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Assessment of Music Therapy for Rehabilitation Among Physically Disabled People in Chiang Mai Province: A Pilot Study

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Abstract

Music has been shown to possess a profound effect on body and mind and can be applied as a therapeutic intervention to modify physiological, psychological, and mental aspects of function. The purpose of this study was to apply music components as a therapeutic tool for improving muscle strength, spasticity, lung capacity, self-esteem, and quality of life (QOL) among 39 children with physical disabilities, from Srisangwan Chiang Mai School in Thailand. The children were assigned to play therapeutic songs, parts of which were selected to match his or her instrument, physical capacity, and music capability. Therapeutic musical notes were designed to improve the children's capability by means of routine music practices. During the study, rehearsals and performances in public as part of a band ensemble were arranged for the children to promote social integration. The results of the therapeutic music program provided indicated that a music therapy could improve grip strength, increase lung capacity, reduce muscle spasticity, and increase self-esteem and QOL and did so for the study participants with physical disabilities. The increase in finger grip strength, especially the lateral pinch grip, was significant in the melodeon group. Increased self-esteem, QOL score, and lung capacity was obvious after the 18-month program. Not only did this musical intervention provide a holistic approach for the children with disabilities, but it also provided an observable spirit boost and improved self-esteem for the children involved and their caregivers during the musical performances.

Keywords

music therapy, children, disability, physical, musical instruments

Research has shown that music has a profound effect on body and psyche, and it can be applied as a therapeutic intervention. Music therapy has been used with persons of all ages and with many types of disabilities.[1-7] With musical skills and experience, the first author (J.K.) collaborated with the second author (L.T.), a registered music therapist from the United States, and the third author (M.B.) to establish the music therapy group (MTG) in order to conduct research and provide music therapies for patients. Research on the effects of music therapy on the physical functions of disabled people has been undertaken in Thailand. However, the study reported here additionally focuses on the effects of an active music therapy on both the physical functioning and emotional development of 39 children with physical disabilities.

Participants and Interventions

Our prospective cohort study was conducted between May 2009 and September 2010. The study was approved by the Faculty of Medicine research ethics committees (No. 236/2552 Study code: 09JUN171310). The target population was children with physical disabilities, from Srisangwan Chiang Mai School. The Srisangwan Chiang Mai School is a special school for children with disabilities and is a project of the Princess Mother's Volunteer Foundation. It was opened officially

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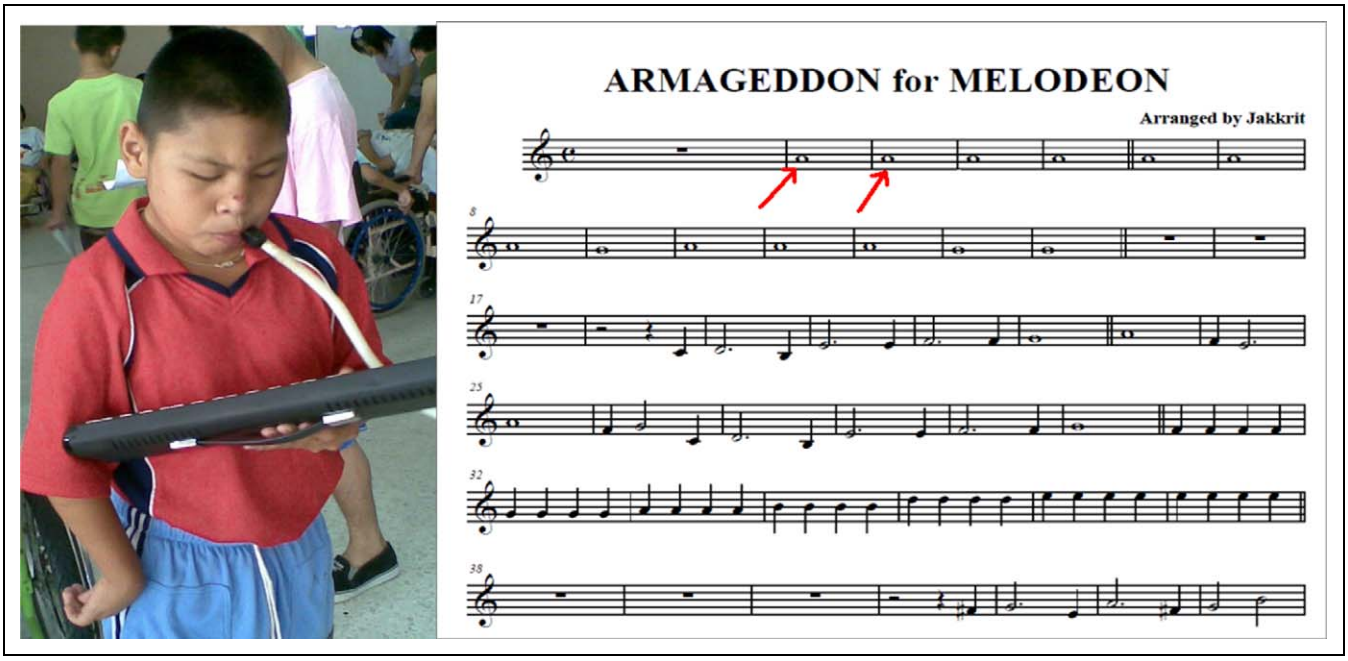

