

Virtual Reality-Based Exergame for Hospitalized Children with Cancer: An Exploratory Study

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Abstract

Background: Exercise is a well-recognized non-pharmacological intervention in pediatric oncology, offering numerous physiological and psychological benefits. However, its feasibility is often constrained by cancer treatments and hospitalization.

Objective: This study aims to evaluate the feasibility of a hospital-based Virtual Reality (VR) exergame for children with cancer by assessing compliance and acceptance, as well as estimating exercise intensity to ensure it meets medical recommendations (>3 METs).

Methods: Thirteen pediatric cancer patients diagnosed with leukemia or sarcoma, aged 12.4 ± 4.2 years participated in VR-based exergame sessions conducted four times per week over a two-months period in the pediatric oncology unit of the hospital. The exergame, similar to Beat Saber (i.e., players slice incoming blocks with lightsabers and dodge obstacles), included adaptability options to accommodate different physical constraints. Games lasted five minutes with participants choosing the number of games they played per session, up to a maximum of 30 minutes. A total of 131 games were analyzed to assess compliance rates (number of sessions attended divided by the total number of sessions offered for each child), patient acceptance (estimated with Technology Acceptance Model which contains Perceived ease of Use, Perceived usefulness, Intention to use, User Experience, Nausea/Oculomotors symptoms corresponding to adverse-effect score and Self assessed performance) and exercise intensity.

Results: The participants demonstrated a good compliance rate of 68 ± 29 % towards the VR-based exergame sessions, with individual variability influenced by factors such as age, prior VR experience, and usage intent. The average exercise intensity by child reached 4.44 ± 1.91 METs (Metabolic Equivalent of Task), surpassing the moderate-intensity threshold. Acceptance was high with a high user experience (5.36 ± 0.51) and no serious adverse effects were reported, with a low average adverse-effect score of 0.37/6.

Conclusions: The main findings suggest that the proposed VR-based exergame practice is feasible and well-accepted with no significant adverse effects in a pediatric oncology setting. It can provide effective moderate-to-vigorous exercise levels while demonstrating a strong patient engagement, even in the face of individual differences. Although the results are promising, with a compliance rate of 68%, there is still room for improvement. Expanding the variety of VR content could better accommodate diverse age groups, particularly adolescents (13–17 years). Additionally, larger-scale studies are needed to confirm and validate these findings while further exploring the potential of VR as a tool to promote exercise in pediatric oncology. Moreover, integrating autonomous adaptation based on physiological and kinematic data could enhance both the effectiveness and engagement of the program.

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Original Manuscript

Original Paper

Jos Déforges^{1 2}, Alexandre Vu^{1 6}, Virginie Gandemer³, Jacinthe Bonneau-Lagacherie³, Fanny Drouadenne³, Steven Gastinger¹⁵, Benoît Bideau¹⁶, Catherine Soladié², Amélie Rébillard¹⁴

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Keywords: virtual reality; pediatric cancers; oncology; exergame; exercise; energy expenditure.

Introduction

Cancer remains one of the leading causes of mortality worldwide, accounting for 10 million deaths in 2022 [1]. The pediatric population is not exempt, with approximately 2.260 children diagnosed with cancer annually in France [2]. Advances in treatment have improved the 5-year survival rate for pediatric cancers to 85% [2]. Standard therapies typically include chemotherapy, sometimes combined with monoclonal antibody therapy (immunotherapy). Depending on the cancer type and stage, additional treatments may involve surgery, radiotherapy, or hematopoietic stem cell transplantation [2]. However, both the disease and its treatments impose significant physiological (e.g., reduced strength and aerobic capacity) and psychological (e.g., stress, anxiety, isolation) burdens, with fatigue being the most commonly reported symptom [3]. These factors frequently diminish the Quality of Life (QoL) of pediatric cancer patients [4,5].

Over the past decade, exercise has emerged as a promising non-pharmacological strategy to mitigate these adverse effects. When tailored to an individual's physical and mental capabilities, exercise has been shown to improve QoL, emotional well-being, self-esteem, and physical fitness [3,6]. Notably, it can reduce cancer-related fatigue and enhance treatment tolerance [7]. In the other hand, the World Health Organization (WHO) recommends that children and adolescents aged 5–17 engage in an average of 60 minutes per day of moderate-to-vigorous physical activity (>3 METs) to improve cardiorespiratory fitness, bone health, and mental well-being [8]. However, pediatric cancer patients consistently demonstrate lower physical activity levels than their healthy peers [9]. Several barriers limit exercise participation in this population. Fatigue, anxiety, and low motivation are common psychological obstacles [10;11]. Cancer-specific factors also play a role: children with leukemia often face prolonged hospital stays and isolation in sterile environments [12], while those with solid tumors may encounter movement restrictions due to amputation or tumor location [13].

Emerging digital solutions offer innovative ways to address these challenges. Among them, exergames—video games that incorporate physical activity—have gained attention for their ability to engage patients in exercise. Systematic reviews suggest that exergames can improve endurance, QoL, and reduce cancer-related fatigue [14]. However, their effects on strength, physical function, and depression are less consistent [14]. Despite this, exergame interventions are well-accepted, with participation rates exceeding 50% and no serious adverse events reported [14]. Within this field, Virtual Reality (VR) using Head-Mounted Displays (HMDs) has emerged as a particularly promising platform. A VR-HMD displays a three-dimensional environment, in which the player can interact through body movements tracked by sensors [15]. By immersing children in engaging 3D environments, VR enhances motivation and provides an element of escapism that traditional exergames often lack [16].

Although VR-based exergames have shown potential in promoting physical activity [17,18], their application in pediatric oncology remains largely unexplored. Previously, immersive virtual reality has been investigated and validated for children in pediatric oncology, aged 6 to 17 years, in order to reduce pain during treatment [19].

