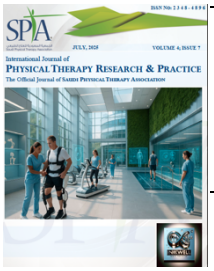

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Original Article

Evaluating the Feasibility and Acceptability of Nintendo Switch-Based Exergaming for Enhancing Physical Activity in Children with Down Syndrome: A Pilot Study

Afaf A. M. Shaheen[1,2], Safia Darweesh Halwsh[1], Samiah Alqabbani[3], Maha F. Algabbani[1]*

[1.] Department of Rehabilitation Health Sciences, College of Applied Medical Sciences, King Saud University, Riyadh11433, Saudi Arabia.
[2.] Faculty of Physical Therapy, Basic Sciences Department, Cairo University, Cairo, Egypt.
[3.] Department of Rehabilitation Sciences, College of Health and Rehabilitation Sciences, Princess Nourah Bint Abdulrahman University, Riyadh 84428, Saudi Arabia.

*Corresponding Author: maljahni@jazanu.edu.sa

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Abstract

Objective: Nintendo Switch-based exergaming is increasingly used in therapeutic settings. This study aimed to determine whether selected Nintendo Switch games are feasible and engaging for children with Down syndrome (DS). **Methods:** This interventional pilot study included a convenience sample of 11 children diagnosed with DS. it involved a 40-minute exergaming session using a Nintendo Switch console with ten games (two sports and eight Family Trainer) that required weight shifting and stepping tasks based on previous studies. After the session, the validated Video Game Applicability Questionnaire was used to evaluate usability, engagement, and enjoyment of the selected games using a five-point visual Likert scale. **Results:** Data from 11 children (7 females), aged 10.45 ± 1.75 years, were analyzed. Games such as Timber Trail (M = 4.96, SD = .07), Log Leaper (M = 4.94, SD = .12), Jump Rope (M = 4.92, SD = .12), Sprint Challenge (M = 4.90, SD = .18), and Head on Hurdler (M = 4.90, SD = .18) received consistently high ratings for usability, engagement, and enjoyment, while others such as Mine Cart Adventure (M = 1.16, SD = .40), Mountain Boarder (M = 1.32, SD = .28), Mole Madness (M = 1.77, SD = .97), Golf (M = 1.77, SD = .76), and Soccer (M = 2.19, SD = .44) were rated lower scores across all domains. **Conclusion:** Several games showed potential for therapeutic exergaming in children with DS, emphasizing the need for further research and long-term trials.

Keywords: Exergaming; Nintendo; Down syndrome; Applicability; Video game, Motor Function.

Introduction

Down syndrome (DS) is a chromosomal disorder characterized by an extra copy of chromosome 21, either in its entirety or partially, resulting in 47 chromosomes instead of the typical 46. It results in a spectrum of intellectual and physical challenges that vary in severity among individuals with this

genetic anomaly (Esbensen et al., 2024). Down syndrome affects approximately 6–6.7 individuals per 10,000 live births in the U.S. and Europe (Antonarakis et al., 2020).

Children with DS frequently encounter motor difficulties that result in delayed skills, balance issues, and poor coordination, which can hinder their participation in regular physical activity (PA). This activity is essential for promoting physical health, social inclusion, and cognitive development (Esbensen et al., 2024).

Exergaming, which refers to interactive video games that involve physical movement, has become a popular tool for supporting therapeutic interventions in children with developmental disabilities, such as DS (Alba-Rueda et al., 2022; Álvareza et al., 2018; Corey et al., 2025; Timaná Sr et al., 2024). By integrating engaging gameplay with structured PA, exergaming provides a motivating and accessible way to encourage exercise and enhance motor development in this group (Prena & Sherry, 2018).