Figure 1. A boy with spastic hemiplegia holding and practicing his melodeon with the left arm. The arrow indicating whole notes (semibreve) to be played with the melodeon for respiratory training objective.

on February 11, 1965, with the main purpose being to help enrich the lives of children with disabilities. There are 3 Srisangwan Schools for disabled children in Nonthaburi, Chiang Mai, and Khon Khaen. The Schools emphasize the importance of meeting the specific needs of these children and accelerating their development by providing medical devices such as wheelchairs, crutches, and walkers as well as learning tools to enhance their writing, reading, and speaking skills. Most of children suffer from cerebral palsy and spinal cord lesions due to trauma and meningomyelocoel. Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University has regularly provided medical cares for these children; and with prospective vision, the head of the department proposed to the school director a music therapy to the children to enhance the rehabilitation programs as a science, not as just an art. All 45 eligible children were enrolled. The MTG evaluated the music preference and music capability in terms of the basic rhythm recognition, pitch perception, and music notation and recruited volunteering physiatrists, physical therapists, and occupational therapists to assess physical and mental functions. Six eligible children who could not play any instrument due to painful conditions, severe physical or mental disabilities, attention-deficit disorder, or follow practice schedule were excluded from the study. They could still play instruments as they wanted or did leisure activities but did not get involved in the band because children with attention-deficit disorder interrupted others and it was unethical to recruit children with painful conditions into the study. The 39 children included in the study were then divided into 3 groups based on appropriate instruments they played, namely, keyboards, percussion, and wind instruments.

The children were asked to play easy therapeutic songs (songs with therapeutic note qualities such as a note duration modification, notes that required a distant hand displacement, notes that required a quick and repetitive key pressing, etc) such as the *Armageddon* theme song and "Billie Jean" (see Online Appendix K), at the beginning of the study and then gradually increasing to difficult songs (eg, *Canon in D* and some Thai folk songs). Parts of songs were selected to match physical capacities, musical capabilities, and the instruments of each child.[1] Specific musical notes were chosen for the children to use in order to improve each individual's targeted goal. For example, whole notes (semibreve) were applied frequently in pieces for melodeon players with the speed of a quarter note at 75 for the children to play a 3-second note via exhalation, assuming that multiple sessions would promote their lung capacity, as shown in Figure 1.

Other specific musical notes were also inserted and rearranged with the aim to improve the finger dexterity[8] and eye–hand coordination for keyboard players and percussion players, as shown in Figure 2.

