



## The effects of game therapy on the static and dynamic balance of 4-10-year-old children with spastic diplegic cerebral palsy

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Article Info	Abstract
<p>Original Article</p> <p><b>Article history:</b> Received: 19 August 2021 Revised: 25 August 2021 Accepted: 04 October 2021 Published online: 05 Decemner 2021</p> <p><b>Keywords:</b> dynamic and static stability, spastic paralysis, virtual reality.</p>	<p><b>Background:</b> Balance is a critical physical factor for achieving independence, and children with spastic cerebral palsy often experience motor and balance difficulties.</p> <p><b>Aim:</b> The aim of this study was to investigate the effects of game therapy on the balance of children with cerebral palsy, with a focus on basic abilities.</p> <p><b>Materials and Methods:</b> This study utilized a quasi-experimental design with a pretest-posttest controlled approach. Twenty children aged 4-10 years, diagnosed with spastic diplegic cerebral palsy with levels 1 and 2 according to SCFMG standards, with a minimum IQ of 80 (to be able to perform the required tasks), and possessing the basic ability to stand and maintain posture balance, as well as communicate and understand linguistic concepts, were randomly selected from rehabilitation clinics in Tehran. Subjects were randomly divided into the control and game therapy groups. The pediatric balance scale (PBS) test was used to evaluate the balance level using a WII device with a wireless controller and a motion controller. The exercise program consisted of nine different games targeting various areas with the common goal of improving the child's balance. After 20 game therapy sessions, (four 20-minute sessions per week,) tests were repeated in the post-test. The data were analyzed with tow way ANOVA Test and paired T-test by SPSS, 20.</p> <p><b>Results:</b> The results of the paired t-test indicate a significant improvement in static balance in the post-test for the game therapy group when compared to the pre-test (<math>P&lt;0.0001</math>). Moreover, the dynamic balance of the experimental group showed a significant improvement in the post-test when compared to the pre-test (<math>P=0.042</math>).</p> <p><b>Conclusion:</b> The study findings indicate that game therapy is a viable method for enhancing both static and dynamic balance in children with cerebral palsy. Given that the games used in the therapy are intended to be played at home with parental supervision, it is advised that these games be utilized to improve the balance of children with cerebral palsy.</p>

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## 1. Introduction

Cerebral palsy is a group of nervous system disorder that appears in infancy or early childhood and which constantly affect body movements and muscles coordination [1]. The first symptom of cerebral palsy may be a child's motor development delay (keeping balance, putting limbs in the right position, and walking abilities) [2]. It causes damage or disorder information of some brain parts; in fact, it is the same encephalopathy that is describe as a non-progressive disorder in body posture and movements [3]. Damage to the central nervous system may cause secondary injuries to children with CP, including physical spasm, amyotrophy/weak muscle tone, skeletal deformity, myasthenia, and developmental coordination disorder [4]. Cerebral palsy results from lesion incomplete brain, and it is relatively a common disorder (2-4 per 1000); the exact cerebral palsy prevalence in the world is three per 1000 live births and in premature infants [1, 5]. The number increases to 40-100 per 1000 live births, which is significant since the patient, their family, and a large part of society are involved in care and protection cycle [1, 5].

Most cases, except mild cases, identify in the first 18 months of life. Between January 2015 and May 2019, 2664 children were recruited from Bangladesh, Nepal, Indonesia, and Ghana (mean age [SD] at assessment: 7y 8mo [4y 8mo], 95% confidence interval 7y 6mo–7y 11mo; male [n=1615] 60.6%, female [n=1049] 39.4%). Overall, 86.6% children acquired CP prenatally and perinatally (e.g. preterm birth, birth asphyxia, neonatal encephalopathy). Median age at CP diagnosis was 3 years. Moreover, 79.2% children had spastic CP and 73.3% were classified in Gross Motor Function Classification System levels III to V [6].

Children with spastic cerebral palsy have many motor and balance problems [7]. Balance is one of the determinant primary components of independence but in cerebral palsy, the motor disorder is accompanies by poor balance [8]. Many of the children can be cared for in the warm environment of their homes. Children with mild disorders can have a useful and almost normal life; but children with severe disorders may need special care [9].

Currently, there is no complete treatment for cerebral palsy [10]. Among prevalent rehabilitation methods, therapists and specialists in this field have always considered game therapy [4]. Playing game has an effective role in a child's development [1] through which many specifications, problems, and a child's growth process can be realized [10]. In comparison with traditional game therapy, which is often repetitive, long-term, boring, and not measurable enough; New treatment methods such as virtual reality programs and virtual environment-based tasks like computer games, all of which are somewhat considered as biofeedback exercise, can be more effective [1, 4]. Compared with traditional schemes, VR game interventions can be performed in a smaller room, and the interaction of VR game device provides a challenging, encouraging, and safe environment, so children with CP who are often unwilling to receive traditional therapy may choose VR game treatment [4].

