J. Phys. Ther. Sci. 28: 2414–2417, 2016

The Journal of Physical Therapy Science

Case Study

Change in functional balance after an exercise program with Nintendo Wii in Latino patients with cerebral palsy: a case series

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Abstract. [Purpose] This study aimed to explore the possibility of improving functional balance using an exercise program with Nintendo and the Balance Board peripheral in subjects with cerebral palsy. [Subjects and Methods] This study included 4 male outpatients of a neurological center. All participants received an exercise program based on the use of Nintendo with the Balance Board peripheral. Training consisted of three 25-min sessions per week for 6 weeks. Each session was guided by a physical therapist. Timed up-and-go and one-leg standing tests were conducted before and after the intervention. [Results] All subjects showed significant improvements in the results of the timed up-and-go test. However, there were no significant changes in the results of the one-leg standing test. [Conclusion] The exercise protocol involving Nintendo with the Balance Board peripheral appears to improve functional dynamic balance in patients with cerebral palsy. However, static functional balance does not improve after 6 weeks of training.

Key words: Nintendo Wii, Functional balance, Cerebral palsy

(This article was submitted Mar. 1, 2016, and was accepted May 7, 2016)

INTRODUCTION

Children with cerebral palsy (CP) show limited postural control due to injury to the central nervous system in the developing brain[1)]. In fact, poor balance control is known to be a major constraint in functional activities of daily living such as standing or walking, in which good functional balance is required in both static and dynamic positions[1, 2)].

Innovative alternatives have been suggested to improve balance control in people with and those without neurological diseases[3–6)]. Nintendo with the Balance Board peripheral (NWBB) has been postulated as a tool to improve functional performance, hand skills, gait, and balance[7)]. NWBB is a low-cost, attractive, and user-friendly therapeutic tool, which makes it an excellent choice for environments with limited resources[5)].

A previous study employed an NWBB training program over 4 weeks, 2 hours per week, integrating different sensory inputs and reported an improvement in the postural stability (symmetrical weight distribution) in 4 children with spastic CP[8)]. Another NWBB protocol, which consisted of 4 weekly sessions of 25 min over 3 weeks in 14 children with spastic hemiplegia CP showed a significant increase in balance using the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2)[4)]. Finally, Tarakci et al.[5)] showed functional balance improvement in 14 children with CP after 12 weeks of training with Wii Fit for 2 sessions of 40 min each week.

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Despite the above-mentioned studies, there are no reports of CP treated with NWBB to improve static and dynamic balance in the Latino population. Therefore, the objective of the current study was to explore the possibility of improving functional balance using an exercise program with NWBB in Latino subjects with CP.

SUBJECTS AND METHODS

Four male outpatients participated in this pilot study. The inclusion criteria were (1) age between 8 and 16 years, (2) diagnosis of spastic hemiparesis CP or spastic diparesis CP, and (3) level I or II in the Gross Motor Function Classification System (GMFCS) and the Expanded and Revised Gross Motor Function Classification System (GMFCS-ER). This study excluded subjects with an average mean score <80, indicating cognitive impairment, as assessed by full-scale intelligence quotient, epilepsy, previous surgeries in the lower limb over the last 2 years, and associated disabilities diagnosed by a neurologist such as uncorrected visual or vestibular impairment. Subjects had no other training during the study period.

Written consent was obtained from all participants. This research study was approved by the Bioethics Committee of the Universidad de Talca (ref. no. 00068).

The intervention was performed in an outpatient neurologic rehabilitation center in the city of Talca, Chile. The NWBB (Wii Fit Plus, Nintendo Co., Japan) training sessions lasted 25 min each and were conducted 3 times per week over 6 weeks (7.5 hours). The treatment setting was a room in which the game image was projected onto a screen on a 2 × 1.5 m white wall. Each participant was located 1.5 m away.

The protocol included 3 sets of exercises; manual and verbal guidance was provided in the first 2 weeks, and in the following weeks, only verbal instructions were provided by a physical therapist. The exercises conducted were Snowboard, Penguin Slide, and Super Hula Hoop for the first 2 series of exercises and the Yoga game for the third series. In the first series, subjects stood with their arms and hands at their sides in a relaxed manner. In the second series, each game was repeated in a standing position and with the subjects' hands on their waist. In the third series, the subjects maintained their posture as relaxed as possible with their eyes open and later with their eyes closed[9].

This study considered 2 functional assessments of balance: timed up-and-go (TUG) test for dynamic balance[10] and one-leg standing (TOLS) test for static balance[11]. Before the TOLS evaluation, a dominance assessment was performed for the diparesis CP. The dominant leg was defined as the leg preferred for kicking a ball. For hemiparesis measurement, TOLS was performed in the affected lower limb. Measures were taken before and after the intervention in the Human Motor Control Laboratory of the University of Talca during the morning, on the same day, and under the same conditions.

The initial measurement considered baseline subject characteristics such as age, weight, height, and body mass index.

Descriptive statistics are presented for TUG and TOLS for each case in Table 1. The level of significance of the differences pre/post-training for all subjects was obtained by paired t-test (one-tailed). IBM-SPSS 20.00 (SPSS Inc., IL, USA) was used for statistical analysis. The level of significance was set at $p<0.05$.