Most of the songs were simplified and split into parts to be played in separate lines by each child. Colored note charts were used to replace standard notes for those keyboard-playing children who could not read notes on a standard 5-line musical staff. The MTG applied 7 different colors to each white key in the middle octave of the keyboards, and then a colored notation was created replacing music notes with colored blocks (pink, gray, red, yellow, green, blue, and orange for A, B, C, D, E, F, and G notes, respectively), as shown in Figure 3. The color choices were made to match the Thai pronunciation of the names of the notes. The MTG found that these colorful charts stimulated enthusiasm and liveliness during practice.

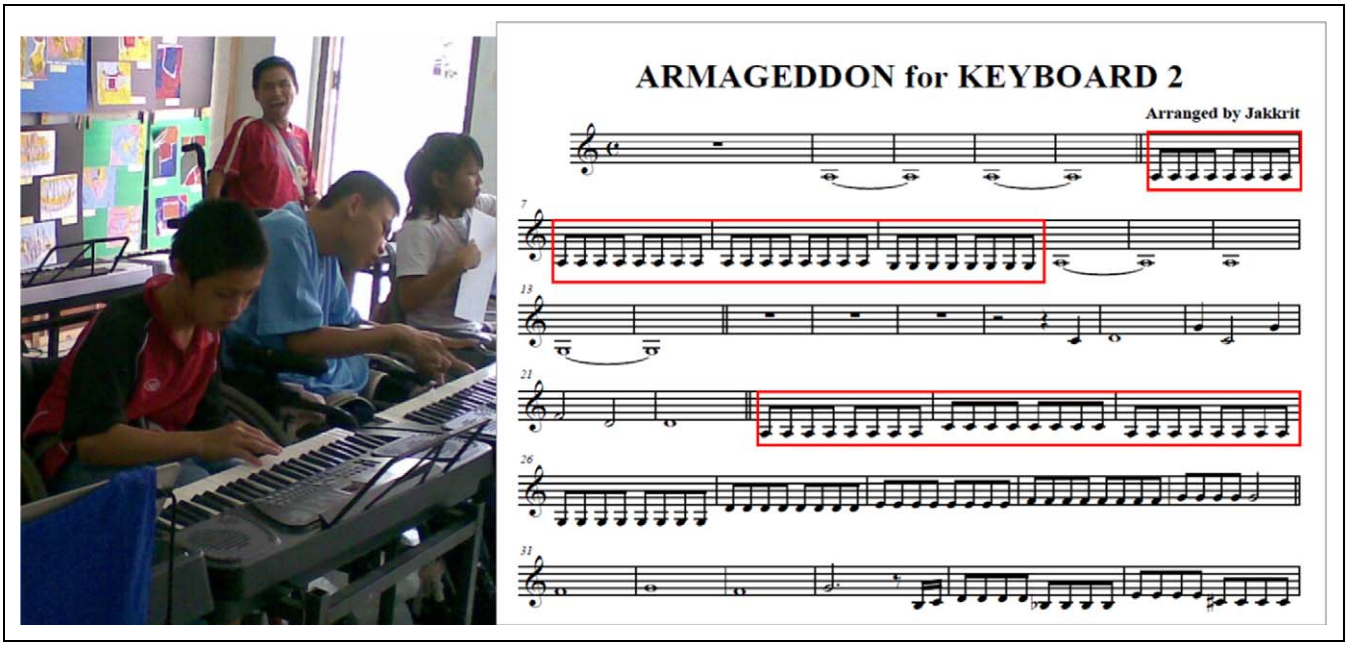

Figure 2. Notes inserted and rearranged with the aim to improve finger dexterity and eye–hand coordination.

