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The effect of interactive computer play on balance and functional abilities in children with moderate cerebral palsy: a pilot randomized study

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Abstract

Objectives: To investigate the feasibility and potential efficacy of a six-week interactive computer play training on balance and gross motor function in children with moderate cerebral palsy.
Design: A pilot single-blinded matched randomized controlled study.
Setting: Community.
Participants: In total, 18 children with moderate cerebral palsy were recruited, paired according to age and severity of cerebral palsy and randomized into intervention group or control group.
Intervention: The intervention group received additional trunk control training using the interactive computer play in sitting four times per week, 20 minutes per session for six weeks. All study children continued their usual physiotherapy programme.
Measurements: All study children were assessed at baseline, week 3, week 6 (completion of intervention) and week 12 using the Pediatric Reach Test, Gross Motor Function Measure–66-Item Set and 2-Minute Walk Test.
Results: All intervention children completed and enjoyed the training with no reported adverse event. All children were assessed at all time points. No significant difference was found between the two groups in all assessments. In both groups of children, significant improvements were found in the Gross Motor Function Measure–66-Item Set between week 3 (intervention group: mean 53.41, SD 5.34; control group: mean 52.86, SD 8.33) and week 6 (intervention group: mean 55.00, SD 6.32; control group: mean 54.20, SD 8.35).
Conclusion: The intervention protocol of a six-week interactive computer play training was feasible and safe for children with moderate cerebral palsy in special school settings. Future studies with larger sample sizes or using single-subject designs are recommended.

Keywords

Cerebral palsy, interactive computer game, postural control, balance, gross motor function

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Introduction

Children with cerebral palsy, regardless of the severity of their condition, have problems of postural control in sitting and standing, which in turn affect their function and participation in daily life.[1,2] Interactive computer play, using commercial devices, has become a popular rehabilitation modality[3–6] to improve postural control and/or balance in children with cerebral palsy.[7] Studies have generally shown a significant improvement in postural control and balance in children with cerebral palsy after interactive computer play,[8–10] with greater improvement than the control group where this was part of a study design.[11] Despite these positive findings, there remain knowledge gaps. The effect of interactive computer play on children with moderate severity of cerebral palsy, that is, Gross Motor Function Classification Scale[12] level III or IV (Individuals of levels I and II ambulate independently and are able to run and jump but with limitations. Individuals of level III ambulate with handheld mobility devices, for example, crutches or walking frames. Individuals of level IV have very limited functional mobility and are mostly limited to an indoor environment. Individuals with level V are non-ambulatory or totally dependent on wheeled mobility aids in all environment settings) is largely unknown. Most commercial devices, such as the Nintendo Wii Fit, are not designed to elicit specific body movements for rehabilitation or have software that is sufficiently sensitive to translate the subtle movements of a child with moderate cerebral palsy into a score in the game while providing the right level of challenge.[13] In addition, based on present research evidence, the medium- to long-term effect of interactive computer play remains unknown.

The objectives of the present pilot study were (1) to investigate the feasibility of a six-week interactive computer play training for children with moderate severity of cerebral palsy, (2) to determine any immediate effect post-intervention on sitting balance and functional gross motor skills and (3) to determine any medium-term effect on sitting balance and functional gross motor skills at six weeks after cessation of intervention. This study used a single-blinded matched randomized design.

Methods

This study was conducted in accordance with the Declaration of Helsinki. Ethics approval was granted from the Departmental Research Committee of the Department of Rehabilitation Sciences in the Hong Kong Polytechnic University (HSEARS20160203002). Parents of all study participants signed an informed consent prior to data collection as the participants were under 18 years of age. The present study has been registered under the ClinicalTrials.gov (NCT02975804) with a commencement date of 1 October 2017.

The research setting was three local schools for students with physical disabilities. Children with moderate cerebral palsy were recruited through their respective school physiotherapists. Children were included if (1) they had cerebral palsy of Gross Motor Function Classification Scale level III or IV, (2) were aged between 6 and 14 years and (3) were able to follow instructions sufficient to participate in simple computer games. Children were excluded if they had epilepsy or seizures that might be elicited by flashing lights or sudden noises from computer screens, were unable to sit for long enough to play the games or were regular users of balance board type interactive computer games at home.