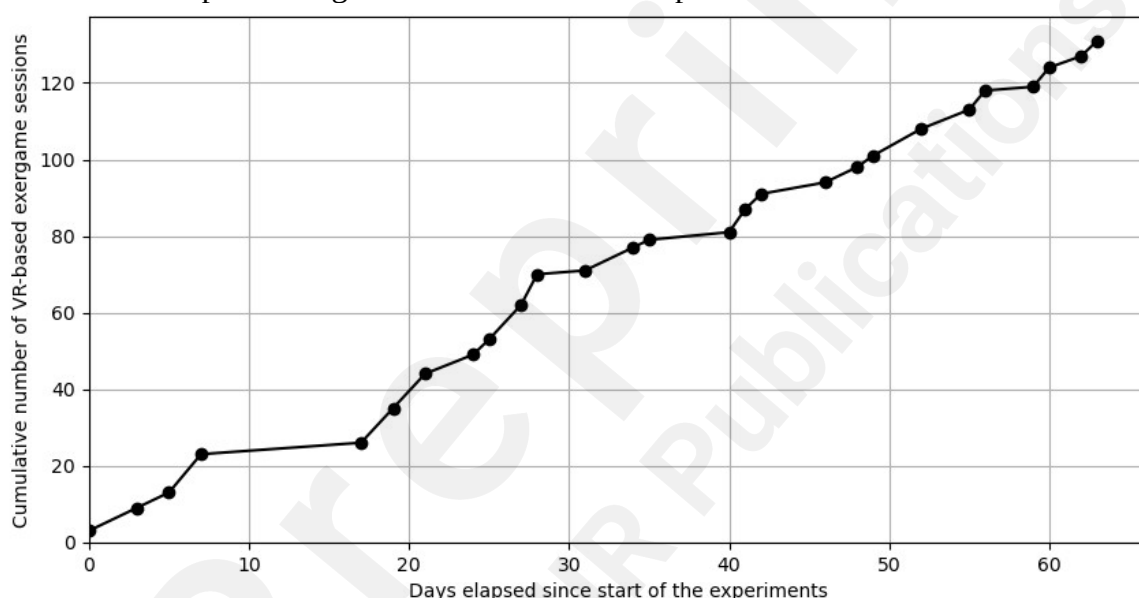
This study aims to assess the feasibility of a custom VR-based exergame for pediatric cancer patients undergoing treatment in a hospital setting. Specifically, it (i) evaluates compliance by examining whether children play the exergame, (ii) assesses acceptance by exploring their experiences during practice, and (iii) measures exercise intensity to ensure alignment with WHO recommendations.

Methods

Experimental Design

This study was designed to evaluate the compliance rate, acceptance, and exercise intensity of a VR-based exergame for hospitalized pediatric oncology patients. The data collection was conducted in the pediatric oncology department at Sud Hospital, Rennes, from February 12 to April 19, 2024. Four exergame sessions were scheduled weekly during the afternoons, offering children the opportunity to participate voluntarily based on their preference or health status. Each session lasted up to 30 minutes, adhering to recommendations from the VR headset manufacturer [20] to minimize fatigue and potential adverse effects associated with prolonged VR use (nausea, eye fatigue, general discomfort). Participants could select one or more games during a session (see “Game concept and Customization” section), allowing for flexibility and personalization. A total of 131 games were played (Fig. 1).

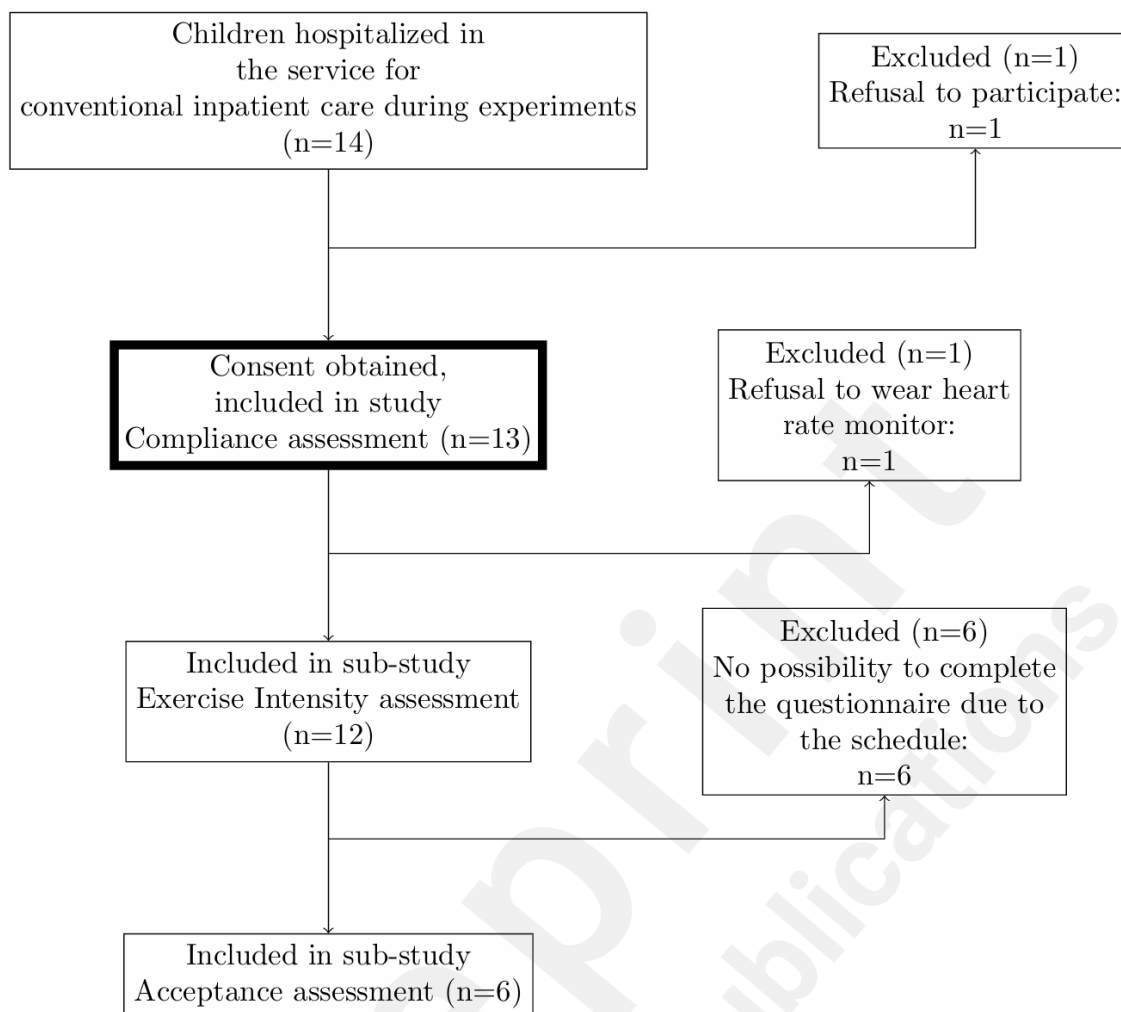
Figure 1 Evolution of practiced game sessions over the experiments.



Recruitment

The study population included children aged 6 to 17 years who were hospitalized in the pediatric oncology department for conventional inpatient care (Fig.2), excluding those in day hospital care. All participants had been diagnosed with either leukemia or sarcoma. The results were grouped by cancer type, given the important differences between these two conditions in terms of age, symptoms, and practice-related constraints. To ensure confidentiality, data were pseudonymized. Inclusion criteria required sufficient physical and cognitive ability to interact with the VR game (ability to read). Medical staff assessed these abilities during routine evaluations. No specific exclusion criteria were applied for compliance assessment, except for medical contraindications to VR use, as determined by the medical staff. The study was explained to both the children and their parents or legal guardians at the time of enrollment, and informed consent was obtained prior to participation.