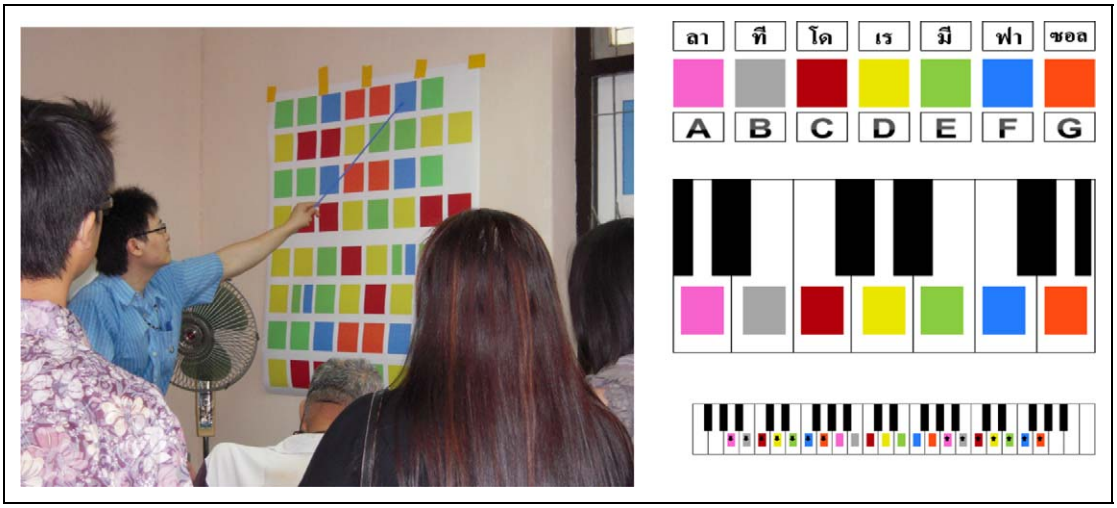

Figure 3. Colored note chart. Seven rectangular stickers were attached on the white keys of a keyboard to signify each musical note, with upward arrows indicating 1 octave above and downward arrows 1 octave below. The therapist pointed at each color block on the colored note chart corresponding to the melody note in the song to guide children to play accordingly.

As a music band, the children had to play in harmony with the others, and a conductor was necessary. In addition, the conductor was responsible for organizing the band rehearsals. The duration of each practice session lasted for 2 hours on average. The children practiced 3 times a week during their term time, and some rehearsals with the MTG were arranged before the public show. The shows in public were organized for the children to perform with or without the MTG members to encourage social integration[9] and increase the motivation to practice. In addition, the MTG arranged a trip to an amusement park after the last show in Bangkok, upon completion of the study.

Assessments

The physical and emotional assessments were performed at baseline, 9th month, and 18th month. The assessments included the finger and hand dexterity test with Minnesota manual dexterity kit set (Lafayette Instrument Company, Lafayette, Indiana), as shown in Figure 4; the handgrip strength test with a Jamar dynamometer (Patterson Medical, Bolingbrook, Illinois), as shown in Figure 5; the finger strength test with a pinch gauge, as shown in Figure 6; the lung capacity measurement by a spirometer, the level of spasticity by a modified Ashworth scale; the limb strength test by manual muscle

Figure 4. Assessment of finger and hand dexterity using Minnesota dexterity test.

Figure 5. Assessment of handgrip using Jamar dynamometer.

testing; and the body balance evaluation by Berg balance scale. The quality of life (QOL) by World Health Organization Thai brief version (WHOQOL-BREF-THAI),[10] a modified 10-QOL questionnaire and an emotional quotient (EQ)[11] test were applied. The QOL included 4 domains, namely, physical, psychological, social, and environmental.

Data Analysis

A descriptive analysis included the proportion, the mean ($\pm$ standard deviation), or the median (or range), depending on data distribution. To determine the factors that might be attributed to a physical improvement, chi-square test, Fisher's exact test, Student t test, and 95% confident interval were applied. The physical improvement overtime was analyzed using a regression model with the generalized estimating

Figure 6. Assessment of finger grip using pinch gauge.

equations (GEEs) with the robust variance estimation that allowed repeated measurements in the same individual. The Epi-Info software for Windows version 3.5.1 (Centers for Disease Control and Prevention 2008, Centers for Disease Control and Prevention, Atlanta, Georgia) and STATA version 11 (Statacorp 2009. Stata Statistical Software: Release 11.0, Stata Corporation, College Station, Texas) software were used for data management and analysis. The significant level was set at P value $= .05$.

