CRITICALLY APPRAISED TOPIC

**TITLE**

Effectiveness of the Nintendo Wii--gaming system on gross motor function and functional mobility in children with cerebral palsy.

**AUTHOR**

<table>
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<tr>
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<th>Date</th>
<th>09/29/14</th>
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<tbody>
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<td>Review date</td>
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**CLINICAL SCENARIO**

Cerebral palsy (CP) is an overarching term to describe several different disorders as a result of brain damage that occurs in children before, during or shortly after birth (Lane & Bundy, 2011). Cerebral palsy is the most common motor disability in children. The Center for Disease Control and Prevention (CDC) estimates that 1 in 323 children in the United States has CP. Children with CP typically experience difficulties with postural control and motor abilities (Ramstrand & Lygnegard, 2012). While CP is a non-progressive disorder, secondary complications such as joint contracture and respiratory limitations often deteriorate children’s abilities over time (Lane & Bundy, 2011).

The Nintendo Wii--gaming system has become increasingly popular in the United States (Taylor et al, 2011). The Wii system consists of a combination of a Wii remote and balance board. The Wii remote translates body movement to an avatar for onscreen movement. The balance board is used during a variety of games to record motor abilities such as balance, fitness and strength. (Deutsch et al, 2008). Wii has been studied in rehabilitation to address issues regarding depression, cerebrovascular accidents, motor disabilities, cognitive impairments, stroke rehabilitation, visual processing and pediatric disorders (Pessoa et al, 2013). Research has shown that Wii has the potential to be an effective adjunctive treatment for the promotion of recovery in motor rehabilitation (Pessoa et al, 2013). Essential components of effective motor learning which are valuable to occupational therapist are the child’s active participation in therapy and the goal-oriented movement, which is elicited by playing an interactive game (Jelsma, 2013). Wii may contribute to the rehabilitation of children with CP by improving their musculoskeletal and neurological conditions by redirecting focus away from repetitive and mundane exercises to fun and competitive activities (Tarakci, 2013). However, we lack a review of the existing evidence to understand the contribution of the Wii--to motor recovery in children with CP.

**FOCUSED CLINICAL QUESTION**

What is the effect of a Wii-based training program on gross motor function and functional mobility in children with cerebral palsy?

**SUMMARY OF SEARCH**

This review consists of 4 articles that look at the impact of Wii in the rehabilitation of children with CP. The first study investigated the impact of Wii as a balance therapy for children with ambulatory cerebral palsy. They found that Wii is an effective tool to be added to conventional treatment to improve static balance of children with CP (Tarakci, OzDincler, Tarakci, Tutuncuoglu & Ozmen, 2013). The second study focuses on the effect of Nintendo Wii Fit on balance and gross motor function for children with spastic hemiplegic cerebral palsy. Results of the study showed that effects from the Wii does not translate into functional gains, thus Wii should only be used in conjunction with traditional therapy (Jelsma, Pronk, Ferguson, & Jelsma-Smit, D, 2012). The third study examined the likelihood that Nintendo Wii can be a rehabilitation tool for gross motor function of children with cerebral palsy in developing countries. Results showed that it has the potential to be an effective tool for rehabilitation (Gordon, Roopchand-Martin, & Gregg, 2012). The last study interpreted the feasibility and outcomes of Wii as an additional instrument in rehabilitation of an adolescent with cerebral palsy. The study found that Wii is a practical, effective tool to address impairments associated with CP (Duetsch, Borberly, Filler, Huhn, & Guerrera-Bowlby, 2008).

**CLINICAL BOTTOM LINE**

Evidence suggests that a Wii-based training program is an effective and motivational adjunct to the rehabilitation of children with CP. However, there is not evidence to support the use of Wii as the primary or only intervention for improving gross motor function and functional mobility in the child’s rehabilitation.
Important note on the limitation of this CAT

This critically appraised topic has been peer-reviewed by one other faculty member.

SEARCH STRATEGY

Terms used to guide the search strategy

- **Patient/Client Group:** Children and adolescents with CP under the age of 18
- **Intervention (or Assessment):** Wii based training program
- **Comparison:** N/A
- **Outcome(s):** gross motor function and functional mobility

<table>
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<tr>
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INCLUSION and EXCLUSION CRITERIA

**Inclusion Criteria**

Participants were children and adolescents with CP under the age of 18. Wii training system was the primary intervention for motor issues. Outcome measures were focused on motor and balance abilities.

**Exclusion Criteria**

Mixed samples that had children not diagnosed with CP.