The Nintendo Wii, launched in 2006, was one of the first gaming platforms widely used for therapeutic purposes, especially for children with motor impairments (Gras et al., 2009; Halton, 2010; Parker, 2007). Its motion-sensing Wii Remote and Balance Board allowed players to translate real-life movements into game actions. Studies have shown that games like Wii Sports (e.g., bowling, tennis, boxing), Wii Fit (including yoga, strength training, and balance activities such as Tightrope Walk or Ski Slalom), and Just Dance can improve balance, postural control, gross motor function, and coordination in children with DS, making therapy more engaging and consistent (Alba-Rueda et al., 2022; Álvareza et al., 2018; Berg et al., 2012; Ghafar & Abdelraouf, 2017; Rahman & Rahman, 2010).

Released in 2017, the Nintendo Switch has become a leading exergaming platform following the discontinuation of the Wii (Nintendo UK). It offers high-definition graphics, portable play, and advanced motion-sensing capabilities through its Joy-Con controllers. Fitness-focused titles such as Nintendo Switch Sports—the successor to Wii Sports—and Family Trainer promote physical activity through full-body movements in games like tennis, bowling, volleyball, soccer, rafting, and obstacle courses. These interactive experiences help develop balance, coordination, and cardiovascular fitness in an engaging, family-friendly environment (Nintendo Official Site).

Despite the established benefits of exergaming via Wii to improve motor skills, balance, and engagement in children with DS through exergaming (Alba-Rueda et al., 2022; Álvareza et al., 2018; Berg et al., 2012; Ghafar & Abdelraouf, 2017; Rahman & Rahman, 2010), there is a scarcity of empirical studies evaluating the feasibility and appropriateness of Nintendo Switch-based games for children with DS. Before evaluating the effectiveness of Switch-based interventions, it is crucial to assess their feasibility and suitability to identify appropriate games that align with the unique needs of children with Down syndrome. This foundational step ensures that therapeutic programs are both accessible and engaging, laying the groundwork for successful implementation and long-term benefits.

Therefore, this pilot study aimed to evaluate the feasibility and appropriateness of selected Nintendo Switch-based exergaming interventions for children with DS, as a preliminary phase of a larger randomized controlled trial.

Methodology

Participants and Study Design

This single-group feasibility pilot study was conducted in September 2024 at the Voice of Down Syndrome Association and the Down Syndrome Charitable Association centers in Riyadh, Saudi Arabia.

The study included children (both boys and girls) aged 8–14 years with a confirmed diagnosis of DS who were able to understand and follow verbal instructions. Children were excluded if they had an intellectual disability with an IQ below 50,

significant chronic medical conditions (e.g., uncontrolled heart disease, severe respiratory issues), or recent musculoskeletal injuries affecting mobility. A convenience sample of 11 participants (7 girls) was recruited for the study, which was an appropriate sample size for a pilot study (Sukserm, 2024).

Outcome Measures

The applicability of Exergaming was assessed, using the Arabic Video Game Applicability Questionnaire (Shaheen et al., 2023). A questionnaire was administered to the child by the researcher during an interview. The validated rating scale has seven statements: two on usability (the games are easily usable, and it was easy to use the board and controllers according to the avatar), three on engagement (I didn't want to stop playing, I lost track of time as I play and I can't tell that am getting tired while playing the game), and two on enjoyment (the games were fun, and I liked the character and graphics). Participants responded by selecting smiley faces rated from one (strongly disagree) to five (strongly agree) on a five-point visual Likert scale. The questionnaire was completed immediately after the game session ended. The final questionnaire score was calculated by averaging the total scores from the three sections.

Procedure

The session took place in a quiet, private classroom with a 45-inch TV screen positioned on a table. The Nintendo Switch was set up, with two controllers: one strapped to the participant's leg and the other held in their hand. In a 40-minute exergaming session, participants played all ten games consecutively.

Before the session began, participants were introduced to the components of consoles and joysticks, and the concept of playing was explained. Each game lasted two minutes, except for the golf game, which ranged from two to five minutes depending on the child's speed in completing three holes, with 30-second rest intervals between games.

To ensure children's safety, signs of exhaustion, pain, or dizziness were closely monitored. Heart rate (HR) was measured at the beginning of the session using an infrared pulse oximeter (Beurer Pulse Oximeter 40, Beurer GmbH, Germany) placed on the children's right index finger. The predicted maximum HR was calculated using a specific formula for children (208 - 0.7 × age) (Machado & Denadai, 2011). During the session, HR was monitored to ensure that the child did not exceed their maximum heart rate. The session ended if any signs of pain, fatigue, or discomfort appeared.

