

Effects of group-activity intervention with multisensory storytelling on gross motor function and activity participation in children with cerebral palsy

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This study determined the effectiveness of 16 multisensory storytelling sessions on physical function and activity participation in children with cerebral palsy. Twenty-four children aged 7 to 8 who belonged to stage I to III of the Gross Motor Function Classification System were randomly divided into experimental and control groups, with 12 children in each group. The experimental group performed group activities through multisensory storytelling for 60 min, twice a week for 8 weeks, while the control group performed structured physical activities. The motor function, activity participation, and peer relationship skills were measured. The collected data were analyzed using the SPSS 25.0 for windows program, and the significance level (α) for statistical verification was set to 0.05. The Wilcoxon signed-rank test was performed for intragroup

changes in motor function and activity participation in the experimental and control groups. The Mann-Whitney *U*-test was used to compare the difference between the 2 groups. Both groups improved gross motor function ($P < 0.05$) and activity participation ($P < 0.05$). A significant difference between both groups was also measured. Multisensory storytelling resulted in significant improvements in large motor function and activity participation. Therefore, it can be an effective intervention for improving gross motor function and activity participation in children with cerebral palsy.


Keywords: Cerebral palsy, Multisensory storytelling, Gross motor function, Activity participation

INTRODUCTION

Cerebral palsy is a disorder of postural and mobility development caused by restricted activity due to nonprogressive impairment in the brain of a developing embryo or infant. The mobility disorder of cerebral palsy may be accompanied by sensory, cognitive, communication, perceptual, and behavioral disorders and epilepsy (Bax et al., 2005). Children with cerebral palsy do not undergo a normal development process at the appropriate time due to postural and mobility problems. Abnormal muscular stiffness and muscular weakness generate disbalance that greatly affects independent movement and postural stability (Ferdjallah et al., 2002). However, not only mobility function is affected. Due to visual and cognitional impairment, children with cerebral palsy experience difficulty

communicating and taking care of themselves in their daily activities like eating, clothing, hygiene, movement, and so forth (McCarthy et al., 2002). The motor ability of children with cerebral palsy does not mean only physical function. However, the physical function is a fundamental ability necessary for interaction with people and adaptation to the environment. Disability of physical function can cause difficulties in play, learning, and interpersonal relationships in general.

The quality of life of school-age children is multidimensional. It consists of physical function level, mental health condition, school life and participation in activities, degree of familial support, service accessibility, among many others (Waters et al., 2005). Yet the limitation in daily activities and participation handicap the role of children with cerebral palsy in society (Davis et al., 2006), thereby

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impairing the quality of their everyday life. Accordingly, in the case of school-aged children with cerebral palsy, along with considering qualitative aspects of their mobility and posture, it is necessary to promote a therapeutic approach associated with self-care activities and gross motor function. The therapeutic approach should emphasize detailed activity goals related to environmental factors, daily life, movement, and learning.

To date, interventions for children with cerebral palsy have comprised therapist-led methods to normalize motor function by reducing neurological damage (Valvano, 2004). These treatment methods demonstrated muscle strength improvement (Stubbs and Diong, 2016; Theis et al., 2015). However, the evidence showing effect in children's daily lives and school participation remains scarce. In an evidence-based systematic review study, Novak et al. (2013) reported that goal-oriented training for children with cerebral palsy was effective in their motor performance, function, and self-care activities.

Children with cerebral palsy experience many limitations and difficulties in integrated environment activities. Therefore, it is essential to expand the opportunities for independent daily life and peer participation and promote social interaction of these children. The approach must be more complex and target their participation in daily activities from various perspectives. Storytelling is a technique that has been recently used in many fields. This technique is being applied to deliver a message through a story in various areas, such as culture and art, politics, public relations, and learning. Gonçalves et al. (2017) reported that the storytelling techniques effectively reduced aggression and improved elementary school students' grades by lowering stress and anxiety and promoting social interaction. Multisensory storytelling is an intervention technique stimulating various senses according to a story scene. It has been used in special education for severe and multiple disabilities in Scotland, United Kingdom. This concept, commonly referred to as a multisensory story box, is a storytelling method that uses sensory props to provide listeners with various sensory experiences according to the story scene. This is a storytelling method that provides a variety of sensory experiences using sensual props and delivers stories through emotion and interaction rather than language. Recently, studies on multisensory storytelling have been reported in the field of special education (Hettiarachchi et al., 2022; Ten Brug et al., 2016).