RESULTS OF SEARCH

A total of 12 relevant articles were located and categorized based on the American Occupational Therapy Association Literature Review Project for OT outcomes research where:

<table>
<thead>
<tr>
<th>Design Level</th>
<th>Sample Size Level</th>
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<td>I=Randomized control trial/Systematic review</td>
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<tr>
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<td>B=n &lt;20</td>
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<td>III=Non-randomized control trial, one group, pretest-posttest</td>
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<tr>
<td>IV=Single-subject design</td>
<td></td>
</tr>
<tr>
<td>NA=Narratives, case studies</td>
<td></td>
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<tr>
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**BEST EVIDENCE**

The following studies/papers were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

- The studies focused on children and adolescents under the age of 18 and were diagnosed with CP
- The intervention consisted of Wii-based training program
- The outcome measures measured gross motor function and functional mobility

**SUMMARY OF BEST EVIDENCE**

*Table 2:* Description and appraisal of Tarakci et al. (2013), Jelsma et al. (2013), Gordon et al. (2012) and Duetsch et al. (2008).

**Study 1:** Tarakci, D., OzDincler, A., Tarakci, E., Tutuncuoglu, F., & Ozmen, M. (2013)
**Aim/Objective of the Study:**

To examine the effectiveness of a Wii-based training program on balance and walking abilities in children with cerebral palsy.

**Study Design**

A pilot study with pre-test/post test design. The Gross Motor Function Classification System Expanded and Revised (GMFCS-ER), one leg standing test, Timed Up and Go test (TUG), functional reach test (FRT), and 6-minute walking test were completed by authors of the study at pre and post test.

**Setting**

Department of Paediatric Neurology outpatient clinic, Faculty of Medicine and Istanbul University

**Participants**

26 participants were eligible for the study, 5 participants were excluded due to criteria, 2 participants did not receive allocated intervention, and 5 participants were lost to follow up. There were a total of 14 participants diagnosed with CP who completed the study. Subjects ranged in age from 5 to 17 years (mean age 12.07±3.36). There were 11 males, and 3 females in the study. 7 of the children had diplegic CP, 5 children had hemiplegic CP and 2 children had dyskinetic CP. Children with a diagnosis of CP were recruited for this study the Department of Paediatric Neurology outpatient clinic, Faculty of Medicine and Istanbul University, during December 2011 to June 2012. All patients’ intellectual disability was within the normal to mild range. The exclusion criteria for the study were as followed: presence of epilepsy, GMFCS-ER level 4 or 5, spasticity of 3 or more according to Modified Ashworth Scale in the lower extremities and inability to cooperate with exercise or measurement.

**Intervention Investigated**

**Control**

No control group.

**Experimental**

14 participants performed 40 minutes of Nintendo Wii Fit training activities twice a week for 12 weeks. Sessions occurred in darkened room where the Wii Fit image was projected on a wall. All patients were supervised by a physiotherapist during the sessions and assessed before and after the training program. The Wii balance board was used in each session to evaluate the patient's balance. The gaming system recorded patient's balance, demographics, weight, and a Wii Fit calculated age. Patients played four of the systems game each session, and the games were updated to higher levels each week. Each game was played a total of three times in one session. A table was provided to depict the therapeutic purpose of each Wii game used in the intervention.

**Outcome Measures (Primary and Secondary)**

The authors completed the Gross Motor Function Classification System Expanded and Revised (GMFCS-ER), one leg standing test, Timed Up and Go test (TUG), functional reach test (FRT), and 6-minute walking test at pre and post-test at the intervention site.

- The GMFCS-ER was used in the study to assess patient's gross motor level. The measure provided 5 levels of classification of gross motor function for children with CP. Class 1 indicates that the child is free to ambulate, class 2 indicates the child cannot run or jump, class 3 indicates the need for devices during ambulation, class 4 and 5 indicates the inability to ambulate. Both inter-rater and intra-rater reliabilities were good, inter-rater reliability (0.88) and intra-rater reliability (0.68). The GMFM is considered to be a useful and reliable instrument for assessing motor function in children with CP. (Nordmark, Hagglund, & Jarnlo, 1997).

- The one leg standing test was used as a balance assessment in the children’s postural stability, as well as indicative of possible functional decline. Physiotherapist instructed to stand on single for leg for as long as they could with their eyes open and recorded the duration of time. In children with CP, one-leg standing tests had moderate to good intersession reliability (ICC 0.56 to 0.99). One-leg standing test is considered to be reliable in children with CP. (Liao, Mao, & Hwang, 2001).

- The TUG was used to measure the children’s speed and balance during functional tasks. Children were seated in a chair with arms at the start of the measure and then instructed to get up and walk three meters at a comfortable pace, turn around and return to the chair to sit down. The duration of the time required to complete the task was recorded. Children were allowed to have one practice session before the actual test was recorded. Reliability of the TUG test was very high (ICC = 0.99) within session, and
The TUG can be a reliable measure for children with cerebral palsy. (Williams, Carroll, Reddihough, Phillips & Galea, 2005).