An initial assessment of all study children confirmed their Gross Motor Function Classification Scale level and their age: participants were then matched based on these two criteria (age within three years). Each pair of children was randomly allocated into the control or the intervention group by a research assistant using the ‘draw a card’ method. The randomization was done separately in each school to take account of different treatment regimes in each school. As a feasibility study, there was no plan for the control group to receive the intervention at the conclusion of the study.

The intervention period was six weeks. All the study children were assessed at baseline (week 0), week 3, week 6 (end of intervention) and week 12, that is, six weeks following the intervention. All assessments were conducted by a blinded assessor (first author, TWP), who was unaware of the group allocation of the children. The standardized outcome measures used were

1. Pediatric Reach Test[14] to assess balance by measuring the distance the child could reach forward, to right and to left: this was measured only in sitting.
2. Gross Motor Function Measure–66-Item Set[15] to assess general gross motor function in lying, sitting, four-point kneeling, high kneeling and standing. The intra- and inter-rater reliability of TWP was established on a convenience sample of six children with cerebral palsy with intra-class coefficients for both intra- and inter-rater reliability >0.98.
3. 2-Minute Walk Test[16] to assess sub-maximal exercise ability. The distance covered in a period of two minutes at self-selected comfortable speed was measured using a trundle wheel. The reliability of TWP on this walk test has been previously established.[17]

The intervention was provided using the TYMO (TYROMOTION GmbH, Graz, Austria): this commercial portable force plate is specifically designed to assess and treat postural control and 'suitable for the therapy of neurological and orthopedic patients of all ages' (http://tyromotion.com/en/products/tymo). The TYMO measures amplitudes and distribution of the force imposed on the plate: the inbuilt software translates this information into computer games in which the user moves the trunk forward, backward and sideways, for example, to manoeuvre a basket to catch falling apples. The level of difficulty can be adjusted as required.[18]

The intervention group received interactive computer play training in sitting four times per week, 20 minutes per session for six weeks. All children continued their usual motor control and muscle strength physiotherapy programme at their respective school and were asked to cease any interactive computer play designed to train balance either at home or at school during the study period.

At the start of each treatment session, the TYMO was calibrated for each intervention child by a research physiotherapist according to the TYMO protocol. This physiotherapist provided all the TYMO intervention across all schools. All children played the computer game in sitting with hips and knees at 90° and both feet supported (Supplemental Figure 1). The game was started at a medium-low level of difficulty. If the child was unable to score for three consecutive trials, the difficulty level was reduced by one level. Similarly, if the child scored full points for three consecutive trials, the difficulty level was raised by one level. The research physiotherapist recorded progression of the intervention phase and maintained a logbook for each child with the level of difficulty in each treatment session, the number and duration of treatment sessions and relevant comments.

Sample size calculation was not undertaken for this pilot study.[19] Non-parametric Mann–Whitney U test was used to compare the between-group results before and after the interactive computer play. Any missing data were analysed by intention-to-treat. The statistical significance level was set at $P < 0.05$.

Results

The study commenced on 1 October 2017 and all data collection was completed by 10 July 2018. In total, 18 children were identified by the school therapists following the inclusion and exclusion criteria and recruited to the study (Figure 1). These 18 children were paired and randomized into the intervention and control groups and were assessed at all time points ($n=9$ in each group) (Table 1 and Figure 1). No significant difference was found in the week 0 baseline comparisons between the intervention and control groups (Table 1). The intervention group all completed the six-week interactive computer play training with an average attendance of 78.11% (SD 7.36). Missed sessions were due to child illness or planned school events. The research physiotherapist had no difficulties in providing or supervising the intervention. No adverse event was reported and all the intervention children enjoyed the interactive computer play sessions. The research physiotherapist noted that approximately half of the children in the intervention group showed co-contraction of trunk muscles during the interactive computer play.

No significant difference was found between the intervention and control groups at week 3 (mid-intervention), week 6 (completion of intervention) or week 12 (six weeks after intervention) in any of the assessments (Table 1).