Figure 2 Flowchart of participants.



Game Concept and Customization

The Meta Quest 2 HMD was used to deliver the VR experience. The game used in this study was designed to resemble Beat Saber (Beat Games, Prague, Czech Republic). Participants sliced incoming cubes in the direction indicated by arrows using virtual sabers. The movement of the virtual sabers mirrored that of the handheld controllers (Fig.3). To adapt to the diverse needs and preferences of hospitalized children, the game included various customizable features:

- **Position** : seating or standing
- **Difficulty levels**: three options (easy, moderate, hard), varying cubes frequency.
- **Active limbs**: both arms or one specific arm.
- **Obstacles**: with or without obstacles to avoid (horizontal and vertical obstacles).
- **Game mode**: using sabers (controllers) or hands (hand tracking mode).
- **Visual environments**: choice between Beach, Space, or Sky.

These customizable features ensured that the gameplay could be tailored to each child's physical condition and energy level, making the experience both engaging and safe. The primary goal was to provide a fun, accessible activity that promoted physical exertion within appropriate limits.

Figure 3 Left: Example of a child playing the proposed VR-based exergame; right: visual of the VR-based exergame (with the options : position "standing", difficulty : "hard", active limbs "both", obstacles "with", game mode "saber" and visual environments "Space").



Outcome Measures

Compliance

Compliance rate

The primary outcome of this study was the compliance rate, calculated as the number of sessions attended divided by the total number of sessions offered for each child. This measure served as the principal indicator of success. The long-term objective was to maximize compliance by tailoring exergame sessions to each child's preferences and physical abilities. To provide clarity on the data collection procedure, it is important to note that while the study period spanned approximately eight weeks, participants were not continuously present or available in the hospital unit throughout this duration. In this term, 81 sessions were proposed along the experiments.

Factors impacting compliance

In order to evaluate the impact of different factors (participant's health, initial intention to use, initial opinion of the proposed exergame) on compliance rate, several data were assessed:

Acceptability

Acceptability was assessed using a child-friendly, tablet-based questionnaire—featuring simplified formulations and fewer items—adapted from the Technology Acceptance Model (TAM) [21]. This questionnaire was only completed at the start of the study and focused on the child's perception of VR-based exergames prior to gameplay. It included 7 Likert-scale items (scored 0–6) covering four categories: perceived ease of use, perceived usefulness, intention to use, and technophilia.

Anthropometry

An anthropometric questionnaire was administered at the beginning of the study via tablet. Data collected included age, height, weight and gender merged with prior experience with VR (Yes or No).

Quality of Life

Quality of life was measured using the Pediatric Quality of Life Inventory™ (PedsQL) [22], a validated tool widely used in clinical settings (Cronbach's alpha = 0.83 for patients and 0.86 for parents). The PedsQL questionnaire, completed only once on a tablet at inclusion, consisted of 23 items divided into three domains: Global Score (Average of all 23 items. Physical Health (Items related to physical functioning). Psychosocial Health (Items addressing emotional, social, and school functioning). Scores are ranged from 0 to 100, with higher scores indicating better QoL.

Acceptance

Acceptance was evaluated after at least one week of exergame practice using a second TAM-based questionnaire [21]. This questionnaire, also completed on a tablet, included 23 Likert-scale items (scored 0–6) divided into the following categories: perceived ease of use, perceived usefulness, intention to use, user experience, nausea and oculomotor issues (General discomfort, Increased salivation, Nausea, Dizziness, Stomach discomfort, Fatigue, Headache, Eye fatigue, Difficulty concentrating, Blurred vision) and self-evaluation of performance.

Exercise Intensity

Exercise intensity estimation

Exercise intensity was estimated through heart rate (HR) monitoring using Withings Steel HR smartwatches (Withings, Issy-les-Moulineaux, France), which transmitted data to a tablet via the Healthmate app. The primary measure was HR evolution over time (beats per minute, bpm).

Energy expenditure (EE), expressed in kcal/min, was estimated using the formula proposed by Lee et al. [23], demonstrating a strong explanatory power ($R^2=0.814$), which considers HR, age, weight, height, and gender.

To normalize these values according to, the MET (Metabolic Equivalent of Task) was calculated as follows: $MET = kcal.min^{-1} / (3.5 \times weight \text{ in kg} / 200)$. According to Courneya & Friedenreich [24], moderate activity corresponds to MET values above 3. Both average heart rate (HR) and metabolic equivalent of task (MET) values were recorded and analyzed for each exercise session, with METs providing a normalized estimate of exercise intensity adjusted for individual anthropometric differences. The average exercise intensity per child is presented to account for variations in the number of sessions completed by each participant:

$$\text{Overall average intensity} = \frac{1}{N} \sum_{i=1}^N \left(\frac{1}{n_i} \sum_{j=1}^{n_i} I_{ij} \right)$$

N: the total number of subjects

n_i : the number of sessions for subject i

I_{ij} : the intensity of session j for subject i

Game Option Choices

The specific options selected by participants during gameplay (e.g. position, difficulty, obstacles and mode) were recorded. These data were analyzed, as independent variables, to determine their potential impact on exercise intensity and to potentially highlight some preferred options.

Statistical Analysis

As compliance rates did not meet the normality assumption ($p < 0.05$), Spearman correlations were

conducted to explore how compliance rates related to factors collected through the response questionnaire. Because of the small sample size ($n < 15$), the p-values for Spearman correlations were computed but not included, as they are likely to lack statistical power.

As gameplay settings were not controlled by experimental conditions but were selected based on children's preferences, an exploratory analysis in boxplots using descriptive statistics (Box : Interquartile range : 50%, Q1 : 25th percentile, Q3 : 75th percentile ; Whiskers : Min-Max) was performed to examine how game options might have affected exercise intensity.

Results

Population Characteristics

Among the 14 eligible children in the pediatric oncology unit, 13 agreed to participate (Fig. 2), yielding a participation rate of 92.9% (i.e., the percentage of children who attended at least one session relative to the total number invited to participate). The detailed characteristics of the study population are summarized in Table 1. Participants ranged in age from 6 to 17 years old, with a mean age of 12.4 ± 4.2 years old. Diagnoses included leukemia ($n = 8$) and sarcoma ($n = 5$), with a gender distribution of [77% male / 23% female].

Table 1. Population characteristics.