- The FRT was used to measure the children’s stability and predict the likelihood that the child is at risk for falling. The authors measured the distance that the children could reach forward without moving their feet and gave them a corresponding score the distance reached. FRT had excellent test-retest reliability (ICC > 0.95) and inter-rater reliability (ICC = 0.98-1.00). The FRT discriminate validity indicates that it can distinguish children with cerebral palsy with different GMFCS levels. (Gan, Tung, Tang, & Wang, 2008).

- The 6-minute walking test (6MWT) was used to measure the functional mobility status of the children. The children were instructed to walk a distance of 8 meters as many times as they could within 6 minutes. Children were notified at every minute and time was recorded with a stopwatch. A lap counter recorded the child’s distance they walked. The test-retest (ICC 0.98). The 6MWT is a reliable test for ambulatory children with cerebral palsy. (Mather, Williams, & Olds, 2008).

### Main Findings

Participants showed performance improvements in all outcome measures following the 12-week Wii-based training program. Specifically, the destabilizing forces of the Wii games improved the children’s dynamic balance on control of trunk and extremities through enhanced left and right transfers of body weight. The results of the study showed that there were statistically significant improvements in the balance parameters, FRT, TUG, and 6 minute walking test, as well as in all of the Wii Fit measures. (Table was taken from Tarakci, Ozdincler, Tarakci, Tutuncuoglu & Ozmen, 2013, p. 1126)

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>Pre-treatment Mean (SD)</th>
<th>Post-treatment Mean (SD)</th>
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<tbody>
<tr>
<td>One Leg Standing Test-R (sec)</td>
<td>6.60 (8.95)</td>
<td>7 (7.99)*</td>
</tr>
<tr>
<td>One Leg Standing Test-L (sec)</td>
<td>5.41 (6.43)</td>
<td>8.50 (9.36)*</td>
</tr>
<tr>
<td>Timed Up and Go Test (sec)</td>
<td>18.26 (4.22)</td>
<td>14.57 (5.39)*</td>
</tr>
<tr>
<td>Functional reach test (cm)</td>
<td>20.78 (9.09)</td>
<td>22.5 (10.75)*</td>
</tr>
<tr>
<td>6-Minute Walking Test (m)</td>
<td>312.71 (95.20)</td>
<td>333.42 (89.66)*</td>
</tr>
<tr>
<td>Wii Fit parameters</td>
<td></td>
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<tr>
<td>One Leg Standing Test-L (sec)</td>
<td>5.34 (4.59)</td>
<td>10.37 (2.07)*</td>
</tr>
<tr>
<td>Left Foot Stability (score)</td>
<td>5 (2.76)</td>
<td>18.35 (12.32)*</td>
</tr>
<tr>
<td>Wii age</td>
<td>44.64 (5.59)</td>
<td>38.42 (14.65)*</td>
</tr>
</tbody>
</table>

SD: Standard deviation, sec: second, cm: centimeter  
*Significantly different from pre-treatment p<0.05

The table above depicts the changes in outcome measures following the 12-week intervention. Measurements were assessed at pre-test and post-test. Effects were determined by the Mann-Whitney U test. Significance level was set at 0.05. Results indicate statistically improvements were made in all outcome measurements.

### Original Authors’ Conclusions

The authors found that the 12-week Wii-based training program was effective in improving the walking and balance abilities in children with cerebral palsy. Significant improvements were made within the balance parameters of the Wii Fit game, as well as during the functional mobility measures such as FRT, TUG and the six-minute walking test. Wii-Fit provides a fun and motivational way to increase motor function of children with CP, but more research needs to be done in the future to create evidence based guidelines for the of Wii in occupational therapy.

### Critical Appraisal

#### Validity

**Internal validity:**

There was no control group in this study, which threatens the internal validity of the study. There was not
information about a specific training for the interventionist, nor did it accurately describe how the training was conducted to the participants. The psychometric properties were not given for the outcome measures, which decreases the reliability and validity of the measurements and decreases the overall internal validity of the study. However, the quantitative data from the study was clearly defined and portrayed with numerous tables for each outcome measure to depict changes made during the study. Selection bias could be present due to the way the children were recruited into the study.

**External validity:**
The inclusion and exclusion criteria were clearly defined increasing the external validity of the study. Researchers provided thorough demographics and clinical features of each participant that strengthens the external validity of study. The sample size (n=14) was small, decreasing the validity of the study.

**Interpretation of Results**
The outcome of the study showed that significant improvements were made in gross motor function and functional mobility, as measured by the GMFCS-ER, TUG, FRT, one-leg standing test and 6 minute walking test. The article demonstrates that Wii-based training program is effective in improvement motor abilities of children with CP. However, several factors were present that decreased the internal and external validity of the study, thus, I would use this evidence with caution when working in this population.

**Summary/Conclusion**
The article supports the use of Wii-based training program with children with CP to increase functional mobility and gross motor function. It is a preferred form of treatment for children; however, findings do not support the use of Wii as the sole intervention. Follow-up measurements from the participants were unclear so the long-term effects are unknown.