Ethical Considerations

The study received approval from the Institutional Review Board on March 18, 2024. Before the study began, legal guardians provided written informed consent, the children gave assent, and the center's administration granted permission.

Statistical analysis

Data analysis was conducted using IBM SPSS Statistics software (Version 30.0). Descriptive statistics were used to analyze participants' responses to the Arabic version of the Video Game Applicability Questionnaire across three domains: usability, engagement, and enjoyment. Frequencies and percentages were calculated for each Likert-scale response (ranging from strongly disagree to strongly agree) for all ten Nintendo Switch games. Additionally, mean scores and standard deviations were computed to provide a summary measure of each game's overall applicability across domains. For descriptive purposes, means and standard deviations are reported for Likert scale items; however, the ordinal nature of these data is acknowledged This approach allowed for the identification of highly rated games based on consistent participant feedback and the detection of variability in responses, as reflected in the standard deviation values. Given the small sample size (n = 11) and the exploratory nature of this pilot study, inferential statistics such as ANOVA or the Friedman test were

not conducted, as the focus was on generating preliminary data and identifying trends rather than testing specific hypotheses.

Results

A total of 11 children with DS participated in this study (7 females) with a mean age of 10.45±1.75. No child complained of pain, dizziness, or general discomfort during the session, and heart rates did not exceed their maximum recommended levels.

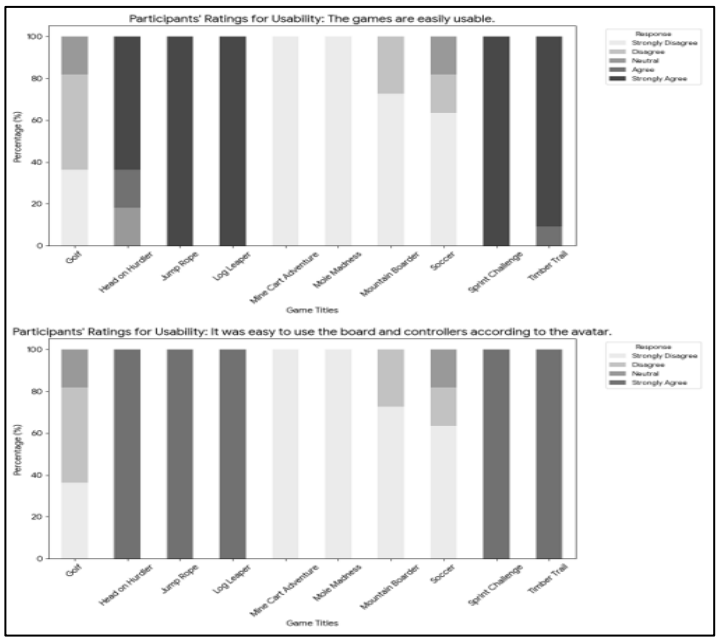

Figure 1. Participants' ratings of the Usability for each game.

Figure 1 presents participants' usability ratings. Games such as Sprint Challenge, Log Leaper, Jump Rope, and Timber Trail received positive ratings, with most participants strongly agreeing that the games and controllers were easy to use. In contrast, Mole Madness, Mine Cart Adventure, Mountain Boarder, Soccer, and Golf were received lower usability scores, with most responses indicating strong disagreement with the gameplay interface and controls.

Figure 2 highlights the engagement responses, similarly showing that Log Leaper, Sprint Challenge, Jump Rope, Timber Trail, and Head on a Hurdler were the most engaging. A significant portion of participants reported not wanting to stop playing and feeling energized rather than tired. In contrast, Mine Cart Adventure, Mole Madness, Mountain Boarder, Soccer, and Golf had low engagement scores.