	Overall (N = 13)	Leukemia (N = 8)	Sarcoma (N = 5)
Age (Mean $\pm$ SD)	12.4 ± 4.2	10.8 ± 4.2	15.0 ± 2.8
Weight (kg)	43 ± 13	38 ± 12	51 ± 11
Height (cm)	150 ± 20	140 ± 16	165 ± 16
VR Experience			
– No (n %)	3 (23)	2 (25)	1 (20)
– Yes (n %)	10 (77)	6 (75)	4 (80)
Sex			
– Female (n %)	3 (23)	3 (38)	0 (0)
– Male (n %)	10 (77)	5 (63)	5 (100)

Compliance

Compliance rate

The average compliance rate, defined as the proportion of completed sessions relative to those offered, was $68 \pm 29\%$ (Table 2). The standard deviation suggests a wide variability in compliance was observed across participants, indicating significant individual differences. These variations may reflect diverse factors such as age, health status, motivation, or prior familiarity with VR technologies.

Table 2. Compliance results for each participant

	Overall (N = 13)	Leukemia (N = 8)	Sarcoma (N = 5)
Sessions proposed (Mean $\pm$ SD)	6.2 ± 4.6	7.5 ± 5.5	4.2 ± 1.9
Sessions practiced (Mean $\pm$ SD)	4.00 ± 3.79	4.75 ± 4.74	2.80 ± 0.84
Compliance (%)	68 ± 29	62 ± 27	78 ± 32

Factors impacting Compliance

Acceptability

Acceptability outcomes were positive overall, with a mean intent to use score of 4.69 ± 1.25 out of 6 (Table 3). However, the relatively high standard deviation suggests notable variability in participants' initial perceptions of VR-based exergames.

Table 3. Acceptability results.

	Overall (N = 13)	Leukemia (N = 8)	Sarcoma (N = 5)
Perceived ease of use	3.46 ± 1.71	3.00 ± 1.60	4.20 ± 1.79
Perceived usefulness	3.81 ± 1.48	3.88 ± 1.64	3.70 ± 1.35
Intent to use	4.69 ± 1.25	4.63 ± 1.51	4.80 ± 0.84
Personal innovativeness	4.90 ± 0.81	4.84 ± 0.96	5.00 ± 0.56

Quality of Life

The mean quality-of-life (QoL) score was 57, an altered score, with substantial variability across participants (Table 4). This variability underscores the heterogeneity of physical and psychological states among the children, likely influenced by their specific diagnoses, treatment phases, and overall health.

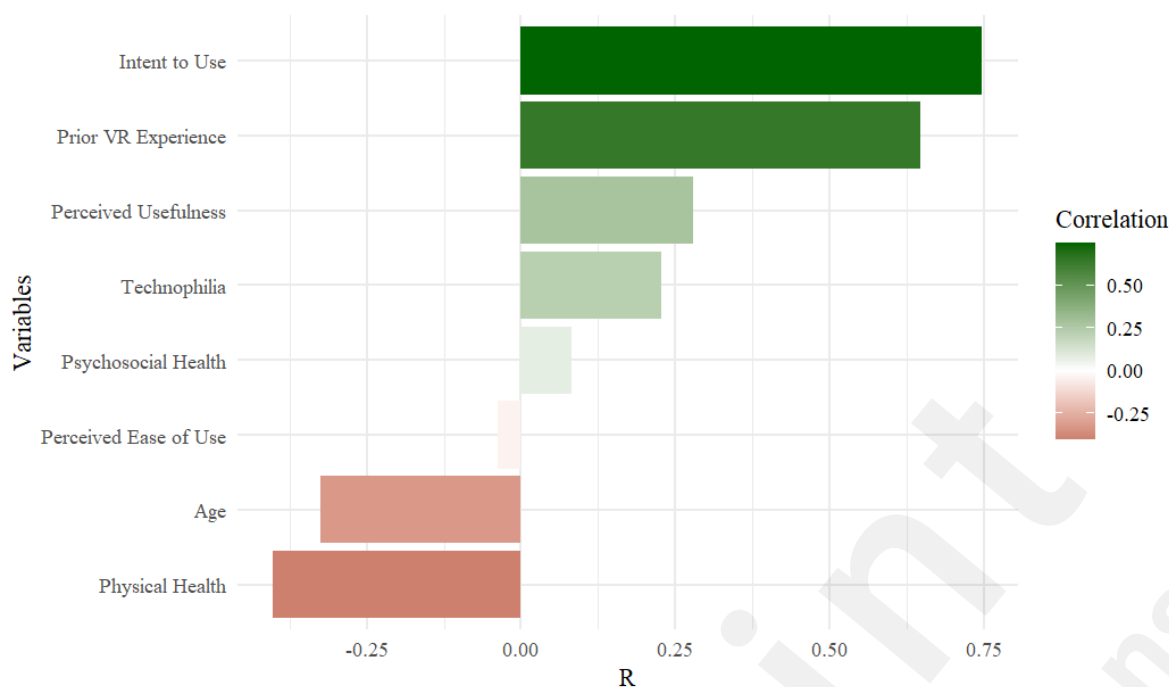
Table 4. Quality of life results (PedsQL).

	Overall (N = 12)	Leukemia (N = 7)	Sarcoma (N = 5)
Physical Health	54 ± 25	58 ± 28	47 ± 22
Psychosocial Health	61 ± 19	65 ± 18	54 ± 21
Total Score	57 ± 21	62 ± 22	51 ± 19

Correlation barplots of Compliance

Spearman's correlations, as illustrated by the barplots, revealed that compliance was positively associated with "intent to use" scores from the acceptability questionnaire ($R = 0.75$) and prior VR experience ($R = 0.52$). Conversely, age and physical health showed a negative correlation with compliance ($R = -0.32$; $R = -0.40$) (Fig. 4).

Figure 4. Spearman's correlations barplots of Compliance.



Acceptance

Six children completed the acceptance questionnaire after participating in at least one week of sessions. Despite the limited number of respondents, with a mean "intent to use" score of 5.5/6 (Table 5). High scores were also recorded for user experience (5.36/6). Importantly, no major adverse events were reported, indicating that VR did not present barriers to compliance in this context.

Table 5. Acceptance results.