**Aim/Objective of the Study/Systematic Review:**
To investigate the impact of Nintendo Wii Fit on balance and activity levels in children with spastic hemiplegic cerebral palsy.

**Study Design**
The authors utilized a single subject, single blinded design for this study. The AB research design used multiple subjects, repeated measures and multiple baselines that allowed the timing of the end of and intervention phase for one child to overlap with the beginning of an intervention phase for another child. Three multiple baseline measurements served as a stable baseline for the study and served as checkpoints to track changes in outcome measurements throughout the intervention. Subjects were randomly assigned to the timing of treatment by research assistants to allow researchers to remain blinded to the study.

**Setting**
School for children with special needs.

**Participants**
There were 18 children recruited for this study by physiotherapists at two universities focusing on children with the diagnosis of spastic hemiplegia cerebral palsy and functioning at level 1 or 2 on the GMFSC, indicating the ability to ambulate without mobility devices. Four children did not meet the exclusion criteria. Of the fourteen children, eight participants were males and eight participants were females. Ages ranged from 7 to 14 years old, with a mean age of 11.36. Exclusion criteria for this study were as followed: access to Wii Fit at home, impairments in vision or hearing, presence of epilepsy, and undergoing any orthopedic surgeries or serial plastering during time of intervention. Informed consent was given for all participants by their parents or legal guardians.

**Intervention Investigated**

**Control**
No control group.

**Experimental**
Fourteen children received 25 minutes of a Wii Fit intervention four times a week for three weeks. All children...
received three baseline measures during the first week of the study. Children were randomly assigned to two groups, which differed based on the start time of the intervention phase. One group started the intervention phase during week three of the study, while the other group started during week five. During the three-week Wii Fit intervention, children did not receive traditional therapy. Children would continue therapy for 30 minutes three times a week during baseline and after intervention phases. To ensure researchers remained blinded, all children were assessed once a week throughout the 9-week study, regardless of which intervention phase that child was currently partaking. Researchers would assess the children on the adapted subtest 5 and 6 of the BOT-2 and the TUDS test. A follow-up measurement was taken two months post intervention to see if improvements were on the outcome measurements were maintained.

The Wii Fit intervention included several games that focused on weight shift and balance but excluded the need for the children to use their hands. Children were instructed to remove shoes, socks and AFOSs before standing on the Wii Fit balance board. Researcher assistants operated the hand controller of the device for the children during the games. Researchers divided the games based on the primary direction it required the children to weight shift. Snowboarding games was used for anterior-posterior shift, skiing, penguin games and soccer was used for medio-lateral weight shifts, and bubble and hula-hoop games were used to assess multidirectional weight shift. Researchers established guidelines for the games to ensure that all children’s balance was properly assessed in all directions. Throughout the study, every session consisted of 2 different Wii Fit games that focused on different directional weight shifts. The children played each game for at least ten minutes during a session and each category of weight shift must have been played at least six times before the end of the study. Every game was played at least once throughout the intervention, and the same game was not allowed to be played in two consecutive sessions. The research assistants recorded the child’s game scores, gaming time, resting time and absenteeism.

### Outcome Measures (Primary and Secondary)

For the outcomes measures, the authors used subtests 5 and 6 of the Bruininks–Oseretksy test of Motor Performance 2 (BOT-2), which focused balance and running speed and agility (RSA) and the timed up and down stairs (TUDS).

- The BOT-2 was used to measure the children’s balance and gross motor function. Subtest 5 of the BOT-2 focuses on balance of the child and BOT-2 subtest 6 focuses on running speed and agility of the child. During typical BOT-2 assessments children are required to stand with their hands on their hips and keep their knees bent to 45 degrees for the assessment. Researchers modified this balance criterion of the BOT-2 to account the problems that children with hemiplegia have in controlling their affected extremities. Researchers stopped the timing of the assessment if the child’s supporting leg moved, the feet leg touched the floor or the child’s eyes opened during the items that required the child’s eyes to remain closed. The intra-class correlations between raters were tested by the researcher and pediatric physiotherapist prior to data collection of the study. There was absolute agreement definition for single measures and correlations were high (Subtest 5 balance: 0.990, 95% CIs 0.961–0.998, p<0.001; Subtest 6 RSA: 0.996, 95% CIs 0.984–0.999, p<0.001).

- The TUDS was used to monitor the children’s ability to control their posture. Children were instructed to ascend a flight of stairs (12-14 stairs) in a “quick but safe” manner, then turn around at the top of the stairs and descend in the same manner. Researchers recorded the amount of time it took the children to perform the task, from the word “go” to their return with both feet on the floor. The TUDS has high intra-rater, inter-rate and test-retest reliability with ICC of ≥0.94 in every case. The significant differences in TUDS scores between the functional levels groups of the Gross Motor Function Measure demonstrated the TUDS discriminant validity.