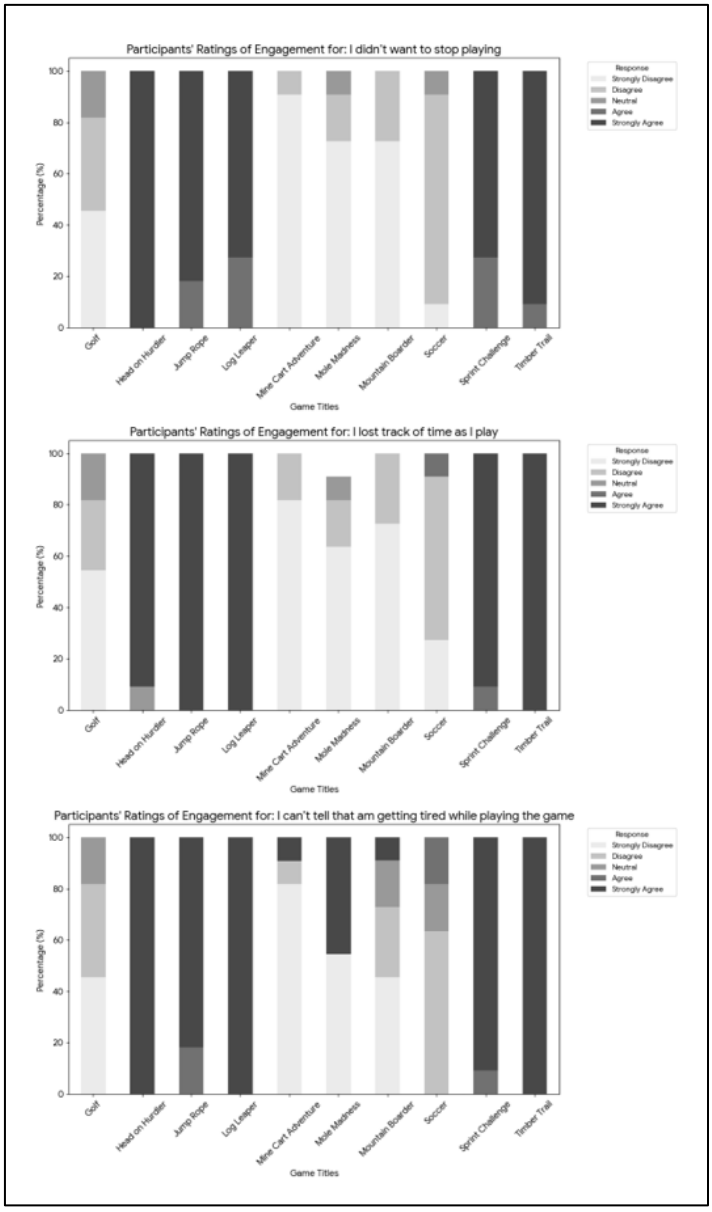

Figure 2. Participants' ratings of the Engagement for each game.

Finally, Figure 3 indicates that Log Leaper, Timber Trail, Jump Rope, Sprint Challenge, and Head on Hurdler were perceived as the most enjoyable. On the other hand, Mine Cart Adventure, Mole Madness, Mountain Boarder, Soccer, and Golf received mostly negative ratings in this domain.

The analysis focused on the survey responses and performance metrics of these 42 participants, who completed the Grooved Pegboard Test under

fatigue conditions. This test assessed fine motor skills and cognitive performance. The accompanying survey, illustrated in Figure 1, aimed to evaluate participants' subjective experiences, focusing on their engagement, the impact of fatigue, and perceived changes in performance. Participants rated their experiences using a Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The survey statements addressed key areas, including engagement with the task, the difficulty encountered, the effect of fatigue on performance, and their willingness to participate in future tests.

The collected data provide valuable insights into the influence of fatigue on cognitive and motor tasks. These findings contribute to understanding how fatigue impacts performance and inform potential interventions for improving outcomes. A summary of survey responses for each statement is presented in Figure 1.