Pourazar, Bagherzadeh and Mirakhori (2021) showed improvement in balance test scores of 50 patients who were in the subacute brain stroke phase after intervention with Wii games [11]. Corbetta, Imeri and Gatti (2015) suggested that rehabilitation that incorporates virtual reality is more effective than standard rehabilitation for improving walking speed,

balance and mobility after stroke, others modified the test and demonstrated more significant improvement in the experimental group than in the control group [12]. On the other hand, one of the problems of families concerning children with polio is their transportation and independence, especially with the incidence of Covid-19. As this method of game therapy is accessible, safe, fun, and comprehensive, families can use it at home, without transportation, and help their kids to improve balance and basic abilities.

Since limited studies have been done in the field and previous research emphasized the use of such exercises, the purpose of the present study is to investigate the effect of game therapy on the balance of children with cerebral palsy, with an emphasis on basic abilities.

## 2. Materials and Methods

This study is a quasi-experimental and pretest-posttest methods applied in control and experimental groups. The study sample selected through spatial sampling. Subjects were 4-10- year- old children with spastic diplegia cerebral palsy levels 1 and 2, which has been selected randomly from Tehran's rehabilitation clinics with distribution of north-south-east-west and center according to inclusion and exclusion criteria. The sample included 17 children (game therapy: 4 girl; 4 boy and control: 5 girl; 4 boy), randomly divided into the control group and game therapy test group based on Swedish Classification of Functional Motor Gross (SCFMG) standard [13]. The participants accepted after having met the needed requirements: children with spastic diplegic cerebral palsy levels 1 and 2 based on SCFMG standards, ranging from 4 to 10 years old, being diagnosed by a pediatric specialist or neurologist, with minimum

IQ=80 (to be able to do required tasks), and with the basic ability to stand and maintain posture balance, and to communicate and understand linguistic concepts. The subject's parents completed the informed consent form, after that they took part in the study. Balance level evaluated through the Pediatric Balance Scale (PBS) test and its inter-rater reliability (ICC=0.99), as well as the test-retest reliability (ICC=0.99) [14] (Table 1).

**Table 1.** Pediatric balance scale (PBS) test

1	Seated position to standing position
2	Standing position to sitting position
3	Transfer
4	Standing without support
5	Sitting without support
6	Standing with eyes closed
7	Standing with your feet together
8	Standing with one foot in front
9	Standing on one foot
10	Rotating 360 degrees
11	Turning to look back
12	Picking up an object off the floor
13	Placing alternate foot on step/ footrest
14	Reaching forward with extended arm

A group of physicians, rehabilitation specialists, nurses, and child counselors for children supervised the procedure of testing. The occupational therapist was responsible for explanation the items of the PBS test for children, test performance, scoring the test and maintaining security and comfort for the children. Each item scored on a scale of 0 to 4. In the beginning, each item requested from the child and then given her/him only one opportunity to practice the item before real performance. During the practice, the occupational therapist provided physical help and/or visual or auditory hints, if needed, to make sure that the child totally understands what he/she is supposed to do. On average, each child needed 15 min to completely finish the test. The setting of the test environment

was a quiet room with appropriate ambience within The Rehabilitation Centers, and away from physical obstacles. The area of assessment fixed during the number of evaluations [14].

Wii device used to perform game therapy protocol. The device has a wireless controller and a motion controller. Wii fit controls body movements while playing and should be installed opposite the participant. This device uses a device like a screen monitor, simulating different motions of aerobics such as yoga, martial movements, and balance. The device has other parts, including the guitar, the Nunchuk, Wii wheel, used for different

aims. In the present study, Wii fit (Wii balance) was used. Game techniques are applied actively by the Wii device. This game therapy method was based on computer games using (a Wii fit) balance board and emphasized body movement coordination with the screen [15].

In the current study Wii fit and DVD were used. The exercise program included nine different games with various target areas that aim to achieve a common goal i.e. child's balance increase. The games are used purposefully and based on a timetable, which has been given in Table 2, respectively.

Table 2. Game therapy protocol

Game	Purpose	Week
Scooter heading	To control head movements	1st week
Sky slalom	To control body movements	
Driving range	To control and use hand movements	2nd week
Bird's eye bull's eye		
Sky jump	To control and use feet movements	3rd week
Balance bubble	To control and use ankle and pelvis mechanisms in balance maintenance	
Hula hoop	To use weight transfer movements on feet and body rotational movements	4th week
Obstacle course		
Snowball fight	To combine hands, feet, head and body movements	5th week

After the intervention period, 20 game therapy sessions (4 sessions per week for 20 min), the post-test was performed. Since the participants in this research were patients referred to the rehabilitation center, it was not possible to stop the regular rehabilitation sessions. Thus, the control group was under traditional rehabilitation treatment, the only way of creating similar conditions was to use equal rehabilitation sessions during a week and apply a similar rehabilitation program for the control group. The rehabilitation treatment program

includes exercises to strengthen the muscles and maintain the joint range of motion, which both groups performed per week.

The data were analyzed by paired sample T-test and two-way ANOVA used by SPSS software version 20.

### 3. Results

The demographic characteristics of the subjects are referred to in Table 3. Additionally, the test of normality was examined by the Kolmogorov-Smirnov test and the related alpha presented.