Results

At the beginning of the study, there were 39 children (25 boys and 14 girls) with an average age of 16.47 $\pm$ 0.88 years. At the time of the second and third data collection, only 17 boys and 8 girls with a mean age of 16.52 $\pm$ 2.85 years and 15 boys and 8 girls with an average age of 16.26 $\pm$ 2.63 years were available, respectively. The majority of children had cerebral palsy, followed by spinal cord lesions and other neuromusculoskeletal diseases, for example, arthrogryposis congenital, achondroplasia, and so on. Their intelligent quotient (IQ) was categorized in the "educable" class in those with cerebral palsy and "normal" in the others.

The analysis of GEEs of Modified Ashworth Scale over 2 consecutive periods of 9 months revealed a significant reduction in the spasticity level of bilateral finger flexors ($P = .025$ Lt, $P = .001$ Rt), the right finger extensors ($P = .009$), the right elbow flexors ($P = .017$), the left hip flexors ($P = .001$), the right knee flexors ($P = .004$), the left knee extensors ($P = .004$), and the left ankle dorsiflexors ($P = .002$), as shown in Table 1.

Using the manual muscle testing, no significant changes in muscle strength was observed, as shown in Table 2; however,

Table 1. Analysis of Generalized Estimating Equations (GEEs) of MAS (Modified Ashworth Scale) of Muscles.

Muscle groups	Side	Coefficient	Standard Error	95% Confidence Limits		*Z*	*P* Value
				Lower	Upper		
Finger flexors	L	−0.1250	0.0560	−0.2346	−0.0154	−2.24	.025[a]
	R	−0.1272	0.0398	−0.2052	−0.4932	−3.20	.001[a]
Finger extensors	L	−0.1875	0.1008	−0.3850	0.0100	−1.86	.063
	R	−0.1563	0.0598	−0.2735	−0.0390	−2.61	.009[a]
Wrist flexors	L	0.0000	0.1990	−0.3900	0.3900	0.00	1.000
	R	−0.1875	0.1008	−0.3850	−0.0100	−1.86	.063
Elbow flexors	L	0.0615	0.1116	−0.1573	0.2802	0.55	.582
	R	−0.2243	0.0936	−0.4078	−0.0409	−2.40	.017[a]
Elbow extensors	L	N/A	N/A	N/A	N/A	N/A	N/A
	R	−0.1546	0.1004	−0.3514	0.0421	−1.54	.124
Shoulder abductors	L	−0.0419	0.0309	−0.1024	0.0187	−1.35	.176
	R	−0.0934	0.0514	−0.1941	0.0072	−1.82	.069
Hip flexors	L	−0.2689	0.0784	−0.4226	−0.1152	−3.43	.001[a]
	R	−0.0023	0.1518	−0.2998	0.2952	−0.02	.988
Hip extensors	L	0.1922	0.1372	−0.0767	0.4612	1.40	.161
	R	0.0450	0.1154	−0.1811	0.2711	0.39	.696
Knee flexors	L	−0.1667	0.1054	−0.3733	0.0399	−1.58	.114
	R	−0.2835	0.0991	−0.4778	−0.0893	−2.86	.004[a]
Knee extensors	L	−0.2715	0.1293	−0.5249	−0.0180	−2.10	.036[a]
	R	0.0448	0.1619	−0.2725	0.3621	0.28	.782
Ankle plantar flexors	L	0.1714	0.1984	−0.2175	0.5602	0.86	.388
	R	0.2492	0.1926	−0.1283	0.6266	1.29	.196
Ankle dorsiflexors	L	0.5566	0.1840	0.1960	0.9171	3.03	.002[a]
	R	0.1943	0.1389	−0.0779	0.4664	1.40	.162

[a]$P < .05$.

