of staff.

4.3. Feasibility of Use of Serious Games for Children with Disabilities in Ukraine

The impact of war on the population, but more specifically on children with disabilities, is profound and far-reaching, encompassing a wide range of consequences, from direct threats to life and health to a diminished quality of life, spanning immediate stress responses to enduring psychological repercussions [18]. Similarly to in other emergencies, in war, children with disabilities face heightened vulnerability and endure the effects of violence, forced displacement, and prolonged chronic stress [2].

The foremost commitment of clinicians is to uphold the right of the patients to attain the highest attainable standard of health. Responsibilities are escalating in tandem with the ongoing conflict, as extensive damage continues to mount due to attacks on medical facilities, shortages of healthcare supplies, and electrical power crises.

Recognizing the need to maintain contact with patients regardless of their current locations, technologies were chosen as a means to achieve this goal. The Stasism platform may serve as a conduit, offering access to a suite of SG under the remote supervision of healthcare professionals. The key results of this study are the feasibility of implementing such solutions despite the conflict and the shortage of healthcare professionals, as indicated

by the high number (186) of patients treated and evaluated using the platform. Daily assessments of patient progress via platform analytics require only 2 to 10 min, depending on the clinical scenario, ensuring uninterrupted care delivery despite a lack of clinical staff. Despite the limited training intensity, a majority of participants have expressed their willingness to continue using the platform. Furthermore, the affordability of the platform renders it accessible to families across various income levels.

An additional pivotal consideration is the fact that the population of this study are children. Every child has an innate affinity for play, and we firmly believe that incorporating SG into telerehabilitation will facilitate motor skill acquisition and cognitive training through gamification [19]. Although the current study does not provide objective measures to support this claim, there is substantiated evidence suggesting that SG interventions can effectively alleviate symptoms of post-traumatic stress disorder, a condition frequently observed in children exposed to military conflicts [20,21].

The results of this study indicated that the use of SG alone or in combination with telerehabilitation is feasible even during war and conflicts. It is essential to acknowledge some limitations associated with this research that require careful attention. First, the study may be susceptible to sample bias due to its focus on children undergoing rehabilitation-only at the ERC. This particular sample may not comprehensively depict the heterogeneous population of children with disabilities in Ukraine, a country with vast socioeconomic and regional disparities. Specifically, children who lack access to rehabilitation services comparable to those offered at the ERC may experience different rehabilitation outcomes, influencing the generalizability of the study's findings. Moreover, the exclusion criteria, which encompass the inability to access the platform due to technical limitations, may add selection bias, potentially leading to the exclusion of children who could benefit from telerehabilitation but are limited by factors such as unreliable internet connectivity or the unavailability of the necessary devices. The applicability of the results may be restricted as the study focuses exclusively on a specific rehabilitation facility in Lviv. The circumstances, available assets, and perspectives in other areas of Ukraine, particularly those immediately impacted by the fighting, may vary dramatically. For example, some children may be adjusting to entirely new environments as displaced individuals or immigrants, while others face the daily trauma and disruption caused by frequent airstrikes. Additionally, many children with disabilities in Ukraine now struggle with access to essential goods and services, including adequate housing, food, and medical care. In this context, having reliable access to personal computers and the internet, which are prerequisites for engaging in telerehabilitation, remains a substantial challenge for many families.

The effectiveness of telerehabilitation relies on the accessibility and dependability of technology, and the potential obstacles or interruptions in internet connectivity, particularly in conflict-affected regions, have not been thoroughly investigated [22,23]. Furthermore, the study lacks a comparison group, which limits the ability to determine if the observed advantages—such as improved engagement, accessibility, and perceived therapeutic benefits—are inherent to telerehabilitation with serious games or if they might be similarly achievable in conventional, face-to-face rehabilitation settings. Without a control group of children receiving in-person rehabilitation under comparable conditions, it is challenging to isolate the specific impacts of the telerehabilitation platform.

The recognition of a scarcity of clinical personnel as a result of the conflict creates apprehensions regarding the caliber of telerehabilitation services and the capacity to deliver comprehensive treatment to children with impairments. The study lacks an in-depth analysis of possible remedies or tactics to alleviate the repercussions of this personnel deficit on service provision.

Moreover, the dependence on self-reporting via surveys and interviews adds the potential for response bias. Families and children may tend to give socially acceptable answers, and the positive views expressed may not capture the full spectrum of experiences.

Finally, the study briefly acknowledges the psychological consequences of the conflict on children with impairments [24]. However, it does not delve into the precise psychological symptoms or potential psychological advantages of incorporating serious games into telerehabilitation [25].

It is essential to overcome these constraints in order to improve the strength and relevance of the study's results for the broader group of disabled children in Ukraine who are impacted by the current conflict. In the future, other aspects, such as sexual and gender-based violence, should also be investigated, given the high prevalence in conflict areas [26]. In addition, we plan to explore more the specific psychological symptoms that tend to arise in children with disabilities during the war in Ukraine, as well as the role of technologies to overcome these effects [27,28]. Presently, Ukraine grapples with the profound impact of an all-encompassing war, the largest of its kind in Europe since World War II [29]. Simultaneously, it provides a unique repository of practical knowledge regarding managing colossal rehabilitation challenges during extraordinary times, insights that are inevitably relevant to other cultures facing similar circumstances.

5. Conclusions

The study demonstrated the feasibility and acceptance of serious games for telerehabilitation in conflict settings. Among 186 children, 89% expressed willingness to continue use, and many reported improvements in mood, balance, and functional mobility. Although this feasibility study did not aim to quantitatively assess therapeutic efficacy, reported therapeutic gains—based on caregivers' and children's perceptions—included improved balance, enhanced walking, better mood, and increased engagement. These perceived improvements support the platform's relevance and usability in disrupted clinical contexts. The platform, specifically created to facilitate customized telerehabilitation, demonstrated its advantages through a 58% adherence rate and 89% of users expressing a desire to continue. These findings support the use of serious games as a reliable, enjoyable, and scalable tool for rehabilitation, particularly in conflict-affected regions where traditional services are disrupted.

Ukraine is currently dealing with the significant consequences of the ongoing conflict. The knowledge and insights gained from handling rehabilitation difficulties during exceptional conditions can be valuable for other areas confronting similar situations. The study's suggestions and factors to consider, such as the requirement for lightweight and energy-efficient technology specifically designed for children with impairments, add to the current discussion on enhancing healthcare services in conflict-affected regions.

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Informed Consent Statement: Informed consent was obtained from all subjects and their legal representatives involved in the study.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, Prof. dr. Bruno Bonnechère, upon reasonable request.

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