	Overall (N = 6)	Leukemia (N = 3)	Sarcoma (N = 3)
Perceived ease of use	5.33 ± 1.08	6.00 ± 0.00	4.67 ± 1.26
Perceived usefulness	4.50 ± 0.55	4.67 ± 0.29	4.33 ± 0.76
Intent to use	5.50 ± 0.84	5.67 ± 0.58	5.33 ± 1.15
User experience	5.36 ± 0.51	5.72 ± 0.48	5.00 ± 0.17
Nausea / Oculomotor symptoms	0.37 ± 0.23	0.20 ± 0.17	0.53 ± 0.12
Self-assessed performance	4.42 ± 1.56	5.33 ± 1.15	3.50 ± 1.50

Exercise Intensity

Exercise intensity estimation

Out of 13 participants, 12 were assessed using HR monitors (one participant declined to wear the device) (Fig. 2). The average HR during gameplay was 113±17 bpm, with an average estimated intensity of 4.44±1.91 METs (Table 6). These results exceed the moderate-intensity threshold (>3 METs). Note that one intensity value was estimated below 0 with the Lee model, which is physiologically implausible.

Table 6. Exercise intensity results.

	Overall (N = 12)	Leukemia (N = 7)	Sarcoma (N = 5)
HR (bpm)	113 ± 17	119 ± 20	105 ± 11

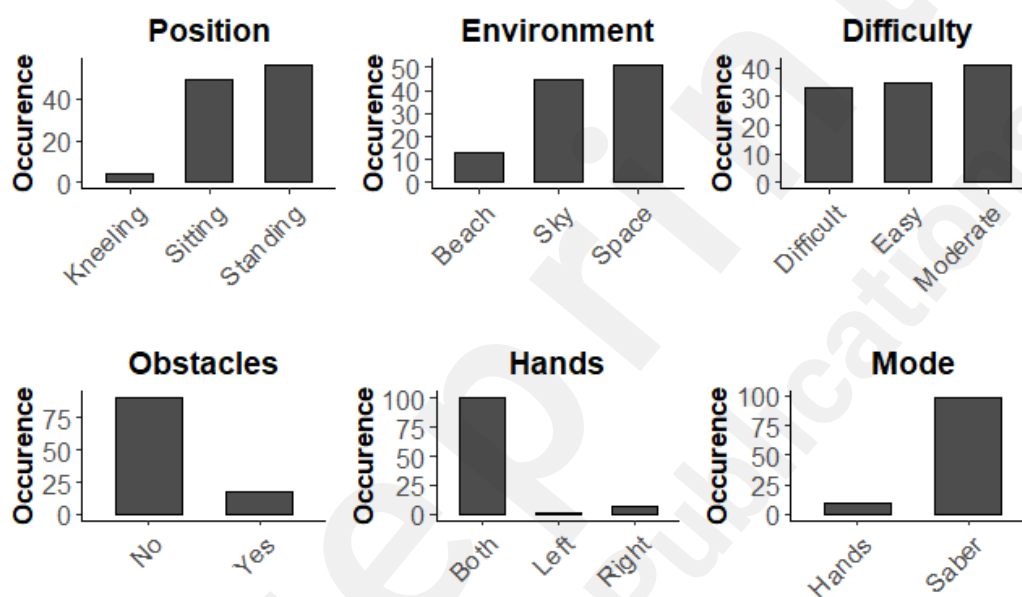
Intensity (MET)	4.44 ± 1.91	4.31 ± 2.45	4.64 ± 0.94
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Game options influences on Exercise intensity

Game Options' Choice

All available game options during the sessions were at least chosen once (Fig. 5). While all three virtual environments were utilized, 55% of sessions were conducted in a standing position. Difficulty choices were evenly distributed across the three difficulty levels, though the "obstacles" mode and "hands" mode were used infrequently.

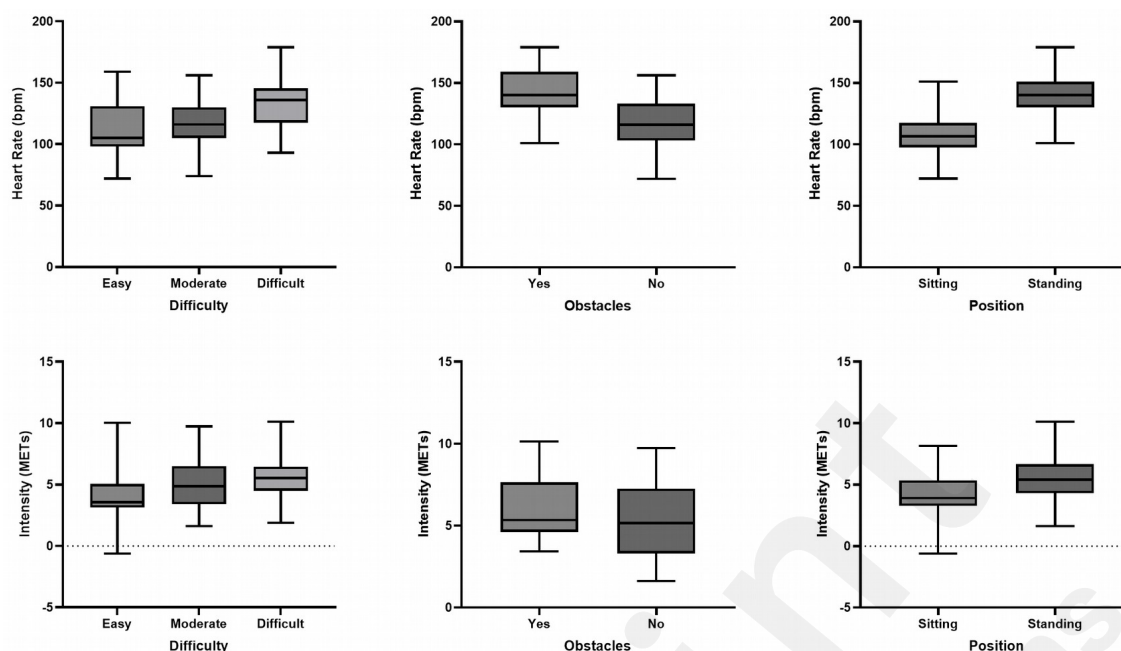
Figure 5. Game options during the game sessions.



Influence of options on heart rate and intensity

Based on results presented in Figure 6, the options of Obstacles, Difficulty Choice, and Position appear to influence HR and intensity during the activity. The presence of obstacles, higher difficulty, and standing position are associated with higher values (Fig. 6). However, the differences seem less pronounced when considering intensity in terms of HR than in MET values for obstacles and position options.

Figure 6. Boxplots of options' influence on Heart Rate (topline) and Intensity in MET value (bottom line).