Table 2. Percentage of Children With Changes in Upper Limb Muscle Strength by Manual Muscle Test (MMT).

Muscle Groups	Side	With Improved Strength	No Changes	With Decreased Strength
Finger flexors	L	10.5%	63.2%	26.3%
	R	15.8%	47.4%	36.8%
Finger extensors	L	15.8%	63.2%	21.1%
	R	15.8%	57.9%	26.3%
Wrist flexors	L	5.3%	57.9%	36.8%
	R	5.3%	52.6%	42.1%
Wrist extensors	L	5.3%	57.9%	36.8%
	R	10.5%	52.6%	36.8%
Elbow flexors	L	21.1%	63.2%	15.8%
	R	15.8%	63.2%	21.1%
Elbow extensors	L		N/A	
	R	42.1%	42.1%	15.8%
Shoulder abductors	L	31.6%	52.6%	15.8%
	R	21.1%	57.9%	21.1%

a subgroup analysis did show more improved muscle strength of bilateral finger extensors in the melodeon group and improved muscle strength of the right wrist and finger extensors in the keyboard group. Thai flute and recorder groups had no change in the strength of their upper limbs.

There were no increase in 14 items of the Berg balance scale but significant decreases in balance features of the sitting unsupported, sitting to standing, transfers, tandem standing, and stool stepping were observed. The lung capacity was increased only in the wind instrument group (average vol = 0.050 L) between baseline and at the 9th month, however, a subgroup analysis with GEE showed a predilection for the melodeon group (coef. = 0.018, SE = 0.192, $P = .090$) over the period between 9th and 18th month. The Minnesota dexterity test revealed no significant changes in all tasks ($P > .05$).

The analysis of GEE for grip strength comparing between the melodeon and the other instrument groups revealed significant increase in the lateral pinch grip strength of bilateral hand (2.796 $\pm$ 0.840 kg, $P = .005$ Lt, 2.981 $\pm$ 1.019 kg, $P = .003$ Rt) and pulp pinch grip of the left hand (2.418 $\pm$

Table 3. Analysis of GEEs for Grip Strength in Melodeon and Other Instrument Groups.

Strength	Side	Instrument[a]	Coefficient	Standard Error	95% Confidence Limits		Z	P Value
					Lower	Upper		
Handgrip	L	Melodeon	8.2606	5.2033	−1.9377	18.4590	1.59	.112
		Others 1	2.6010	0.8616	−0.9122	4.2897	3.02	.003[b]
		Others 2	−4.5289	1.5001	−7.4691	−1.589	−3.02	.003[b]
	R	Melodeon			N/A			
		Others 1	−0.8624	2.4186	−0.56031	3.8778	−0.36	.721
		Others 2	0.7591	3.6391	−0.63733	7.8916	0.21	.835
Lateral pinch grip	L	Melodeon	2.7961	0.8400	1.1498	4.4424	3.33	.001[b]
		Others 1	0.8628	0.3060	0.2631	1.4624	2.82	.005[b]
		Others 2	−0.0234	0.6994	−3.7667	−0.2802	−2.28	.023[b]
	R	Melodeon	2.9808	1.0186	0.9844	4.9772	2.93	.003[b]
		Others 1	1.7075	1.0284	−0.3081	3.7232	1.66	.097
		Others 2	−2.7793	1.7429	−6.1953	0.6366	−1.59	.111
Pulp pinch grip	L	Melodeon	2.4181	0.6262	1.1909	3.6453	3.86	.000[b]
		Others 1	1.1431	0.2766	0.8710	1.9552	5.11	.000[b]
		Others 2	−2.0127	0.5065	−3.0054	−1.0199	−3.97	.000[b]
	R	Melodeon	1.2538	0.7882	−0.2910	2.7987	1.59	.112
		Others 1	0.9105	0.3080	0.3068	1.5142	2.96	.003[b]
		Others 2	−1.4675	0.4852	−2.4186	−0.5165	−3.02	.002[b]

Abbreviations: Others, Thai flute, recorder, percussion and keyboard instruments; GEEs, generalized estimating equations.
[a]Others 1 include comparison for the other instruments between baseline and at ninth month. Others 2 include comparison for the other instruments between baseline and at 18th month.
[b]$P < .05$.