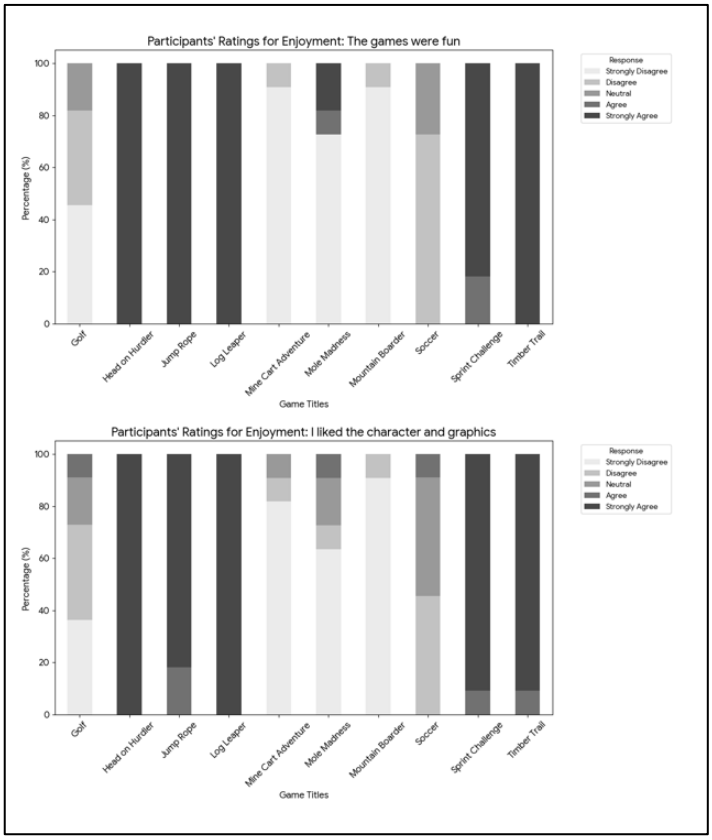

Figure 3. Participants' ratings of the Enjoyment for each game.

Table 1 displays the mean scores and standard deviations for the Nintendo Switch games, reflecting participants' ratings of usability, engagement, and enjoyment on a 5-point scale. The highest-rated games were Timber Trail (M = 4.96, SD = .07), Log Leaper (M = 4.94, SD = .12), Jump Rope (M = 4.92, SD = .12), Sprint Challenge (M = 4.90, SD = .18), and Head on Hurdler (M = 4.90, SD = .18), all of which received consistently high ratings with minimal variation among participants. In contrast, the lower-rated games—Mine Cart Adventure (M = 1.16, SD = .40), Mountain Border (M = 1.32, SD = .28), Mole Madness (M = 1.77, SD = .97), Golf (M = 1.77, SD = .76), and Soccer (M = 2.19, SD = .44)—received less favorable ratings, with Mole Madness and Golf showing higher standard deviations, indicating mixed user experiences. Overall, the results consistently highlight a subset of games that were well-received across all domains, demonstrating strong potential for exergaming use in children with DS.

Table 1. Mean scoring of the exergaming applicability questionnaire.

Nintendo Switch game titles	Mean	Std. Deviation
Sprint challenge	4.90	.18
Log leaper	4.94	.12
Timber trail	4.96	.07
Jump rope	4.92	.12
Mole madness	1.77	.97
Mine cart adventure.	1.16	.40
Head-on hurdler	4.90	.18
Mountain boarder	1.32	.28
Soccer	2.19	.44
Golf	1.77	.76

Discussion

This pilot study investigated the usability, engagement, and enjoyment of selected Nintendo Switch exergames in children with DS. Unlike previous research focused on the Wii platform, this study is one of the first to evaluate Nintendo Switch games specifically designed to align with the motor

and cognitive profiles of children with DS. The results identified a subset of games—*Timber Trail*, *Log Leaper*, *Jump Rope*, *Sprint Challenge*, and *Head on Hurdler*—that were consistently rated highly across all domains, suggesting their potential suitability for therapeutic and recreational use in this population.