Discussion

Compliance and Factors Influencing It

Our study confirms the feasibility of VR-based exergame sessions in pediatric oncology, with a participation rate of 92.3%, suggesting high initial interest. The average compliance rate was 68%, consistent with other VR-based exergame studies in oncology [14, 25], though individual variability was high ($SD = 29.11$). Patients with sarcoma demonstrated a higher compliance rate than those with leukemia. This could stem from differences in hospitalization processes (continuous for leukemia and intermittent for sarcoma). Key factors correlated with compliance included intention to use ($R = 0.75$), prior VR experience ($R = 0.52$), age ($R = -0.32$) and physical health ($R = -0.40$). The negative correlation between age and compliance highlights that younger children may find the game more engaging. Diversifying VR content development (e.g., type of exercises, gamification strategies) could enhance compliance across a broader age range [26]. Additionally, prior exposure to VR technology appears to facilitate compliance. Providing a brief familiarization tutorial to participants with no prior VR experience may help reduce barriers related to the novelty effect [27]. Importantly, compliance is not only limited by patient interest or motivation, but also by specific constraints, including fatigue, treatments, and hospital care protocols [28]. In this regard, children with lower physical health scores tend to have lower compliance rates. This first version of the exergame was developed with a focus on adaptability. Future work should aim to expand these efforts by designing even more adaptable solutions. However, the potential for adaptation remains constrained by clinical realities such as hospitalization schedules, fatigue, and symptoms [28]. Overall, this VR-based exergame appears promising for some patient profiles, while others showed limited interest or were not in a condition to participate in the program. A future objective is to optimize compliance and to better define the limits associated with the specific context of pediatric oncology in hospital settings.

Acceptance

Acceptance scores were highly satisfactory (user experience: 5.36/6; intent to use: 5.50/6), indicating that children had a positive experience with the VR-based exergame, both in terms of enjoyment and pragmatic usability. Furthermore, the high intent to use score suggests that motivation to continue

engaging with the exergame remains strong, even after only a few sessions. Moreover, no significant adverse effects reported, a crucial point giving the potential fragility of this population. However, only six children completed the acceptance questionnaire.

Exercise Intensity and game options choices

The average MET intensity met the criteria for moderate exercise [24], demonstrating the program's capacity to provide effective physical activity for children with both leukemia and sarcoma, suggesting that the exergame can reach the targeted intensity for specific constraints of both cancer groups. However, the relatively high standard deviation in MET intensity values indicates variability in participants' responses. Options obstacles and hands were less frequently chose by the children, this suggests a preference for simpler gameplay mechanics among participants. Game options, obstacles, position and intensity choices, influenced HR and MET intensity. The differences in HR were more pronounced than in MET, likely due to the diversity of individual profiles (age, height, weight, illness). This adaptability suggests the exergame is customizable to individual fitness levels, though further development of a fatigue indicator is needed. Practicing exercise during long hospitalizations is crucial. This VR-based exergame offers a promising solution to promote physical activity among children hospitalized for cancer, though supervised sessions with an adapted physical activity teacher remain essential [29].

Game Adaptability

The game's flexibility to accommodate children with varying physical abilities (e.g., one-handed play, seated play) suggests it can be adapted for a wide range of profiles. Future updates could include a "colorblind mode". Analyzing why specific options are chosen (e.g., due to fatigue or preference) could provide deeper insights into optimizing the game for different needs.

Limitations

While Withings Steel HR watches provided portable monitoring and indicated a mean heart rate of 113 bpm, corresponding to moderate intensity, their data accuracy was limited in terms of frequency acquisition. Future iterations could benefit from integrating wrist-worn accelerometers or skin temperature measurements for more reliable intensity assessment [30].

The study's sample size is small, and results should be interpreted with caution. In this pilot study, we did not assess the statistical significance of the options' influence on intensity due to limited participant numbers. In this study, only patients with leukemia and sarcoma were investigated due to the actual patient population in the hospital. Other pediatric cancer types (e.g., lymphoma, brain tumors) should be included in future studies.

Conclusions

This pilot study evaluated compliance, acceptance, and exercise intensity in a VR exergame program within the pediatric oncology. VR-based exergames appear to be a valuable strategy for supporting exercise in hospitalized children with cancer (leukemia and sarcoma). The results showed high participation rates and good compliance, though with individual variation. Factors such as age, intent to use the game, and prior VR experience seem related to compliance. Acceptance scores were high, with no major adverse events reported.

The exergame can achieved moderate intensity, in line with WHO recommendations, suggesting that regular use could provide benefits similar to traditional exercise. While it does not replace an exercise supervisor, the VR exergame is cost-effective and suitable for hospital settings without adding to the caregivers' workload. Larger-scale studies are needed to confirm these results with

sufficient statistical power. Furthermore, more diverse content could enhance the exercise experience. The project is exploring the development of a comprehensive platform combining VR exergames with health data collection to further study exercise's molecular responses in pediatric cancer patients.

Acknowledgements

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Conflicts of Interest

None declared.

Abbreviations

HMD: Head-Mounted Display

HR: Heart Rate

JMIR: Journal of Medical Internet Research

VR : Virtual Reality

Data availability statement

The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author by mail contact.