Table 4. Modified 10-QOL Score at Baseline and 18th Month.

Items	% of Children		
	More	Same	Less
Satisfaction in life	88.9	11.1	0
Concentration in study or playing music	83.3	16.7	0
Self satisfaction	61.1	38.9	0
Bad feeling (lonely, sad, anxious)	0	61.1	38.9
Satisfaction in music capabilities	77.8	22.2	0
Satisfaction with assists from others	66.7	33.3	0
Feeling that my life is invaluable	61.1	38.9	0
Ability to get along with others	83.3	16.7	0
Overall perception of my living	50.0	44.4	5.6
Other players getting along with people	66.7	33.3	0

Abbreviation: QOL, quality of life.

0.626 kg, $P < .001$). In the other groups, significantly increased strength was observed in the left handgrip, lateral pinch grip of the left hand, and pulp pinch grip of bilateral hands, as shown in Table 3.

Regarding WHOQOL-BREF-THAI and emotional aspects, the children reported that the QOL scores in all domains (physical, mental, social, and environment) were moderate at both baseline and the ninth month, without a significant difference. However, an assessment with a modified 10-QOL questionnaire (invented by the second author [L.T.] with more relevant questions particularly for the school-age children) revealed that most of the children reported better QOL in all items at the 18th month than the QOL before participating in the study, as shown in Table 4. The majority of the children had an EQ in normal levels in all aspects both before participating in the study and at the ninth month of the study. The "emotional control" score was also high during both periods.

Discussion

We started a baseline assessment of lung capacity (forced vital capacity [FVC]) as the first song (*Armageddon* theme song) was introduced to the children. All children who were assigned to play the melodeon, Thai flute, recorder, keyboard, or percussion had different music sheets to perform. The nonwind instrument group would be a comparator control when the objective of lung capacity was focused. We increased song difficulty when the children were able to perform together as a band smoothly. Minor mistakes were neglected. The practice session usually lasted for 2 hours at least. The children rehearsed together under the supervision of the music teacher at Srisangwan School and sometimes at the hospital, especially when the public shows were to be arranged. The difference between the melodeon/wind instrument group and nonwind instrument group was analyzed in terms of lung capacity at the 9th and 18th month after the music therapy started.

Regarding the musical notes assigned to the keyboard and melodeon playing children, we started with the easy notes to play repeatedly on the same white keys. Then we progress with using the black keys, from the narrow range of key pressing to the wider range and from the simple note pattern to the

complex note patterns. The mechanism of finger flexion combined with the wrist flexion contributed to the strength of handgrip. The assumption was that more use of these actions in the song could improve the hand and finger grip strength, the nonuse of the other hand being a comparator. The extensor muscles were also explored. When the children with spastic hands tried to perform with finger flexion, the interfering antagonists might preclude them from isolating one finger to flex and to press the key on the keyboard or melodeon. However, with repetition of finger flexions, the spastic tone of the antagonist could be reduced, and the children had more control of finger and hand movement at the end of each practice session.

This study revealed that melodeons seemed to be more effective than recorders or Thai flutes in improving the finger and wrist extensor strength. The finger grip strength increase was also pronounced in the melodeon group, especially for the lateral pinch grip. The handedness of players obviously affected the results since 82% of all melodeon players were left-handed, whereas all the keyboard players were right-handed. Increased handgrip strength of bilateral hands in the nonmelodeon group implied more use of the extrinsic muscles for the finger and wrist flexion, whereas the finger grip strength improvement might be attributed to more use of the intrinsic muscles generating force to control fine movements rather than gross movements from the spastic and larger extrinsic muscles.