The present study investigated the effect of multisensory storytelling on gross motor function and participation in daily activities of children with cerebral palsy. Considering characteristics of children with cerebral palsy, interventions focused on group activities with multisensory storytelling, adding sensory experiences to them.

MATERIALS AND METHODS

Participants

The subjects of this study were 7- to 8-year-old children corresponding to Gross Motor Function Classification System level I–III who were medically diagnosed with spastic diplegia cerebral palsy. However, children who had continuously taken medications such as anticonvulsants or antispasmodics or those who had undergone a chemical nerve block like botulinum toxin or a surgical operation such as tenotomy in the 3 months prior to participants' selection were excluded. A total of 28 children were recruited in consideration of the dropout rate. Among them, four children were eliminated due to inappropriate diagnosis (2 children), botulinum toxin treatment within 3 months (1 child), and continuous participation restriction (1 child). Therefore 24 children were finally selected. Afterward, the subjects were randomly assigned to experimental and control groups, with 12 children in each group. The design of this study was set as a single-blinded study. Therefore, the subjects were not informed into which group they were assigned. The research and the procedure were explained in detail to the subjects and their parents (legal representatives). Consent was obtained to provide personal information to participate in the research. To protect the rights and safety of the study participants and comply with the Bioethics and Safety Act, approval was obtained from the Institutional Review Board of Dong-Eui University (DIRB-20207-HR-R-18).

Gross motor function measure

Gross motor function measure (GMFM), a tool to evaluate the motor function of children with cerebral palsy, was used to confirm the change in gross motor function. The gross motor function evaluation is a valuable tool to evaluate the development and level of motor function and measure motor development changes in children with cerebral palsy. This measurement tool consists of five areas with 88 items: A: lying and rolling - 17 items, B: sitting - 20 items, C: crawling and kneeling - 14 items, D: standing - 13 items, E: walking/running/jumping - 24 items. The evaluation score of each item is from 0 to 3 on a Likert 4-point scale, and the score for each area can be calculated as a percentage (%). The total score is calculated by dividing the sum of the percentages for each area by 5. It is a reliable, standardized measurement tool with 0.91 (Palisano et al., 2000) for the validity of GMFM test items and interexaminer reliability of 0.99 (Nordmark et al., 1997).

Activity participation assessment

To evaluate children's activity participation of children with cerebral palsy, the activity participation assessment (APA) was used. APA measures activity participation for children with or without disabilities aged 7 to 12 years old. It comprises five activity sections: self-care, instrumental activities of daily living, school and daily activities, leisure and social activities, personal hobbies. The level of participation in activities can be measured by answering 83 questions by the child himself or by an evaluator recording the child's reaction on a 6-point scale from 1 to 6, with a higher score meaning a higher level of activity participation. The test-retest reliability of the Korean version of the APA for children is 0.86–0.92, and the internal reliability is 0.63–0.89 (Kim et al., 2016).

Measurement method

This study was designed as a 2-group pretest-posttest to investigate the intervention effect of multisensory storytelling on group activities of children with spastic diplegic cerebral palsy. Due to the single-blind design of the study, the children and their parents were not informed about the child's assignment to the experimental group or the control group. The intervention program was conducted in 16 sessions for each group, with 60 min twice a week for 8 weeks per group. The group-activity intervention consisted of two multisensory storytelling stories in the experimental group: Snow White and Who is the Class President Today? The multi-