- The Modified Ashworth Scale also assessed muscle spasticity.
Main Findings

The participants in the Wii Fit intervention showed significant improvement in their balance performance; however, there were no significant changes in the RSA or the TUDS over the course of the intervention. Improvements of each outcome measurement are depicted in the table below. (Table taken from Jelsma, Pronk, Ferguson & Jelsma-Smit, 2013, p. 34)

![Graph showing balance improvement](image)

**Individual balance scores of BOT** (Table taken from Jelsma, Pronk, Ferguson & Jelsma-Smit, 2013, p. 31)

![Graph showing individual balance scores](image)

Figure 1: Scores on the Balance component of the BOTM for each child plotted against time in weeks (N=14). Intervention was initiated at data point 5 (note that this was a different week due to the randomisation of time of intervention) and withdrawn after data point 8.

Findings from the table above show that all but one child showed improvement in balance performance. Balance improvements were sustained two months post intervention.
Findings from the table above show that nine children demonstrated medium to large improvements on the RSA test and three children showed a decline in performance.

**Individual Running and Agility scores of BOT** (Table taken from Jelsma, Pronk, Ferguson & Jelsma-Smit, 2013, p. 33)

Figure 2 Scores on the Running and agility section of the BOTM for each child plotted against time in weeks (N=14 children). Intervention was initiated at data point 5 (note that this was a different week due to the randomisation of time of intervention) and withdrawn after data point 8.

**Individual timed scores of TUDS** (Table taken from Jelsma, Pronk, Ferguson & Jelsma-Smit, 2013, p. 33)

Figure 3 Scores in seconds on the TUDS for each child plotted against time in weeks (N=14 children). Intervention was initiated at data point 5 (note that this was a different week due to the randomisation of time of intervention) and withdrawn after data point 8.

Findings from the table above show that six children demonstrated medium to large improvements in TUDS, whereas six children showed deterioration in scores.

**Original Authors’ Conclusions**
The authors found that the children’s balance was improved after the 3 week Wii Fit training period, however there was not a significant improvement in the RSA or TUDS of the children. Balance improvements were maintained at the 2-month follow up. There was no correlation between increased time spent on the Wii to increased balance. Several of the children’s TUDS performances declined after the intervention. The deterioration of performances was hypothesized to be due to physical demands of the intervention affecting the children’s fitness levels, motivational may vary from test to test and responsiveness of TUDS over time. Authors also noted that most of the children showed a preference of the Wii Fit over traditional therapy to suggest that motivation is higher using Wii. However, since there was no evidence that Wii Fit performance can lead to increased function, Wii should only be used as an adjunct to traditional therapy.

Critical Appraisal

Validity

Internal validity:
The study used an AB, single subject blinded design with multiple subjects and baselines to compensate for the small sample size and lack of control group. The recruitment process for the participants were unclear and has the potential to threaten the interval validity of the study by creating a selection bias. The psychometric properties of each outcome measurement were included to increase the reliability and validity of the measures, which also increase the internal validity of the study. Participants did not participate in any additional therapies during the time of the intervention, which increases the internal validity of the study by decreasing confounding variables. The study performed several repeated measures throughout the study, which could lead to a training effect and result in a decrease in internal validity.

External validity:
The researchers remained blinded to the intervention phase by having the research assistants randomize participants to intervention groups, which increases the external validity of the study. The inclusion and exclusion criteria were clearly defined which also increases external validity. However, an SSRD yields only limited generalization to a broad population.

Interpretation of Results

The outcome of the study showed significant improvement in balance; however, improvements did not translate into an increase in the participant’s functional mobility according to the BOT-S or TUDS measures and even resulted in a deterioration of performance for some participants. The evidence should be used with caution due to threats to internal validity based on study design and recruitment process.

Summary/Conclusion

Wii has the potential to have a positive effect on children’s balance and motor abilities, but the article does not support the use of Wii-based training as the primary means for rehabilitation for children with CP. Findings may be skewed due to problems with interval validity presented in the study. Further investigations should be done to support the findings on this topic.


Aim/Objective of the Study/Systematic Review:
To examine the use of Nintendo Wii in rehabilitation for children with cerebral palsy in a developing country and determine its impact on gross motor function.

Study Design

A pre-test/post-test design was utilized in this pilot study. The University of the West Indies Ethics Committee granted approval for the study (Mona Campus). The Gross Motor Function Measure was used to assess participants before and after intervention. Participants were allowed to use the Wii twice before the start of the intervention to become familiar with how it works. The study was non-randomized and assessors were not blinded.