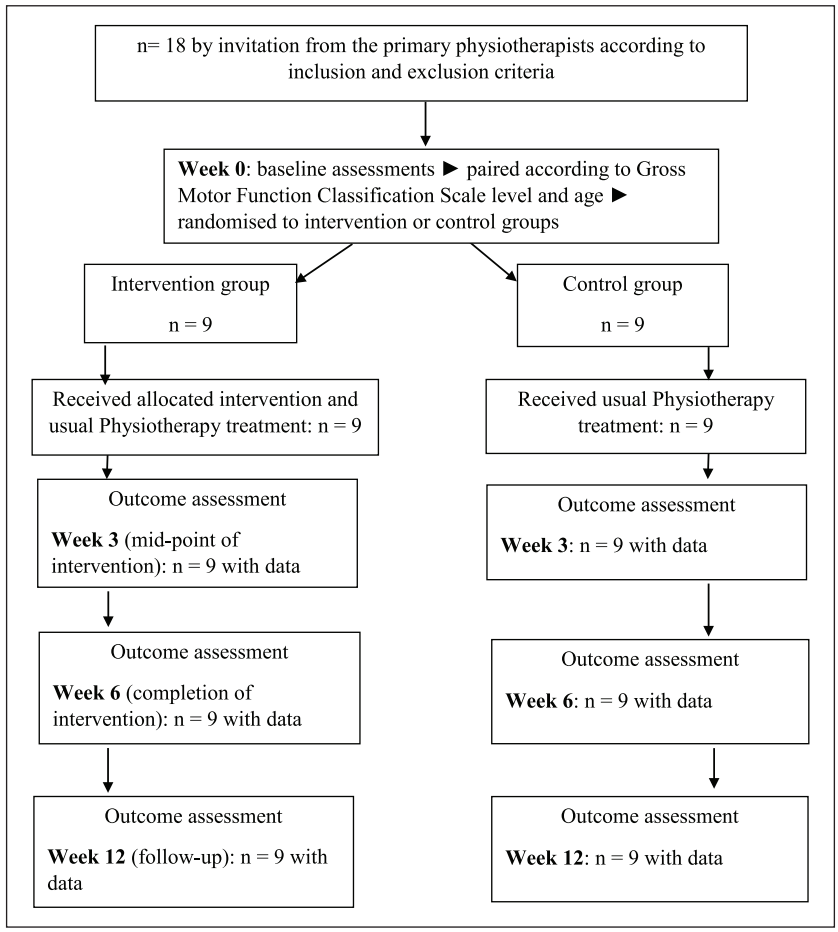

Figure 1. Participant flowchart.

Discussion

The ease of delivery of the interactive computer play, the high attendance rate, excellent compliance rate and absence of any adverse event in the present study confirms that the intervention protocol was feasible and safe in the setting of special schools for children with physical disabilities. The results of this study showed that children in both the intervention and control groups generally improved their sitting balance and functional gross motor skills over the 12-week period and this was particularly true of the Pediatric Reach Test and the Gross Motor Function Measure–66-Item Set. There was no added benefit found from the additional six-week interactive computer play training (Table 1).

Although the protocol was viable, the therapists at the schools involved had difficulties in recruiting children to the study. Their main problem was that the children were required to have a reasonable level of cognitive function to participate in the interactive computer play. Cognitive impairment is one of the commonest comorbidities of cerebral palsy, especially those with greater severity[20] and this should be taken into account when planning future studies for children with moderate cerebral palsy.

The findings related to balance and functional abilities are not in line with past literature. One reason may be the difference in the study populations. The majority of previous studies in this area were on children with mild severity of cerebral

Table 1. Results of outcome measures between two groups of participants.