sensory storytelling group activities containing visual perception and sensory components (vision, hearing, touch, etc.) were applied according to the flow of the story, which was divided into four phases: exposition-rising action-climax-resolution. The program details are shown in Table 1. A children's physical therapist with more than 5 years of experience helped a child in case of physical function limitations or needed assistance in activity participation. When excessive tension or compensatory pattern appeared during the activity, the therapist corrected the child's motion and modified the direction and posture of the movement. In addition, when selecting multisensory stimuli materials for the story activity, she introduced and promoted the material so that children in each small group could experience the needed sensory stimulus. The control group was provided with a structured environment where the children performed structured physical activities. The environment was equipped with a mat, a vaulting horse, a balance beam, and a trampoline at a difficulty level suitable for the physical function of the children with cerebral palsy.

Data analysis

The number of subjects in this study was calculated using the G-Power version 3.1 (University of Dusseldorf, Dusseldorf, Germany) program. We performed a two-sample *t*-test with a significance value (α) 0.05, power 85%, and effect size 0.6. According to the probabilistic calculation related to the classification of cere-

Table 1. Group-activity intervention program

Phase	Composition	Group-activity content
Introduction	Story understanding	Listen to the story Connect and tell stories one by one
Development	Creation of theatrical properties and background	Creating Snow White's clothes and a belt Creating Dwarfs' house Making a way to Dwarfs' house Preparing classroom's environment Making a playground
	Activity related to the story's scene	Watching a reflection in a mirror Talking to a mirror like a queen (mirror, mirror on a wall who is the fairest of them all?) Working like a Dwarfs Preparing food like a Snow White in Dwarfs' house Eating a meal like a Snow White and Dwarf together Returning home Creating a name tag with a nickname High-five with friends Cooperative painting in art class Physical education class Cooking class with class
Expansion	Story's role-play	Snow White, Who is the Class President Today?
Summary	Recalling the story	Telling one's impression about the story's activities Expressing a scene that one's remember via action

bral palsy, 24 children were used as the minimum sample size. The Mann–Whitney test was conducted to compare the difference in change between the two groups. data collected were analyzed using IBM SPSS Statistics ver. 22.0 (IBM Co., Armonk, NY, USA), and the significance level (α) for statistical verification was set at 0.05. Regarding the general characteristics of the research participants, descriptive statistics were calculated, and as to the normality of the measurement variable, a nonparametric test was conducted after checking variability through a Shapiro–Wilk test. A Wilcoxon signed-rank test was conducted to analyze the changes in the experimental and control groups before and after the intervention, and a Mann–Whitney *U*-test was conducted to compare the difference in the variance between the two groups.

RESULTS

General characteristics of the research subjects

A total of 24 subjects, with 12 in the experimental group and 12 in the control group, were studied. There were 11 males (45.83%) and 13 females (54.17%) among the subjects. The average age was 7.71 ± 0.95 years old, the average height was 121.58 ± 0.70 cm, and the average weight was 24.09 ± 0.93 kg. There was no signif-

icant difference in general characteristics between the experimental and control group (Table 2).

Gross motor function

There was a significant difference in gross motor function in crawling/kneeling, standing, and walking/running/jumping and in the overall score for both the experimental group and the control group ($P < 0.05$) (Table 3). The amount of change between the two groups showed significant differences in crawling/kneeling, standing, walking/running/jumping, and overall score. ($P < 0.05$) (Table 4).

Activity participation

There was a significant difference in activity participation in both the experimental and control groups ($P < 0.05$) (Table 5). The experimental group showed significant differences in the total score and all sub-factors within-group ($P < 0.05$). There were no significant differences in self-care activities, leisure and social activities, and personal hobbies in the control group. But there were significant differences in total score, instrumental activities of daily living, and school and daily activities ($P < 0.05$) (Table 5). There was no significant difference between the two groups in leisure

Table 2. General characteristics of subjects

Characteristic	Experimental (n=12)	Control (n=12)	Z	P-value
Gender			0.39 [†]	0.69
Male	5 (41.7)	6 (50)		
Female	7 (58.3)	6 (50)		
Age (yr)	7.67 ± 0.49	7.75 ± 0.45	-0.43	0.67
Height (cm)	120.67 ± 2.96	122.50 ± 3.75	-1.33 [†]	0.25
Weight (kg)	23.67 ± 4.62	24.50 ± 4.64	-0.44 [†]	0.67

Values are presented as number (%) or mean \pm standard deviation. [†]Chi-square test. [‡]Mann–Whitney *U*-test.