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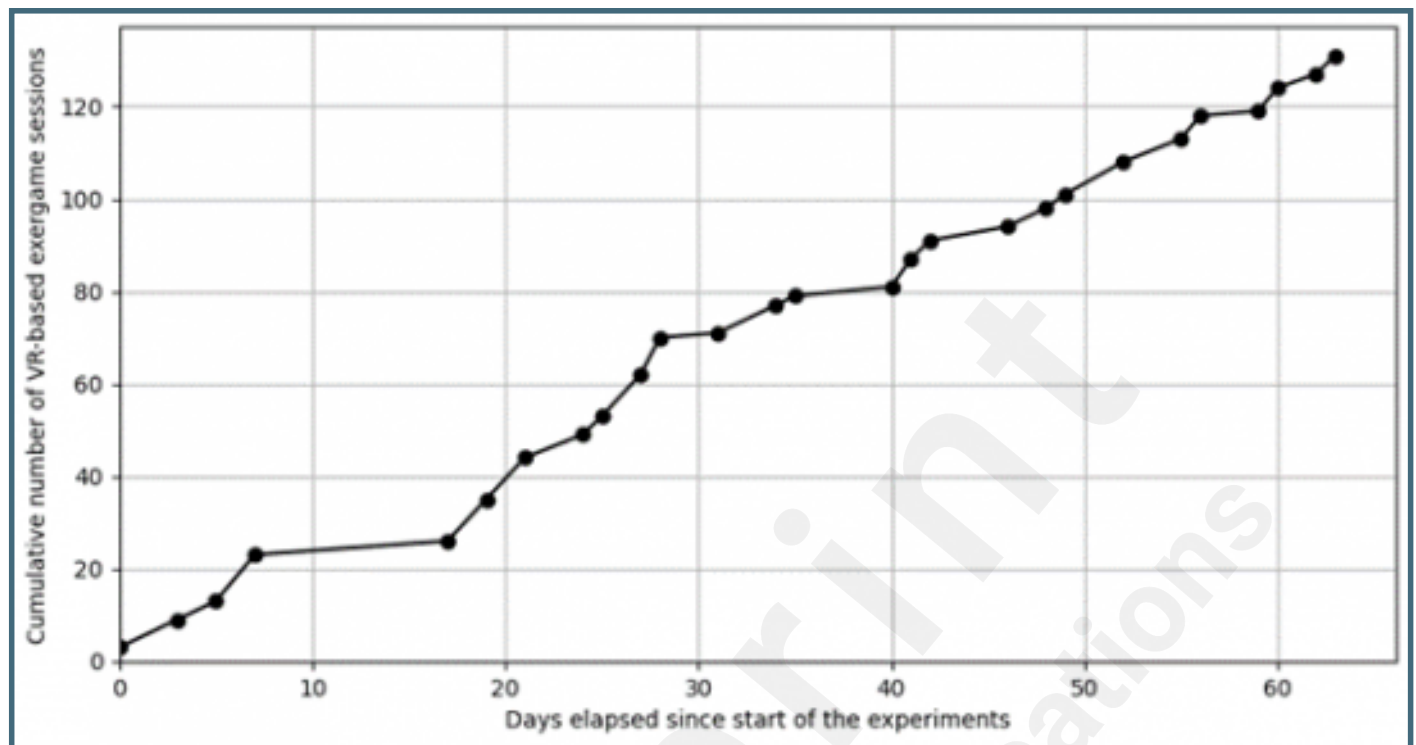
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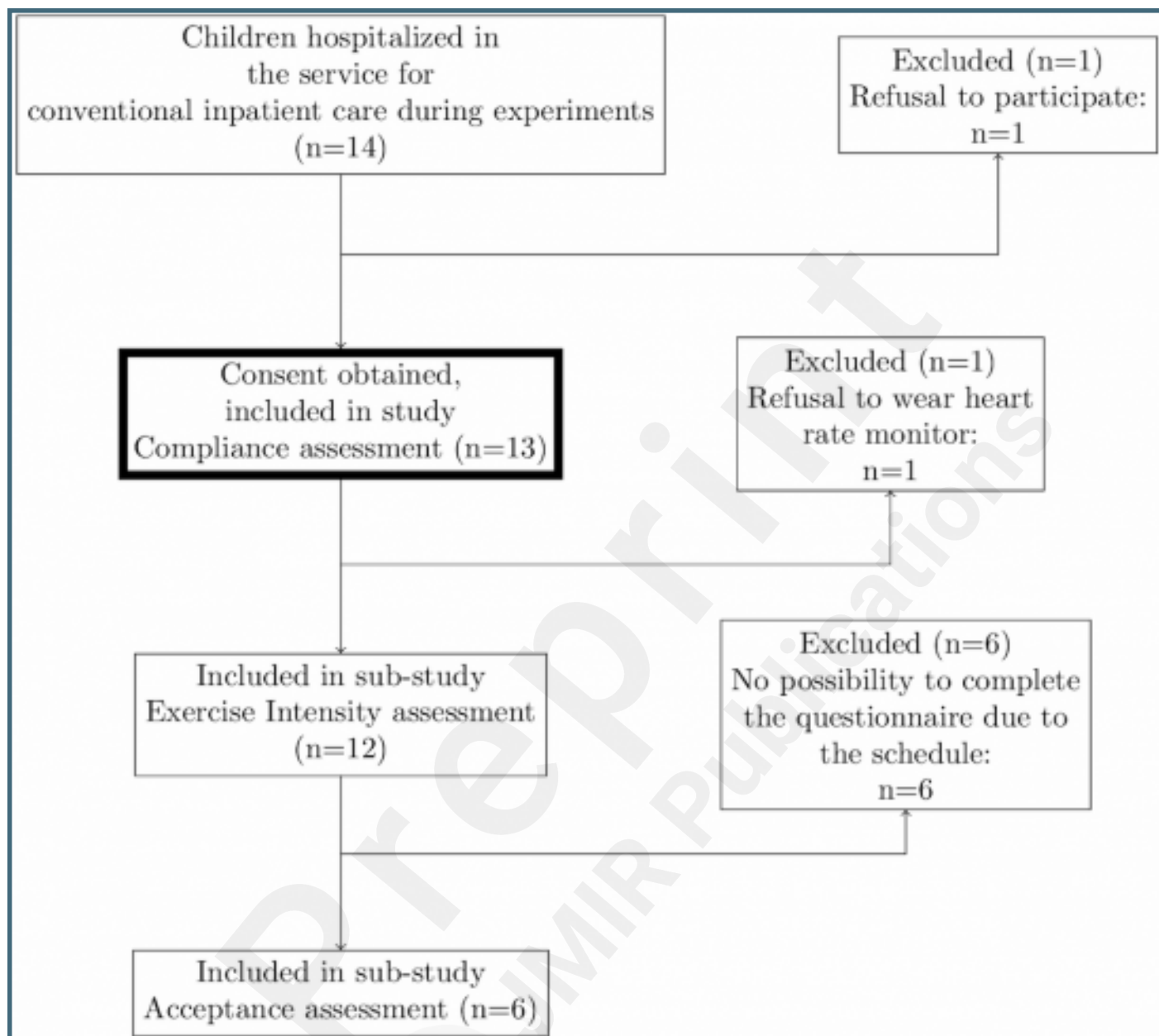
Supplementary Files

Figures

Evolution of practiced game sessions over the experiments.