		Intervention group	Control group
Number		9	9
Gender		Male = 5 (56%)	Male = 6 (67%)
Age, years (mean, SD)		8.92 (2.25)	9.59 (1.87)
Gross Motor Function Classification Scale			
Level III[a]		8	8
Level IV[a]		1	1
Bilateral spastic CP		9	9
Pediatric Reach Test forward, cm (mean, SD)	Week 0 (baseline)	17.11 (4.34)	17.28 (7.28)
	Week 3	20.94 (5.78)	18.89 (5.28)
	Week 6	22.50 (6.16)	22.22 (6.59)
	Week 12	20.39 (5.23)	22.50 (9.82)
Pediatric Reach Test right, cm (mean, SD)	Week 0 (baseline)	12.94 (4.40)	11.83 (6.48)
	Week 3	14.56 (4.18)	12.11 (6.80)
	Week 6	13.00 (3.68)	12.22 (5.39)
	Week 12	14.50 (3.95)	15.28 (7.95)
Pediatric Reach Test left, cm (mean, SD)	Week 0 (baseline)	11.50 (5.62)	10.00 (5.80)
	Week 3	12.78 (4.99)	11.83 (6.43)
	Week 6	15.78 (8.09)	13.78 (4.82)
	Week 12	15.38 (3.51)	15.22 (7.77)
Gross Motor Function Measure–66-Item Set score (mean, SD)	Week 0 (baseline)	52.39 (5.32)	51.88 (8.41)
	Week 3	53.41 (5.34)	52.86 (8.33)
	Week 6	55.00 (6.32)	54.20 (8.35)
	Week 12	52.90 (4.61)	53.92 (8.86)
2-Minute Walk Test, m (mean, SD)[b]	Week 0 (baseline)	61.06 (33.11)	59.61 (37.75)
	Week 3	57.26 (25.53)	58.14 (34.29)
	Week 6	63.97 (28.03)	68.44 (34.33)
	Week 12	62.49 (29.70)	70.01 (31.82)
Overall attendance (%)		169/216 (78.24)	Not applicable

[a]Significant difference $p < 0.001$ using chi-square test.
[b]Results based on the eight participants with Gross Motor Function Classification Scale level III only.
CP: Cerebral palsy.

palsy. These more physically able children have reduced ability in the fine-tuning of specific trunk and limb muscles when their sitting balance is challenged: in contrast, children with more severe cerebral palsy show stereotyped responses, for example, by recruitment of all muscles and stiffening of the trunk.[1] Children with mild cerebral palsy may therefore have sufficient inherent trunk control to benefit from the specific postural control training of interactive computer play leading to the reported improvements in balance and gross motor function.[3–7] Half of the intervention group in this study showed stereotyped co-contraction of all trunk muscles.[21] Future research into interactive computer play research in children with moderate cerebral palsy should be aware of this potential compromise to effective trunk control learning.[22]

Another reason for results that differ from past literature may relate to the relatively short intervals between assessments, which could have led to some learning effect or greater sense of familiarity with the assessments. As an example, the children may have been more assured about reaching forward and to the side during the Pediatric Reach Test after the baseline assessment. The same sense of expectation of what was required is likely to apply to the other outcome measures.

A main limitation of the present pilot study was small sample size meaning that no firm conclusions can be drawn about either effectiveness or ineffectiveness of interactive computer play for children with moderate severity of cerebral palsy. In addition, the statistical analyses involved repeated measurements, inflating the type I error. Future studies with larger sample sizes may overcome this problem if assessments are more widely spaced. Alternatively, a single subject with multiple baselines research design[23] may offer greater insight into the mechanisms used by children with moderate severity of cerebral palsy when using interactive computer play devices. This could help to identify any necessary modifications to the intervention protocol for these children and/or refine the inclusion criteria in terms of trunk control status.

This pilot study has shown that a six-week interactive computer play training for children with moderate severity of cerebral palsy was both feasible and safe in the settings of schools for children with physical disabilities. Cognitive impairment may be a barrier to the recruitment rate for future studies on this population group. The preliminary findings of this study showed that this training programme did not confer extra benefit in improving sitting balance and gross motor function for children with moderate severity of cerebral palsy over conventional physiotherapy. Future studies with larger sample sizes may be of value but single-subject, multiple baseline study designs may have greater potential to identify the specific criteria that influence trunk control during interactive computer play in this population group.

Clinical Messages

- Interactive computer play training was feasible and safe in special school settings.
- Cognitive impairment may affect the recruitment rate for future studies.
- Studies with larger sample sizes or single-subject designs are required to verify present results.

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Availability of Data and Material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

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