Table 3. Comparison of GMFM between pre and post intervention

Variable	Group	Pre	Post	Z	P-value
GMFM C (crawling/kneeling)	Experimental	91.50 ± 7.49	93.17 ± 7.64	-2.84	0.01
	Control	90.33 ± 8.53	91.00 ± 8.16	-2.27	0.02
GMFM D (standing)	Experimental	76.50 ± 12.30	79.00 ± 12.41	-3.14	0.00
	Control	75.33 ± 11.65	76.83 ± 12.02	-2.57	0.01
GMFM E (walking, running, jumping)	Experimental	58.08 ± 17.44	60.50 ± 17.65	-3.15	0.00
	Control	56.42 ± 17.92	57.75 ± 18.50	-2.38	0.02
Total	Experimental	85.22 ± 6.76	86.53 ± 6.93	-3.08	0.00
	Control	84.41 ± 7.10	85.12 ± 7.20	-3.09	0.00

Values are presented as mean \pm standard deviation. GMFM, gross motor function measure.

Table 4. Comparison of changes in GMFM between the 2 groups pre and post intervention

Variable	Experimental	Control	Z	P-value
GMFM C (crawling/kneeling)	1.67 ± 1.07	0.67 ± 0.77	-1.46	0.02
GMFM D (standing)	2.50 ± 0.67	1.50 ± 1.24	-2.08	0.04
GMFM E (walking, running, jumping)	2.42 ± 0.51	1.33 ± 1.44	-3.91	0.04
Total	1.32 ± 0.29	0.70 ± 2.89	-3.68	0.00

Values are presented as mean \pm standard deviation. GMFM, gross motor function measure.

Table 5. Comparison of activity participation between pre and post intervention

Subtest	Group	Pre	Post	Z	P-value
Self-care	Experimental	33.25±5.19	35.75±4.86	-2.99	0.00
	Control	29.75±4.13	30.25±4.11	-1.90	0.00
Instrumental activities of daily living	Experimental	29.67±9.29	32.16±9.68	-2.91	0.00
	Control	27.58±4.23	28.92±4.19	-2.87	0.00
School and daily activities	Experimental	95.83±24.29	99.92±24.69	-3.11	0.00
	Control	83.58±16.18	85.92±16.09	-3.08	0.00
Leisure and social activities	Experimental	56.42±9.39	57.42±9.51	-1.63	0.01
	Control	50.25±8.19	50.75±8.67	-1.61	0.11
Personal hobbies	Experimental	35.75±7.09	36.42±7.18	-2.53	0.01
	Control	5.67±0.98	31.75±5.66	-1.73	0.08
Total	Experimental	250.92±50.00	261.67±50.50	-3.08	0.00
	Control	222.42±30.30	227.58±30.80	-3.08	0.00

Values are presented as mean ± standard deviation.

Table 6. Comparison of changes in activity participation between the two groups pre and post intervention

Subtest	Experimental	Control	Z	P-value
Self-care	2.50±1.17	0.50±0.80	-3.59	0.00
Instrumental activities of daily living	2.50±1.38	1.33±0.98	-2.22	0.03
School and daily activities	4.08±1.24	2.33±1.23	-2.93	0.00
Leisure and social activities	1.00±0.85	0.50±1.00	-1.21	0.23
Personal hobbies	0.67±0.65	0.50±0.90	-0.63	0.53
Total	10.75±2.99	5.17±1.90	-3.54	0.00

Values are presented as mean ± standard deviation.

and social activities, Personal Hobbies. Still, there were significant differences in the total score, self-care activities, instrumental activities of daily living, and school and daily activities ($P < 0.05$) (Table 6).