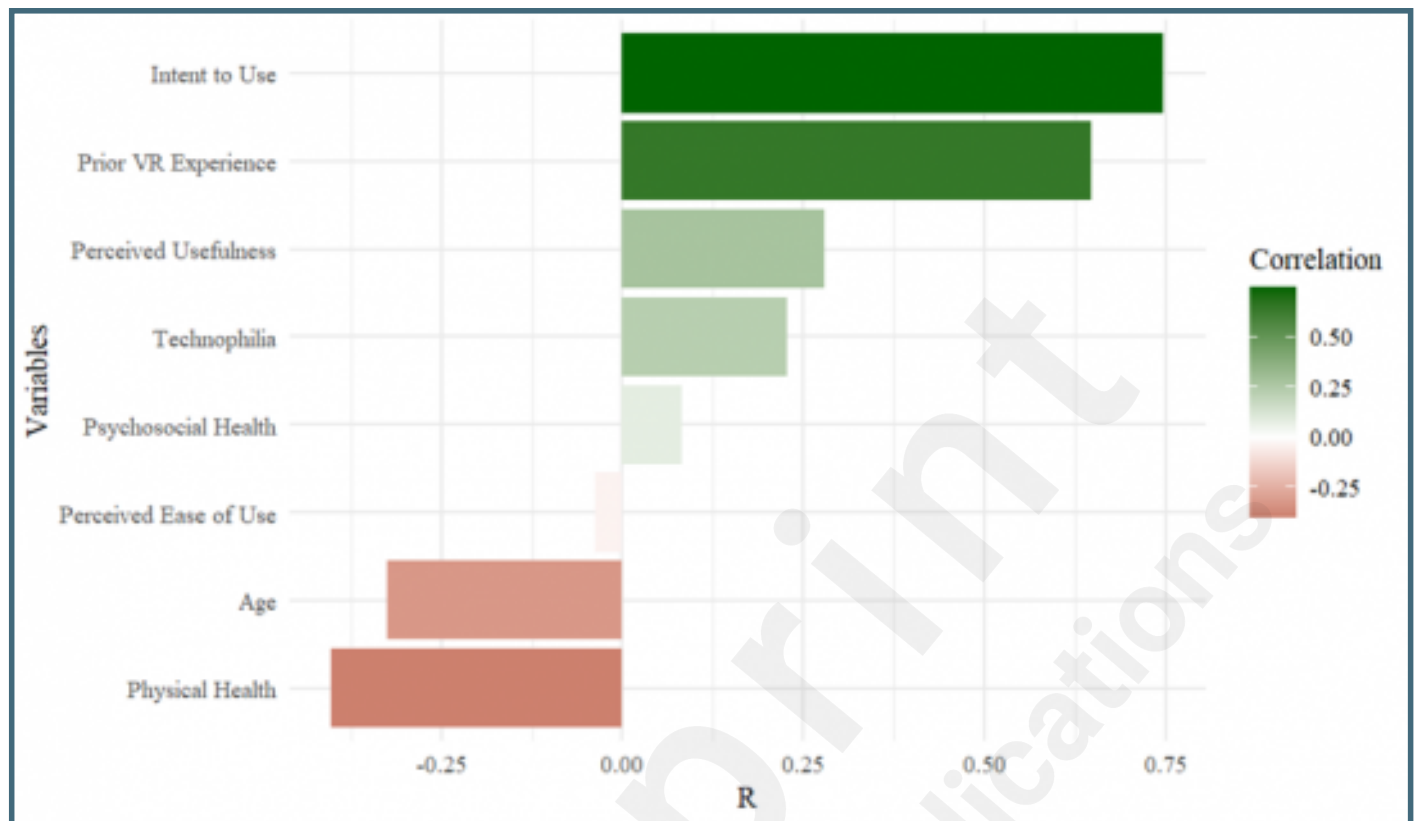
Flowchart of participants.



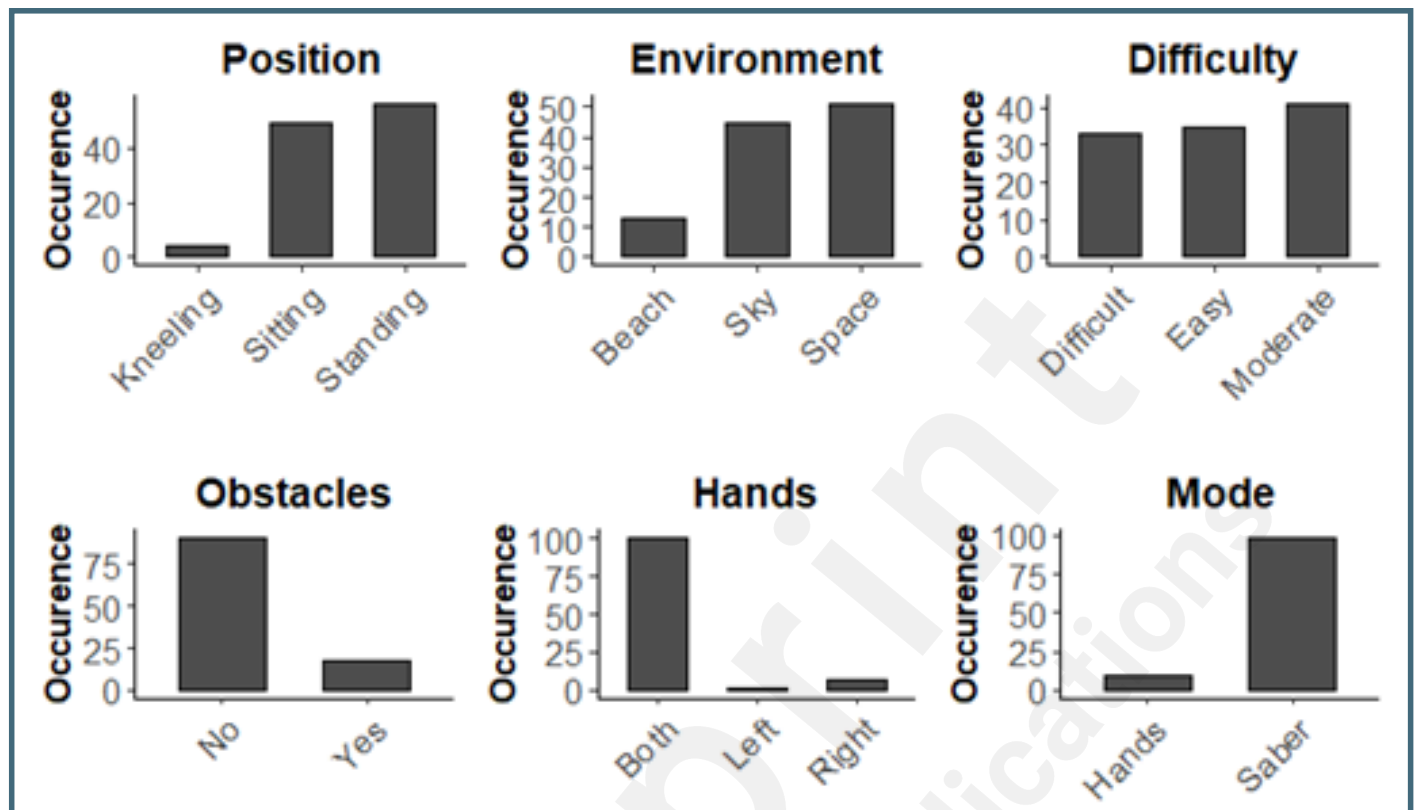
Left: Example of a child playing the proposed VR-based exergame; right: visual of the VR-based exergame (with the options : position “standing”, difficulty : “hard”, active limbs “both”, obstacles “with”, game mode “saber” and visual environments “Space”).



Spearman's correlations barplots of Compliance.



Game options during the game sessions.



Boxplots of options' influence on Heart Rate (topline) and Intensity in MET value (bottom line).