Positive usability feedback aligns with existing research on motion-based gaming systems such as the Nintendo Wii, which has proven effective in enhancing motor learning and physical activity among children with developmental disabilities, including DS. For instance, Álvareza et al. (2018) engaged participants (mean age 8.30 ± 2.06 years) in Wii Fit exergames, including Snowboarding, Penguin Slide, and Ski Jumping, using the Wii Balance Board (Álvareza et al., 2018). Similarly, Ghafar and Abdelraouf (2017) employed Wii Sports and Wii Fit, incorporating games such as Football Heading and Ski Slalom for their experimental group (mean age 7.18 ± 1.85 years) (Ghafar & Abdelraouf, 2017). Rahman (2010) focused on balance-oriented Wii Fit games such as Tightrope Walk and Soccer Heading (mean age 10.92 ± 1.16 years) (Rahman & Rahman, 2010), while Wuang et al. (2011) utilized Wii Sports Resort and Just Dance 2 for aerobic endurance training in children aged 7–12 years (Wuang et al., 2011).

Engagement ratings were particularly high for *Timber Trail*, *Log Leaper*, *Jump Rope*, *Sprint Challenge*, and *Head on Hurdler*, with many participants reporting a loss of time awareness and minimal perceived fatigue during gameplay. This aligns with Berg et al. (2012), who found that exergaming enhances intrinsic motivation and adherence to physical activity through immersive, gamified design. Notably, children with DS demonstrated heightened engagement when games incorporated strong visual appeal, immediate feedback, and straightforward instructions—features well-represented in the top-rated games of this study (Berg et al., 2012). These findings support Michalsen's (2024) emphasis on clear, visually stimulating, and responsive gameplay as critical for sustaining focus and participation in this population (Michalsen, 2024).

Enjoyment ratings further validated the applicability of selected games. High-scoring games shared key characteristics: engaging graphics, responsive controls, and meaningful interactivity. This consistency with Prena and Sherry's (2018) research, which examined parental reports on video game preferences in children with DS, reinforces that rewarding challenges and immersive game worlds are primary motivators(Prena & Sherry, 2018).

Their work highlighted that children with DS frequently gravitate toward action/adventure games, where achievement and in-game rewards drive sustained participation. Given that enjoyment and engagement are strong predictors of long-term adherence, these elements are especially vital for promoting physical activity in children with limited access to traditional exercise due to motor or cognitive barriers.

Conversely, games such as Mine Cart Adventure, Mole Madness, Mountain Boarder, Soccer, and Golf received low usability and engagement ratings. This disparity underscores that not all exergames are equally suitable for children with DS, emphasizing the need to prioritize titles with intuitive mechanics and sensory compatibility with this population's abilities.

Limitations and Future Directions

While this pilot study provides valuable insights into the feasibility of using exergames for children with developmental disabilities, several limitations should be noted. First, the small sample size though and the method of sampling (convenience), typical for feasibility studies, limits the diversity of perspectives and may not capture all potential usability challenges. Second, the short-term nature of the intervention allowed only a preliminary assessment of engagement and accessibility, leaving long-term adherence unexplored. Third, reliance on subjective feedback (e.g., user preferences) without complementary objective data (e.g., gameplay analytics or instructor observations) may overlook subtle practical

barriers. Additionally, the study tested a limited selection of exergames, which may not represent the full range of technical or physical demands encountered in real-world settings. Future feasibility research could address these limitations by incorporating mixed-methods data (e.g., system logs + user interviews), broader game selections, and iterative testing to refine protocols. It's also important to note that children's self-reported engagement and enjoyment may be influenced by social desirability bias, potentially leading to overly positive responses due to the novelty of the activity or a desire to please the adult facilitators in the small-group pilot setting.

Conclusion

This pilot study highlights the feasibility of integrating carefully selected Nintendo Switch games into exergaming interventions for children with DS. When appropriately chosen, these games offer high usability, engagement, and enjoyment—key components of effective interventions. These findings will inform the design of a larger RCT and contribute to the growing body of evidence supporting inclusive digital health tools for children with developmental disabilities.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountabilities for all aspects of the work.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

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Conflicts of Interest

The authors declare no potential conflicts of interest related to the research, writing, or publication of this work.

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