DISCUSSION

The results of this study confirm the effectiveness of multisensory storytelling on gross motor function and activity participation of children with cerebral palsy, suggesting that multisensory storytelling is an effective clinical intervention method. Sensory and motor disorders of children with cerebral palsy require lifelong management, which significantly impacts children's daily and school life. Until now, interventions for children with cerebral palsy have emphasized the qualitative aspects of movement, such as muscle tone control, strength improvement, joint range of motion improvement (Law et al., 2007) and have focused on improving body structure and dysfunction (Rosenbaum and Gorter, 2012). Most children with cerebral palsy experience difficulties in exer-

cise performance (Rosenbaum et al., 2007), which makes it necessary to acquire a proper understanding of exercise interventions. There is substantial evidence about the effectiveness of exercise interventions for cerebral palsy, Ryan et al. (2017) confirmed that aerobic exercise, strength exercise, and resistance exercise improve physical ability. However, the evidence on activity, participation, and quality of life remains insufficient. Therefore, it is necessary to more closely explore the effect of exercise interventions on the activity and participation of children with cerebral palsy.

Arnoni et al. (2019) used virtual reality games to conduct exercise interventions. The subjects consisted of 15 children with cerebral palsy of the I and II levels of the GMFCS. The children exercised 45 min twice a week for a total of 8 weeks. Significant improvements in standing (D) and walking/running/jumping (E) areas of the gross motor function were reported. The virtual reality games (Kinect adventures) made the children immerse themselves in the game, promoting motivation for activities through fun. The children performed physical exercises like squats, jumping, and crossing obstacles via the games' missions, which improved their gross motor function. This study used multisensory storytelling to improve the gross motor function of children with cerebral palsy. The multisensory storytelling immersed children in a story and promoted children's motivation, active participation, and physical activity in each scene. Each session lasted for 60 min. The sessions were scheduled twice a week for a total of 8 weeks. The results showed a significant change in children's gross motor function, confirming a parallel between the intervention method and effect. Furthermore, Sorsdahl et al. (2010) applied goal-oriented daily activity interventions to 22 children with cerebral palsy 5 times a

week for 3 weeks. The authors reported improvements in gross motor function, self-care, and mobility in everyday life. In addition, children in GMFCS levels I–II showed more improvement in gross motor function than those in groups III–V. As with previous results, it can be supposed that children with cerebral palsy of GMFCS groups I–II (58.3% of subjects) significantly affected this study's gross motor function results.

This study designed group-activity interventions of multisensory storytelling to promote a playful exercise of school-age children with their peers. The goal was to improve the performance of activities necessary in children's daily lives. In addition, movements needed for everyday and school life were naturally repeated through story scenes. This resulted in significant changes in the children's gross motor function and the difference between the groups. The gross motor function means an ability to perform different types of postures. In this study, the experimental group repeatedly practiced postures and movements according to story scenes, including standing up from and sitting down to a chair, walking while making a path, crossing obstacles, jumping with both feet, and jumping over the rope. Consequently, the children's gross motor function improved. Since the experimental group enthusiastically participated in activities similar to actual daily life, it can be stated that their improvement of gross motor function was more effective than the improvement of the control group that performed structured physical activity.

Previous studies have confirmed the effect of exercise on the physical function of children with cerebral palsy. However, Shelly et al. (2008) reported that the quality of life of children does not necessarily match the level of their physical function. The quality of life of school-age children is multidimensional and is related to many factors, such as the level of physical function, psychological health status, school life and activity participation, family support level, access to services, and economic level (Waters et al., 2005). Particularly participation in daily life activities is an essential factor that affects the quality of life of children with cerebral palsy (Davis et al., 2006). With an increase of their participation in everyday life, they reach greater satisfaction in life, which affects their psychological health stability (Engel-Yeger et al., 2009). Movement control for functional tasks is learned while actively solving problems through performance. As adaptation to environmental changes is a crucial part of functional recovery, learning various ways to solve a task is favorable (Shelly et al., 2008). In a study on preschool children with cerebral palsy, Löwing et al. (2010) found that a goal-oriented intervention group accomplished the set goals. Moreover, children's motor function and performance of daily activities sig-