Setting

Sir John Golding Rehabilitation Center, Jamaica, West Indies.
Participants

There were a total of seven children diagnosed with dyskinetic CP recruited in the study. One participant dropped out during the fourth week of intervention due to disinterest from the parent. Of the six participants who completed the study, there were three males and three females. The ages ranged from 9 to 12 years old, with a mean age of 10.6 years. Three participants had impaired grip function and four participants were dependent on a wheelchair. All participants who completed the study attended every session for the six-week period. Inclusion criteria included diagnoses of cerebral palsy, cognitive ability to understand process and visible shoulder and elbow movement. Exclusion criteria included children participating in an exercise/rehabilitation program or diagnosed with additional medical problems that could affect participation. Participants were recruited from three different treatment centers in St. Andrew, Jamaica.

Intervention Investigated

Control

No control study.

Experimental

Six participants received 45 minutes of Nintendo Wii training program, 2 days a week, for 6 weeks. Before the start of the intervention, participants went through two practice session to get acquainted with the Wii system. Two therapists, who were familiar with GMFM, conducted the pre-test/post-test assessments. Wii training sessions were conducted by a physical therapy student with the supervision of a qualified therapist. Researchers made the following accommodations to enable participants to use the Wii system: participants who were dependent on a wheelchair were instructed to sit unsupported on a stool during the sessions, participants who were ambulatory were instructed to stand during the sessions and participants who had impaired grip were instructed to use a crepe bandage during sessions. The program began with Wii Sports Boxing game for all participants and then progressed to Wii Baseball and then to Wii Tennis once participant completed 90% of each game. The children with impaired grip were not able to play Tennis. The therapist did not provide any form of manual facilitation or guidance to the participants during the intervention.

Outcome Measures (Primary and Secondary)

The Gross Motor Function Measure was used to assess any changes in the children’s gross motor function throughout the intervention. The GMRM-88 is an observational tool that measures a child’s ability to move in different directions and change positions. A four-point scale is used to score children’s movement in different tasks. Dimension scores are turned into a percentage with the maximum possible score per dimension equally to 100. The average of the five dimension scores yield the total GMFM score. The 5 domains of the measure were crawling, kneeling, sitting, lying and rolling. A clinically significant change on the scale is 1%. The GMFM-88 has excellent psychometric properties, with a high test–retest, inter-rater and intra-rater reliability. The intra-class correlation coefficient is 0.88 to 0.99.

Secondary outcomes measures included the percentage of attendance records of children and ability to complete the entire session.

Main Findings

The participants showed changes in all domains of the GMFM following the 6-week Wii based training program. The table below depicts participants’ changes in the GMFM during the intervention. The crawling and kneeling scores improved for all participants. The domain with the greatest amount of change occurred in the sitting scores (SD 13.94), however researchers suggests that this is because children had the lowest scores in this domain at baseline. Rolling and lying domains showed minimal changes (SD 3.34), which could be the rest of high scores in this domain at baseline.

Pre- and post-test mean (SD) values for the Gross Motor Function Measure (GMFM)

(Table taken from Gordon, Roopchand-Martin & Gregg, 2012, Supplemental Materials Online)

<table>
<thead>
<tr>
<th>GMFM section</th>
<th>Subjects</th>
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<th>Mean (SD)</th>
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<tr>
<td>Original Authors’ Conclusions</td>
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<td>The authors found that Nintendo Wii can be a tool for rehabilitation in developing countries as all participants were able to attend and complete sessions. The gaming system could be modified to allow children with varying levels of impairments still successively participate in the game. The authors hypothesized that Wii has the potential to impact gross motor function but suggested the need for future clinical trials.</td>
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<tr>
<th>Critical Appraisal</th>
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<tr>
<td><strong>Validity</strong></td>
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<tr>
<td>Internal validity:</td>
</tr>
<tr>
<td>The design of this study was a pre-test/post-test design with no control group. The participants were chosen based on a convenience sample which could have created a selection bias and threaten the internal validity of the study. Psychometric properties of the outcome measurements were provided which increase the reliability and validity of the study and therefore increase the internal validity. The assessors of the study were not blinded which decreases the internal validity by creating the possibility of an internal bias. Participants were not participating in any additional therapies during the duration of the study, thus eliminating the potential for confounding variables.</td>
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<tr>
<td>External validity:</td>
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<tr>
<td>There was a clearly defined inclusion and exclusion criteria for the participants, which increases the study’s external validity. The study was completed with children from Jamaica so will have more limited generalization to children in the United States.</td>
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<tr>
<th>Interpretation of Results</th>
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<tr>
<td>The authors of this study found that Wii-based intervention was effective in improvement the gross motor function of children with CP. These results could have been skewed due several biases presented in the study that threatened its internal validity. The small sample size compromises the study's ability to generalize results to a larger population.</td>
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<tr>
<th>Summary/Conclusion</th>
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<tr>
<td>Due to several threats to the internal validity of the study, the evidence should be used with caution when applying the results to a broader population of children with CP. Further research is required before these findings can be substantiated.</td>
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**Study 4: Duetsch, J., Borberly, M., Filler, J., Huhn, K., & Guarrera-Bowlby, P. (2008)**

**Aim/Objective of the Study/Systematic Review:**
To identify the effects of a low-cost, commercially available gaming system (Wii) during rehabilitation of an adolescent with cerebral palsy.