RESULTS

Characteristics of the subjects are shown in Table 1.

Six weeks of exercise protocol using NWBB significantly improved the time and speed in the TUG test in subjects with CP (Table 2). Subject 1 had the largest decrease in execution time (31%), followed by subject 4 (21.4%), subject 2 (21.1%), and subject 3 (17.5%), respectively. However, the participants who showed the greatest change over time (measured in seconds) were subjects 1 and 3.

None of the subjects showed significant changes in TOLS. However, the average post-training time was higher than the pre-training time (Table 2). Subject 4 had the largest increase (61%), followed by subject 2 (45.7%) and subject 1 (8.4%). Subject 3 failed the test in the pre-training stage (0 sec), but was successful in the post-training stage (1.38 sec). The greatest differences were seen in subject 2 and subject 4 with 21.55 sec and 14.89 sec, respectively.

DISCUSSION

Few studies have investigated the effect of the NWBB training program on static and dynamic functional balance. A previous study on TUG and TOLS assessment showed that training 2 times per week for 12 weeks was effective in improving balance, but the sample was more heterogeneous (7 diplegic, 5 hemiplegic, and 2 dyskinetic) and had greater motor impairment (GMFMCS-ER 4 and 5) than the sample in this study[5].

Although the CP subjects of this research were GMFCS levels I and II, these results are in agreement with previous research[5]. Such agreement indicates that NWBB benefits are not limited and/or related to those conditions. Additionally, Mombarg et al.[12] showed an improvement in balance after 6 weeks of training with NWBB in 29 children with poor motor performance.

Another study demonstrated that NWBB gaming improves the balance control assessed with BOT-2[4]. The BOT-2 is a game-like test, which it encourages use by children[13]. Similarly, TUG is a dynamic test that involves walking speed, in addition to standing and sitting. From this perspective, TUG can be considered a game-like test, unlike the TOLS test, which

Table 1. Characteristics of the subjects

Subject	Age (years)	Weight (kg)	Height (cm)	BMI (kg/m²)	GMFCS/GMFCS-ER (level)	Type CP
1	16	71	165	26.08	II	Right spastic hemiparesis
2	9	45	148	22.54	I	Spastic diparesis
3	14	56.2	157	22.80	II	Spastic diparesis
4	9	56.4	145	26.83	I	Right spastic hemiparesis

GMFCS: Gross Motor Function Classification System; GMFCS-ER: Expanded and Revised Gross Motor Function Classification System; CP: cerebral palsy; GMFCS: subjects 2 and 4; GMFCS-ER: subjects 1 and 3

Table 2. TUG and TOLS results before and after the intervention for all subjects

Test	Pre-NWBB (Mean ± SD)	Post-NWBB (Mean ± SD)
TUG (sec), *n*=4*	12.49 ± 4.10	9.68 ± 3.52
TUG (m/sec), *n*=4*	0.26 ± 0.08	0.33 ± 0.10
TOLS (sec), *n*=4	22.52 ± 19.43	28.74 ± 14.37

NWBB: Nintendo with the Balance Board peripheral; SD: standard deviation; TUG: timed up-and-go test; TOLS: one-leg standing test. *$p<0.05$

can affect the motivation of participants. This would explain why TOLS showed no significant changes in this study.

The data obtained in this study suggest that the effects of training with NWBB on functional balance are conditioned by the various characteristics of each subject, such as their topographic diagnosis and age, the latter because age is linked to the maturation of sensory systems in charge of postural control[14].

The results of the dynamic functional balance test (TUG) were due to the topographic compromise presented by each subject. Those subjects who achieved a higher improvement over their baseline performance were those with right hemiparesis, because motor impairment in these subjects is less than in diparesis spastic subjects.

Another important aspect of the TUG results is the age of the subjects; those who had the largest reduction in the time were 16 and 14 years old. The literature explains that the first system to be calibrated at the age of 3–4 years is the somatosensory system, consisting of mechanoreceptors and proprioceptors, followed by the visual system at approximately 7–12 years. Finally, the vestibular system is calibrated at approximately 16 years of age. Consequently, it is likely that the sensory systems (visual, vestibular, and somatosensory) contributing to postural balance were more developed in the older subjects included in this study.

The TOLS results showed that two 9-year-old subjects increased their time by the largest amount. When the subject is in a developmental stage, the NWBB training probably facilitates the phenomenon of brain plasticity[6], which favors the generation of motor patterns to maintain the unipodal position longer.

Human balance does refer to a particular/stationary position, but a complex process involving several factors as the support base. In the TOLS test, there is less support base, and since the person is supported on only one foot, it requires greater postural control to correct the forces that interact in the body. However, in the TUG test, the functional activity of walking has a greater support base. Therefore, a smaller improvement in TOLS is not surprising.

The results of this exploratory study support its aim: a training protocol with NWBB prescribed and guided by physical therapists can improve functional balance in Latino subjects with CP. However, static functional balance does not improve after 6 weeks of training. Future studies should complement the assessment of clinical tests with a force platform or other instrumental measures.

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