As shown in Table 3, the groups have



normal distribution regarding height, weight, and level of disability. No significant difference between the two groups was observed in any studied factors

( $P>0.05$ ).

The static balance has a normal distribution; therefore, parametric statistics are used to analyze the variance (Table 4).

**Table 3.** Demographic characteristics of children with spastic diplegia cerebral palsy and the P-value of T test

Characteristics	Game therapy	Control group	Normality (K-S) ( $\alpha \leq 0.05$ )	P-value ( $\alpha \leq 0.05$ )
Height (cm)	111.67±10.524	112.6±4.44	0.040	0.666
Weight (kg)	20.11±3.822	22.33±2.784	0.543	0.073
Age (month)	80.22±22.738	86.78±20.48	0.464	0.293
Disability level	1.44±0.527	1.44±0.527	0.957	0.970
Static balance	23.75±5.14	23.66±4.92	0.335	0.125
Dynamic balance	20.5±4.03	20±4.06	0.645	0.235

**Table 4.** Inter group (T test) and between group (two way ANOVA) analysis results for static and dynamic balance

Variable	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	P-value ( $\alpha \leq 0.05$ )
Static balance	Game therapy	23.75±5.14	35.5±5.97	0.000*
	Control	23.66±4.92	24±8.66	0.65
	P-value	0.125	0.000*	
Dynamic balance	Game therapy	20.5±4.03	21.87±2.9	0.042*
	Control	20±4.06	20.66±3.55	0.124
	P-value	0.235	0.001*	

According to Table 4, t-test results show game therapy group has significantly improved static balance in the post-test in comparison with the pre-test ( $P<0.0001$ ). In addition, the game therapy significantly improved dynamic balance in the post-test when compared to the pre-test and in comparison to the control group ( $P<0.0001$ ).

#### 4. Discussion and Conclusion

The purpose of this study was to investigate the effect of game therapy on the balance of children with cerebral palsy, with an emphasis on basic abilities. Considering the statistical test results of game therapy effect on static balance in 4-10-year-old children (including 8 children: 4 boys and 4 girls) with spastic diplegia cerebral palsy levels 1 and 2. The statistic balance of the game

therapy group improved significantly in post-test in comparison with the pre-test ( $P<0.0001$ ). The results show a significant improvement in dynamic balance performance in the post-test than pre-test ( $P=0.042$ ).

Bonnechère et al. (2017) studied the effect of developed games on the balance improvement of children with cerebral palsy [16]. In that study, 10 children with cerebral palsy Participated in four-game therapy sessions (one session per week, for 30 min) for 4 weeks. The body control and balance of the children measured by multislice spiral computer tomography CT (MSCT) before and after the study. The results showed a significant increase in body control and balance after applying intervention [16].

Furthermore, others studied the effect

of rehabilitation development on dynamic balance based on interactive computer games. They used Nintendo Wii to intervene in a group of adults with neurological damage. The results showed improvement in balance, but more accurate and complete results are needed for future studies [17]. Montoro et al. (2021) claim that Nintendo Wii therapy (NWT) can be considered an effective treatment for improving functional and dynamic balance in children with CP, especially when combined with CPT in 30-min sessions with interventions lasting longer than three weeks [18]. Other studies used the TGUGT and OLST tests to evaluate static balance [4, 19] but in this study, we applied the PBS test that emphasis on basic abilities. Therefore, we can claim that this protocol of game can improve the basic ability of kids with spastic diplegic CP.

The results of this study show that game therapy is effective in static and dynamic balance. In addition, families reported that it increased their children's self-confidence and removed fatigue caused by traditional rehabilitation, effectually. Therefore, the present study results can be used as therapy methods besides other methods.

Overall, children's cerebral palsy is a group of nervous system disorders in infancy or early childhood, which has Lasting effects on body movements and muscles coordination. CP can't be cured completely [18]. Besides, because it is chronic and it accompanies patients lifelong, any treatment with the least role in decreasing the disabilities and improving performance is welcomed. This research holds that the improvement of visual perception, muscle strength, and motor skills on the hemiplegic side by VR games plays the most important role in the enhancement of the balance of children with

CP. For example, Bilde et al. (2021) found that muscle strength and visual perceptions of children with CP were significantly improved after a VR game intervention [21]. Snider, Majnemer and Darsaklis (2010) also showed that VR games could improve the visual perception and movement stability of children with CP [22]. Cho et al (2016) found that VR games increased the lower limb strength of children with CP, thereby raising the postural control of these children, enhancing their body symmetry and balance ability [23]. Thus, the researchers' findings on dynamic balance improvement are in line with the present study results; but we need researches that are more accurate.

Suggestions for future research; 1) doing a similar study with a longer time and treatment period, and 2) doing a similar study with a larger sample size probably gives valid and accurate results. 3) It is better to consider the level of physical fitness and body composition of people in the inclusion criteria.

#### **Conflict of interest**

The authors declared no conflicts of interest.

#### **Authors' contributions**

All authors contributed to the original idea, study design.

#### **Ethical considerations**

The author has completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

#### **Data availability**

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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