**Study Design**

Retrospective and prospective case report. Wii intervention was planned prospectively but the researchers used patient’s existing chart data as a baseline for functional mobility. Outcome measures were assessed before and after intervention, with variability in timing dependent on each individual outcome measure. Postural control was measured 1 day after intervention, TVPS-3 was repeated 1 month following intervention and walking was assessed 3 months after intervention.

**Setting**

School-based setting for children with developmental disabilities.

**Participants**

The single participant for this case study was a 13-year-old male. He was diagnosed with spastic diplegic CP and delayed development. He was classified at level 3 on the Gross Motor Function Classification System, indicating that he could walk with assistive devices (bilateral ankle foot orthoses and posterior rolling walker). Inclusion criteria included adequate hand function to use the remote, gross motor skills for standing and sitting, and sufficient cognition to understand the process. He was recruited during summer session at school for children with developmental disabilities.

**Intervention Investigated**

**Control**

No control study.

**Experimental**

The participant received 11 Wii training sessions over 6 weeks, with sessions ranging from 60 to 90 minutes each. Authors used various Wii sports games to emphasize different functions per game. Trunk and upper extremity control was promoted in every game. Participants performed the games in both seated and standing positions. The duration of each game varied from 5 seconds to 5 minutes. The first 7 sessions focused on the participant learning how to use the system. During the 8th session, a typically developing child worked with the participant. The 11th session incorporated 2 to 3 person games. The authors adjusted positions, tasks and doses of treatments based on observations of participant’s performance. The intervention occurred in conjunction with the participant’s normal therapies.

**Outcome Measures (Primary and Secondary)**

Authors assessed the participant’s motor control with the Quality of Upper Extremity Skills Test (QUEST) and Gross Motor Function Measure (GMFM).

GMFM: The GMFM has high inter-rater and intra-rater reliability with (ICC = 0.92-0.99). Authors used subtests D and E of the GMFM. Sub-test D focuses on the standing ability of the participant and requires him to independently go from kneeling to standing, stand and then reach for items while standing. The raw score for subtest D is 12 with a total percentage of 30.77%. Subtest E focuses on the participant’s ability to walk, run and jump. The participant is instructed to walk forward, cruise, step over items, hump, and climb stairs. The raw score for subtest E was 21 with a total percentage of 29.17%. A score of 100% on subtests indicates that participants can perform all the activities independently.

QUEST: The QUEST has a high test-retest reliability (ICC=0.93-0.95) and inter-rater reliability (ICC=0.91). A score of 100% on sub-test of QUEST indicates perfect performance. Authors used subtests of the QUEST that focused on dissociated movements and grasp subjects. These measures are typically used to assess motor development prior to 18 months old, but were used based on the participant’s functional level. Within the dissociated movements subtest, the participant’s raw score was 95.31 with a standardized score of 90.62. Within the grasp subtest the participant’s raw score was 81.48 with a standardized score of 62.96.

The authors used retrospective data from the participant’s chart review to determine his functional mobility. The same rater conducted repeated measures from the participant’s therapy goals from 2 years prior to the intervention. The participants walked with forearm crutches a distance of 30 ft. with a physical therapist with moderate assistance. After intervention he walked 10 to 150 feet with forearm crutches with contact guard to minimal assistance.

Secondary outcome measures include the Test of Visual Perceptual Skills to assess motor free visual...
processing, and a Posture Score Analyzer to determine postural control.

**Main Findings**

The participant showed improvements in several outcome measurements following the Wii-based training program. The participant showed greater control of posture following the intervention. He was less dependent on walker for mobility and demonstrated more equal weight distribution and less postural sway. All domains of visual perceptual processing improved with the exception of the participant’s visual memory. The participant was able to ambulate greater distances to increase his functional mobility.

**Level of assistance during functional mobility** (Table taken from Deutsch, Borberly, Filler, Huhn & Guerrera-Bowlby, 2008, p. 1203)

![Graph showing level of assistance during functional mobility](image)

**Original Authors’ Conclusions**

The authors found that Wii is an effective tool to supplement the rehabilitation of children with cerebral palsy. It is a low cost, commercially available possibility that can help improved functional levels and reduces impairments associated with cerebral palsy.

**Critical Appraisal**

**Validity**

*Internal validity:*

Psychometric properties of the outcome measurements were provided which increase the reliability and validity of the study and therefore increase the internal validity. Functional mobility was assessed retrospectively using participant’s patient history records and then compared to prospective outcome measurements, which decreases the validity of findings. Outcome measurement timing was inconsistent and did not match baseline measurements.

*External validity:*

Study design was a case report, thus making it difficult to assign cause and effect. Generalization to a broad population from a case study is not appropriate which limits the application of this study.