The significant reduction in the spasticity level of bilateral finger flexors and the right finger extensors was attributed to frequent finger movements during playing the instruments via both concentric and eccentric contractions.[7,8,12] In the keyboard group, multiple attempts to stretch the right elbow to reach the keys seemed to cause reduced spasticity of the right elbow flexors as compared with the left side. However, the hip flexors, the right knee flexors, the left knee extensors, and the left ankle dorsiflexors needed more investigation to explore a relation between frequent limb use and the spasticity level. The frequent sitting of children on stools without backrest or leaning forward at some points of time during the practices might account for improvement in the "sitting to standing balance" score in the Berg balance scale.

This study gave evidence of lung capacity improvement by playing the wind instruments as shown in the previous studies,[13-15] our study showing an average of 50 mL increase in lung capacity. Of all wind instruments, the melodeon was the most effective instrument for training. Basically, the melodeon players needed to exhale an adequate volume of air to produce a single-key sound tone and more air ventilation would be required for a simultaneous 2- or 3-key sound. From the GEE analysis, an increase in the lung capacity was measured within 9 months of practice. The arrangement of songs using multiple prolonged musical notes was the key factor as there were no changes in the lung capacity in the percussion and keyboard groups.

There were no significant changes in Minnesota dexterity test in all groups, which proves the facts that the tasks of playing all instruments required less hand and finger movements than those of placing, turning, and displacing in the test. Regarding keyboard playing, the dominant hand had to be close to the white keys nearly at all times and the music notation was easy (without large gaps between any 2 keys to play); therefore, no complex finger or hand movements occurred. Most of keyboard players needed to move their fingers averagely less than 3 cm in range. In percussion playing, tambourines and maracases were used with a few tasks involving hand turning and displacing. In playing wind instruments including melodeons, Thai flutes and recorders, there were minimal movements of shoulders, arms, and hands compared with all tested tasks in the Minnesota dexterity test.

There were some limitations in this study. We recruited most of the eligible children; however, sample size was not large enough for comparator controls. The study site was the only school for disabled kids in the northern region of Thailand. There are other schools for disabled children in other regions (central, northeast, and south). A multicenter study can be done, but the context of study populations should be assessed. When we started the study, there was no existing knowledge as to how long the music therapy should be implemented. Due to the study duration of 18 months, there were some children who graduated from the school and were excluded from our study. Thus, lost follow-ups were problematic in our study due to the long-term program. However, the collected data were adequate to determine the effect of the music therapy program.

It was found that our music therapy was a significant tool to stimulate learning capability, increase self-esteem, improve the muscle flexibility, increase the lung capacity, reduce the muscle spasticity, and improve the muscle strength among the children with disabilities. Having joined the music therapy group as the players in the band, these children felt happier and more joyful than they did when participating in the regular physical therapy program. Able-bodied people who had the chance to know them and see their fabulous performances were remarkably touched by their efforts and braveries, which led to a spirit boost and improved motivation for the audience as well.

Because of the success in the music therapy, the MTG energetically continues to provide useful information and create guidelines of a musical rehabilitation for other health care providers that take care of disabled people as well as people with pain and anxiety, in a holistic approach. Recently, the MTG has been creating networks of music therapy applications in the Northwestern part of Thailand.

Conclusion

This study revealed that the music therapy designed by the MTG could improve the strength and reduce the spasticity level of the physically children with disabilities by assigning targeted muscles in playing appropriate music instruments. Melodeons seemed to be more effective than the other instruments in improving the finger and wrist extensor strength and the lung capacity. The arrangement of songs by applying multiple musical notes with a prolonged duration was the key factor to improve the lung capacity. The QOL score by a

modified 10-QOL questionnaire was higher in most of the children after 18 months of the program; however, the EQ level was already high both before and after participating in the program. Our musical therapy provided a holistic health care for the children with disabilities; in addition, it returned a significant motivation for the health care providers to overlook their inferiority.

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