nificantly improved. The intervention methods of previous studies emphasized the importance of various experiences and practical exercises to enhance children's participation and independence in everyday life. Treatment for infants and toddlers focuses on basic posture formation such as sitting, crawling, standing and moving. Children, in contrast, aim for independent participation in daily and school activities, such as playing with peers. They value entertainment and physical activity within a group (Rosenbaum and Gorter, 2012).

Although school-age children with cerebral palsy gain educational and social experiences via school life, specific difficulties may arise in group activities. The same level of these children's participation in daily life as that of nondisabled children gives the former a sense of vitality and belonging to the community (Engel-Yeger et al., 2009). This study designed activities to help school-age children with cerebral palsy integrate them into daily and school life. Through story scenes and situations, the children performed activities related to their age group, such as moving objects, exercises with a ball, standing from and sitting down to a chair, moving, hand washing, organizing clothes, preparing food, and so on. The experience gained via group activities might have significantly influenced the children's participation in daily life. Experience of fun and joy while participating in activities promotes continued engagement (Stankov et al., 2012). Moreover, when children find physical activity enjoyable, their participation improves. Motivation stimulating activities also promote an initiative in peer activities, creating an excellent chance for cooperation.

Various group activities should be considered a treatment approach for school-age children with cerebral palsy (Valvano, 2004). Interventions for children with cerebral palsy should include goal-oriented and meaningful movements. Moreover, since group activities can greatly encourage social interaction among participants, this factor should be considered while planning a treatment program. Therefore, a positive effect of the treatment can be anticipated not only in the physical, but also in the mental aspect. In the present study, children in the experimental group initially showed no interest in each other or just observed each other. However, as the session progressed, they started cooperating. Gradually, the children started to create story backgrounds and direct the scenes together. The children also considered their disabled friends and helped them while they were immersed in the role-play. Therefore, group-activity interventions of multisensory storytelling might promote interactions among children. The story-based activities and role-plays promote children's spontaneity through fun and enjoyable activities. Therefore, a significant change in the level of

participation was observed.

Eyre et al. (2020) combined motor skills and movement training with storytelling techniques and tested this treatment method on children aged 5–6 years old for 12 weeks. The authors observed improvements in children's motor skills and language. The combination of movement and story promoted more significant creative stimuli, leading to positive changes in children's executive function and motor skills. The results confirm substantial differences in gross motor function and activity participation of children with cerebral palsy through multisensory storytelling that provides various sensory and movement activities. This study used multisensory storytelling, as this approach effectively stimulates children's interest and motivation. Activities through stories promote interactions among children. Storytelling should not be misunderstood as a simple illustration of a book's content. Rather, it creates a story's background in each scene and provides children with sensory stimulations by immersing them in role-play. Therefore, the children could improve their task performance through activities necessary in their daily and school life. A comparative review of previous studies confirmed that group-activity interventions of multisensory storytelling positively affect gross motor function and activity participation of children with cerebral palsy. The present study has several limitations. First, because this study is a clinical trial for children with cerebral palsy, the number of subjects was small. Therefore, it is difficult to generalize the results of this study to all children with cerebral palsy. Second, the interventions' effect has not been checked after the end of this study. Therefore, it is necessary to address this problem in future studies.

The present study examined the effectiveness of multisensory storytelling on the gross motor function and activity participation of children with cerebral palsy. The interventions of multisensory storytelling consisted of activities necessary in children's environment. The group activities were designed as a physical therapy program that was based on thorough understanding of movement and physical mobility of children with cerebral palsy. The results confirmed a significant change in children's physical function and activity participation. In future research, it is necessary to further explore the effect of multisensory storytelling on children with disabilities.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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