**Interpretation of Results**

Due to the single subject research design, the validity of the findings from the study may be compromised and should not be generalized to all children with cerebral palsy. The retrospective design for outcome measures pertaining to measures involving functional mobility decreases the internal validity of the study.

**Summary/Conclusion**

The article purports the use of Wii-based training to increase gross motor function and functional mobility in children with CP but lacks a high level of evidence. Results should be generalized to wider population with caution. Further research is needed to verify this method.

**Table [x]:** Characteristics of included studies
<table>
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<tr>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
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<tbody>
<tr>
<td>[Tarakci et al., 2013]</td>
<td>[Jelsma et al., 2013]</td>
<td>[Gordon, Roopchand-Martin, &amp; Gregg, 2012]</td>
<td>[Judith E Deutsch, Megan Borbely, Jenny Filler, Karen Huhn and Phyllis Guerrera-Bowlby, 2008]</td>
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</table>

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<tr>
<th>Intervention investigated</th>
<th>Nintendo Wii Fit training program</th>
<th>Wii-based balance therapy</th>
<th>Nintendo Wii training program</th>
<th>Nintendo Wii training</th>
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<tr>
<td>Comparison intervention</td>
<td>None</td>
<td>None</td>
<td>None</td>
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<tr>
<td>Outcomes used</td>
<td>GMFCS-ER, one leg standing test, TUG, FRT and 6-minute walking test</td>
<td>Balance and RSA of BOT-2 and TUDS</td>
<td>GMFM-88</td>
<td>GMFM and QUEST</td>
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<tr>
<td>Findings</td>
<td>Effects of Wii training did not carry over into increased function performance.</td>
<td>Improvements of static balance in conjunction with traditional therapy.</td>
<td>Potential for positive impact on gross motor function</td>
<td>Improvements in functional levels and reduction in impairments</td>
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</table>

**IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH**

This critical appraisal included four studies that examined the effects of a Wii-based intervention on improving the gross motor function and functional mobility in children diagnosed with cerebral palsy. Information gathered from these articles found that there is promising, but limited evidence to support the use of Wii in the rehabilitation of children with CP. All four of the studies used Wii as intervention. All studies used either gross motor function or functional mobility as an outcome measurement. All studies found that Wii made improvements in children's motor abilities, however there is discrepancy regarding if these improvements have a lasting effect. One article found that the improvement gained by using Wii did not carry over into increased functional performance (Tarakci et al., 2013). Another article found that Wii is effective but should not be used as the primary therapy, but only in additional to traditional therapy (Jelsma et al., 2013). These findings suggest that Wii has the potential to be an effective rehabilitative tool, but future research is still required before Wii can be used in lieu of other therapy.

**Practice:**
Wii-based training program may contribute to improving a wide range impairments associated with cerebral palsy. It has been linked to improvements in balance, postural control, gross motor function, and functional mobility of children with CP. Cerebral palsy causes significant physical limitations in children that prevent them from partaking in many childhood games and activities. Wii generates a virtual reality where the children can perform tasks that are often similar to real world games and requires them to do so using body movements that mimic real world motions. This provides occupational therapists with a motivational tool to encourage the engagement and participation of children with CP. Wii is commercially available and can be utilized in many different rehabilitation settings. Wii-based training program does not yet have enough evidence to stand alone as the primary approach to improve gross motor function and functional ability in children and adolescents with CP. However, evidence shows that it is a safe, enjoyable and effective addition to the child’s rehabilitation. Occupational therapists and occupational therapy assistants should consider using Wii as an adjunct to traditional therapies when working with children diagnosed with cerebral palsy.

**Education:**
Wii and other virtual reality interventions should be included into the OT education process. Evidence suggests that Wii can be a beneficial intervention strategy to incorporate into practice. Children show increased levels of engagement during Wii that can lead to enhanced feelings of self-efficacy and motivation levels for future progress. As occupational therapists, our goal is to create an intervention that is both effective and engaging. It is important that the OT profession provides training regarding the method of use appropriate use of Wii, so future patients will receive optimal outcomes.

**Future Research**
Our findings suggest that we need more rigorous research on Wii gaming for children (≤18) with CP. Multi-site,
randomized controlled trials with detailed protocols outlining protocol and dosage are needed to guide practice. Knowing that the treatment of CP will likely include a multi-factorial approach, studies examining Wii alone and in conjunction with relevant interventions would also be useful in evaluating the evidence. Designs that capture the long-term effects of Wii are also necessary. Also, the current evidence was unclear about the specific techniques each assessor used when implementing Wii based training sessions with their participants. Research needs to be done on which techniques will yield the most effective outcomes, specifying the optimal duration of each training session and activities utilized in each session. Furthermore, additional research is needed to understand the impact that improved motor function via Wii gaming has on the child’s occupational performance.

REFERENCES


Shih, C.H., Shih, C.J., & Shih, C.T. Assisting people with multiple disabilities by actively keeping the head in an


